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Implementing Inland Waterway Transportation as a mode for Construction Logistics in Gothenburg

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“The difficulty lies not so much in developing new ideas as in escaping from old ones.”

- John Maynard Keynes

Abstract

Urbanisation is an undeniable trend that will put tremendous stress in the transport systems and networks of modern cities. The growth of these cities will require huge development projects that will add to the already existing problems, since the vehicles used for the transportation of construction materials and waste are generally bigger and heavier. Hence, innovative solutions need to be implemented to help cities' growing populations cover their needs and facilitate the increased flows of goods and waste. In that context, a modal shift from the current road transport system to inland waterway transportation could be beneficial for various reasons, like less pollution and congestion, as well as fewer accidents, noise, and visual intrusion. This study analyses the successful implementation of inland waterway transportation in Gothenburg, Sweden, as a mode for construction logistics. To gather information, semi-structured interviews with local stakeholders were conducted and analysed in comparison with concepts identified through the review of relevant literature. It was found that economic factors, operational ones, current regulations and behavioural change represent the most challenging barriers to deal with. However, there is strong interest from all stakeholders, and strong political initiatives at every level (local, regional, national, international) that could drive the transition forward. It is concluded that there is great potential for the implementation of inland waterway transportation. Additionally, if certain preconditions are in place to facilitate the modal shift, then inland waterway transportation could complement or serve as an alternative to the current road transport system.

Keywords: inland waterway transportation, sustainable transportation, modal shift, construction logistics, urban transport

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Table of Contents

1. Introduction

1.1 Background

Urbanisation is a trend that every European city is facing or will have to face at some point in the near future. Despite the stagnating population, the number of people living in urban areas will increase dramatically. By 2025, more than 75% of people will be living in urban areas and by 2050 the percentage is estimated to be around 85% (Transmodal, 2012). However, in Sweden the urbanisation trend has already exceeded those numbers, with almost 87% of people living in urban areas in 2018 (Plecher, 2020). The increased number of citizens will increase the overall consumption of goods, as well as the production of waste, locally. Consequently, the need for transportation into and out of urban areas will put tremendous pressure on the current transport network and the related infrastructure (Jandl, 2016).

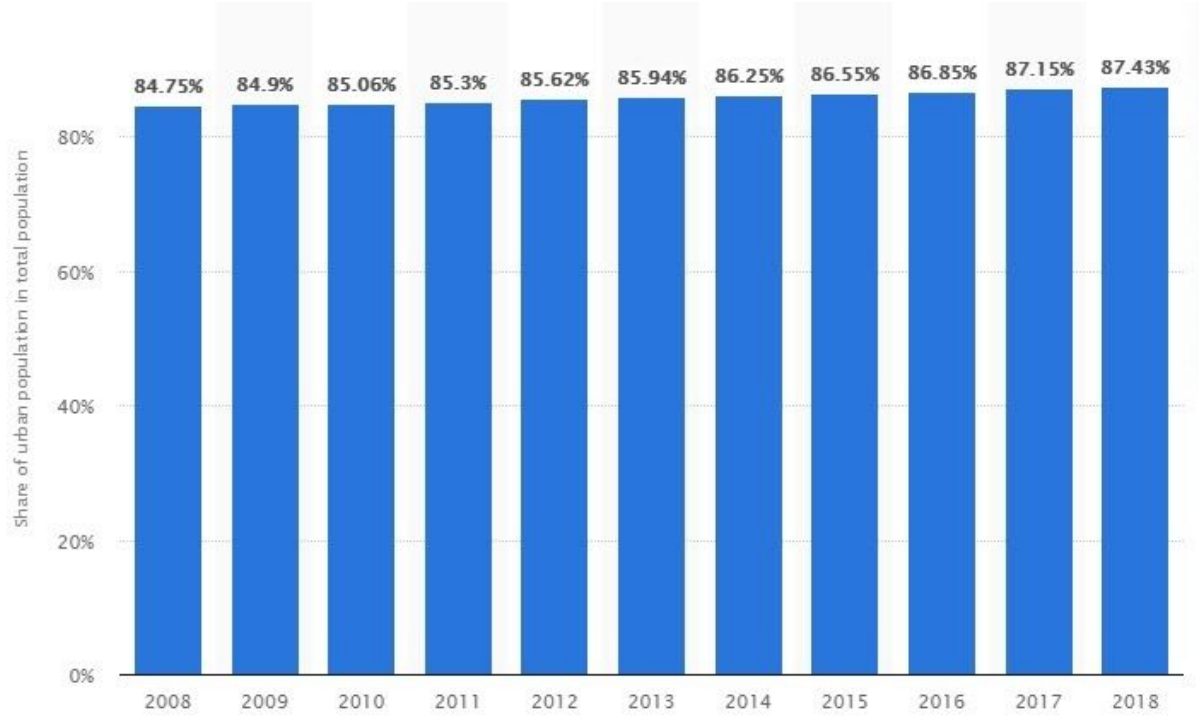

Figure 1: Urbanisation rates in Sweden from 2008 to 2018 (statista.com)

According to Anderson et al. (2005), several sustainability issues will have to be addressed; economic (i.e. congestion, inefficiency), environmental (i.e. pollutants emissions, waste production), and social (i.e. deterioration of public health, noise, accidents, and visual intrusion).

The average urbanisation rate in Europe right now is 0,6% and that indicates a steady increase. In coastal cities the rate is even higher and, thus, the implications are greater (Uhel, 2008). According to current forecasts, the population of Gothenburg, which is a coastal city located in West Sweden, will increase tremendously in the next 20 years; according to the municipality's forecasts, the population of the city will increase by 150.000 people by 2035 making the city a regional central point (Göteborgs Stad, 2015); that means that transportation will also increase, especially when it comes to freight movement (Guldbrand et al., 2015). In that context in October 2012 the municipality of Gothenburg adopted strategies that led to a vision, the RiverCity Project (Älvstaden), which started being put into effect in 2015.

If those issues are to be addressed in an urban area, there has to be an efficient and sustainable transport system in place, in order to complement or replace the conventional one; this is when urban waterways (a term used to describe navigable rivers and canals) starts playing a very important role. In the White Paper of 2011, the European Commission stated that there is a need to shift the balance between the different modes of transportation and that the integration of waterways should be stimulated. (Carlen et al., 2013)

Cities located at shorelines or at large inland waterways have traditionally played a big role in the movement and trade of goods, but, after the 19th century, the dominant role of waterborne transportation was lost to other modes of transport. However, waterways have shown to be safe, reliable and environmentally friendly. Furthermore, the transportation cost is low, especially when transporting high and frequent volumes of freight. (Carlen et al., 2013)

Gothenburg is a coastal city, strategically located on the shores of Göta Älv, which has historically played a dominant role when it comes to the transportation of goods in the region; however, freight movement in the city is currently held predominantly by road. In that context, the implementation of the waterways in Gothenburg is of great interest, since they are heavily underutilised. The utilisation of the waterways could reduce congestion on the roads and pollutant emissions in the environment, along with some of their externalities.

1.2 Why goods movement needs to be sustainable

Goods movement is absolutely crucial to our everyday lives. If one takes a look at the way our world works, they will immediately see that it is a world established on trade, where people and goods are connected, both locally and globally. Just as many people have to transport themselves to go to work, go to the supermarket or just visit their friends, goods also have to be transported on a daily basis to their final destination in order to support our needs and life. Most of our economic activity heavily depends on the movement of goods;

from grocery stores to restaurants, services, the public sector, retail shops, and, last but not least, construction. Besides, supporting the economy, the movement of goods provides jobs, directly or indirectly. (Nolmark et al., 2016)

During the last few decades, freight transportation has increased significantly in Europe. Moreover, this increase was translated to an increase in road transportation; road transport's share went from 65% in 1980 to 76% in 2010, with the share of barges being only 7% (Eurostat, 2013). However, the externalities caused by road transportation have also increased during the same period of time, namely congestion and accidents, air pollution, and noise (Wiegmans and Konings, 2015).

Moreover, when transporting goods, carriers have to deal with challenges, especially in dense urban environments. The most significant issue is congested roads; goods distribution contributes to the problem as well, but congestion also raises the levels of air pollutant emissions in the atmosphere, as well as noise. For many years, these issues were overlooked by urban planners and public authorities, leaving the industry to develop in some sort of hostile environment. However, these problems, even though they are invisible to most people, are quite complex and affect our daily lives significantly. Thus, they need to be solved in order to have more sustainable cities that are liveable and efficient. (Nolmark et al., 2016)

According to Transmodal (2012), the share of freight transport in urban environments is 8-12% of the total traffic. However, its share of emissions is disproportionately higher up to 20-30%, mostly due to frequent stops, the use of fossil fuels and the outdated vehicles' fleet. Moreover, the loading and unloading of goods significantly decrease the capacity of the road network and, due to congestion, decrease the level of service quality when it comes to transport times, since those times usually increase and are difficult to predict.

Traditionally, the logistics sector is focused on minimising costs and maximising the outcome (Piecyk et al., 2015). But, recently, the European Commission (2011) set a goal, according to which by 2030, urban freight transport should not contribute any CO2 emissions to the environment. The success or failure of this goal depends on whether we will manage to make the transportation system more sustainable or not.

1.3 Urban Waterways is not a new concept

All the aforementioned issues are challenges that need to be addressed, road transportation needs improvements, but other modes should also play a greater role in an improved transport system; intermodal transport could serve as an alternative in order to overcome the issues under discussion, but for this to happen it has to be competitive compared to road transport, in this case road-only. The task is not an easy one, since road transport has been perceived as

being flexible, inexpensive and reliable, one that succeeds to improve its service levels over time, while managing to stay cost-efficient (Wiegmans and Konings, 2015).

Inland waterways is definitely not a new concept and historically they have played a significant role in urban freight transport. According to Platz (2009), inland waterways are the oldest mode of transporting freight, but they were left behind after the industrial revolution, with the interest shifting towards railway transport. However, many are still used and the existing infrastructure of old cities offers a great potential, since the mode is currently significantly underutilised. According to Vierth et al. (2012), inland waterway transportation represents only 5% of the total traffic in the European Union; the percentage falls even more if focused solely on urban freight transport. If one takes into account that the volumes of goods, which account for urban freight transport are growing, and on the other hand that there is a growing concern from local public authorities for sustainability issues and challenges, then inland waterway transportation shows great potential (Konings, 2009). The benefits of an inland waterway transport system are significant; if we take into account environmental benefits, plus external costs from congestion, accidents, noise and so on, then the same cost for a transport system with integrated inland waterway transport is seven times lower (Lowe, 2006).

1.4 Problem Description

The municipality of Gothenburg has forecasted that in the next 20 years there will be a huge increase in the population of the city. In the documentation of the RiverCity project, it is stated that Gothenburg is in a transition process to become a bigger city. More specifically, the authorities expect the population to rise by almost 150.000 people by 2035 and, consequently, the local economy to grow, leading to the creation of 80.000 more jobs in the area.

This increase in the population will cause an increase in transportation; an increase in personal mobility, as well as an increase in the mobility of goods. One aspect is that the increase in the population will increase the flows of people moving into and out of the city on a daily basis. On top of that, the consumption of goods will show an increase, and, thus, generate increased flows of goods locally. However, another aspect, usually overlooked, is that in order to provide proper living conditions for the people (i.e. places to live and work) the construction activity in the area will also show an increase. The local authorities have already approved and started major construction projects, like the RiverCity project (Älvstaden) and the WestLink project (Västlänken).

The RiverCity project is an urban development project in Gothenburg, Sweden. Over the next two decades, 5 million sqm are going to be developed along both banks of the city's river

(Göta Älv); which translates into 25.000 new homes and workplaces (GothenburgDevelopments, 2019). The West Link, on the other hand, is a railway tunnel being constructed under central Gothenburg; the aim of the project is to increase the capacity and decrease travel times on the current network in Gothenburg (Trafikverket, 2015).

The construction activity that is going to take place in the city will generate huge flows of construction material and construction waste in and out of the city centre. Moreover, the externalities caused by such projects are going to put pressure on the already saturated road network. It is obvious that the levels of congestion and pollutant emissions (air and noise) will grow tremendously and that also leads to more problems, such as road accidents, visual intrusion, and vibration. In that case, the cost aspect should also be considered; congestion will raise the cost for the construction and real estate companies, whereas accidents caused by congestion, health issues caused by pollutant emissions, and the maintenance of a road network used by heavy trucks, will all raise the cost for the local public authorities.

1.5 Purpose and Research Questions

The purpose of this report is to investigate the implementation of inland waterways, as a transport mode, for construction logistics, in Gothenburg. More specifically, the report aims to identify barriers and enablers, as well as the necessary preconditions that could facilitate the modal shift, and come up with new knowledge, inputs and perspectives regarding the implementation of the waterways in the aforementioned context.

In order to do so, the report aims to answer the following research questions:

1. What is the potential for the implementation of the waterways, as a transport mode for construction logistics, in Gothenburg?
2. Are the waterways a solution, when it comes to construction logistics, that could complement or serve as an alternative to the current road network?

The findings of this study can be used for existing development projects in Gothenburg and potentially West Sweden. However, they could also be used for development projects in urban areas, in general, in cases of scarcity of land and easy access to inland waterways that are currently underutilised, similar to the area of Gothenburg. In that context, the report should provide knowledge about certain aspects that can positively influence the successful implementation of a transport system based on inland waterways.

1.6 Scope and Delimitations

The aim of the report is to investigate a possible transport solution and to give recommendations and suggestions, regarding a mode of transport that can be feasible and sustainable to use for construction logistics in the specific geographic area (Gothenburg). Therefore, the report does not aim to present a technical solution or describe how the logistics chain could look like.

