International Review of Regulations and Business Models for City Freight

Case Study Tomteboda

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As Robert Frost said, “Two roads diverged in a wood, and I— I took the one less travelled by, and that has made all the difference”, these words put an end to one road, but in front of me many others start, and those people who accompany me will be the ones that make all the difference.
Preface

The transportation sector is one of the main actors in the economic development of a society. During the last years, the European Union has adopted as a key strategy policy, the promotion of the intermodal transport together with the reduction of the polluting emissions; the rail mode has become the most promising tool to reach this aim. However, during the last decades the importance of rail for freight transportation has decayed, losing market share as a consequence of its lower routing and time flexibility, and the higher available infrastructure and planning required.

This thesis was conceived with the purpose of investigate the different possibilities and scenarios for a future reinforcement of the rail mode in the area of Stockholm, specifically, the inner city. The present issue has a high importance not just regarding the observance of the urban policies, but also an available rail freight facility, Tomteboda, for their development.

This rail yard is under the focus of the Swedish transport authority, Trafikverket, and the City of Stockholm. The present thesis will try to put some light on the management of the facility, but also the surrounding network in order to find a function to ensure the continuity of Tomteboda.

Consequently, considering the features of this case study, and analysing different projects that has been taking place related with this topic, the research will find out new business models and management procedures for this inner-city rail freight facility. The results will show if the objectives proposed by the different projects have been achieved, and how the different factors considered in the proposed analysis intervene.
Förord

Transportsektorn är en av de viktigaste faktorerna i den ekonomiska utvecklingen av ett land. Under de senaste åren har Europeiska Unionen antagit en nyckelstrategi i främjandet av intermodala transporter för minskningen av förorenande utsläpp, och järnvägen har blivit det ledande verktyget för att nå detta mål. Men under de senaste årtiondena har vikten av järnvägen för godstransporter minskat, vilket har lett till förlorade marknadsandelar till följd av dess lägre tillgänglighet och tidsflexibilitet, samt den nya infrastruktur som finns och den planering som krävs.

Denna uppsats undersöker de olika möjligheterna och scenarierna för en framtida utveckling av järnvägen i Stockholmsområdet, framförallt innerstaden. Den aktuella frågan har stor betydelse, inte bara när det gäller övervakning av stadsbebyggelsen utan också en tillgänglig produktionsanläggning för järnvägsfrakt, bangården Tomteboda, för deras utveckling.

Denna bangård är under fokus för den svenska transportmyndigheten Trafikverket och Stockholms stad. Denna avhandling kommer att försöka belysa förvaltningen av anläggningen, men också det omgivande nätverket för att hitta en funktion för att säkerställa kontinuiteten i Tomteboda som en nav för godstransporter.

Med tanke på den presenterade fallstudien, och genom en analys av andra projekt som är relaterade till denna studie, kommer denna undersökning att presentera nya affärsmodeller och förvaltningsförfarande för järnvägens fraktanläggning i innerstaden. Resultaten kommer att visa om de har uppnått de mål som de olika projekten och hur olika faktorer som beaktas i den föreslagna analysen inblandade.
Prefacio

El sector del transporte es uno de los principales actores en el desarrollo económico de una sociedad. Durante los últimos años, la Unión Europea ha adoptado como clave en su política estratégica, la promoción del transporte intermodal junto con la reducción de las emisiones contaminantes; el ferrocarril se ha convertido en la herramienta más prometedora para alcanzar este objetivo. Sin embargo, durante las últimas décadas la importancia del ferrocarril para el transporte de mercancías ha disminuido, perdiendo cuota de mercado como consecuencia de su menor flexibilidad itinerario y tiempo, y el requerimiento de una mayor infraestructura disponible y planificación.

Esta tesis fue concebida con el objetivo de investigar las diferentes posibilidades y escenarios para un futuro refuerzo del transporte ferroviario en el área de Estocolmo, concretamente, el centro urbano. Este tema tiene una gran importancia, no sólo en lo que se refiere a la observancia de las políticas urbanas, sino también a una instalación de transporte ferroviario disponible, Tomteboda, para su desarrollo.

Este patio de vías está bajo el foco de la autoridad de transporte sueca, Trafikverket, y la ciudad de Estocolmo. La presente tesis tratará de poner alguna luz sobre la gestión de la instalación, pero también la red circundante con el fin de encontrar una función para garantizar la continuidad de Tomteboda.

Por lo tanto, considerando las características de caso objeto de estudio, y analizando los diferentes proyectos que se están llevando a cabo relacionados con este tema, la investigación descubrirá nuevos modelos de negocio y procedimientos de gestión para esta instalación de transporte ferroviario en el interior de la ciudad. Los resultados mostrarán si se han conseguido los objetivos propuestos por los distintos proyectos, y como intervienen los distintos factores considerados en el análisis propuesto.
El sector del transport és un dels factors més rellevants per al desenvolupament econòmic de la societat actual. Per aquesta raó, la promoció del transport intermodal juntament amb la reducció de les emissions contaminants ha sigut adoptat com a sector clau a la política estratègica de la Unió Europea. Tenint en compte els diferents tipus de transport, el ferrocarril destaca com una de les eines més prometudes per assolir aquest objectiu. No obstant això, durant les últimes dècades, la importància del ferrocarril per al transport de mercaderies ha disminuït i ha perdut quota de mercat com a conseqüència de la seva menor flexibilitat, en referència a itinerari i horari, i el requeriment d’una major infraestructura disponible i planificació.

Aquesta tesi ha sigut concebuda amb l’objectiu d’investigar les diferents possibilitats i escenaris per reforçar i potenciar el transport ferroviari a l’àrea d’Estocolm, i més concretament, al seu centre urbà. Aquesta tesi no sols es centra amb l’observació de les polítiques urbanes, sinó que també estudia una instal·lació de transport ferroviari disponible, Tomteboda, per al seu desenvolupament. D’aquesta manera, el tema estudiat destaca per la seua gran aplicació pràctica que pot resultar en clars beneficis per als països membres de la UE.

S’ha escollit el pati de vies de Tomteboda ja que el seu desenvolupament està també al punt de mira de l’autoritat de transport sueca, Trafikverket, i la ciutat de Estocolm en general. La present tesi investigarà la gestió tant de la instal·lació actual com de la xarxa circumdant, amb la finalitat de trobar ?una funció? per garantir la continuïtat de la instal·lació de Tomteboda. Els resultats mostraran si s’han aconseguit els objectius proposats pels diferents projectes, i com intervenen els diferents factors considerats en l’anàlisi proposat.

Per tant, si es consideren les característiques del cas objecte d’estudi i els diferents projectes relacionats amb aquest tema que estan duent-se a terme actualment, la investigació permetrà descobrir nous models de negoci i procediments de gestió per a aquesta instal·lació de transport ferroviari situada a l’interior de la ciutat esmenada.
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1 Introduction

This report presents the realization of an original project or study in which the attitudes, knowledge, and skills acquired during the Master's degree are applied, integrated, and developed. This work has, therefore been integrative, which make use of general and specific skills associated with the background of the student.

1.1 Background

The current freight market is characterized by the growing number of companies competing to provide a service to increasingly demanding clients, where concepts such as cost and time are the difference between success and failure.

Among the different transportation modes and, according to the core of the present project, it is to be focused principally on the railway transportation system and, on its most intermodal aspect. The principal advantage of the railway mode is based on the low rate of greenhouse gases emission (EEA, 2013) and cost-effective operation, associated with long distances (Nemoto, 2006). Compared to other inland transportation modes, it also offers a high load capacity offered. On the contrary, as a negative aspect, it is worth mentioning the rigidity of the railway mode when it comes to solving the 'last mile' problem (Gevaers, 2011), which reinforce the intermodal character of the railway mode through the supply chain perspective.

In order to understand and implement acting measures in this last stage of the supply chain, the chosen scenario is extensive population centers where various factors, both internal as external influence to transportation and logistics, are involved. The existing situation in these population cores is based predominantly on the offshoring of heavy industries out from of the urban areas to the outskirts or specific industrial areas (Fujita, 2002). As a result of this development, the essence of the freight from and to Stockholm has been altered. The city of Stockholm is a clear example of this tendency. Comparing the rail freight data between Stockholm and the average of the whole Sweden, freight transport to Stockholm is mostly composed of consumer goods and highly processed good, on the other hand, from Stockholm, shipments consist of express freight and highly processed goods, and garbage and waste. The highly processed goods account for 72%, while the remaining 28% is processed goods (21%), low value-added goods (3%) and bulk goods (4%). However, the average of the whole Sweden shows an inverted model, where 22% are highly processed goods and 78% other goods (Ohlsson, 2011).

The freight transport by rail in Sweden, both domestic and foreign, in 2014, 68 million tonnes were transported. In Figure 1, the main group of goods transported was by far was the bulk goods and other products from extraction, 46% of the total amount. Followed by unidentified goods, which are the one transported in containers and swap bodies, and agricultural, forestry and fishing products, each group represents 13% of the total volume. The group of wood and wood products etc. was the third largest product group by 10 percent. Food, beverages and tobacco amounted
to just over 1 per cent or 900,000 tonnes in 2014. Of the freight transported, almost 5 per cent were hazardous goods, but the transport work the dangerous goods amounted to 9 percent in 2014. Flammable liquids, for example petroleum products accounted for the largest part of the dangerous goods (TrafficAnalys, 2016).

![Figure 1: Freight transport by rail by product group, 1,000 tonnes. Year 2014](image)

The present project address the possibilities offered the railway system for processed and highly-processed goods in the urban areas supply, the principal demanding of these products. The transport of low values-added and bulk goods is going to have a neglected consideration in our future estimations.