Furthermore, the scope of the research only takes into consideration the transportation of construction material and construction waste. Other types of freight were not explored during the literature review, although there are implications that the same concepts might apply for goods with the same characteristics. Moreover, the interviews conducted were focused on construction logistics and relevant actors were chosen to participate and give the perspective of the industry/market.

Finally, all actors are part of the local industry/market; thus, the solution is mostly shaped to fit a local context. However, as noted already, it could apply in other cases where certain similarities are evident.

2. Theoretical Framework

2.1 Inland waterway transportation (IWT)

According to Achmadi et al. (2018), inland waterway transportation (IWT) is a form of freight transport that uses navigable waterways (i.e. rivers and canals) in order to move freight cargo from the main port to the hinterland. One of the preconditions is that the vessels used for IWT operations have not crossed any ocean.

Inland waterway transportation represents a cost-effective and environmentally friendly way to transport goods. It could be one of the foundations of a future transport system, due to its ability to transport heavy and large amounts of goods at a reduced cost. Furthermore, since the waterways are heavily underutilized, there is still free shipment capacity available. And because as a mode it is cost- and energy-efficient as well as reliable, it is considered to be the only viable option for shifting transport away from the road and, thus, reducing the environmental impact of conventional transportation. (Mircetic et al., 2017)

Policymakers on a European level have expressed the need to shift transportation towards inland waterways (European Commission, 2011). That could lead to more environmentally friendly modes and lower congestion levels, but further research and funding are needed to stimulate the transition (Caris et al., 2014).

It is a fact that research, in general, is mostly focused on longer distances when it comes to intermodal transportation and IWT, mainly because of the potential achievement of economies of scale that could make the solution feasible (Quak, 2008b). However, according to Maes et al. (2012), there are two conditions under which IWT could be linked to urban freight distribution; the first is cities where the last-mile deliveries are conducted by barges (e.g. Utrecht and Amsterdam), and the second is deliveries to or from cities where freight is transported to a consolidation center within the center of the city or in an area with close proximity to it. In the first case, the deliveries could be of goods in high volumes, like beverages, perishable goods, frozen food and construction materials to businesses and sites in the city center; the barges could collect waste material on their way back. In the second case, the deliveries could be conducted between a terminal and a consolidation center and vice versa, while the first- and last-mile deliveries would be conducted by conventional modes of transportation (e.g. trucks).

IWT historically played a huge role in north-western Europe and is again nowadays gaining momentum, because of the limited space and the high levels of congestion; usually it

involves inland ports along the waterways as a way to relieve the main port from the aforementioned problems (i.e. limited space and congestion). (Caris et al., 2014)

According to official data, in 2016, only 3% of freight transport was conducted with water transportation, and 0,7% via IWT (Trafikanalys, 2016). Historically, from the 14th century and until the 1990s, the waterways (mainly rivers) were used in Sweden to transport freight such as iron and paper, but nowadays the volumes are much lower and the main categories of transported goods have also changed; today these goods are sand, soil and gravel (Trafikanalys, 2018). Traditionally, IWT was used to transport forest products, which meant to be exported, from the inland and imported oil products to the inland; from the 1990s onwards rail transport took over being the preferable mode of transportation (Rogerson et al., 2019).

Currently, most of the flows transported using waterway transportation are dry bulk. Liquid bulk (oil, chemicals, etc.) comes second in the list and is usually transported in tank vessels. Containers are a small, but growing, sector of waterway transportation. As of lately, there are more "niche" sectors that are growing; some examples would be palletized goods, freight movement in urban waterways and canals (especially construction materials and waste collection), and the transport of flour and vehicles. (Wiegmans and Van Duin, 2017)

Moreover, Janjevic and Ndiaye (2014), determined several types of goods that would be appropriate for IWT; some examples are palletized and containerized goods, parcel deliveries, waste and recycling materials, and deliveries to restaurants and shops.

2.2 The trade-off with IWT

The most significant types of externalities of the current road system are: air pollution and climate change, congestion, accidents and noise. If one takes into consideration the average performance, then IWT performs significantly better than the road. However, if one looks closer the results are not that clear; in some categories IWT scores lower than the road. Noise and accidents are insignificant for IWT, especially when compared with road transportation, but when it comes to air pollutant emissions, IWT performs way better in CO2 emissions, but significantly worse in Sulphur Oxide (SOx), Nitrogen Oxide (NOx) and Particulate Matters (PM). Moreover, there is data implying that the sustainable advantage of IWT over road, will be put under pressure in the near future due to the advancements in technology. (Caris et al., 2014)

Maritime transportation is cleaner per kilogram of transported material when compared to road transportation and that is the main reason why authorities favour a modal shift from road to water. That being said, pollutant emissions from shipping contribute to the degeneration of

air quality, especially of coastal cities, with the effects being noticeable within a radius of 400 kilometers. One major issue is that emissions from ships are generated even when the vessel is not moving, due to the fact that in many cases the engines have to keep running. Moreover, emissions from maritime transportation (NOx, SOx and PM), affect not only big international ports, but also smaller ones that facilitate operations on a national, regional, or even local level. However, public authorities and port authorities have put several mitigation strategies into effect, and these strategies have been proven effective; specifically for SOx the decrease was from 50% to 66%. These results further support the implementation of waterway transportation as a complementary alternative to the current road system. (Viana et al., 2014)

Achieving a modal shift from road transport to water is believed to be extremely significant when trying to make the transport industry more sustainable. According to Medda and Trujillo (2010), water transportation generates less CO2 emissions, less congestion and less noise, when compared to road transportation, but when it comes to SOx, NOx and particles, the emissions are more. However, with the focus on climate change (i.e. CO2 emissions) and noise, water transport is promoted by political authorities, both national and international (Rogerson et al., 2019).

Whether the modal shift will be successful or not, depends on several factors; traditionally water transportation is preferred for longer distances, since the size of the ships makes it, by far, the most competitive mode, both in terms of costs (economies of scale) and emissions. When it comes to shorter distances, the costs are higher, basically due to transhipment costs and the smaller size of the vessels making it impossible to reach the economies of scale achieved for longer distances. However, there are cases where urban freight is moved via waterways in specific areas where the geography is favourable for such ventures, compared with adequate volumes of goods and supporting policy from the authorities' side. (Rogerson et al., 2019)

2.3 Barriers that have to be overcome

If one takes a look at transport geography, they could understand that in Sweden it is not as favourable as in other parts of Europe, but then the waterways needed for IWT already exist (Rogerson et al., 2019). If then we took a closer look at countries where IWT plays a great role, we could see that authorities promote that role (port authorities included) (Mihic et al., 2011), and there is relevant research on ways to solve the current issues and the use of policies as measures that could promote the modal shift even further (Macharis and Pekin, 2009). However, in countries with a low share of IWT, such measures may be not-existent and IWT may be trying to draw volumes in, thus facing extra challenges (Rogerson et al., 2019).

There are four main challenges when implementing IWT: financial, regulatory, market characteristics, and service quality. Furthermore, infrastructure and costs are two key issues; infrastructure can be a challenge if neglected, but it can be overcome with appropriate policy measures from political authorities (Mihic et al., 2011). Costs, on the other hand, could be overcome with appropriate fleet management (Fazi et al., 2015) and policy measures (Macharis and Pekin, 2009).

The following table is a summary of the main barriers that hinder IWT in Sweden according to Rogerson et al. (2019).

Barrier Type	**Barrier**
Financial	Cost of pre/post haulage
	Additional handling costs
	Port charges
	Fairway dues
	Piloting fees
	Fee structures of other modes
	Personnel cost
Regulatory	Uncertainty (regulations, cabotage)
	Piloting fees
	Fairway dues
	Regulations for other modes
	Stevedore agreements
Market Characteristics	Volume
	Competitiveness over other modes
	Condition of the waterways (ice, water level, height of bridges)
	Prioritisation between traffic on land and water at bridges
	Inflexibility of specialised vessels
	Potential locations of inland ports may vanish

	Environmental concerns
Service Quality	Time
	Frequency (due to vessel size)
	Prioritization of loading/unloading at the ports
	Resistance to change

Table 1: Barriers for IWT in Sweden (Rogerson et al., 2019)

If one takes a closer look at the barriers showcased in the table above, they would see that some of the challenges, one would expect to be identified as barriers, are absent. Some examples would be: administration and infrastructure in the regulatory barriers, investment costs in the financial, and lack of promotion initiatives when it comes to market characteristics. That could be seen as a benefit in the implementation of IWT, especially if one takes into consideration that the investment costs and the maintenance of the infrastructure are traditionally considered to be major issues.

IWT competes with land-based transport (i.e. road and rail), since players from different modes, essentially, offer services for the same market; the problem with IWT, especially in Gothenburg, is that the railway system is extremely well-developed and able to transport goods directly from the port of the city to the hinterland (Bergqvist and Woxenius, 2011). The main advantage of IWT and water-based transport in general, is the economies of scale that can be achieved due to the size of the vessels; because of this the costs and the emissions per tonne are both reduced (Rogerson et al., 2019). Consequently, it is essential, when setting up an IWT system, to ensure the volumes needed to achieve economies of scale and take advantage of the benefits that come along. For that, some sort of consolidation should exist, and nowadays containerization has a huge potential providing great opportunities for IWT (Rogerson et al., 2019).

Rogerson et al. (2019) stress the need to change stakeholders' opinions about IWT in order to successfully implement it. Flodén et al. (2017) point out that one of the problems lies in the way that transport buyers choose transport services. According to their analysis, the choice of mode or service happens in two steps; first the overall quality of the service is assessed and it is examined if certain quality criteria are met (e.g. time, damages, etc.); then the final choice is made based on cost/price and there is low interest in paying for services with lower impact on the environment. In that context, it is extremely hard to use environmental arguments to promote a transport solution (ibid.).

Level	Importance	Factor
1. Benchmark	1	Cost
2. Qualifiers	2	Quality
	3	Reliability
	4	Transport time
3. Particularities	5	Frequency
	6	Damage
	7	Environment
	8	IT

Table 2: Ranking list of factors for the selection of transport service (Flodén et al., 2017)

However, Meers et al. (2017) identified that the biggest problem is that when stakeholders examine modes of transportation, IWT is not even considered an option, usually. In the case of Gothenburg, although many stakeholders need to be informed and persuaded to consider IWT, the local public authorities are the main concern, since there is a gap between the existing policy and the existing practice (Rogerson et al., 2019). To elaborate on that, it is evident that the public stakeholders promote the use of the waterways through policies and measures, but there are no regulations, including taxes and fees, to pave the way for the modal shift to take place, and in most cases the existing framework is acknowledged as a barrier by many actors (ibid.).

2.4 The economics of IWT

One trend that is noticeable during the last decades is that the public authorities have invested heavily in road and rail transport systems all over Europe. The waterways seem to not be supported to the same extent, probably due to the misconception, by authorities and public alike, that the seaways are some sort of free "highway" that does not deserve the same amount of attention. (Baird, 2007)

The term "modal shift" implies that the movement of freight shifts from road to greener modes. However, the economics of a road system are very different from its water counterpart. (ibid.)

The first thing to mention here is that roadways are provided by the public and that is a great difference with the waterways. In most cases the building of the roads is a task undertaken by the government; in some cases there are examples of road pricing being introduced mainly as a measure to reduce externalities caused by the road system, but for the most part the public authorities still heavily subsidize the current network. However, when it comes to the waterways the infrastructure costs and who is going to pay for them are legitimate questions.

Regarding the current road system, the market was never concerned with similar questions; the public sector took care of it, using public resources in most cases. (ibid.)

The second thing to consider is that, from an economic perspective, railways have many similarities with roadways. They are both planned, constructed, owned and operated by the government, thus, their financing is also a responsibility of the public sector. There have been attempts to mitigate the cost of infrastructure to the users of the network, but this is extremely difficult given the huge initial investments, and the railways, just as the roadways, are provided by the public sector and not the markets. (ibid.)

According to Baird (1998), there are three distinct benefits of using the waterways:

1. The waterways already exist, they are free and they require limited to no maintenance, although as already mentioned they are not free highways.
2. The waterways extend in spaces that are, for the most part, not affected by congestion caused by traffic; the same thing cannot be said for roadways nor for railways.
3. The capacity of the mode can be increased, fast and to a great extent, with the increase of the number of vessels, or with larger vessels, or faster vessels and so on. However, in order to increase the capacity of the road systems, investments to infrastructure and adjustments to legislation are required, both of which are costly.

So, waterway transportation should be considered by policy-makers when making decisions, like roadway and railway. However, the waterways should not be regarded as free highways; the water is free but the "way" needs to be created. The same goes for roadways and railways alike; the land is there but the platform (roads and railways, respectively) has to be created. The waterway equivalent of the road is not the port, which is simply a node and not a platform. The equivalent waterway infrastructure is the deck of the ship. (Baird, 2007)

The most obvious measures to be implemented by public authorities in order to promote the use of the waterways, could therefore be:

1. Raise the user cost of roadways and railways alike, so that it (i.e. the cost) contemplates the cost of initial investment and further maintenance, as well as the external costs caused by the users of the system.
2. Subsidize waterway infrastructure (i.e. vessels needed), in the same way that is already been done for the other two modes mentioned.
3. A combination of (1) and (2).

According to Baird (2007), although many countries have managed to promote waterway transportation with the support of the public sector, Sweden is mentioned as a "problematic example". That is justified by the fact that roads are still provided by the state and are free (more or less) for truckers to use, whereas the private sector has to undertake the full cost of

waterway transportation; that immediately makes IWT a less attractive proposition for the private sector.

2.5 Why should IWT be part of a sustainable transport system?

According to Brundtland et al. (1987), sustainable development is "...meeting the needs of the present without compromising the ability of future generations to meet their own needs, balancing and integrating a prosperous economy, a quality environment, and social equity…"

Furthermore, according to the European Commission (2001a), "a sustainable transport system is defined as one that:

- allows the basic access and development needs of individuals, companies and societies to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations;
- is affordable, operates fairly and efficiently, offers choice of transport mode, and supports a competitive economy, as well as balanced regional development;
- limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and, uses non-renewable resources at or below the rates of development of renewable substitutes while minimising the impact on the use of land and the generation of noise."

According to existing literature, IWT is a very environmentally-friendly, safe and efficient mode of transportation, and these are characteristics that it has managed to keep throughout the years. Furthermore, if IWT's share was bigger in the transport market, that could lead to a more sustainable transport system, overall. Hence, appropriate action should be taken, by all involved actors and stakeholders, to increase that share, by promoting solutions that help overcome the difficulties of implementing a multi-modal transport system, within which IWT's position is reinforced. (Rohács and Simongati, 2007)

2.6 Enablers of an effective IWT system

An IWT system is first and foremost an efficient urban freight transport system. In that context, several enablers of an efficient urban freight transport system are discussed that could play a significant role in the implementation of IWT as well, with attention given when needed to concepts associated with construction logistics (e.g. construction consolidation centers).

2.6.1 Partnerships among stakeholders

The responsibility of the public authorities is to make sure that there is enough capacity of transport links to assist an economy that is growing. However, the combined engagement of private and public entities can create uncertainty and hold back investments that could upgrade the current system in terms of capacity. (Monios and Bergqvist, 2017)

Urban freight transport is usually not prioritized on local public authorities' agendas, especially when compared with public transportation. When it comes to dealing with the issue, public authorities often choose the road of regulations, most of which are focused on restrictions regarding the size of the vehicles and the time schedule of the operations. (Browne et al., 2014)

In the EU transport policy document issued in 2001 (European Commission, 2001b), there was a clear statement leaning towards supporting intermodal transportation in order to reduce congestion and emissions. During the same period, several other policy documents promoted environmentally friendlier transport solutions to reduce dependence on road, while making sure that they were not perceived as hostile from the road haulage industry (Monios and Bergqvist, 2017).

Those targets cannot be met through regulations, or through the actions of the private sector alone. In that context, it is likely that partnership initiatives will gain momentum in the future (Lindholm and Browne, 2013). Interaction between private stakeholders and the public sector is not well developed yet, but partnerships with a long-term perspective are a potential way to raise awareness and increase the knowledge among stakeholders (private and public), which may lead to sustainable and suitable solutions in urban areas (Lindholm, 2012).

Breuil and Sprunt (2009), note three issues, when it comes to the facilitation of partnership initiatives:

- The importance of political engagement of the local public authorities.
- The need to determine possible groups that could promote the urgency of urban freight solutions, design them and then facilitate the implementation among all stakeholders.
- The need for strong and rigid management that could set objectives, assess the progress of the project and determine possible barriers that hinder implementation.

A network of stakeholders cooperating to facilitate the waterways, or any transport solution, in an urban context should include stakeholders from local public authorities, suppliers, retailers (in the case of construction logistics that would be construction companies), haulers and transport associations. However, it would be better if more stakeholders are included, like

real estate companies and property owners, infrastructure providers, chambers of commerce, and the police. (Browne et al., 2014)

According to Lindholm and Browne (2013), the formal participation of the local public authorities, through their representatives, is a key factor for the success of the partnership.

When it comes to the number of participants in such a project, Browne et al. (2014) conclude that groups up to 25 participants are optimal, being able to tackle issues efficiently while remaining manageable. Having more participants usually leads to complicated discussions as it is difficult to reach consensus. Moreover, the participants should be eager to share perspectives from their organizations' point of view, and also be able to implement the agreed-upon solutions from the partnership meetings.

Although sharing information and knowledge is one of the most important aspects of a partnership, increasing the knowledge of freight transport challenges among stakeholders and improving communication among them is equally important. One of the things that should be stressed is that the participants should better hold senior positions in their respective organizations. That way, they can make sure that the issues considered during the meeting will be handled by their organizations. However, focusing on a specified action plan could be difficult, since it would require agreements on several issues at the same time and, thus, should not be the immediate goal of the partnership. (ibid.)

2.6.2 Consolidation Centers

According to Van Duin and Munuzuri (2014), a consolidation center could be described as:

> "A logistics facility situated in relatively close proximity to the geographic area that it serves (be that a city center, an entire town or a specific site), to which many logistics companies deliver goods destined for the area, from which consolidated deliveries are carried out within that area, in which a range of other value-added logistics and retail services can be provided."

According to Crainic et al. (2009), one could identify three levels of consolidation:

- None: There is no dedicated physical consolidation center; consolidation is made possible by sharing information, destinations, products and delivery routes.
- Single-level: Consolidation takes place at a dedicated physical consolidation center, from which the vehicles distribute goods within their respective area. The loads go through one consolidation center only.
- Two-level: Consolidation takes place at two dedicated locations or physical consolidation centers; the first one is usually located on the outskirts of the city, while

the second one acts as a platform where loads are consolidated into vehicles adapted for use in dense urban areas.

More recently the two-level system is more popular for use in medium and large cities, where operations are restricted by specific time windows for deliveries, and, thus, the second consolidation center acts both as a parking space for heavier vehicles and as a hub where goods are consolidated into vehicles suitable for urban deliveries. (Van Duin and Munuzuri, 2014)

In the context of construction logistics, a Construction Consolidation Center (CCC) is a dedicated distribution center through which construction materials are transported to construction sites, usually on a just-in-time basis. The basic function of a CCC is shown in the figure below.

Creating the best material flow possible must be designed in a holistic view. This entails improving coordination and communication between project stakeholders when setting up a CCC (Agapiou, et al. 1998).

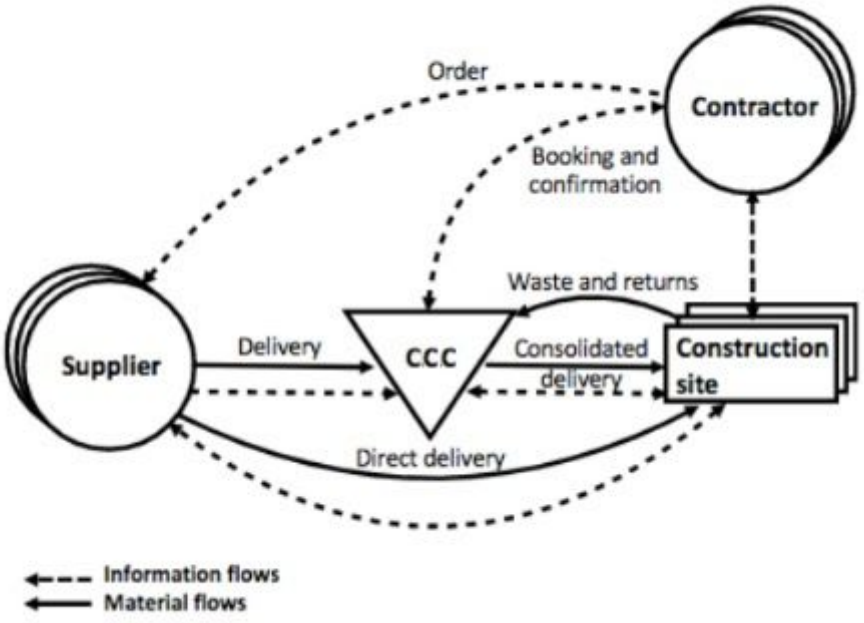

Figure 2: The operating procedure of a CCC (Janné, 2018).

Regarding the operating procedure of a CCC, the most common one is that the contractors place orders to the suppliers, who fulfill these orders either as direct delivery to site or delivery to the CCC (Brunge, 2013). Meanwhile, the contractor places also a delivery booking in a joint planning system run by the CCC operator for the same materials delivery (Lundesjo, 2010, 2011). The materials come from multiple suppliers to the CCC, where the

materials are received, controlled, registered and put away for storage (Lundesjo, 2010, 2011). When the construction site needs the materials the contractor calls off materials that are picked, packed and delivered (Lundesjo, 2010, 2011).

The CCC is completely utilized during reverse logistics operations; on their way back vehicles can transport unused materials, packaging and waste from the construction site. (Lundesjö, 2015)

2.6.3 Cooperative Freight Transport System

According to Yamada (2014), Cooperative Freight Transport Systems (CFTS) are "systems in which multiple entities cooperatively use and operate the whole or a part of the transport elements of their logistics activities". In order for a CFTS to be successful, a communication system is usually in place, in order to share information and transport systems; that often leads to a reduced number of vehicles being used. Moreover, the utilization rates of those vehicles increases, while travel times go down. Consequently, CFTSs have a great potential to solve complex challenges in an urban environment, while reducing congestion levels and relieving the environment from CO_2 emissions at the same time. Furthermore, CFTSs can reduce costs, infrastructure bottlenecks and accidents related to traffic. (ibid.)

Consolidation centers of any kind, discussed in the previous chapter, play a significant role in the utilization of CFTSs, not only when it comes to the transportation of goods, but also to the exchange of information (Browne et al., 2005). Thus, the implementation of a CCC can have an even greater effect if a CFTS is introduced at the same time.

However, a CFTS needs some preconditions in order to be successful. First, the management costs are usually high and assistance of the (local) public authorities is usually needed. Second, the cooperative has to be approved by all the entities that participate; without good partnerships the cooperative is unlikely to succeed in the long-term. Thus, frequent meetings have to be held, during which rules are set, which are accepted by all parties involved. Finally, measures need to be taken that will ensure the transported volumes for carriers, who are the most vulnerable part of the CFTS. (Yamada, 2014)

2.7 The Role of Local Public Authorities

2.7.1 Access Restrictions

According to Quak (2014), urban freight operations and their significant externalities have an effect in the triple bottom line:

- People: Accidents with heavy vehicles and road users, as the infrastructure is shared by both; implications in public health caused by emission pollutants; noise.
- Planet: CO2 emissions degenerate the air quality and contribute to the greenhouse effect.
- Profit: Regulations and restrictions damage logistics operations in urban environments; congestion only makes the problem worse.

For that, the local (usually) public authorities impose restrictions on traffic, in an attempt to deal with the externalities mentioned. Those measures can vary depending on the effort dedicated by the public authorities and the degree of freedom for the affected actors (most often the carriers). (ibid.)

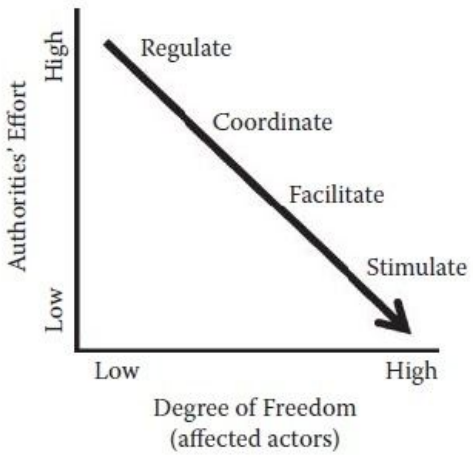

Figure 3: Roles of authorities in city logistics context (Quak, 2014)

When it comes to the regulations themselves, they usually apply for all types of transportation and include parking restrictions, speed limits and so on. However, some of the regulations are designed and directly intended for freight transport; some examples would be environmental zones, restrictions for vehicles regarding weight and/or length, time restriction for the deliveries, road pricing, load restrictions, and so on. The main principle behind these rules is that the public authorities try to make the carriers change their behaviour and delivery patterns, so that the environmental impacts of freight transport are relieved. (ibid.)

Following a list of the most common restrictions adopted by public authorities will be presented, briefly explained and then assessed to see if they manage to succeed in their objectives.

Time access restrictions: The main principle is that vehicles are prohibited from accessing specific areas during certain hours of the day. The objective is to facilitate deliveries in those times of the day when it is less disruptive for the citizens of the area or the general public. As a measure, time restrictions are often applied in the city's center, or a smaller area within it. The carriers are the most affected group of stakeholders, since time restrictions are difficult to pair with the delivery hours required by the receivers. Furthermore, carriers are often annoyed by the lack of alternatives (e.g. off-hour deliveries are not a possibility, even if the noise levels are kept to a minimum). The enforcement of time windows usually involves rising poles prohibiting vehicles from entering specific areas. If the area is too large, personnel need to be employed (usually police officers) to make sure no violations occur. (ibid.)

Vehicle restrictions: The main principle is that vehicles with certain characteristics, usually regarding weight and length, are prohibited from accessing specific areas, in order to improve safety, reduce congestion and protect the current infrastructure. The main reason is that the infrastructure itself (roads, bridges, etc.) usually does not allow vehicles of certain characteristics to use it efficiently. One secondary reason is to reduce the number of vehicles currently in the network, by reducing the number of heavy or long vehicles. The enforcement of vehicle restrictions is always difficult, because it requires inspection, usually visual, of the vehicles; length restrictions are difficult to enforce and the case is the same for weight restriction, especially when the vehicles are small and operate on the edge of the rules. In general, such restrictions are unsuccessful and usually result in a larger number of smaller vehicles being used, thus having a negative effect on all aspects of sustainability. For example, the use of two smaller vehicles instead of a big one would increase the problems of accessibility, environmental pollution and logistics costs, all at the same time. (ibid.)