The research of different solutions adopted internationally for the adaptation and conversion of existing railway infrastructures is to be performed, solutions with the aim of integrate the facilities with the supply chain and its management. Moreover, approaching to the case study, the existing logistic network in Stockholm is to be analysed, locating the different facilities such as logistics centers and intermodal terminals (Figure 2), including their influenced area and future expansion strategies.

Moreover, the identification of the different companies and authorities involved, in order to enable the establishment of the boundaries of the different responsibilities of each one.
1.2 Research problem

The management of an intermodal supply chain is not an easy issue, there are many actors involved and various different models that can be applied for freight operations. The difficulty that appears in this project is related to the peculiarities of the studied facility, Tomteboda rail yard, located in central Stockholm.

At the moment there are research groups analysing how Tomteboda can find its role in the present railway urban freight market. The most useful tool available to discover it is the literature research, the compilation of the measures and results of several cases similar to the present one, the clear problem of this is the fact that some of the cases examples are ad hoc, each case presents several unique characteristics.

1.3 Aim and Research questions

The present project has the aim to put light on the transport supply chain from an intermodal point of view, in order to investigate and identify the different actors involved in the freight market and establish the different responsibilities. Moreover, there will be a special interest of the organization and business models for city consolidation centers and railway terminal.

To this project and the possible results obtained, based on a qualitative analysis, will be presented in an objective way where not only the economic value will prevail.
but also, will take into account environmental and social criteria in the area where it is located. This process will be useful to discover which project cases have been developed and their particular features and results showed, among them, which are the ones than can represent a guide, an example for Tomteboda's management, and how to fit in the Stockholmare and Swedish transportation market.

### 1.4 Scope

The following project does not present a qualitative nature, but qualitative. For this reason, and in order to avoid the use of unnecessary and irrelevant information and literature, it is needed to define a proper scope for the development of the project and an adequate use of the consulted literature and sources.

The complexity of the present topic makes impossible to limit the literature research to specific time frame or regions. The literature research will be already limited by the peculiarity of a system where the requirements make that the possible sources and examples are not going to be very abundant. The requirements treated within the scope of this thesis consist of; urban areas’ restrictions, specific facilities as consolidation centers and city terminals, and the disposal of Tomteboda uniquely as a rail yard, and innovative business models for the terminal, such as fully electric system for distribution of freight.

The scarcity of specific literature about the topic studied makes necessary to consider also the backgrounds of different projects, even if at the beginning they do not look very suitable, for the initial review. Considering that projects within the European Union will make the research easier in terms of regulations and future objectives and policies, such as environmental and economic.

The structure of the Swedish rail freight market will give main trajectories to discover and look for the different flows and business models that can fix to Tomteboda, but also combining them with the preliminary principles that are desired for Tomteboda, such as a good integration in the multimodal transport network Figure 3, and multipurpose logistics area, and a referent of sustainable urban transport facility.

![Figure 3 Intermodal terminal network. Source: Kordnejad, 2016](image)
This thesis will go from the general to the particular. The initial research will define and analyze the freight transportation system in its perspective intermodal and the actual situation in Sweden, the structural and construction characteristics as well as the business agents and roles involved. From there, the project will situate Tomteboda in the center of the literature and it will develop and explain the different layers around it, like the surrounding structures and facilities that somehow can affect and transform the future uses and operations in Tomteboda. International cases are to be studied in order to detect and identify possible good strategies and measures to be applied, but also examples of unsuccessful policies.

1.5 Method

The present thesis will not analyse data apart from general figures related to general concepts of the transportation market, such as consumptions, emissions or economic outputs. It means that the thesis will principally be based on a strong literature research and the existing situation of the studied facility, followed by a sustainability analysis, which will evaluate concrete aspects of the different models proposed.

The initial literature research will give an overview of the general frame that the project will be developed in. As a pyramid, from a wider base with general information and many different source of information, the project will climb, refining the sources and the open discussions to a smaller but more precise bunch of literature. The final step in this process will be the conclusions raised in order to ensure the future of Tomteboda, if there is any because of the negative aspects and the existing drawbacks, from two different scopes, network and facility, reaching the final stage of the thesis development process. (Figure 4)
The planned meetings with the owner of the rail yard, the Swedish Transport Administration, Trafikverket, and the City of Stockholm will draw the traces to follow in order to find the best solution for all the stakeholders of Tomteboda, i.e. the City, the owner, the operator of the facility and the clients. Interviews with clients even being considered important, are beyond the scope of this master thesis, for future studies they should be performed.
2 Theoretical Framework

2.1 Railway System in Sweden

According to data from Trafikanalys 2015, the extensive Swedish railway network has a length of approximately 12,800 km, of which 10,900 km correspond to single track lanes and the rest; almost 2000 km have more than one track. The network is under a continuous process of transformation of the single track lanes to double ones, which are the 18% of the actual length. The gauge existing in the Swedish network corresponds to the standard gauge of 1,435 mm.

The other process of improvement is focused on the electrification of tracks, with a slow increase rate, the total electrified network reached a length of 8,235 kilometers, with 70% of the single-track lanes were electrified. The double and multi-track lanes are entirely electrified. Concerning the management systems only 540 kilometers were under the ERTMS traffic management system, and lanes with automatic train control constitute 8,350 kilometers of the network (Trafikanalys, 2015).

The length of the trains that can use the network depends on mainly two factors, the length of the platform and the length of the passing loop. The length of the platform is not that restrictive in the present case because cargo trains can be split up into different sections once they arrive to the transhipment yard. The passing loop is the most severe restriction, in single-track lanes, trains are going in both directions, it force one train to wait for the train from the opposite direction to finish passing a certain segment of the network before having open the lane for it. The place where the train wait is called passing loop, the maximum length of the passing loops determines the maximum length of the trains.

Since the mid-1990s, new stations have been built on the Swedish rail network to reach 750 meters length. Despite this, there are few places apart from the Botniabanan, which today is able to meet with longer trains; Malmbanan allows 750m long trains. This means that the ability to carry trains over 630 meters today is severely restricted throughout the country (Trafikanalys, 2016)

2.2 Railway business structure

Tomteboda, as inner urban area facility, is a point of transhipment between the shipper and the rest of the transportation network, and in the other direction, between the ‘sellers’ and the rest of the transport till the final receiver.

Due to this status, there are many different actors carrying operations in Tomteboda with different interests, but all of them are part of the supply chain. How good the management of the facility is to fulfil these interests together will make the difference between a successful business, or a non-attractive one.

The first step to apply measures to create a business-friendly facility for all the actors, is to identify them and their role in the supply chain. The knowledge of the
system will enhance the planning process where merge different companies, different modes, different transportation units, different administrations, and different needs.

Woxenius (1994) identified a gap in the transportation industry’s structure. Based on previous models, he established three different elements to describe the system: actors, activities and resources. In this section an emphasis in the first element is going to be put. Later modified in 2002, Woxenius classified the actors as shippers, forwarders, hauliers, intermodal operators, terminal companies, rail operators and equipment leasing companies (Woxenius et al., 2002).

### 2.2.1 Shipper

The role of the shipper can be defined as the buyer of the system’s output, the final actor of the intermodal transportation system. Its importance and knowledge about the system depends on the size and volume of their load units. The shipper use to be more involved in the system as the importance of the shipment is larger; shippers who are able to send full unit loads perform their own delivery road haulage fleet, if the shipper does not manage full loads units, it is not very aware of the working process. In the latter case, the contact between the shipper and the transport operator does not exist; one or several forwarders will intermediate between both (Woxenius et al., 2002).

### 2.2.2 Forwarder

Between the shipper and the transport operator normally there is an intermediate, the forwarder. Following the requisites of the shipper concerning transport volume, prices or frequency; it is often the one who decided the transport mode chosen for each operation. As it was mentioned before, when the shipper is not large enough, it does not care about the transport mode, it follows to meet criteria as price and quality; the forwarder will fix the rest in order to increase the profitability keeping those criteria sufficiently good for the client. For example in Sweden there have always been large traditional forwarders dominating the market. Forwarder perform different activities such as consolidation, warehousing and storing services, administration stuff, customs declarations, and the supply of load units (Woxenius, 1994).

### 2.2.3 Hauliers

In literature, hauliers have often a minor role. This is a result of their low decision maker power, it is the forwarder or the shipper the actors who choose the transport mode. It can also happen that the haulier takes on a forwarding role in the intermodal transport system. In Sweden the hauliers are of moderate size and they are normally contracted by forwarders, lacking of a direct link with the shipper (Woxenius et al., 2002).

### 2.2.3 Intermodal operators

These operators offer their services in terminal-to-terminal transportation, these services include transhipment and rail haulage. They can have a direct
communication with the shippers or only with forwarders and carriers (Woxenius, 2002).

2.2.4 Terminal companies

According to Flodén (2011), terminal companies’ ownership may be outsourced, for this reason it can be made a differentiation between the owner and the operator of the terminal. These companies that manage the transhipment services may be owned by the rail operators, infrastructure managers or dedicated terminal companies.

While the terminal owner is in charge of building, planning and maintaining a railway freight terminal; the terminal operator is in charge of performing the operations and management of the rail terminal. It can also happen that the same company is in charge of both roles but normally, the dedicated terminal operator is subcontracted by the terminal owner (Bergqvist, 2014)

2.2.5 Rail operators

The railway operator can be related with goods and/or passenger transportation. It runs the trains through the network, providing the traction and performing the transportation (Prince, 2015).

2.2.6 Equipment leasing companies

These companies own locomotives, wagons and or load units, leasing them to other actors of the transportation network, e.g. railway infrastructure managers. The infrastructure manager can owned the lines but also other facilities as terminals and yards, it is in charge of their construction, maintenance, and planning; however, with the actual deregulation of the sector, this role is not that clear, with new formulas of management and operation (Prince, 2015).

2.3 Railway transhipment facilities

2.3.1 Intermodal terminal (intermodal rail yard)

In the intermodal transport system, intermodal terminals are nodes in the network between different transport modes, it is the physical point where the different freight flows have the access to intermodal transport services.

In an intermodal terminal are performed various operations directly linked to the transhipment between one transport mode to the other, but also the different process and controls that ensure the good development of that operations.

As it has been mentioned, the main important operation is the transhipment of loading units from one mode to the other, but which are the other operations that make possible the first one are not that visible. This measures are focused on the security and legal controls; the check in/out functions control the documents and the proper custody of the goods, attending to the damages of the loading goods but also the proper handling of dangerous goods (Prince, 2015)
The transhipment operation requires a proper management in order to ensure the disposition of the rail and truck for loading/unloading operations, or temporal storage facilities, as well as the equipment to move the loading units. (Cosmos, 2017)

The proper development of the operations at the intermodal terminal must be supported by structural components. Among the most important:

- The terminal gates; both for trucks and for rail, where the vehicles are registered and the goods are inspected, the rail gate is connected to the shunting area and the rail tracks as well.
- Transhipment tracks; tracks where trains are parked during the loading/unloading operations.
- Buffer area; temporary storage area for ITU’s next to the tracks waiting to be loaded or unloaded to or from entering trains.
- Side tracks, they do not have a define purpose, they can be used for controls and inspections, wagons parking, waiting areas...
- The storage area, dedicated to longer term storage (approximately 24h) with high capacity.

(Rizzoli et al., 2002)

2.3.2 Marshalling yard

Also called shunting yard or classification yard, it increases the versatility of the freight rail system. The possibility of disassembled the inbound trains and afterwards assembled the rail wagons according to their final destination generating new outbound trains makes possible every origin-destination routes. This procedure reduces the amount of point-to-point connections (Boysen et. al., 2012). Main lanes can be built between two marshalling yards, and to the initial one, and from the final one, a capillary infrastructure can completed the goods’ movement.

The classification procedures can consume around 10-50% of the total trains’ transit time according to Bontekoning and Priemus (2004) in the European background. The consumption depends on many factors; with no doubt the ease of movement of the locomotives and the wagons in the yard is the main important factor together with planning. Aspects as the length of the tracks or the existing humps can reduce significantly the number of movement to dissemble and assemble the trains.

The mentioned procedure has to be supported by an infrastructure that can be divided into three areas (Figure 5):

- Receiving tracks, where the inbound trains are received and prepared for being sent to the marshalling tracks.
- Classification tracks, here the wagons are classified in order to create trains according to their final destination.

- Departure tracks, trains are finally prepared and assembled together with the locomotives before the departure.

![Figure 5 Marshalling yard structure. Source: Boysen et al., (2012)](image)

Figure 5 shows standard marshalling yard, however there are different yard types according to different schemas which Boysen (2012) classified the yards in, hump yards, flat yards and gravity yards. It can happen that one of the different areas does not exist so one of the other areas has to perform two operations. The most common one is the hump yard.

2.3.3 Free-loading area concept – Capillary infrastructure

According to Bärthel (2011), a free-loading area is a 'location/area without loading platform (loading ramp) at the freight station adapted for loading and unloading of shipments and goods'. Where these types of areas can be found in the transportation structure will help to identify more clearly the future position of Tomteboda.

The capillary infrastructure, play a main role for the rail freight industrial and urban services, the link between the main routes and rail lines, and the origin and destination of the shipments and goods. This issue has been discussed in two Swedish reports in recent years. The first report, Östlund et al. (2006), describes the development of the capillarity network in several Swedish municipalities selected, it was based on different interviews with a representation of authorities, transport buyers, railway operators and Banverket, about the development of the capillary network in the different areas selected. Ten different projects were proposed for a ten years-scenario that in almost all cases concluded that relatively large volumes (>30.000 tonnes) require the investment of a single company.

The second report was carried out by Banverket (2007), it had a deeper economic perspective about the capillary infrastructure for industrial trains, and the possible conditions that may be necessary to change in order to increase their competitiveness against truck transportation. One of the conclusions was the need of reducing the bureaucracy, and another, that is more interesting for this project, need of a state subsidy for investment and reinvestment costs in industrial trains facilities and network to connect the with the main lines.
Is in this capillary infrastructure where we can find the free-loading areas, where the share of transshipments and goods has its major importance, Figure 6.

![Figure 6 Capillary infrastructure for freight transport. Source Bärthel and Troche, 2008](image)

In Scandinavia there are more than 65 terminals including free-loading areas, private siding, regional terminals, port terminals, and conventional terminals, (Bärthel et. al., 2011). The free-loading areas in Sweden are the following:

- Gällivare
- Haparanda
- Piteå
- Skellefteå
- Skövde
- Ånge
- Örnsköldsvik

### 2.4 Urban logistics improvement measures, local perspective

The different tools available for the improvement of a city terminal performance, apart from the logistic and freight management, are clearly linked to urban planning and public transport policies. These tools are available for local administrations for better planning and performance of city logistics systems. City logistics attend to deliveries located in congested urban areas, what it is called the ‘last mile’ transport, defined as “the process for totally optimizing the logistics and transport activities by private companies in urban areas while considering the traffic environment, the traffic congestion and energy consumption within the framework of market economy”. (Taniguchi et al, 2001)
Before explaining the different actions that can be adopted, it has to be mentioned that their use does not necessarily mean bigger benefits for logistics companies, but rather an attempt to better regulate and manage freight deliveries in urban areas. The ultimate objective is the reduction of the clash between the interests of logistic companies and those of other stakeholder groups involved in urban mobility. Concerning urban logistics improvement solutions, measures can be approached from different scopes (Muñuzuri et al., 2005):

2.4.1 Public infrastructure

Many of the existing terminals will need the adaptation of their existing facilities to serve as a transfer of the city logistic system, particularly the freight movements from road to rail.

a. The terminal ownership implies the need of a good collaboration and relation between the terminal owner and future operators for the approval of measures proposed by private initiatives. This position does not necessarily mean a disadvantage for any of the two parts, as long as their final goals tend to the same point.

b. Outskirts logistic centres. Inner-city are part of a capillary infrastructure together with facilities located in the cities’ outskirts such as, intermodal freight terminals, warehouses, etc. These locations are a very important part of the interurban supply chain system.

For the transport between outskirts logistics centers and between these and the inner-city, many possibilities have been explored. The option of a shuttle train as a penetration leg is the searched one for this project. The lanes used would be the existing one, and if the network must be spread the lanes dedicated for passenger traffic can be used. For this latter option it would need a further study due to the different speed reached, faster in the case of passenger trains. The main requirement for the implementation of this solution is to attain large quantities of good in order to ensure the full loading of entire trains, in order to make the transport mode economically feasible. The cost of the infrastructure adaptation is also the main drawback of this solution.

The cost of the infrastructure adaptation is also the main drawback of this solution.

c. In order to succeed with the ‘b’ perspective, the facilities must be improved, in order to be adapted to the aim of enhancing the concentration of carriers to ensure a stable flow of traffic and goods, taking place a conjoint exploitation of technologies and infrastructure. There are three ways of regulating the use of the yard (Muñuzuri et al., 2005):
According to the investment made by each company within the total investment, in case this investment was made by the companies themselves.

According to sizes of the companies, in case the resources were provided by the administration to the companies.

According to the rate paid by each company, in case the use of the resources provided the companies with clear added value.

The advantages that the rail yard offers being in the city center area are the use of the non-occupied space as a loading/unloading area. The possibility of receiving or sending goods on trains from the above mentioned intermodal freight terminals, or a transhipment point between long distances rail freight transport and final urban deliveries.

2.4.2 Land management

Inner-city locations can be seeing and advantage but with certain limitations. The latest urban policies in urban areas tend to reduce and limit the trucks movements for environmental, traffic and security reasons, externalities such as pollution, noise, congestion unsecure vehicles movements.

One of those limitations is the high pressure of the surrounding highly urbanized area that limited the boundaries of future expansions. For this reason the efforts must be focused on the optimization of the available areas in order to maximize the number of freight flows and their volumes.

Land use management access conditions are similar, based fundamentally on the reduction of efficiency of certain areas from others due to the restriction policies. Moreover, these solutions are the most controversial depending on the level of the changes adopted, going from a no rejection to a tough opposition from stakeholders.

2.4.3 Access conditions

This epigraph is referring to the urban perspective more than to the facility itself. Here must be highlighted the different traffic, time and spatial restrictions that affects to delivery vehicles and their movement throw the city road network and limits the periods operability.

The promotion of a certain transport dynamics, such as the use of rail infrastructure for the flow of goods from and to the centre of Stockholm, also requires the use of stimulus but also penalties for those activities that are to be limited, and the criteria may take into consideration characteristics as fuel consumption, emissions, axle-pressure, height, width, length, weight and load factor. (Browne et al., 2007)

On the side of stimulus, different measures have been implemented. The actual tendency according to the transportation infrastructure is the conditioning or bigger areas as pedestrian zones, burying the network and reorienting the traffic management. For these reasons is getting more and more complicate the access to
certain areas of the delivery services, having an special access to those areas will clearly encourage to take the allowed modes. The establishment of time windows during little transited hours for freight delivery vehicles, during the day or to be more specific referring to night deliveries. From this point the use of special vehicles, less noisy, electrical or without engine for example, must be considered, as well as the delimitation of the restricted areas.