Low emission zones (LEZ): The main principle of the LEZ is that polluting vehicles are prohibited from accessing specific areas; this restriction focuses only on the engine of the vehicle. The objective of public authorities for implementing LEZs, is the improvement of air quality and lower the levels of air pollution. In Europe, the restrictions often take into account the EURO norm of the vehicle, with the standards becoming increasingly stricter. The enforcement of such restrictions requires some kind of visual inspection, usually of the plate number of the vehicle, which can be then linked to the type of the engine. Inspection may take place either via camera systems on the road network, or by police officers physically present in the streets of the restricted areas. In order for LEZs to be effective, it is essential that the progression of the restrictions is not too fast and that they are announced well in advance, so that carriers can plan the investments needed for the replacement of their respective fleets. (ibid.)

Vehicle load factor controls: The principle is that vehicles that are not fully (or at least to a certain extent) loaded should be prohibited from accessing specific areas. The main objective of the public authorities here, is to promote consolidation outside the city and increase the utilization of already existing vehicles, thus lowering the number of vehicles in the restricted area and relieve it from the externalities caused by freight transport. The actual effects of such restrictions have never been examined in real life. However, in principle it is believed that larger carriers/companies could easily comply with the rule, whereas smaller companies with lower volumes would have to deal with an increase in costs for delivering in the restricted areas. Since these controls cannot be applied fairly, they are not usually accepted by carriers. Finally, the enforcement of these restrictions is very difficult to implement, since it would require the carriers to certify that they complied with the rules and entered the restricted areas transporting full loads. (ibid.)

Road pricing: The principle is to establish a fee for using the road infrastructure in a specific area, usually the center of the city. The fee changes according to the vehicle (bigger vehicles are usually charged more) and the time of the day (during peak hours the fee is usually higher). Road pricing is considered a traffic management measure and not an access restriction one, since it does not, usually, differentiate between freight and other types of transport. The objective of the public authorities when implementing road pricing is to distribute the traffic better throughout the day and, hence, reduce congestion levels directly and local concentration of pollutants indirectly. Road pricing is usually well accepted by carriers for two reasons: the measure is fair and does not discriminate between big and small, or native and foreign companies; and the money from the fees are used to maintain, if not improve, the current road network. There are different ways to collect the fees; however, the most successful has been automatic number plate recognition (ANPR), which is currently used in Gothenburg, among other cities. (ibid.)

Parking and unloading restrictions: The principle is to regulate, rather than restrict, dedicated spaces within a specific area, where large/heavy vehicles are allowed to park and unload their cargo. The authorities' objective for imposing these measures is to (i) ensure that vehicles will be able to load/unload in large cities where traffic and congestion put the system's capacity under stress, and (ii) to avoid traffic issues caused by large/heavy vehicles that park illegally when making deliveries. The enforcement is often the responsibility of traffic authorities, with the officers' work being complemented by recognition cameras sometimes. Most studies have shown that strict imposition of these restrictions has the opposite effects by making the problems worse. (ibid.)

2.7.2 Innovation-friendly regulation

According to Porter and Linde (1995), pollution can be seen as a form of economic waste; a sign that resources have been used ineffectively and inefficiently. Furthermore, the companies have to do certain things that add to the costs without creating any value for their customers, in order to compensate for the pollution that they generated. These inefficiencies are evident for the company in the form of underutilisation of materials/resources and poor performance of operations; these two factors often lead not only to unnecessary waste, but also defects and increased inventory costs. Customers on the other hand have to pay for these costs when they buy a product or service that does not fully utilise resources and/or wastes energy. Those resources are usually lost without creating value for the customers, who have to pay for them anyway, directly (included in the price) or indirectly (e.g. taxes). The main goal should be to be proactive and limit pollution before it is generated.

Porter and Linde (1995) argue that if properly planned environmental regulations are put into effect, that will induce innovations that will lower the costs, while preserving the environment. Organisations will have to innovate in order to use resources more efficiently and improve environmental performance; at the same time this improved productivity will make the companies themselves even more competitive. In their article, "Green and Competitive: Ending the Stalemate" published in 1995, they propose a guideline for public authorities to follow that could result in innovation-friendly regulations.

- *Focus on outcomes, not technologies.* In most cases, technology is regarded to be a catalyst for innovation. In that context, regulators often describe optimal practices and by doing so they set boundaries that kill innovation.
- *Enact strict, rather than lax regulation.* Companies can usually handle lax regulation with treatment solutions, maintaining their "business as usual" mindset. Hence, regulation should be strict enough to promote actual innovation.
- *Regulate as close to the end-user as practical, while encouraging upstream solutions.* That allows innovation to happen during all phases of operation (i.e. production, distribution, etc.). Avoiding, or limiting, pollution early on requires almost always less costs than trying to offset it after it occurs.
- *Employ phase-in periods.* These periods should be well defined and follow the investment cycles of the industry. That will allow companies to develop and implement innovative solutions, rather than last-minute (cover-up) solutions that will only raise their costs.
- *Use market incentives.* Some market incentives (e.g. pollution charges) make companies focus on inefficiencies, while others (e.g. tradable permits) stimulate

continuous innovation and promote the creative use of technology, sometimes beyond its current standards.

- *Harmonize regulations in associated fields.* By doing so, exposure to liability is no longer a problem of a single company and the entire sector is being forced to innovate in their respective area of expertise.
- *Develop regulations in sync with other countries, or slightly ahead of them.* By synchronizing regulation with that of other countries to minimise potential competitive disadvantages from international companies that do not yet follow the same standards. However, if regulation is slightly ahead, that raises the level of innovation, giving domestic companies a great export potential due to the fact that they become more sustainable ahead of their competition.
- *Make the regulatory process more stable and predictable.* The process is equally important as the standards. Thus, standards and phase-in periods should be set early on and accepted by the industry. Moreover, the regulators should be committed to the standards for a certain period of time, long enough to allow the industry to innovate, instead of trying to figure out when the next turn in government policy will occur.
- *Require industry participation in setting standards from the beginning.* Regulators should request information and initiate interaction with industry representatives, as a compulsory step of the process. This should be done in a way that creates trust between the two parties; the industry needs to provide information that is true and, thus, useful, whereas regulators need to take the industry's input into serious consideration.
- *Develop strong technical capabilities among regulators.* Regulators must understand the industry and its economics, and take them into account. Badly-designed regulations could lead to costly mistakes; the input of the industry early in the process will eliminate such incidents.
- *Minimize the time and resources used in the regulatory process itself.* Time delays are costly for companies. Allowing for self-regulation with intermittent inspections, usually works better than demanding formal licensing and approvals.

2.8 Review of Ongoing IWT Projects

Following, there is a review of ongoing IWT from two European countries (the Netherlands and France) that show a certain level of success. The goal is to identify success factors, from each case, that can be used in a broader concept and identify which could be applied in Gothenburg.

Vert Chez Vous (Bestfact, 2014)

Vert Chez Vous is an urban logistics project, using 100% environmentally friendly vehicles for the distribution of goods in the cities of Paris and Toulouse. When it comes to the utilization of the waterways, a river barge ("Vokoli" barge) provides multimodal distribution for packages via the Seine river, in Paris. The "Vokoli" barge is loaded at 7 am at the port of Tolbiac. From there, the barge makes five stops before returning back to its initial point. At each stop, which lasts for almost 90 minutes, a team leaves the barge to make deliveries in the area, using environmentally friendly modes of transportation (e.g. cargo bikes), and then rejoins the barge once deliveries have been made. During the sailing time, the staff do logistics sorts by route and prepare for the return of each delivery team.

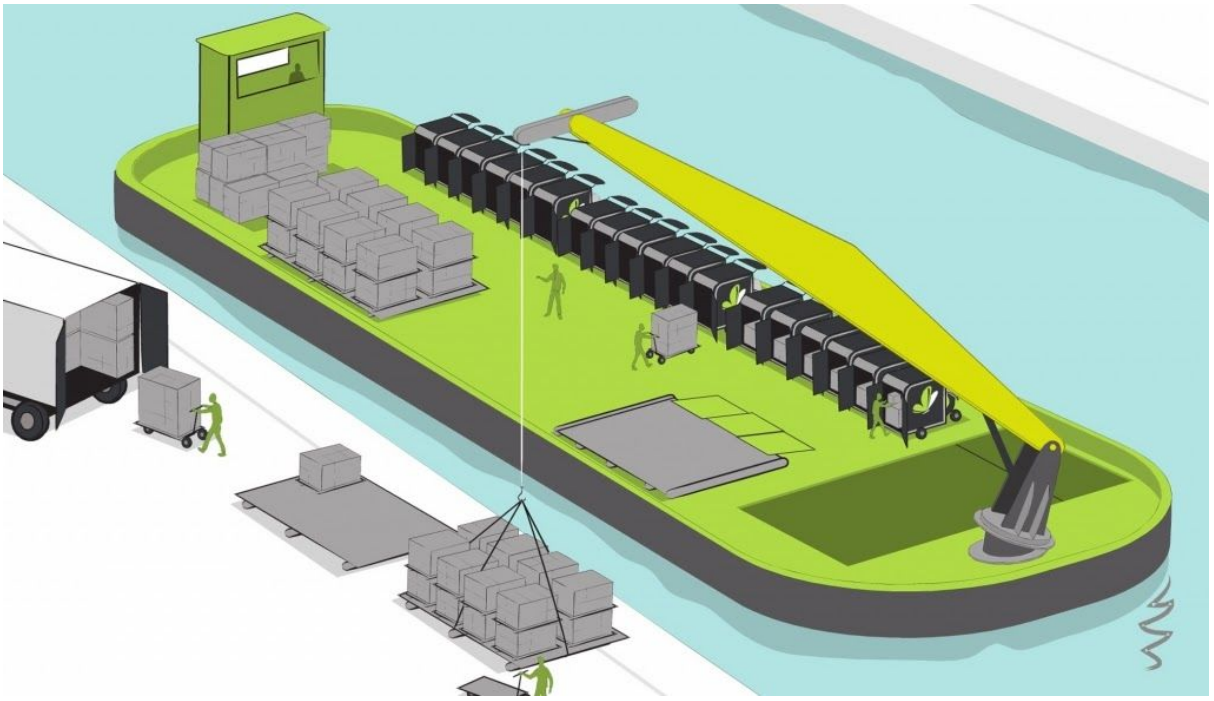

Figure 4: The vokoli barge as a floating distribution center (Fluvialnet.com)

The aim of the project is to reduce the impacts of climate change, by reducing CO2 emissions, and noise in the area that it operates. Furthermore, reduced congestion and improved utilisation of the current infrastructure are also among the targets.

There are two main factors contributing to the success of the project: there is a public policy in place that promotes this type of initiatives and certain information systems are in place to guarantee following day deliveries.

Franprix (Bestfacts, 2013a)

In 2012, Franprix, a French food retail company, initiated a project with the aim to utilize waterways as a transport mode to make deliveries to its stores in the centre of Paris. The

project is called “Franprix entre en Seine”. In order to do that, the company partnered with Norbert Dentressangle, a logistics service provider. The latter developed and implemented an innovative door-to-door solution. Franprix operates a warehouse located 20 km south-east of Paris. On weekdays, pallets of goods are loaded onto containers that are specifically designed for intermodal transport. These containers are transported with trucks to the port of Bonneuil, 8 km away. Following, the containers are loaded on the barge by cranes mounted on heavy vehicles. From Bonneuil, containers are carried 20 km to the “Quai de la Bourdonnais” downtown in Paris, very close to the Eiffel Tower, completely avoiding the road. Then, the containers are loaded on trucks once again for the final delivery. Once the deliveries are completed, the barge returns to the port of Bonneuil, loaded with empty containers that are going to be used for the next load.

The aim of the project is to reduce congestion on the roads to and from central Paris, tackling the negative impacts of road freight transport. Moreover, the impact transportation has for the environment is reduced significantly. The project also guarantees on-time deliveries for the supplied stores and their customers.

The project was enabled by the willingness of a private actor to experiment, matched with the knowledge of the logistics provider regarding multimodal door-to-door operations. Other factors that contributed to the success of the project were: the availability of a quay in the centre of Paris and a public-private partnership (PPP) aiming to reduce truck traffic in the centre of Paris.

Mokum Mariteam (Bestfacts, 2015)

The freight operator Mokum Mariteam uses the canals of Amsterdam to transport goods, waste and to deliver services. The vessels and barges are fitted with silent and clean electric engines. Goods are transported in the city and are delivered without noise or air pollutant emissions. The transportation is made possible using existing transport units (i.e. containers, pallets, etc.). Returned goods, including waste, are collected from the place of delivery in an efficient and sustainable way, allowing the system of reverse logistics to increase the efficiency of the distribution concept enormously.

Figure 5: Mokum Mariteam full-electric barge with own crane loading construction waste (amsterdamsebinnenstad.nl)

The project was possible due to the partnership of two private companies, trying to explore alternative ways of sustainable transport. The benefits were numerous: the air pollutant and noise emissions from transportation was considerably reduced and there was a reduction of road accidents caused by freight movement. Moreover, the transport costs of bulk goods were reduced. Finally, there was a decrease in the damage of current infrastructure, caused by trucks.

The project was successful mainly because of the better use of the already existing infrastructure (canals) in Amsterdam. However, the fact that the two organizations initially involved, both realised the advantages of sustainable transportation. Finally, the reverse logistics operations (waste collection) greatly contributed to the success of the project. The system has the potential to be used by other clients/organizations in the future; that makes it extremely scalable.

Zero-Emission Beer Boat (Bestfacts, 2013b)

The Beer Boat concept was introduced in Utrecht by the city's local public authorities, in 1996. Initially, the project's purpose was to distribute food and drinks to catering establishments that were located along the canals; the authorities wanted to preserve the historical centre of the city, reduce congestion and comply with labour laws (for carrying

barrels). In 2010, the project was already successful, leading the municipality to introduce a new fully electric, zero-emission boat, in order to replace the original one. Moreover, in 2012, the local public authorities decided to expand the project; they acquired another electric boat with much greater capacity, in order to transport waste (among other products) from the city centre.