Penalties may receive more objections but it also have to be considered. Measures as road pricing have been implemented in different cities such as London or Singapore among others (Santos et al. 2006, Olszewski et al. 2005); however, these kinds of measures are far beyond the scope of this project. This point corresponds to a strategic policy that must be applied by the city authorities and the actors involved.

2.4.4 Traffic management

Apart from the infrastructure itself, the management of the operations must involve the different companies and shippers that may be interested in the model proposed. These actors can be classified in order to clarify the different flows and business needs to improve the management of the yard.

a. There are several types of shippers. The intention of the project is also to determine those types in order to maximize the number of stakeholder, without congestion the facilities, avoiding any disturbance among them.

  o The premises size. This will be useful to establish night deliveries, while big premises as supermarkets, department stores among others, can set night turns for receiving goods during the night; small premises, normally managed by a small number of employees, cannot be that flexible. At the time of organizing the delivery schedule, and in consequence, the carrier preference for loading and unloading at the yard, this classification is highly relevant. (Watson, 2002)

  o The number of delivery per vehicles. Multiple deliveries lead to more complicated routes with higher traffic movements. Also depending on the number of deliveries, more time will be spent on driving or loading and unloading the goods with its respective need of parking areas.

  o The load factor. Here the effective use of the vehicle is to be considered. If there is only one delivery per vehicle it can be assumed that, on the way to the final destination, the vehicle would be full-loaded but, on the way, the load factor wouldn’t be significant.
As it can be observed, the three classifications are linked; the proper distribution of the working hours and the yard zoning according to type of carriers is, beyond any doubt, one of the first steps to create a business model for the present project. Traffic management solutions basically imply the reduction in flexibility in order to achieve better transportation cost together with the brand image protection and contact with the client.

b. Considering the small shippers group, normally, because of the lower flow moved and the inability to charter a wagon or a train, they have to use the road mode. Marshalling yards can be the key point for the cooperation between the different shippers or forwarders. However, even considering that one of the benefits can be the reduction of the transportation costs, the policies of alliances are not very common at this company level, they are competitors and it makes difficult to establish a stable cooperation due to the sense of losing their presence in front of the client. One model that can be considered for future studies is the container freight at ports, where big flows from small carriers (comparing to the whole total volume moved) are handled.

These four categories of solutions may produce different effects that should be analysed from the perspectives of all the transportation actors involved. As it has been mentioned before, the existence of a facility in good conditions and with good equipment is not a guarantee of success, it may also offer a secure and advantageous place for shippers to develop their activities. To reach a balanced between the shipper, the terminal operator and owner, and the transportation operator is one of the main aims in urban logistics and one of the purposes of this project.

2.5 International Case Studies

During the last years different logistic management projects have taking place. These projects have tried to improve the development of the transportation system attending to different criteria beyond the economic only, considering environmental and social issues. These examples have their own peculiarities caused by the characteristics of the study area, different behaviour of the stakeholder, consumption patterns, and public policies and legal framework; however, the creation of a business model for Tomteboda can consider some of the measures applied that, with the proper context, can be useful for the future activities of Tomteboda.

2.5.1 Samada-Monoprix

In Paris, one of the most interesting cases is taking place. Monoprix a large French retail group with a strong presence in city centres and specialized in convenience stores decided to reorganize their supply chain from truck to rail for the supply of the 90 stores located in Paris and its suburbs. This project is part of the environmental policies that Monoprix has been adopting during the last 20 years. The project has been developed by Samada, the logistic division of Monoprix together with institutional actors like the Ministry of Transport, Île-de-France Regional
Council, the Paris City Council, RFF (French rail network authority); logistics companies as the French railway operator, SNCF, and trucking companies, Geodis BM and GT (Dablanc et al., 2011).

2.5.1.1 Project principles

Before the new system, Monoprix delivered by trucks from a terminal located 35 km south of Paris to its stores. The option of delivering by train was considered due to the increasingly restrictive policies and regulations concerning the deliveries and fleet movements in urban areas.

The first stage of Samada-Monoprix structure (Figure 7) is located 40 km south away from Paris city centre, here there are two warehouses situated in Lieusaint and Combs-la-Ville where the shuttled trains are loaded. Every week are sent, from Sunday evening to Thursday evening, 5 trains with 17 wagons per train carries 750 pallets on average each. They arrive to the logistic platform called “Halle de Bercy” situated in Paris, from 9:30 pm to 4:30 am the pallets are scanned and stocked, from 6 am the pallets are loaded in the Natural Gas Vehicles (NGV), which are used for the delivery toward Parisian stores. (Delaitre, 2012)

![Figure 7 Samada-Monoprix structure. Source: Turblog](https://example.com)

According to Delaitre (2012), with huge volumes, electric vehicles are not suitable for the present supply, and as a consequence NGV, still cleaner than diesel vehicles, where chosen for this operation (Figure 8). These vehicles are part of the first private French fleet of distribution NGV, 26 vehicles which are refuel in a station located in Bercy platform area. In order to optimize the transportation, apart from Monoprix service, the NGV also delivered fresh food from other refrigerated platforms. But these vehicles are not only less polluting, they incorporate devices for anti-noise.
In Paris, the Bercy Platform occupied 3,700 m² over 10,000 m² available for the transhipment operations from the train to the NGV, without cross-docking. For this terminal the Paris City Council invested 10 million euros, where goods as general products and good stuff and transhipped. Along a year 210,000 pallets enter in Paris through Samada-Monoprix platform, the equivalent of 120,000 tonnes of goods.

2.5.1.2 Environmental contributions

Two of the most important indicators to justify the project’s investment were the emission reductions and the energy savings. Even though various assessments showed lower values than expected, the reductions remain significant. As equivalence, the new transport scheme supposed the reduction of 12,000 trucks entering in Paris per year, this fact not only concern terms of pollution and emissions, also factors as traffic congestion, noise, and traffic security were enhance.

With approximate figures, it the greenhouse gas emission CO₂ was reduced 25%, 7% the reduction of CO. Attending to the pollutant reduction, NOₓ and particulate matters showed a reduction of 50% and 16% respectively. Together with these measures, the environmental impact was even higher considering the contribution of the river transport for Monoprix containers. (Dablanc et al., 2011)

2.5.1.3 Economic impact

There is a wide literature about the cost of transport. In general, studies have shown a linear relation between the cost per tonne and the distance, where for short distances truck is considered as more suitable than rail due to the initial base cost of rail. The estimate decoupling point from where rail starts to be more cost efficient that truck is allocated approximately at 200 km, (Figure 9), of distance travelled, considering the distances of the Samada-Monoprix project, 40 km, the profitability may be in doubt. (Marinov, 2013)
Even though, Samada-Monoprix suppose a change from a traditional conception of supply chain to a “new smart supply chain involving rail” proposed by Deketele et al. (2008), this model assumes the rational use of different transport modes. However this conception introduces more cost factors like additional transhipment points, which may make necessary the improvement of the terminal operations.

The economic effect of the new scheme compared to the 100% road supply chain performed before will be based on the logistic cost per pallet. The former is slightly more expensive due to the introduction of new stages in the supply chain. More transport modes also trigger the introduction of additional transhipments points. The inclusion of the rail in the system increased the total cost from 13.25 euros per pallet to 17.61 euros per pallet, Table 1. (Maes, 2009)
From the company perspective, this cost increase is seeing as a short term effect. Considering both external and internal factor, this difference of 25% can be reduced to an acceptable difference, as it occurred; the following year was reduced to 18%. Among the external factors have been considered the rising price of the fuel and the legal framework, initiatives like the road pricing for heavy trucks inside urban areas and environmental taxes will suppose an incentive for the rail transport use. As an internal measure, the actions have been taking at the optimization of the platform, the 3,700 m² rented of the actual platform have been proven rather small from the beginning of the process, this situation has made the company (Samson, 2009), considers the renting of the rest of the 10,000 m² available.

Subletting the platform is another measure considered. Due to the routine of Monoprix, during the afternoon and evening till the arriving of the train the platform is not used, for this reason one scenario for the future is to search an outside partner to occupy part of the platform and also make use of the delivery chain as well. This scenario would have an attractive benefit for the productivity of the platform, but there are other factors to consider. For example the truck return in the morning presents can present a peak that should be overcome if the intention is the performed all the handling operation by the Samada’s employees alone. Another factor is the prize charging for the new partners, the idea is to include expenditures like cleaning, and electricity consumption on the cost of delivery. (Delaitre, 2012)
2.5.2 A MUDC scheme for Rome

In Rome, Fresh Food Centre S.P.A. (FFC) is the logistics services provider for the distribution of fresh food for supermarket chains (Auchan, Cityper, SMA), in central Italy and, in Rome in particular. The transportation system starts in the area of Santa Palomba, 30 km south of Roma, where FFC´s logistics platform is located, and the project consists on the fish distribution to Roman stores. (Alessandrini et al, 2012).

This network (Figure 12), as the previously mentioned for Tomteboda, has its first stage in a rail urban penetration leg with a rail terminal located at the outskirts of the city called Pomeniza Santa Palomba. From there, the goods are transported by shuttle trains to the eastern inner city Multimodal Urban Distribution Centre, MUDC, in Scalo San Lorenzo, Rome. At the MUDC the products are transferred to road vehicles, for the final delivery to the 18 supermarket stores, “Alessandrini et al, (2012)” paper explains a case study about the suitability of using low-pollution trucks.

![Figure 12 MUDC scheme for Roma Source: Alessandrini (2012)](image)

In the case of Scalo San Lorenzo, passenger traffic is a priority at the station, the freight services operate during the night between the two terminals. The good flow considered only one kind of product, fish, according to this, it is expected to replace with the train four individual truck journeys, which can suppose 287 km less travelled per day by road (Alessandrini et al, 2012).

Santa Palomba Pomeniza terminal covers an area of 190,000 m², where 40,000 m² are for the storage of ITUs. The terminal is equipped with rails 11, 6 for the exclusive use of intermodal traffic and 5 to the connected and transhipment service from truck to rail cars. The Terminal is equipped for the handling of ITU, four-wheeled cranes with maximum load of 45 tons. All cranes are equipped with a spreader with an opening 20’- 30’- 40’- 45’, the piggy-back for crates mobile and semi-trailers. Traffic volumes are performed about 45,000 ITU / year and 2,500 trains / year. (SGT, Gruppo Ferrovie dello Stato Italiane)

In mentioned paper, for the MUDC are considered special designed ITUs. The smallest standard units are 20 feet container or class C swap-body (Seidelmann, 2013), those are more than 6 meters long, 2.5 meters wide and an minimum weight of
14 tonnes, what means that cannot be handled using small transhipment equipment as forklifts or horizontal and automatic.

2.5.2.1 Project principles

FFC moves 7,100 tonnes of fish food per year, data of 2,009. The fish arrival to Santa Palomba platform between 6 a.m. and 12 noon, after the arrival it is kept in special warehouses till 5 p.m., where it is distributed and placed properly in order to facilitate the distribution. To avoid unnecessary transhipment operations it is planned according to the final destination. Next day, the shipments are load between 4 a.m. and 6 a.m. into trucks for its final delivery.

In Alessandrini’s paper, with this reference scenario, two other scenarios have been studied, both of them considered the rail transportation mode from the logistics platform to the inner city MUDC, and from there two different possibilities, a fleet of conventional vehicles or hybrid vehicles, for the final delivery. The former of the simulated scenarios showed the effect from monetary and environmental perspectives corresponding to the rail “effect”, and the latter the combined action of rail and eco-friendly truck fleet.

According to the data from the Centre for Transport and Logistics, university of “La Sapienza” the fuel consumption is significantly reduced as well as the emissions and their associated pollutant particles, Table 2.

| Source: Alessandrini et al. (2012) |

As it was explained in the Paris example, the new transportation system may produce a higher cost compared to the traditional reference scenario.

According to the calculations made for this case project, based on the data from the Italian Automotive Club and the magazine Tuttotransporti (September 2.010), they established the road operation cost, of the reference scenario and both of the designed scenarios, Table 3. Road operating cost.
The operation cost of the reference scenario is per km is the lowest one; however, the daily distances travelled is more than the double of the design scenarios, it is the reason why the operation cost per tonne increases in the cases of the reference scenario, becoming the highest.

Calculations about the environmental cost were also displayed, considering the different emissions and the fuel consumption, the reference scenario showed an extra cost of 121.63 €/tonne, while the design scenarios, with conventional and green vehicles, had and extra cost of 65.06 and 21.72 €/tonne respectively. The emissions have been monetised following the European Commission’s handbook for the external cost in the transport sector. This new cost and its difference with the others scenarios would give an estimate of the monetary incentives that public administrations can pay to encourage new operators to adopt the MUDC scheme. To the environmental cost must be added the operating cost including amortisation, insurance, maintenance, taxes, fuel and driver’s wage, for both different fleets Table 4. (Maibach, 2008).
The incentives would increase the cost that can be afforded by operators to have profitability in the MUDC scheme. The difference between the reference scenario and the design scenarios road operating costs, show the maximum amount of transfer and rail costs to have scheme profitability with MUDC.

2.5.3 BEHALA, Berlin inland port.

The TELLUS project in Berlin has consisted of 10 measures of different contests, types and policies, in order to improve the transport strategy in the cities. One of the most relevant for this study in the one concerning “Inner City Logistics Centre”, the measure aimed at changing to more sustainable modes for the urban freight transport, introducing CNG powered vehicles. It is also considered the need of increasing the acceptance of multi-modal logistic centres, new container tracking system and the above mentioned clean vehicles. (Becker, 2006)

In the region Berlin Brandenburg there is an important logistics actor, BEHALA, with 120 employees and a transported volume of 4,000,000 tons per year, it is one of the biggest inland harbours in Germany. BEHALA has two different operation fields, as a Rail Company it manages the railway traffic, and the

**Table 4. Relation of operation and monetized environmental costs**

<table>
<thead>
<tr>
<th>Source: Alessandrini et al. (2012)</th>
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<tr>
<th></th>
<th>Reference Scenario</th>
<th>Design scenario with conventional vehicles</th>
<th>Design scenario with hybrid vehicles</th>
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</thead>
<tbody>
<tr>
<td>Operation road cost</td>
<td>150.19</td>
<td>107.66</td>
<td>96.91</td>
</tr>
<tr>
<td>(Euro/tonne)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation + environmental</td>
<td>271.82</td>
<td>172.75</td>
<td>118.63</td>
</tr>
<tr>
<td>cost (Euro/tonne)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum cost of rail</td>
<td>0</td>
<td>42.53</td>
<td>53.28</td>
</tr>
<tr>
<td>and transhipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Euro/tonne)</td>
<td>0</td>
<td>99.07</td>
<td>153.19</td>
</tr>
<tr>
<td>Maximum cost of rail</td>
<td></td>
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<td>and transhipment,</td>
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<tr>
<td>considering environmental</td>
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<td>extra cost (Euro/tonne)</td>
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infrastructure as a Rail Infrastructure Company, owing its own locomotives. With a modern dock railway, BEHALA offers services 24 hours, 6 days per week. (BEHALA, 2017)

In BEHALA, one operation in particular takes the attention of this study. In 2005, a private railway company, DHL, after the closure of the inner-city container terminal it was using, Treptow-Neukölln. From the distribution stock in Unna, 40 swap trailers are sent per day to Berlin-Westhafen reaching approximately 20,000 containers per year. (Alessandrini et al, 2012).

In 2008 the German Government offered subsidies for terminal operators who decided to use those funds to expand their railway tracks, the measures adopted let them to service a full trait split over the two existing tracks, besides the introduction of new handling equipment. As a result of these measures the volume of sifted loading units increased from 20,000 TEU in 2005 to 120,000 TEU in 2015.

With no further information it is not possible to good beyond that point about the DHL service; however, it is interesting to highlight the project taking place in BEHALA “KV-E-CHAIN”, to show that a fully electric supply chain is possible (KV-E-Chain project, 2015).

2.5.4 Tramways

Although the following tram systems have not the same nature as the challenge present in Tomteboda, the idea of including these cases arises of the ideas that they can offer as examples of urban freight movements, shuttle services, short distances and special loading operations. With the examples that have prevailed, cases that had no success will be also mentioned in order to highlight the negative aspects to be aware of.

2.5.4.1 CarGo Tram, Dresden

In Dresden, Germany, Volkswagen’s has developed the project CarGo. Together with Dresden’s traffic enterprise (DVB) made possible that, since 2001, the logistics centre and the inner-city “Transparent Factory” were connected by rail (DVD, 2012).

In this case, the “Transparent Factory” is located in the historical city centre, which limited its capacity of stock and waiting areas. To connect the factory to its 4 km away logistics centre, Volkswagen decided to supply the service by rail. With an existing tram infrastructure next to both locations, a big investment was not needed, offering at the same time a transport mode with a high utilization rate and environmental friendly management (Oelmann, 2007).
The CarGo Tram project is part of the Dresden Transportation Strategy which was awarded in 2005 for being a unique case in Germany concerning sustainability transport policies (CIVITAS, 2005). As a result, each CarGo tram journey equals three trucks, showing a clear benefit reducing the CO₂ emissions and the traffic congestions, 200,000 km per year by road have been saved (DVB, 2012).

2.5.4.2 Vienna

In Vienna, the ‘GüterBim’ project is an urban logistic solution for the transportation of goods using the existing inner-city network, turning the transport mode from road to rail (Ehrlich, 2005). Among the potential applications considered were hospitals, shops delivery and waste disposal; moreover, the introduction of the rail as part of the urban distribution system has been tested focus on the combination of both tram and rail (Fochler, 2005).

The entrepreneurs and institutions involved in the project were the railway operator Wiener Lokalbahnen (WLB), and two consulting companies, TINA Vienna Transport Strategies and Vienna Consult (Fochler, 2005). They carried out different tests to find low-cost solutions, optimal routes, and techniques for fast handling. (Arvidsson, 2013)
The project started in 2004 and the demonstrations were implemented in 2005. After the three years development and the test phase, the results obtained were less positive; the pilot test had a cost of 1.4 million euros (569,000 euros of public subsidy) which were under the public control to check if they were justified. Moreover, for a good development of the project, private customers were needed, the project turned out to be a flop when the customers were missing combined with high associated operational cost (Ziegler, 2007).

2.5.4.3 Amsterdam

This project was the most ambitious and biggest among the many different studied. Due to the structure of Amsterdam, narrow streets, and canals, the intention was to turn the transportation modes from road (vehicles, trucks) to the already existing tram network. The results expected were reducing the traffic congestion caused by the cargo traffic together with the polluting emissions and noise.

In 2008 the testing stage started serving different stores and restaurants in the city. The project was estimated to reduce in 2,500 the truck movements per year, and 15% of the particle pollution. Despite this, the usefulness for serving small companies and its limitation for big companies made not very interesting for them.

The Amsterdam project was taking into consideration by several cities of an example to develop; however, the company in charge of the project faced financial stability problems. Many projects as this one are not profitable from the start, but their incapability to offer a bank guarantee required by the city of Amsterdam only let them the option of declaring bankrupt. With an estimated cost of the project of 70 million euros the most certain reason of the failure was the difficulty to find investment, together with merge of different politics interest and disagreement among the companies and authorities involved (Arvidsson, 2013).
3 System Characteristics

3.1 Case Study. Tomteboda Railway Station

3.1.1 Background

In central Stockholm, north of Stockholm Central Station, at the junction between East Coast and Mälarbanan, is settled Tomteboda yard, which has been used primarily for freight, including for transhipment, setup and postal freight. Premises and track operations and maintenance activities and construction within the yard and through traffic and turns of both freight and passenger trains.