The Beer Boat succeeded in reducing emissions and congestion greatly, since its implementation in 1996. Furthermore, it supports the preservation of the bridges, roads and infrastructure in general, within the area of the historical centre of Utrecht.

Several factors have been identified to have contributed to the success of the project; the project is publicly subsidised and, thus, the cost for the end-customer is low, with the transportation costs being reduced for last-mile deliveries. Moreover, certain policies are in place regarding time windows for deliveries and labour rights, which were surpassed with the utilisation of the waterways. Finally, the geography of the area and the location of the establishments that directly benefit from the project, were a great advantage for its successful implementation.

2.9 General Considerations about Construction Logistics

In the construction industry, just like most industries, differences of bargaining power among stakeholders condition their relationships. Bigger stakeholders have bargaining power due to their size and central position, whereas smaller, more specialized stakeholders have bargaining power through their asset specificity (Benson, 1975). When it comes to logistics, these stakeholders may have different demands and conditions on how operations should be carried out. This can make management complex and difficult due to uncertainty and multitude of organizations (Locatelli, et al., 2014). Another aspect conditioning relationships is the fact that the construction operations are organized under several projects limited by time and disconnected from the parent company (Dubois and Gadde, 2000, 2002; Karrbom Gustavsson and Gohary, 2012; Karrbom Gustavsson and Hallin, 2015) . Due to its temporary nature, it has been very difficult to find a good form of long-term collaborative relationship (Fernie & Thorpe, 2007). Therefore contracts are characterized by a culture of litigation and arm's length relationships appear to be the preferred way of managing relationships (Fernie & Thorpe, 2007). All of these factors affect how logistics and material deliveries are managed.

When reviewing the literature the authors could not find specific information about how these aspects of the construction industry would affect the implementation of a new logistics solution, like the waterway transportation. Therefore, this aspect (i.e. the combination of IWT and construction logistics) is going to be further investigated through interviews with relevant stakeholders.

3. Methods and Methodology

This chapter will explain the research steps followed throughout this thesis and present the choice of research methods used to gather relevant information, how data were collected and analyzed, and finally a description of the quality of the research. The thesis was written within Chalmers Challenge Lab, which is a challenge-driven innovation and co-creation arena for a sustainable future where many topics are developed and explored throughout interacting with local stakeholders from academia, the public sector and the industry (Larsson & Holmberg, 2018). The following chapter is divided in two sub-chapters that represent the two phases of the research. Phase 1 relates to the Challenge Lab process that led to the formation of the research questions, whereas Phase 2 refers to the research project itself.

3.1 Phase 1

3.1.1 The Challenge Lab Process

The thesis process at Chalmers Challenge Lab uses backcasting as an overarching methodology in developing the research questions. It is an iterative process, iterating through the different backcasting steps and methods in order to reach the final result. The first four weeks at Challenge Lab were a co-creative process engaging all the participating students, and only on week four was there an opportunity to choose thesis partners and topics to work with. The process was supported by the Challenge Lab team at all times. The co-creative process entailed: defining sustainability principles, mapping socio-technical systems, identifying gaps between the current system and the sustainability principles, and identifying leverage points to address the gaps.

3.1.2 The Backcasting Method

In essence, backcasting is envisioning a desirable future, comparing that future with the current state, and then developing ways to go from the present situation to the desirable future (Vergragt & Quist, 2011). Backcasting is a strategic and systematic process that aims to deal with complex, and wicked challenges (Holmberg & Robèrt, 2000). Especially when the challenge requires a complete innovation of the existing system, when the problem is defined by dominant trends, and when there is a significant amount of time to act proactively

(Dreborg, 1996). This makes backcasting a key method when addressing sustainability challenges. In fact, in 2018 the backcasting method has been suggested by the Sustainable Development Solutions Network to achieve the Agenda 2030 as well as the Sustainable Development Goals (Holmberg & Larsson, 2018). Skilled facilitation is critical for the success of this process. The four steps of the backcasting process, as illustrated in figure 6, are :

1. Develop principles for a desirable future.
2. Analyze the gap between the present situation and the desirable future.
3. Identify leverage points to bridge the gap.
4. Create strategies to address the leverage points.

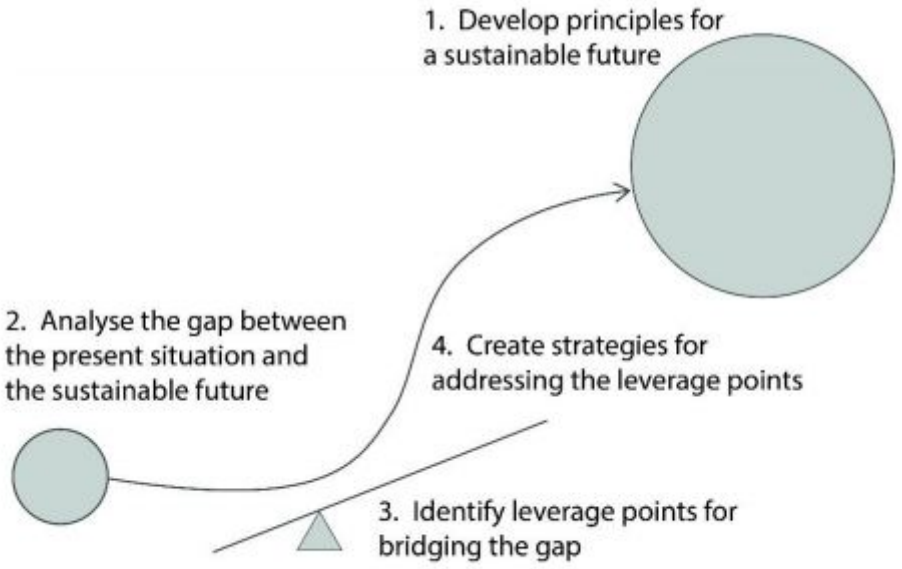

Figure 6: The steps in Backcasting (Larsson & Holmberg, 2019)

Though it is presented in a linear fashion here, backcasting is by nature an iterative process, where, for example, the identification of a leverage point opens up a deeper investigation around the circumstances of the system pertaining to the leverage point.

Step 1: Develop Principles for a Sustainable Future

This first step in backcasting aims to envision a sustainable future at the level of principles. This creates a strong foundation, as the expression of the future changes from what we know and believe today, understandings change depending on country and context too. Staying at

the level of principles brings the possibility to be open towards different possibilities and opportunities that will arise along the way, and to adapt to the uncertainty and unknowable nature of the future.

Different ways to develop these principles exist. Holmberg & Larsson (2018) suggest a balanced approach that provides a foundational framework called the *Sustainability Lighthouse*, as well as contextual expression of the principles that are developed by the stakeholders. This motivates engagement and ownership, through connecting to basic human engagement and inviting the stakeholders to participate and collaborate rather than dictating them rules to follow. Indeed, this framework smooths the path of conversation and helps the stakeholders to think beyond the current established unsustainable systems, in order to incorporate their thinking of the different dimensions of sustainability (while providing guidance on each one) and thinking altogether to create shared understanding (Holmberg & Larsson, 2018).

The Sustainability Lighthouse

The Sustainability Lighthouse is a framework conceived to facilitate the visualisation communication around the different dimensions of sustainability (Holmberg & Larsson, 2018). It fosters a balanced, open and guided approach in conceiving sustainability. The three pillars often talked about in the context of sustainability are ecological, economic and social. They are complemented by "human needs and wellbeing" in order to differentiate between the collective human needs of a society from the individual needs of each person. Human wellbeing constitutes the aim of us all to live a good life and is often forgotten when incorporated into "social sustainability". Ecological sustainability is the essence of all sustainability, supporting both the social and economic dimensions.

Figure 7:The Sustainability Lighthouse (Holmberg & Larsson, 2018)

Step 2: Analyse Gap Between the Present & Desired Future

In the second step of backcasting, the current socio-technical system of the given challenge or thematic area is mapped out using Multi-Level Perspective. The system's map is then contrasted with the sustainability principles developed in step one, and the gap between the two is analysed. The general thematic area of the Challenge Lab for 2020 was Mobility. This thematic area was divided into three branches: Mobility of people, Mobility of goods, and Tourism. By building-up on previous knowledge the authors started exploring the socio-technical systems of the three topics within a regional context, specifically West Sweden. Knowledge of the systems was expanded through dialogues with societal stakeholders from academia, the public sector and industry. Seven different dialogues were held regarding the three thematic areas. By sharing perspectives and thinking together, a rich understanding of the local context was created among the participating stakeholders, including the participating students. This understanding and acquired knowledge was then used to further develop the initial maps of the socio-technical systems. Beyond increasing the participants' knowledge, the dialogues also served the purpose of finding engagement and identifying willing recipient(s) for the thesis work.

Dialogue insights

Many gaps between the present and the sustainability principles developed in Step 1 were found through the process of mapping the system**s** and engaging with stakeholders

A shared view among the participating stakeholders was that the transition towards a sustainable future is very slow. It has been found that there is a shortage of competence within many organizations of leading the experimental and explorative processes that are necessary for sustainability transitions. During most of the dialogues, collaboration between actors was a hot topic. It was agreed that there is a lack of collaboration.. Many actors, mainly within the industry, tend to be protective about their insights and knowledge, since it is considered to be the core of competitive advantages. However, this trend is shifting slowly, and the added value of sharing knowledge becomes clearer and clearer. In addition to collaboration and trust, the need for participation was emphasized

Step 3: Identify Leverage Points

In the third step of the backcasting process, leverage points for addressing the gap analysed in step two are identified. As the name indicates, a leverage point is a point in the system where a targeted action leads to disproportionately higher results. In this context, leverage points can be seen as opportunities for creating shifts in the socio-technical system. Meadows

(1999) defines leverage points as “places within a complex system … where a small shift in one thing can produce considerable changes in everything.”

For this thesis the authors chose to delve deeper into the *Mobility of goods* thematic area. Using the dialogues, systems mapping and complementary conversations, leverage points were identified in order to address the gap in the innovation system.

The two initial leverage points were:

- The underutilisation of the existing infrastructure in order to transport goods.
- The application of an intermodal system as a way to shift and alleviate some amount of traffic performed on roads.

The gap and leverage points were further researched, for example through mapping the current freight transportation system within the city of Gothenburg and through discussions with the Challenge Lab team, in order to find a suitable approach and scope for a master’s thesis. In that context, personal interests and engagement were given high priority. The decision was made to focus on the urban waterways system as a leverage point, and how that could be used in the construction logistics in Gothenburg.

Step 4: Create Strategies for Addressing the Leverage Points

In the fourth, and last, step of backcasting, strategies are created for addressing the selected leverage points. The leverage point itself is only an opportunity. To realise that opportunity, strategies and actions are needed. Note that it is not until this last step that solutions come into play. Although the authors were thrilled at this point for forming an initial research question, it was acknowledged that the research needed to be narrowed down to fit within the scope of a master thesis. This was a time consuming and arduous, but necessary, process that ended with successfully coming up with the final research questions.

3.2 Phase 2

3.2.1 Research approach

Different types of research problems require an explicit research approach in order to be solved and explained (Creswell, 2013). According to Collis & Hussey (2013), the process of how a research is conducted can be sorted into two main categories, qualitative and quantitative.

In order to answer the formulated research question, a qualitative approach was applied in order to gain insights and understandings of the different stakeholders' viewpoints and opinions for the potential of urban waterway transportation in the construction industry in Gothenburg. It is an approach that is often used when there is limited information about the topic. Moreover, it is used when the study has an exploratory purpose. In addition, the strength of this particular approach is that it brings in-depth and detailed information about participants' individual values and opinions (Johnson & Christensen, 2008).

3.2.2 Data collection

3.2.2.1 Literature review

The literature study provided the authors with insight in the areas of urban waterway transportation, EU and Swedish regulations as well as construction logistics. Furthermore, data from similar urban waterway projects in other European countries were also gathered and compared. The secondary data were gathered from numerous sources such as academic articles, journals (e.g. Journal of transport geography, Transportation planning and technology and International journal of sustainable transportation), textbooks, company websites and official government websites. Search engines such as Google Scholar and Web of Science were used to find the related academic articles and textbooks. Keywords, such as *urban freight transport, sustainable development, modal shift, urban waterway transport, construction logistics,* and *construction consolidation centers* were used extensively to find the relevant literature in the field of construction logistics and urban waterway transportation. Non-academic reports, articles and project reports were gathered utilizing the aforementioned and other keywords through search engines.

3.2.2.2 Interviews

To fulfill the purpose and answer the research questions of the study, interviews were chosen as the main source of data collection. Since the report aims to get new insight from different stakeholders, both from the public and the private sector, interviews were the most appropriate method for this study. They capture a full insight from people's experiences, opinions, values, motivations, attitudes and feelings (May, 2011). Additionally, the purpose of an interview is to optimize the value of information from targeted respondents (Brinkmann, 2013).

There are several types of interviews widely used by researchers including structured interviews, unstructured interviews, semi-structured interviews, and group/focus group interviews. Being aware of the strengths and limitations among them, semi-structured

interviews were chosen as the main type to be used. This type of interviews makes sure that the interviewee stays on the topic set by the interviewer without losing the ability to speak freely about each theme and emphasize on what the interviewee finds most relevant (Merriam, 1988). Semi-structured interviews give, according to Bryman (2012), the respondents the opportunity to speak more freely and emphasise on the real issues that matter for them rather than simply answering the researcher's questions. Open-ended questions let the participants elaborate their opinions and ideas to the level of details that are often of valuable interest in qualitative research (Merriam, 2009).