Due to the reduction of the activities at Tomteboda to a minimum value, the yard has a deferred maintenance and a very deteriorated and aged infrastructure, being needed a major maintenance.

The different conditions that have led Tomteboda to a current situation of underuse are to be studied, so that to be known the possible shortcomings compared to other facilities with a similar functionality that have brought the operations that were previously carried out in Tomteboda. An exhaustive inventory of Tomteboda assets must be performed to establish future investment protocols in maintenance, renovation, and new constructions.

Once past and present conditions have been studied, the future forecasts of cargo freight in Stockholm and the whole Sweden are to be analysed. This will help to locate future business opportunities for Tomteboda.

The viability of Tomteboda is conditioned by different factors, both internal and external. Tomteboda's own situation and the transport network where it is integrated are combined with the liberalization of the passenger transport system, and the expansion of infrastructure, and delivery business changes affecting the yard. Due to the location of Tomteboda, pressure is also exerted from the real estate sector due to the value of the shaped network where the yard is located. It should be mentioned that Tomteboda is not contemplated in future public investment plans, so a model should be created that could be attractive to the administration or that the measures adopted be carried out by private initiative.

When we talk about Tomteboda, and this is one of its peculiarities, we talk about Tomteboda yard. The following project will reflect the different aspects and actions to take place at the yard independently of the terminal, which is owned by a private company. The principle aim of the project is focused on the viability and advantages of Tomteboda to hold future operation and activities on their facilities, the independence of the yard from the terminal will need an extra effort to identify the possible measures and policies to implement on the way to overcoming this aim due to the lack of existing literature.

Stockholm is the largest consumer market in Sweden; this status requires a large frequency and accessibility. Both of these requirements are conditioned by the
network the station is connected to and the infrastructure condition itself. The proper connection with the surrounding facilities and freight transportation areas is determining for a stable flow able to connect with as many as possible stakeholders. Apart from the connection with the network, the structure of Tomteboda yard is utterly determinant for the configuration of the trains that can arrive to the yard, criteria as the available number of yards, their length and the areas for tracking and untracking the trains.

3.1.2 Studied future functions of Tomteboda

The yard must be adapted to the type of freight flow that Tomteboda would like to offer, there are several possibilities that can take place in a unique way or combined. The type of flow is also related with the type of stakeholder that can make use of Tomteboda yard.

According to past studies about future functions of Tomteboda yard, for both freight and passenger services have been summarized as follows (Trafikverket, 2011):

- Tracks for short-term positioning of freight vehicles which is required for locomotives and cars for the time between the marshalling / transhipment and arrival / departure.
- Proposed transit tracks (connecting links) should be provided and designed in an efficient track system in order to easily reach respective line systems in the rail network.
- The free loading area remains. Tomteboda will eventually be one of the few remaining free loading areas in the northern central region.
- Facilities and tracks for maintenance should remain in the area.
- Functions such as storage, service, maintenance and workshop for passenger vehicles can be found within Tomteboda Marshalling yard. The yard should be studied closely to see what opportunities are available for one or more of the mentioned functions within the area.
- The required sections of the yard should be regulated by a signaling system in order to increase security as well as enabling multiple actors at the same time on the yard.
- Existing marshalling facilities with associated hump and braking system will be discontinued. Alternatives for marshalling should however be provided at the required level within Tomteboda Marshalling yard.

All this functions should be implemented in a full competitive neutrality scenario on the way to allow the presence of more companies simultaneously. The possible measures to reach the mentioned functions are under the responsibility of the public authorities and stakeholders.
At the moment Tomteboda has also been developing other operations apart from the loading/unloading of goods, such as a parking area for commuter trains. In the future this activity will be moved to new facilities owed by the rail operator.

3.1.3 Tomteboda’s yard. How to manage intermodal transportation without a terminal.

Tomteboda’s facilities correspond to the terminal and the shunting yard, in the present case, the shunting yard has to be treated independently from the terminal due to different ownerships. One question that arises is how to endow an intermodal nature to Tomteboda’s activity without the intermodal facility par excellence, the terminal.

The following literature will try to explain how to consolidate a stable and regular flow without an urban consolidation centre. It is important to know what a UCC is in order to identify its operations and to find a way to compensate them at the shunting yard.

“Urban Consolidation Centres” (UCC) are operational concepts that reduce freight traffic circulating within a target area by fostering consolidation of cargo at a terminal. In most cases, carriers that otherwise would make separate trips to the target area with relatively low load factors, instead transfer their loads to a neutral carrier that consolidates the cargo and conducts the last leg of the deliveries. (José Holguín-Veras et al., 2015)

The problem of UCC’s is the additional cost of a new transhipment, in some cases it has been solved with the subsidies of local authorities due to the positive impacts on traffic, environmental and social management. (Ibanez, 2004)

The way Tomteboda yard can play an important role in the supply chain without having consolidation facilities is simple, moving the consolidation operations to a previous stage in the supply chain. With two kinds of clients as objective for ensure the sustainability, big companies with big flows and small retailers, the possibilities are as follow (Verlinde et al., 2012):

- For big companies the need of consolidation in urban area is lower. Even with high-valued goods or bulk materials, their potential is strong enough to reach high load factors due to the same origin and/or destination of the goods. They can plan in advance the best and most optimized way of transporting their products, based on their own fleet.

- For small retailers the perspective is different. As it was mentioned before, their small economic impact does not let them to have a flexible transportation offer. Normally, trucks are their only option, sometimes ad hoc per each order,
with the loss of efficiency that it implies. The proposed measures for this situation are fundamentally linked with the cooperation aspect. At this point there are two principal groups, retailers and carriers, for this purpose, at least one of these stakeholders must change their processes and internal procedures, e.g. “a retailer can cut back his weekly number of orders with a particular supplier in order to enlarge the size of the deliveries to his premises”. (Verlinde et al., 2012)

There are, consequently, three action fields, receivers’ behaviour, carriers’ behaviour and a combination of both (Verlinde et al., 2012):

- Receivers’ behaviour. Concerning receivers, the reduction of the freight vehicles number entering to the city has a small significance, it cannot be clearly seen how this effect would benefit them. The most tangible aspect can be the improvement of the shopping area perception without the presence of large trucks. For this reason receivers are not very aware of the configuration of transportation chain.

  The fact that a receiver’s order puts a complete system into action, make necessary the adjustment of the ordering procedure, unifying its orders. Even going further, there must be considered the hypothetical cooperation between receivers. For example, receivers supplied by the same carriers can agree a date for the delivery of pick-up of goods. For urban areas, another possible option to be explored is the settle down of automated lockers for goods’ pick-ups and deliveries. This project ‘Consignity’ is based in three new concepts: night time supply depots, as a consequence of this first, the delivery in the absence of the receiver, and final consolidation of delivery trips. A single carrier supply the different Consignity lockers during the night, that way, freight movements are minimized. One of the aspects that still need to be considered is the introduction of security, and a system of verification the condition of the good in order to establish responsibilities of conservation. (SUGAR, 2011)

- Carriers’ behaviour. Concerning carriers, they are directly affected by the consolidation, due to the load factor of their fleet is higher and consequently the cost per km is lower. Carriers with several delivery points along their routes try to make the distance among them as short as possible. The elaboration of a refine mesh of receivers to supply and their different order routines can be used to establish delivery routes more optimized, covering as much receivers as possible while driving as less kilometres as possible. For this aim it may be necessary a previous agree with the receivers to establish certain pat terns on the way to avoid ‘peak and valley’ periods, distributing the orders in the best possible way for both roles. The problem of this action is the sense of less flexibility which may not be good to attract more clients, companies use to prefer a certain reduction of efficiency to gain better brand image instead.
From both perspective what is clear is that, there can be no possibility of improvement and development about the supply procedures and trades without the proper share and flow of information. It may causes some objections from both sides, on one hand, receivers are sceptical of measures that they do not really perceive, or can consider as restrictive. On the other hand carriers may refuse the idea of collaborate with other carriers to the detriment of free competence and client’s catchment.

3.2 Tomteboda’s surrounding facilities

The place that Tomteboda can fulfil in the goods distribution and transportation system must be defined. For this aim it is necessary, firstly, define the existing facilities and their fundamental uses and capabilities, secondly, detect the gap and the possible fields of development and growth for Tomteboda. It is the objective to offer a complementary service instead of to become direct competitors, which would need a higher investment and an unclear positive forecast for the viability of Tomteboda.

Stockholm has two main facilities that conditioned the activities of Tomteboda, in the south “Stockholm Årsta Kombiterminal”, and in the north “Stockholm Nord Kombiterminalen” at Rosersberg. The position of Tomteboda located next to the city center, in between them, can be an advantage to optimize the routes, reducing the movements.