The stakeholders that were chosen to be interviewed for the needs of this thesis are considered to possess both important information as well as experience in their respective fields, hence, their thoughts and reflections were of much interest in order to acquire an understanding that is as broad as possible.

Bryman and Bell (2015) state that qualitative interviewing is a good method when rich and detailed answers are desired. Especially since it allows for more open dialogue and discussion of points, which has not been given enough attention to when conceiving the interview guide. It also allows the altering of the order of the questions as the interview progresses. A semi-structured interview means that an interview guide is prepared before the interview (Bryman & Bell (2015). This guide must not be followed completely during the interviews. In fact broad topics are discussed throughout the interview. According to Bryman and Bell (2015), the fact of not asking all the questions in the interview guide is one of the characteristics of a semi-structured interview and that most qualitative interviews are a mix of semi-structured and unstructured interviews. Consequently as the interview progresses, the interviewee's answers determine what question to address next and what aspects the interviewer has to focus on in order to get the best knowledge from the interviewee. Sometimes new questions arise when explaining a specific situation or concept, which have not been treated in the literature review, and sometimes questions prepared before are not asked. According to Dubois and Gadde (2002), this is an appropriate approach when the researcher wants to find out about dimensions and gather new data in a given context.

3.2.2.3 Online interviews

In the following section, the tools used to conduct our interviews will be discussed. Two online tools were chosen to administer the interviews; video-calls and emails. The choice of these online tools was more of an obligation since the authors could not consider organizing a face-to-face physical interview due to the outbreak of the Covid-19 in Sweden, and the fact that they had to comply with the recommendations by both the Swedish government and the University of Gothenburg.

Video call interviewing

VoIP technologies provide a platform that enables an opportunity for a more democratic research process. Fleitas (1998) highlights that distance is a variable that prevents an international representation of interviewees in most qualitative studies. According to Deakin and Wakefield (2013), Skype provides an opportunity to talk to otherwise inaccessible participants and thus allows the interviewers to maximize research effort on a budget. It also gives participants themselves a freedom to participate without the need to travel offering the chance to switch a research away from a purely geographical-centric focus.

When using video calls, interviews can easily be conducted from the comfort of one's home, eliminating not only the need to travel but also the need to find a venue. A venue which can be unfamiliar for the participants and, in some cases, can generate financial and logistical issues that needs to be dealt with by the interviewer. With VoIP solutions, the place of the interview is not an issue anymore (Deakin & Wakefield, 2013), and logistical issues regarding the accessibility to some spaces such as a classroom, meeting room, area of a hospital, a sports centre or dance studio are out of consideration. Due to the use of video calls for interviews, time can be used in a more flexible way, according to the needs of participants, while keeping synchronicity with the interviewer.

Emails

Online interviews carry a risk relative to face-to-face interviews that the respondent is somewhat more likely to drop out of the exchange. Mann and Stewart (2000), however, suggest that in fact a relationship of mutual trust can be built up. In fact, it is important for interviewers to keep sending messages to respondents to reassure them that their written participation is helpful and significant, especially when knowing that online interviewing is an unfamiliar experience for most people. Furthermore, potential interviewees are more likely to agree to participate if their agreement is solicited prior to sending them questions especially since unsolicited emails are often regarded as spamming. It is even more effective when the researcher uses some form of self-disclosure, such as directing the person being contacted to the researcher's website for information regarding the research project and the organization involved which can have a very reassuring effect on the participant (O'Connor and Madge 2001). This kind of relationship makes it easier for a longer-term commitment to the interview to be maintained beyond the interview time. In fact, the researcher can go back to his or her interviewees for further information or reflections, which sometimes is difficult to achieve in the case of a face-to-face personal interview.

One of the issues that the interviewer needs to consider is whether to send all the questions at once or to interview on a question-followed-by-reply basis. The problem with the first option is that respondents may read all the questions and then decide to reply only to those which

they are interested in or to which they feel they can make a greater contribution. In this case, asking one question at a time will bring more input. When sending questions in small batches, Bampton and Cowton (2002), report that this tactic, on one hand takes pressure off interviewees to reply quickly and gives them the opportunity to provide genuine replies, and then on the other hand gives the interviewers the opportunity to respond to interviewees' answers.

3.2.3 Limitations

Bandwidth Capacity: Although video call carries significant advantages in terms of democratisation and saving time and money, it can be obstructed by some external factors such as the network's bandwidth capability for both the researcher(s) and the participant(s). Network bandwidth is the capacity of a wired or wireless network communications link to transmit the maximum amount of data from one point to another over a computer network or internet connection in a given amount of time, usually one second. Normally, the infrastructure is generally accustomed to certain peaks of activity at specific times of the day, such as in the evening when people return from work and get online at home. But in such exceptional situations, with the pandemic, when drastic measures are taken to increase social distancing, more and more businesses and organisations are encouraging remote work. This vast and sudden transfer of work and learning to people's homes has shown new heights of internet use, with many users sharing the same internet connections throughout the day, using data-hungry apps that are usually reserved for offices and schools (Avey & Kang, 2020). Consequently, the network bandwidth capability has been put under pressure reflected on the reliability of the internet. The quality and the effectiveness of video calls is therefore impacted in terms of the quality of the video's image and sound and sometimes can generate interruptions during the call. This may affect the level of communication between the interviewer and the respondent, thus affecting the quality of the information being exchanged.

Rapport: It might seem that it is more difficult to assure the same level of rapport on email, telephone or via online methods, compared to offline face-to-face interviews. "Rapport is …about trust –enabling the participant to feel comfortable in opening up to you" (King & Horrocks, 2010). According to Cater (2011), building a rapport over a video call is challenging to achieve. However, Deakin and Wakefield (2013) noticed that video-call interviewees were more responsive and rapport was built faster than in a number of face-to-face interviews. Additionally, participants may be more willing to open up when being interviewed via video calls, because they can be in their chosen environment, as Hanna (2012) argues, "both the researcher and the participant are able to remain in a safe location without imposing on each other's personal space". Being in a familiar setup may be beneficial to participants who are shy or introverted, making them feel comfortable opening up in front of a screen (Seitz, 2015).

Nevertheless, online rapport can be an issue when the interviewee is reserved or less responsive. To alleviate that problem and create a connection with participants over time, exchanging a series emails before the interview might strengthen the rapport (Seitz, 2015). However, Seitz (2015) highlights that video call rapport is shown to be limited when the research is about personal topics. In fact, it appears to be more difficult to obtain in-depth responses to sensitive questions via video calls. This is mostly due to suspicions related to the video element of the interview, rather than lack of trust in the interviewer.

Nonverbal Cues: Video calls allow another level of interaction using facial expressions, thus avoiding some of what Holt (2010) refers to as the "the lack of non-verbal communication" present in telephone interviews. However, this non-verbal communication is limited. Video calls interviews are missing cues from the rest of the body, since in most interviews, only the face is visible. In fact, in a head and shoulders presentation a full range of postural, gestural, and expressive movements that the body conveys are lost (Bayles, 2012). This can be overcome by putting more effort into listening to the participant's voice and looking carefully at their facial expressions in order to determine whether facial expressions are deliberately used to convey understanding and emotion (Seitz, 2015).

3.2.4 Ethical Considerations

Ethics is a central aspect in data collection methods (Cohen et al., 2007) including interviews carried out using VoIP. All empirical qualitative studies must respect a range of ethical considerations identified by Plummer (2001): Intellectual property, Informed consent, Right to withdraw, Unintended deception, Accuracy of portrayal, Confidentiality and Financial gain.

Online research makes these ethical considerations less easy to define especially because the blurring of public and private in the online world raises ethical issues around access to data and techniques for the protection of privacy and confidentiality (Garcia et al. 2009). Furthermore, consent in cases of not meeting in person could be tricky to establish and the use of cloud storage for sensitive data could put data at risk of being hacked (Buchanan & Zimmer, 2012).

The use of VoIP for remote interviews has a great potential to become an alternative to the gold standard of face-to-face interviews. However, for it to be conducted in the best way possible, new skills must be learned such as presentation on-camera, as well as basic interview techniques in order to improve interviewer rapport with the participant to maximize the chances to collect more granular data. Technical skills are also needed in terms of basic

IT skills that are necessary to install, upgrade a program or and avoid interruption and delays.

If the participants are not used to holding a conversation over VoIP services it may be more difficult to have a quality interview especially when participants show an aversion to technology, or when they are visually or hearing impaired. (Gibson & Naomi 2009). Therefore in this case email interviews can be an alternative.

4. Empirics and Analysis

This part of the report will showcase all the information that was gathered either by observations or during the interviews with the chosen stakeholders. The first part will outline the traffic regulations that apply in Gothenburg at the time of writing this report, since these measures can be seen as a framework that will potentially facilitate the modal shift, by helping mitigate traffic away from the current road network. That information is based on observations supported by documentation highlighting the important aspects of the restrictions in place. Then the data that were gathered from the interviews will be presented and analysed.

4.1 City of Gothenburg - Traffic Regulations

The city of Gothenburg has introduced Low Emission Zones (LEZ) and road pricing (tolls) to regulate traffic in the center of the city. Both measures were introduced in 2015.

The low emission zone (LEZ) applies to all heavy, diesel-powered lorries and buses in the area showcased in Figure 8. All lorries and buses are allowed in the LEZ for six (6) years from the date of their first registration. Euro 5 and enhanced environmentally-friendly vehicles (EEV) are currently allowed until 2020 or 8 years from their first registration. Euro 6 or better do not have any limitations to enter the LEZ as of the time being. All vehicles that are Euro 4 or lower are prohibited from entering the area. Foreign vehicles are also affected from the regulations, and restrictions apply every hour of every day throughout the year. (Urban Access Regulations, 2020)

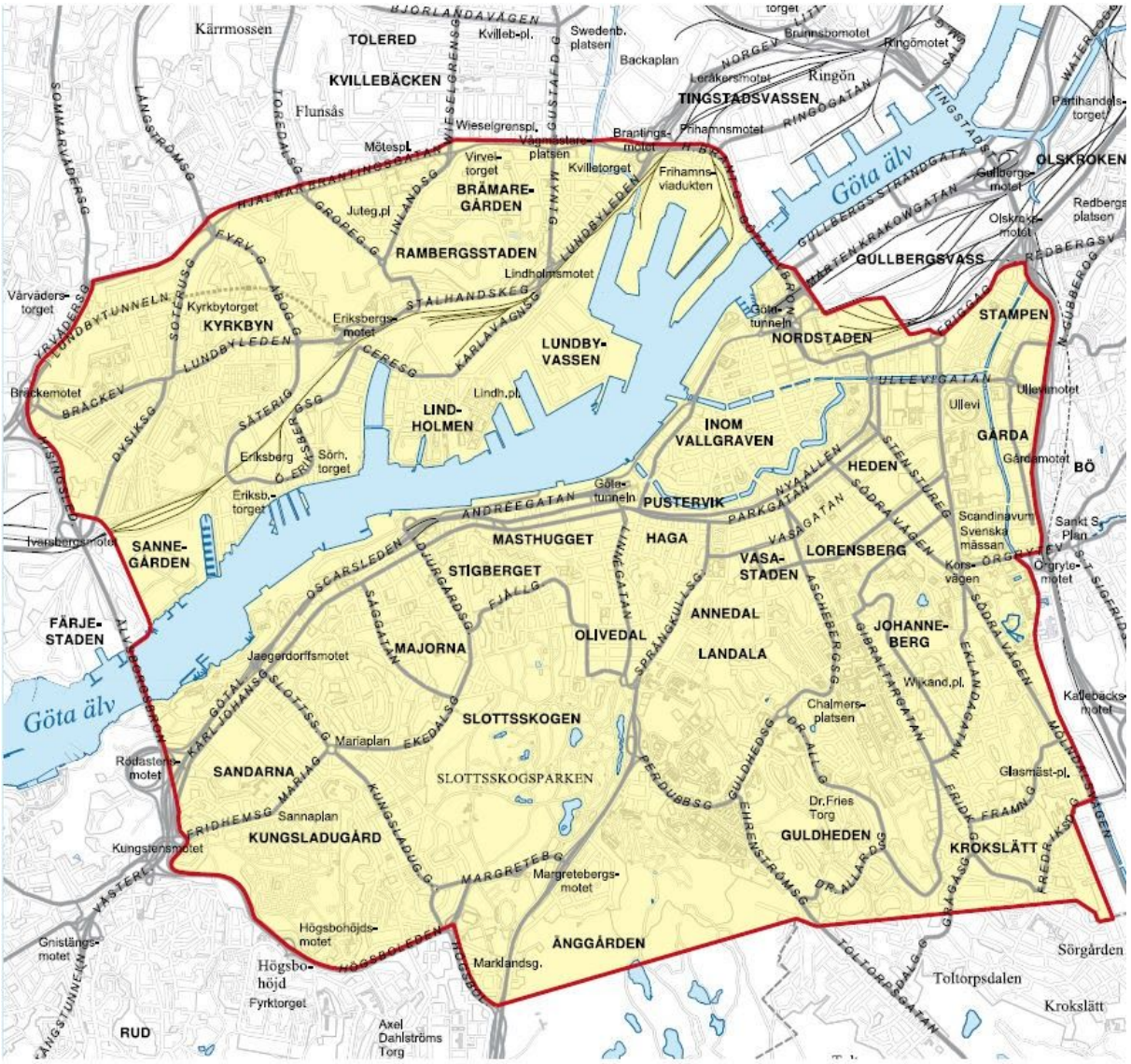

Figure 8: Low Emission Zone, City of Gothenburg (urbanaccessregulations.eu)