3.2.1 Stockholm South Årsta Intermodal Terminal

Stockholm Årsta Kombiterminal was a project of 400 million SEK for the construction of a referent logistic area in Stockholm with a capacity of 120,000 units annual capacity. Close to the highway E4 (Södra länken) and with a direct connection to the railway, has an strategic location which offers optimal city distribution to a consumer market of more than 3 million people with combined transportation by train and truck, with it respective facilities for loading-unloading activities, and marshalling and consolidation areas (Figure 17).
Stockholm Årsta Kombiterminal is owned by Jernhusen AB, a public entrepreneur of the Swedish State, and Carrier Transport AB as terminal operator, it is a facility majorly adapted to the transshipment of semitrailers (80%) and containers (20%) due to the existence of two cranes both with a capacity of about 25 lift per hour. Besides, 100,000 m² of total terminal area is a special area for cooled crossdock (9,500 m²) and heated crossdock (5,500 m²), and 1,000 m² for tank cleaning. These areas are supported by a good connection with the road network thanks to 27 loading doors and external loading dock ramp for trucks and vans which count with parking spaces and garage for truck repairs. Altogether, supposed a stimulation that enhances the flows through Årsta. (Jernhusen, 2014)

3.2.2 Stockholm North Rosersberg Intermodal Terminal

Stockholm Nord Kombiterminalen is a combined logistic terminal between rail and road located in Sigtuna commune at Rosersberg. The terminal is one of the country’s rail connections to the east coast’s largest container port in Gävle and an optimal location in Rosersberg in the country’s most important growth region. It is one of the country’s important locations of companies with high demand on efficient transport. Today, companies as Lidl, with a central warehouse, Post Nord terminal, serving 800,000 households and 77,000 companies and Samedistribution AB, which distributes over 20 million books and articles for Bonniers per year, among many others. create a large distribution area which guarantee a stable goods flow for the future. (Gävle, 2016)

In a combined terminal, containers, trailers and loaders are moved from train to truck or from road to rail. A powerful IT system ensures that the right load is in the right place. The 80,000 sq. m. area offered 4 rail tracks of 750 metres length. It has a capacity of 200,000 units per year and their movements are done by two electric rail straddled gantry cranes, Figure 18, with a capacity of 300,000 units and forklifts. This equipment is operated by SPT North Stockholm AB, part of Yilport Holdings Inc. (MellanSveriges LogistikNav, 2016)
According to Trafikverket 2011, Stockholm Nord relieves the Årsta terminal which presents capacity shortage and accessibility problems. Connecting road and rail infrastructure is already fully utilized. However, the recent opening of the facility, autumn of 2015, makes difficult to have a certainty of the expected changes in cargo market.

3.2.3 Stockholm Norvik Harbour

Located in Nynäshamn, Figure 19, this facility under construction expects to take the freight route directly to Stockholm and the Mälardal region. The harbour will have a total of 1400 meters of dock that accommodates both container and rolling goods, so-called RoRo vessels. When the port is fully expanded, it has a surface of 44 hectares and can handle approximately 500,000 containers per year. To Stockholm Norvik Harbor we also build 4 kilometers of railways connecting to Nynäsbanan. (Stockholm Hamnar, 2016)
With the construction of this new harbour it appears an opportunity for Tomteboda to be one of the receivers of the goods coming from and to it. The capacity of Årsta seems limited to absorb the new flow which will be generated, and the route to Rosersberg’s terminal implies crossing the whole Stockholm urban area from south to north. Tomteboda offers a closest location to the city centre with the capability of moving to both directions.

3.2.4 Free loading areas in Stockholm

There is not much literature about these areas. This gap must be fulfilled with the information required ad hoc for this project and given by Trafikverket. The two areas where free-loading operations have been taking place are Sundbyberg, and Spånga in Lunda.

These areas are not only dedicated to free-loading operations, rail locomotives and wagons maintenance, as well as train parking areas. The future of these two locations depends on the expansion of Mälarbanan, and the new Mälaren Line Project (Figure 20). Between Tomteboda and Kallhäll the tracks have reached their maximum capacity, along 20 km all trains must share two tracks. This forced the regional trains and long-distance to queue behind the local commuter trains, with stops in every station. The project will double the number of tracks and three new stations are going to be build, Kallhäll, Barkarby and Sundbyberg, replacing the old ones (Trafikverket, 2015).

![Figure 20 Mälarbanan Line Project. Source: Thomas Ohrling](image)
The two stations will be shut down, for this reason Tomteboda looks like the most suitable facility to hold the operations in the future. This will make Tomteboda as the only reference for free-loading transhipment, ensuring a constant and stable flow for the future. Once more, Tomteboda receives the role of the good penetration-leg for freight into Stockholm, in the following pints this concept is going to be developed and explained basing on different international cases.

From the different examples of facilities explained above, Tomteboda emerges as an advantageous facility located in the urban area of Stockholm, a central location that may help to create a better optimized distribution network in Stockholm. Both Årsta and Rosersberg terminals due to their locations present some shortages and limitations for nonstandard units that Tomteboda could be able to achieve.

### 3.3 Tomteboda future flows

The categorisation of the good flows must attempt two different types, the nature of the good and its transportation unit. As it has been mentioned in epigraph 4, the capacity of Tomteboda for handling standardized transportation units shows a lower level compared to the offered by Årsta or Rosersberg. Besides, they offer the possibility to store and tranship cooled and heated containers reinforcing this difference. However, part of the transportation market goes from the 20 feet, container par excellence, to non-standardized transportation units, short haul units or adapted to special goods, this aspect will be deeper analysed.

New terminals are built in order to adapt their services to large-scale conventional transport; this effect leaves terminals with free loading areas and without large transhipment equipment as heritage of the past. Gantry cranes and reach-stackers have a high efficiency but for standardized transportation units, this limitation made them unsuitable for several types of freight flows. This limitation also affects to the type of vehicles that can use the facilities, because not all the terminals are fully electrified. This equipment also requires larger space for its movement and for the storing of the goods, because initially they are designed to move the heaviest units and some of the used units are not adapted to the conventional transhipment technologies.

According to the report of Trafikanalys² of rail traffic in 2015, the majority of cargo units (58%) of combined goods transported were container and swap bodies, the fastest progress has however been made in the transport of goods by semitrailers and other road vehicles, Table 5. During the years 2010 to 2015 the development by volume of goods transported in containers and swap-bodies fell and volume of freight transported by semitrailer and other road vehicle by rail, increased.

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With a lower initial investment, the role of a small-scale intermodal terminal seems proper for Tomteboda business model. As a part of a fully electrified supply chain, the use of electric equipment as forklifts is considered for the yard operations, offering flexibility for loading and unloading and with a lower cost than large equipment.

The other vital point for Tomteboda’s business model is the free loading areas. The possibility of offering to the shippers the option to load and unload their own shipments, which in many cases consist in unstandardized units, reinforces the suitability of unconventional freight flows for Tomteboda together with small transportation units.

But the importance is not just the type of transportation unit, it is also its load factor. The profitability of any logistic system is based on the continual moving of goods, both in and out flows, to reach it, it is necessary to identify the different freight types and which ones can by hosted by Tomteboda.

Each city presents to a greater or lesser extent, different conditions concerning transport and traffic, conditions such as demands, supply, traffic control and management, infrastructure..., besides some other factors as legal framework, socioeconomic aspects, demographic. As a result of different surveys, it was obtained the characteristics of the city commodity flows as well as the transport service types. The larger flow is the one that includes foodstuffs, followed by home accessories, stationary, clothing and building materials. The type of commodity can also give a clue of the transport services that are delivering them, from retailers to third parties (Nuzzolo et al., 2015).

For the good transported classification, it will be followed the NST 2007 freight category, adopted by Trafikanalys in its report ‘Bantrafik 2015’ which divided goods in 20 different categories, Table 6.

This classification is the base for a deeper development where the commodity flow will be explained with each respective transport service and how the future Tomteboda can offer the proper transhipment services.
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4 Analysis, Results, Synthesis

The present chapter will present the results regarding the international cases studied, and the measures applied and their consequences. Those aspects with more interest to be discussed and to extract conclusions from are going to be stressed. Aspects such as the evaluation criteria and the outputs obtained.

The analysis will be developed from a sustainability perspective (Carter & Rogers, 2008). The characteristics of this analysis which attends to three criteria Figure 21, economic, environmental and social, makes of it the most suitable one, according to the scope chosen for this project.

![Figure 21 The triple bottom line of sustainability Source: Carter & Rogers (2008)](image)

The economic criterion can be considered as the most analytical one, it concerns factors as cost, availability of capital, incomes, state of market, subsidies, etc. However, to define an accurate and profound economic analysis it will require going deeply in the financial documentation of each case, or even each company involved in the cases, it is certainly beyond the scope of this thesis. In the cases with available data the effort was focused on the general cost of the transport in order to show results in a synthetic way.

Social may be the most theoretical or philosophical criterion. The perspective of this criterion can be very different depending on the population sector or group you refer to, e.g. the reduction of the truck movements in the inner city area can be beneficial to solve traffic congestion's externalities, but on the other hand the truck drivers may suffer from rise of the unemployment. For this analysis, the urban policies about the heavy traffic in the inner-city areas, and the factors discussed have been the reduction of the number of trucks entering into the city and the lower disturbance for its inhabitants.

The environmental criterion follows to concepts, the reduction of the emissions from the different transport modes, and an eco-friendly use of the natural resources.
Both are pretty linked due to the main aspect it is the fuel consumption which implies consequences in both concepts. The available data found has been the decrease of the pollutant emissions and particles compared to the reference scenarios, the existing one. The advantage of this criterion is the possibility to monetize its effects in order to better estimate the economic criterion.

4.1 Economic analysis

The cases with more available information have been Paris and Rome new transportation schemas. In the case of Paris and Rome, the application of the new systems meant an increase of the operation cost of the transportation, linked to new transhipment point and a short distance rail lane, below the profitability ratios for rail-mode. In the case of Paris this extra cost is around 20%, and in the case of Rome is specified, just intervals of maximum costs that can be afforded by operator for the extra transhipment point and rail, Table 4.

The German case of BEHALA did not offer much information about the economic aspect; however, it can be highlight that in 2008 the German Government offered subsides for terminal operators, used in the improvement of the tracks and the introduction of new handling equipment, raising the loading units in 10 years, from 20,000 to 120,000 TEU.