Road pricing has also been introduced as a measure to control congestion and the externalities that derive from traffic. The regulation affects all vehicles that enter the marked area showcased in Figure 8. When it comes to heavy vehicles transporting cargo, it has to be mentioned that vehicles with a weight higher than 3,5 tonnes have to pay double the regular price. The fee varies according to the time of the day a vehicle enters the restricted area, and is charged from 06:00 to 18:29, from Monday to Friday. Foreign vehicles are also affected as of 2015. The restriction does not apply on weekends, national holidays, and the month of July. (Urban Access Regulations, 2020)

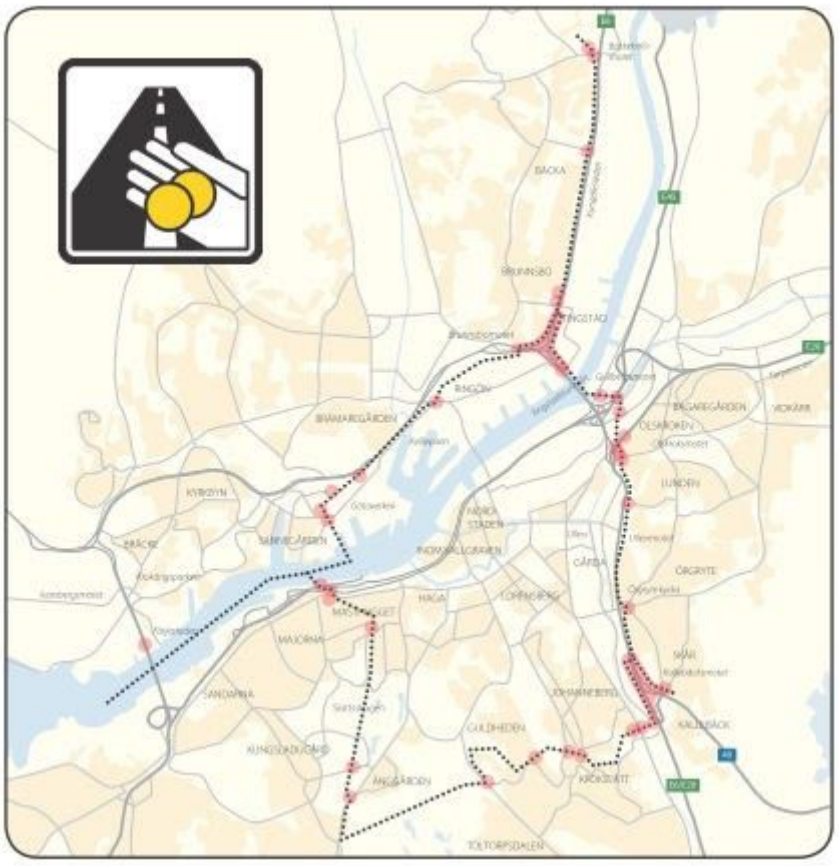

Figure 9: Road pricing area, City of Gothenburg (urbanaccessregulations.eu)

4.2 Analysis of Interviews

This part of the chapter attempts to interpret and analyse the interviews, based on notes and recordings. Some of the respondents did not want to be directly quoted; hence, the authors decided to set this as a rule to be followed, and provide an interpretation of the interviews instead. At the same time the interviews were analysed and presented in a way that follows the same structure, based on concepts identified during the literature review (i.e. barriers, enablers, success factors). The reason for doing so was to make it easier for the reader to follow the interviews. The aim of the interviews was to investigate the concepts identified for IWT and see which of them can be applied for construction logistics and how.

All interviews took place during April 2020. Because of the outburst of the coronavirus pandemic (COVID-19), which affected Sweden, video conferencing was chosen as the appropriate method to conduct them, as explained in Chapter 3.

The following table presents the stakeholders that participated in the interviews for the needs of this thesis. Their names, respective organisations, positions and industry are all mentioned.

The authors wanted all information to be referenced, since they think anonymous responses are less valuable and can be regarded as speculations or made-up. All interviewees were asked and gave permission for their personal data to appear in this thesis.

Interview	Respondent	Company	Position	Industry/Sector
Interview A	Peter Årnes	Kretslopp Och Vatten	Strategic adviser for waste management	Environmental agency
Interview B	Kristofer Andrén	Sea Advice	CEO	Inland Shipping
Interview C	John Wedel	Business Region Gothenburg	Managing Director	Public Sector
Interview D	Björn Södahl	Södahl & Partners AB	Owner	Inland Shipping
Interview E	Ola Gunnarsson	PEAB	Project Manager	Construction
Interview F	Filip Elland	Castellum	Sustainability manager	Real estate
Interview G	Lina Gudmundsson	Älvstranden	Project manager	Real estate
Interview H	Anna Denell	Vasakronan	Sustainability director	Real estate
Interview I	Alexandra Bakosh	Trafikkontoret	Project manager	Urban Transport Administration
Interview J	Pia Berglund	Trafikverket	National coordinator of domestic shipping and short sea shipping	Swedish Transport Administration

Table 3: Presentation of the stakeholders that participated in the interviews

4.2.1 Interview A

Interviewee A found the implementation of IWT for construction logistics a brilliant idea right from the start. He stated that urban waterways are a perfect way to transport construction material and construction waste; he also mentioned that the timing is great because of the construction activity going on in Gothenburg.

He mentioned that according to his point of view, the most challenging part would be the loading and unloading of goods. However, a consolidation center, dedicated to construction logistics, could provide accessibility, lower the transhipment costs and raise the volumes of the goods (materials and waste) to be transported.

When asked about the preconditions needed for such a transition to take place and be successful, he stated that collaboration is the key. There are too many actors that would be involved in a project like that, and without collaboration the transition towards IWT cannot take place. In that context, the municipality needs to take responsibility and that means two things: (i) maintain the infrastructure that is needed in good condition, and (ii) take care of the regulations needed for the movement of heavy traffic, in order to facilitate the modal shift.

When asked to comment on why the waterways are not utilised, he mentioned that the modern city of Gothenburg was built around trucks and cars and that the automotive industry is very dominant in the area. Consequently, the system (i.e. waterways) that was historically used for the transportation of goods was left behind. However, the current construction projects that take place in the city give a great potential for the waterways to start being used again.

When asked about the benefits of the waterways, he mentioned that the decrease of congestion in the city, caused by heavy trucks, would be the biggest benefit. He also stated that Gothenburg is tied to the water for the last 500 years and that when it comes to construction logistics, the transportation of construction waste could be extremely easy to implement.

When asked for a final comment, he mentioned that his opinion is that if the municipality could take care of the infrastructure and the regulations that could facilitate the transition, then the industry could take care of the rest on its own, without other support from the public sector.

4.2.2 Interview B

Interviewee B started by stating that the implementation of the waterways as a mode for logistics is a matter that always stucks in the bureaucracy that the private sector faces when it has to cooperate with the public. He stated that there is resistance from bureaucrats who do not understand the business. He believes that the waterways are a perfect solution when it comes to logistics in general and construction logistics specifically; a solution that could help mitigate the externalities caused by road traffic and help decrease CO2 emissions and congestion, making the city more liveable. Moreover, he believes that trucks have a role to play in an intermodal system; more specifically he mentioned that electric trucks could be used for last-mile deliveries and if they could be limited in last-mile deliveries that alone could help reduce congestion, accidents and air pollutant emissions.

When it comes to the barriers that hinder the transition, he mentioned that there are various challenges that have to be faced. First, there is the matter of infrastructure and how to use it. He stated that most of the actors think that the infrastructure is non-existent, but according to him there are, for example, at least four quays that we could immediately use. He also pointed out that certain authorities, including the Port of Gothenburg, do not even consider the solution of the waterways, and even show a cynical attitude when faced with questions regarding IWT. According to his opinion, the problem with the politicians is that they do not understand shipping and, thus, are unwilling to change their behavior.

Secondly, there is the mindset and behavior of logistics managers, who do not even consider IWT as a solution in most cases. In that context, he mentioned that some of the big shipping companies closely cooperate with the automotive industry and they also fund the shipping association. That is quite problematic, since they do not consider changing their business models and continue doing the same things; of course that is not a problem for the major shipping companies themselves, since they keep making a profit out of this. Last but not least, he mentioned that the financing of IWT is complex and can be perceived as a barrier.

When asked about the preconditions that could move the transition forward, he said that a consolidation center needs to be in place, but that the use of the construction consolidation center cannot be optional; it should be mandatory for every actor to use (the respondent mentioned a specific case in Stockholm, where the local public authorities have made the use of a construction consolidation center mandatory and that their actions boosted the implementation of IWT forward). At that point, he commented that even a barge could work as a floating consolidation center. However, according to his opinion, the consolidation center cannot be run by the municipality, or any other public authority/organisation, but run by professionals instead. He also added that whether we are talking about a consolidation

center or any other logistics solution, the municipality needs to condition procurement by saying that the inbound flows need to be handled in a certain way.

When it comes to the financing, the respondent believes that the government should lower the rules, regarding the specifications of the vessels for example, to make it easier for the industry to find funding. Moreover, he does not believe that the government should provide funding to the industry directly. However, he said that when it comes to the railways and the roadways, the current rates are low and act as a subsidy; those rates should be higher to compensate for the initial investment and the maintenance of the system. The shipping industry, on the other hand, does not have those subsidies and has to finance the whole spectrum of operations, including initial investments and maintenance expenses. Adding to the same problem, the interviewee mentioned that currently there is no market for inland shipping, which means that for a project to be financed the financial institutions (i.e. banks) need to take a very high risk, which they are not ready to.

The interviewee also mentioned that the use of a construction consolidation center is linked to the financing of the project. According to his opinion, since the volumes are going to be generally low and this will affect the profitability of the project in the long run (especially when the construction activity around the river will come to an end), there should be additional operations (e.g. storage) that add value, as part of a holistic approach of the overall service, and this is the only way to compensate for the small volumes.

When asked about the stakeholder with the biggest influence he mentioned that this stakeholder is the clients of the service. Expanding the concept “customer is king”, the respondent thinks that if the customers create the demand then the industry can provide the service.

As a final comment, he added that many people are waiting for trucks to become electric and, thus, emissions-free, but that could not be considered. The main reason is that we should be concerned about how to lower energy consumption and then the emissions will be reduced as well. He also believes that in the future electric energy will become more expensive, due to the taxes that will be imposed for the maintenance of the road network (those taxes are currently imposed upon fossil fuels, but in a future where the use of fossil fuels will be heavily decreased, the same taxes will have to be imposed on the energy that is going to be used at the time). That argument makes the reduction of energy consumption more relevant and raises questions about the extensive use of trucks (i.e. in operations other than last-mile deliveries).

4.2.3 Interview C

Interviewee C started by stating that urban waterways as a mode of construction logistics are a very good opportunity for Gothenburg in the current situation and with the ongoing construction projects around the city. The fact that many construction sites are located in close proximity to the water makes the opportunity greater. In that context, he mentioned that IWT could relieve the city from the congestion problems it faces, plus the waterways are free to a large extent. Moreover, he mentioned that such a project also aligns with the city's ambition to become a "green" example for the rest of the world. He also mentioned that he has witnessed a similar solution being implemented already in London and he is convinced that it could work in Gothenburg as well.

When it comes to barriers hindering the implementation, he mentioned that the biggest challenge is financing, due to the raised costs of transshipments and handling of the material. For that he believes that construction sites need to be located near the water, otherwise the costs would be extremely high.

The second biggest challenge is that there is a knowledge deficit, meaning that city planners, more often than not, do not take into account the transportation of goods, especially construction material and waste, and that makes urban transportation in general, and IWT specifically, difficult to deal with.

When asked about preconditions that could move the transition forward, he mentioned consolidation and close proximity to the water. He then stated that, according to his opinion, some sort of standardisation of the transported units (i.e. containers, pallets, etc.) could help reduce the costs of transshipment, and stressed the importance of a construction consolidation center even further. Finally, he said that according to his perspective, in a service like that (i.e. IWT) reliability is the most important aspect, but speed comes right after and should not be neglected.

Referring to the stakeholder that could have the greatest influence, he believes that the local public authorities could play this role. Of course, there are companies that want to "go green" and they should be part of a project like that, but in the end the biggest winner is the society. Hence, the municipality could be involved in the start-up phase, to initiate a public-private partnership. However, the municipality should facilitate the transition, but without putting barriers/restrictions for other modes of transport.

Finally, he commented that in order for an initiative like this to be implemented, new vessels would be required, since the already existing ones are too old and not "green" enough. If older vessels were to be used, then the costs have to be significantly lower; since that is not

going to happen, because the transported volumes are not going to be high enough, new vessels are a prerequisite that will promote the environmental benefits of the endeavour. The only case for using an older vessel would be to run a project trying to test the solution.

In the same context, he mentioned that the best way to implement IWT would be to start a project, and demonstrate through that the benefits that would come out of IWT. According to his view, the case is not yet clear and that is why companies are not using IWT for their operations already.

4.2.4 Interview D

Interviewee D stated right from the start that IWT is a very suitable way to transport construction material and waste, since the waterways are available and basically free to use. As a solution it has great benefits; most significantly it could reduce congestion levels in the city and relieve the environment from air pollutant emissions, thus contributing to the fight against global warming.

When asked about the challenges that hinder the modal shift, he mentioned costs, delivery times and behavioral challenges as the most difficult to overcome. However, according to his opinion, costs could be overcome if certain volumes were ensured. In that context, a construction consolidation center could be really beneficial, since through that those volumes could be reached. Moreover, the transportation of materials will face less disruptions, due to the fact that waterborne transportation is more reliable and avoids congested roads, and the waste that is going to be generated will be significantly lower. In the case of a consolidation center, he believes that the vessels could serve as such, if needed.