Concerning tram projects there were three projects interesting for an overview of the inner-city transportation market, Dresden, Vienna, Amsterdam. Dresden is an example of succeed, because of several reasons, the initial investment was low due to an existing lane in proper conditions, besides, all the system is managed by and for the same company which has all the active roles in this network.

The cases of Vienna and Amsterdam are failures. Both of the projects have been shut down due to the economic unsustainability of them, suffering and important difference between the incomes and expenditures, and with lack of financing.

4.2 Social analysis

The results of all the cases according to this criterion are clear; all of them showed that the use of rail as a penetration-leg into the cities produces an important reduction of the number of trucks movements and kilometres travelled by road. However, how this effect is valued by different actors, internal or external to the supply chain change significantly among them.

The internal aspects such as the improvement of the working quality or the job creation are not evaluated in this project; the external aspect as the sense for the pedestrian and the private vehicle user, of the traffic congestion and the safety were searched. An interesting finding was the high number of trucks substituted by a smaller number of trains but with a higher load rate and capacity, in the case of Paris, 12,000 less trucks per year entering into the city. There is no much information about the tram projects, just to mention that the Dresden project CarGo has saved 200,000
km of road transportation per year, and the unsuccessful project of Amsterdam estimated to save 2,500 truck movements per year.

4.3 Environmental analysis

For the environmental analysis the aspects considered have been the emissions and the fuel consumption, the latter not very deeply due to its evident relation to the reduction of the number of trucks and the kilometres travelled by truck.

Even that the positive environmental effect of changing from road to train mode have been monetized for the economic analysis, there are explicit data of the emission levels and the variations.

In Paris, the greenhouse gas emission CO$_2$ was reduced 25%, 7% the reduction of CO approximately. Attending to the pollutant reduction, NO$_x$ and particulate matters showed a reduction of 50% and 16% respectively. And in the case of Rome, in Table 2, Alessandrini et al. (2012) showed a greenhouse gas emissions reduction of 54% with conventional vehicles and 77% with hybrid vehicles. In the case of NO$_x$, the reduction was 34% and 96% respectively. The tram projects didn’t show any information about the environmental benefits apart from the already in the social analysis.

The key strategy of this thesis is the combination of the three different criteria in order to evaluate the possible solutions in their entire scope. Once the results have been highlighted, they will be criticized and discussed in the following chapters.
5 Conclusions

All the process developed in this project has tended, from different ways and perspectives, to answer a simple question, what can be the future for Tomteboda, if there is any. The objective has been to support the proposed measures with a solid basis and a tested literature background.

Studying the Swedish railway network and the capillary infrastructure linked to it, a growing network is observed but it is losing balance and leaving behind aspects of it that could be very useful to give dynamism and proximity to the client.

In the case of Stockholm, there are two situations. On the one hand, large combined or multimodal stations have been erected in areas far from the center of the city, if we add to this the increasing demands on reducing the size of vehicles and access to traffic to downtown areas; It seems that policies are contradictory.

New passenger traffic growth plans, such as the Mälarbanan case, require the removal of facilities dedicated to freight traffic, such as Spånga or Sundbyberg. In this way Tomteboda would be the only installation option for the transhipment of goods at the interurban level. These two locations hold operations like free loading areas, and train workshop facilities to which Tomteboda is a serious candidate to operate them in the future.

The more promising cases, as Paris and Rome, were only performed with a specific and reduced group of products; this performance can be considered as a pilot stage. During the last years, Tomteboda was limited to a small number of shippers with a big presence (Posten, COOP), it created a weak position for Tomteboda in the transportation of dependence, once the shippers decided to end up with their business relation, Tomteboda has lost almost its entire activity. It is why for the new management of Tomteboda a wider group of clients and group may be considered, in order to stimulate continuous freight flows. An important discovery of this thesis is the possibility of establishing in Tomteboda a space for flows that apparently are not the most standard, but that due to the versatility with which Tomteboda can be endowed, will be able to give service to these flows. As previously mentioned, Tomteboda does not seek, nor would it be logical, to seek to be a pure competitor of the large intermodal terminals such as Arsta or Rosersberg, where there has been a great investment and support from the authorities.

How it can be done is the main question to answer in this project. We refer to load units not above than 20 feet, easily manipulated with simple equipment, as well as flows already consolidated that from the rail yard go directly to the shipper, such as retail groups or supermarkets. In addition, as mentioned, construction materials constitute one of the great flows of goods towards the cities due to the important construction dynamism they present, for this reason, Tomteboda can also be a perfect location for a flow that responds to more project criteria than to continuous flows.
In order to offer this versatility to address these various types of flows, one of the most promising options is the zoning of the Tomteboda track yard in order to create a free loading zone that would be unique in central Stockholm, as mentioned above. This concept is already being implemented with a housing construction company, but on a small scale, it would be necessary to create protocols and regulation for the management of this system as well as modernize the existing facilities.

There were three criteria that were established to evaluated in the most accurate manner, the results of the different measures taking in the international cases described, the economic, the social and the environmental.

As a deepening in each case was made, it became more obvious that one criterion could not be considered independently of the other. Doing so would lead us to create a conflict of interests between the different parties involved, as well as create an arbitrariness that would distance us from the true impact produced.

According to the results, the transportation system is made more expensive by using the railway as a transportation mode to penetrate into the cities, because the distance between the consolidation centers and the inner-city station is less than the profitable distances for this mode, as well as the introduction of a new transhipment point between transportation modes.

From the cases studied it is observed that public subsidies are necessary to ensure the viability of the projects. As in the case of Paris, Rome, Amsterdam and Vienna, the projects in their initial phase are not profitable, so companies, applying an economic logic, prefer to maintain the existing system. In Paris, the primary obstacle of the project was that the operating and investment costs for the private sector were not covered sufficiently by subsidies from the public authorities, as well as the availability of affordable locations for a rail terminal in the urban area. (Dablanc, 2011)

However, public administration also considers social and environmental issues and for their promotion they legislate on penalties for the road transportation. It is must be also considered necessary to provide incentives in order to solve the problem from the beginning, in order not to suffer the latter consequences of environmental and social mismanagement of urban transport.

From the environmental point of view, the reduction of pollutant emissions would favor a higher environmental quality and the reduction of respiratory diseases linked to them, among other benefits. From the social point of view, according to the examples, a train is equivalent to the capacity of transport of several trucks, reducing the congestion of the traffic in interurban areas, as well as a greater safety for the pedestrian a perception of the traffic lighter.

Among the disadvantages that Tomteboda presents for the success of the project is the lack of a terminal to carry out operations of consolidation and manipulation of the merchandise. Therefore, these tasks are forced to be carried out at an earlier stage
in the supply chain, and limit the capacity of shipping from Tomteboda. Connecting Tomteboda with any of these centers would, by a complementary partnership, maximize levels of service or minimizing costs, where the way from the logistic centre to the city Tomteboda yard would be accomplished by the rail mode. It can combine the privileged location of the yard, with the capability of managing logistics activities at the outskirts, which would require the cooperation between companies for load consolidation.

To summarize, there are many measures to be taken, but has also been seen that projects can fail. The difference between success and failure on many occasions has been the will of agreement between the actors involved so that the solutions are not a zero-sum game but that produces a greater benefit for all of them. So from the perspective of this project and summarizing its content, yes, Tomteboda can have a promising future in the transport system of Stockholm.
6 Discussion. Further research

From the very beginning this Master Thesis has been characterized by strong literature research. The process followed tends to go from a general research focused on the various fields that can have any connections with the urban supply policies and its management, to a more specific background.

Once a large amount of information has been obtained, it has been meticulously studied, and reduced to the one that went along the lines of our particular case, deepening now in the sources and studies from which this information came, closing those lines that move away from the characteristics of our case study.

Once defined policies and measures aimed at achieving a sustainable system from different criteria, projects and initiatives, at international level, that could be related to the development of solutions for intermodal transport have been studied, and thus create a theoretical framework where to place our case study.

With this more refined and precise information, with a defined theoretical framework, international cases classified and characterized, and the case study evaluated, both its definition and internal factors, and those external factors that condition its current condition and future development; the analysis and synthesis of the results is performed. This has been the basis of the conclusions finally obtained and the tool to fix the gaps in the literature and point of future investigations.

Both the search for literature and its subsequent analysis, the main drawback has been the difficulty to extrapolate measures, or results, between different cases, due to the unique characteristics of each one depending on the typology of the city, the urban policies of the last years, and the projects carried out, since they depend on the actors involved, from local authorities, to shippers market, management of the system, etc.

For further research, it will be necessary a profounder evaluation of the interaction Tomteboda-city area. The possible flows generated by the future activity in Tomteboda, considering different levels of capacity and exploitation of the facility, will help to characterized the social impact which was hardly quantifiable. Taking into account those flows with Stockholm as a destination, as well as those generated in Stockholm, the latter are of particular importance because the possibility of loading the trains that have been unloaded in Stockholm would allow greater profitability and efficiency, both economic and environmental.

It is also advisable to involve more the companies related with the supply chain and transportation, it is necessary to know their perspective and needs. Any possible solution has to unite and balance the different interests of the different actors. Moreover, the process of public consultation to city inhabitants and small shippers and retailers would enhance the strength of any project.
The analysis of Tomteboda has been, it can be said, as superficial, considering it as an entire concept. The study of the rail yard deeply, evaluating the zoning of the yard, and the possible flows between Tomteboda and the near intermodal facilities, as well as the behavior considering the effect of the terminal together with the yard, will give a strong knowledge of the case study and, maybe, a different solution perspective.
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