Furthermore, the interviewee commented on the current availability of resources, saying that there are some operators that have barges, but they cannot present a total solution that could guarantee high levels of reliability. Additionally, the technology currently used in IWT is lagging behind the technology of the road transport sector. That can be justified by the fact that IWT has been non-existent and marginalised for a long period of time, but he also stressed that in order to revert the situation the mindset of the automotive industry should be applied to the maritime industry as well.

Making people in the industry change their behaviors was presented as an equally challenging issue. That is exaggerated by the fact that trucks are very efficient and also the fact that road infrastructure is already paid through taxes. At that point the role of the local public authorities was discussed. According to the interviewee, in the public sector there is a level of incompetence and unawareness, and most people in the public sector see the waterways as a barrier and not a possibility to be explored. However, he believes that public

authorities have a role to play in the implementation of IWT; the municipality could regulate logistics and promote the modal shift. Continuing, he commented that the road's external costs need to be internalised, and that the (local) government should provide the framework for that to happen; by doing that it could help "even the playfield" and promote the modal shift indirectly.

Furthermore, local public authorities could be part of a partnership that would promote IWT, but only in the start-up phase; once the modal shift is established the industry professionals can take the venture forward. Finally, the interviewee admits that the public authorities' position is delicate, because they face the risk of being accused that they favour certain players.

When asked about the actors that could participate in a public-private partnership, he said that this is a really complex issue, because there are too many actors. However, he stated that besides shipping companies, the municipality needs to be there, and especially the traffic agency, due to the fact that usually there is a misunderstanding regarding which agency owns what (i.e. infrastructure). But the most influential actors are the buyers of the service, in this case construction and real estate companies; they will create the demand and the market within which IWT will be established.

When asked for a final comment, the interviewee commented that the system could work without an actual consolidation center. In his opinion, the vessels could be used as floating consolidation centers, since they can both consolidate goods and mitigate traffic in the water. Moreover, a floating consolidation center is very flexible, meaning that it could be moved to achieve proximity to the construction site(s) it needs to serve.

Finally, he mentioned that one of the greatest difficulties to overcome, is to make the customers invest in the venture before they see the result. Initial investment is a responsibility nobody wants to undertake and, most of the time, actors in the industry point fingers to each other when they are faced with this challenge.

4.2.5 Interview E

According to interviewee E, the implementation of the waterways as a mode for construction logistics is a good idea, but there are certain things that need to be taken care of. More specifically, the equipment needed is not available and the waterways are not prepared for the venture. Moreover, he mentioned the logistical problem that has to be faced: the construction sites have to be close to the water.

When asked about the reasons that hinder the implementation, he mentioned that the main ones are costs, regulations and time. More specifically, the interviewee believes that the costs for loading and unloading the cargo are quite significant and the fact that the infrastructure is not prepared for the task makes things worse. He pointed out that these are the main reasons why project managers chose already established solutions. If we examine the local suppliers, they are not located near the water, so according to his opinion, trucks have to be used anyway.

When it comes to time, he stated that it is a huge aspect, since the projects that take place in the city have a time horizon that is determined right from the start, and the waterways, although reliable, are not a very fast mode. He mentioned, however, that waterways could work with construction waste, since the time element is not present.

He expressed the opinion that in order to implement IWT, there needs to be a project to demonstrate that the solution works. Without that, there is a risk that the client has to accept and it is very difficult to find actors willing to pay for a risk like that, especially when proven alternatives exist.

Regarding the actors that should take part in a venture like that, he stated that in the industry "client is king". Customers of the service need to be convinced, because they are going to create the demand and they are going to pay for the service. The local public authorities have a role to play; the municipality has to "make the field even". No company will start when they know that they are going to raise the costs, but if it is regulated and part of the contract then it could be seen as a way to start something new. Most importantly, the costs will be higher, but still the same for everyone.

If IWT could demonstrate that it could work, the interviewee believes that in the future it could work well. He mentioned that there could be cost benefits for the industry, due to the capacity of the vessels; construction companies are already aware of that, since they already transport certain materials (e.g. cement, rocks) using waterborne transport. Moreover, a floating consolidation center could be a good idea; consolidation centers already exist, but their location is fixed and a floating one could prove itself very useful and reduce the total transport distances and costs.

As a final comment, he added that construction companies cannot invest in a vessel, because it is too expensive compared to their alternatives. However, if a third party owned a vessel that could be used for their operations and it was available as a service, then he thinks it would be a solution that would be considered, with the precondition that results could be demonstrated.

4.2.6 Interview F

Interviewee F believes that for IWT to be developed and succeed, the demand has to be set. He stated that many organisations, including his, want to reduce their carbon footprint by 2030 in order to be aligned with national and international policies. In order to do so, they have to set targets and that includes two major categories: materials and transportation.

When asked about the barriers that hinder the implementation, he mentioned information incompetence and cost, as the main ones. But in the end it all comes down to costs; that is the reason the interviewee believes that the carbon emissions should be part of the cost (the polluter should pay). Continuing his thought process, he said that, although the company can set whatever demands they want, they have to keep the costs in mind. If they set demands that are too tough, they need to make sure that those demands are met and this is very difficult sometimes. Moreover, there are cases where contractors do not even give an offer because the demands are too tough for them to meet. According to his opinion, one cannot make things too tough too soon.

He also mentioned that one has to keep in mind that the construction industry is not more efficient than 40 years ago. Although some technological progress has been made, the sector is quite slow and usually does not change the way of doing business, especially if it worked during the last development project. The sector prefers already proven solutions and that keeps the level of innovation low.

When asked about the different actors that should take part, he mentioned that a collaboration between the city of Gothenburg and the different actors in the industry is a prerequisite; he believes that everybody involved should be included, from the real estate companies and the carriers to the waste contractors, if they are involved at some point in a development project. Otherwise, if it is a single company, he believes that it is just a project and the chances of turning it to a success story that could be implemented are low.

Besides collaboration, he mentioned that the municipality has to set the demand by creating a framework to mitigate the traffic to the water. However, when faced with the question about who could be the most influential actor that could move things forward, the interviewee answered that either the university or the city planning authorities should take it forward; a private organisation cannot do this, since that could raise competition issues. Furthermore, he stated that a solution like this (i.e. IWT) needs planning, if we want to use it as a long-term solution and not something that will be implemented once for the needs of a specific project and not used again in the future.

Finally, he commented that the implementation of greener solutions is a political decision. Political authorities play a key role, because the industry needs a framework within which to operate. That means that the appropriate decisions could move the transition forward much faster.

4.2.7 Interview G

According to interviewee G, as long as the river is not used to a greater extent, it is only an obstacle that separates the two sides of the city. Currently, the points of access are not a lot and that causes problems when it comes to transportation.

Moreover, she mentioned that at the time of writing this report, there is a project in Frihamnen, trying to test a transport solution regarding the waterways. However, she mentioned several barriers that have to be addressed; most importantly, companies want continuous flows and are afraid of the delays that may be caused when using IWT. Furthermore, many companies do not see the environmental benefits of using IWT, since they will use trucks for the last mile deliveries anyway. Finally, she stated that the cost of investment is also something to be considered; some infrastructure already exists, but the condition is quite bad at the moment and it needs to be better prepared if it is to be used in the future (the interviewee mentioned, for example, that certain parts of the land have to be raised due to the rising water levels).

When asked about the benefits, the interviewee commented that she is convinced of the benefits in terms of emissions and congestion, and she believes that the timing is also right to implement such a solution; everybody (private companies, public authorities, etc.) want to lower their CO2 emissions and the ongoing RiverCity project is a great opportunity to implement a solution that will stay after the project is finished. However, the municipality has to be clear from the start in order to set certain demands for the industry to operate.

At that point, the interviewee pointed out that, according to her opinion, the municipality is the most influential stakeholder; it owns the land (e.g. Frihamnen) that could be used to test solutions, and since high initial investments are needed the municipality has to undertake some of the cost initially. However, there is a conflict among the different public agencies about who owns what infrastructure and that hinders the implementation in a way.

According to the interviewee, the implementation of IWT is also a political decision; the city understands that the different parts of the metropolitan area are quite segregated and the river could be the way to connect them. When it comes to the different problems that have to be faced, the interviewee stated that there are some issues with bridges (e.g. low bridges built for

pedestrians and cyclists are an obstacle for IWT), but these problems could easily be overcome (e.g. bridges can open and close, time windows can exist, etc.).

When asked about the factors that could enable IWT in the area, the interviewee pointed out collaboration among the actors, infrastructure for loading, unloading and storage (i.e. consolidation center) and political decision as the most important ones. She seems convinced that if the solution existed the market for it would also exist and the industry would use it. According to her, the municipality, as a dominant and influential actor, should initiate certain actions to promote the collaboration, but also to invest in the infrastructure needed.

The case of a construction consolidation center was discussed extensively. According to the interviewee, the municipality can provide the land for a construction consolidation center (e.g. at Frihamnen); that is going to happen anyway regardless of the transport solution, since the construction activities in the area are going to last for the next couple of decades and inhabitants will start occupying the area during the same period. As the interviewee commented there will be children who will live most of their years in a construction site, and a consolidation center is something that will promote their safety in the first place and be helpful for the industry as well. The question is where to put the CCC; if the agencies in charge are convinced that the river is going to be used in the future then the CCC can be located next to the water to facilitate the transport solution. However, if they are not convinced that this is going to be the case, the CCC will be built away from the river, where land is cheaper.

When asked for her final thoughts, the interviewee said that we have to keep in mind that Gothenburg is a "car city". The automotive industry is part of the city's identity and that is something that is not going to change from one day to another. Moreover, she pointed out that construction waste could be easier to handle as cargo, because the time aspects are not that important and the industry would be more willing to transport it via IWT. Finally, she commented that the municipality has to be more proactive and think about those things early before the initiation of a project (e.g. RiverCity); when things have started it is really hard to make changes, since nobody is willing to change their operations in the middle of the project.

4.2.8 Interview H

Interviewee H believes that IWT is a good idea to start with, although she admitted not having seriously considered it as an option. She mentioned that IWT could be a good way to reduce the externalities of the road system. However, she also believes that the biggest benefits would be societal ones and not environmental ones, since although CO2 emissions could be reduced, there would be a rise in other types of emissions, like SOx and NOx. By societal benefits, she referred to the congestion problem that Gothenburg faces, which affects

people (i.e. people using the road, people going to their workplaces, noise problems, etc.). In her opinion, it would be good to mitigate some of the flows to the water, if the society was to be relieved from such issues.

The interviewee mentioned that the best thing to do right now is to test the solution and be able to demonstrate results for the actors that are going to use it. She also mentioned that if the industry was convinced about the social and environmental benefits of IWT, it would be easier for developers to demand such a solution from the contractors.

When asked about challenges that hinder the implementation, the interviewee mentioned that (i) costs of transhipment and (ii) lack of awareness are probably the most important ones. She mentioned that the costs of transhipment are quite high for a single company to deal with, if that company wants to hold an advantage over its competition. Lack of awareness is self-explanatory; most people in the industry have little to no knowledge about the environmental and social benefits of IWT and most of the time it is not even considered as an option.

Furthermore, the interviewee referred to a couple of drivers she things could change the situation; she mentioned of a law that will be implemented by January 2022, which will make it compulsory for companies to make a declaration of their environmental/climate impact; transportation is a important part of a company's environmental impact at the time of writing this report. She also mentioned that usually there is some level of cooperation among the actors in the industry, but competition is always present and everyone wants to be in an advantageous position in terms of costs.

When asked about the actors/stakeholders that could move IWT forward, the interviewee mentioned that the municipality is probably the most influential stakeholder. The (local) public authorities are always important, and if the municipalities use their bargaining power then usually companies are forced to innovate and come up with solutions for things that were considered impossible before that. Then the buyers of the service (i.e. real estate companies) would be the most important actors, since they will be the ones to create a market for IWT. According to the interviewee, it is the real estate companies that could influence the transition towards IWT, because the contractors will not easily change their way of doing business if certain requirements are not set. It was mentioned, during the interview, that it is usual for real estate companies to think that their contractors will refuse to deliver under tougher requirements, but in practice that hypothesis has not been confirmed; real estate companies cannot be too tough too soon, but it is usually safe to be ambitious and set requirements.

As a final thought, the interviewee commented that if IWT could be used after the end of a development project and not be tied only to that development project, that would make it an interesting idea and give it some potential. However, it is unlikely to have an impact in the

decision making process of the industry, although it could be beneficial. Finally, she mentioned that although a real estate company would be unwilling to invest themselves in IWT and the infrastructure needed to support it, she believes that the industry could contribute by using the solution and the infrastructure while developing their projects, if it seems like a suitable solution.

4.2.9 Interview I

Interviewee I believes that IWT is very suitable for Gothenburg, and that the local public authorities think alike, since it can transport huge volumes and have huge benefits for the society at the same time. She mentioned that the road network is too congested and the municipality is getting a growing number of complaints to relieve the problem. Furthermore, she mentioned that in order to implement IWT, certain things have to be taken care of. First, the mandate and the responsibility of the different agencies of the administration should be considered. The second aspect is the infrastructure; where it should be located, how it is going to be shaped, what the costs are, and so on. Then, the flows of materials have to be considered; what types of goods are the waterways more suitable for transporting. Finally, one should look at the business model that could make the operations economically sustainable in the future.

At the time of writing this report, there seems to be an ambition from the municipality of Gothenburg to engage and work more with the waterways, but it is not mature yet. According to the interviewee, the municipality should provide the infrastructure, since it is their responsibility, but they should also set requirements under which the industry could work. Moreover, she commented that these requirements should be set during the procurement process, so that every part is aware of what is expected from them and act accordingly. However, in order to do so, the solution has to exist already.

When asked about the factors that could hinder the implementation of IWT, she stated that those are: the ownership of the infrastructure, the investment costs that are quite high, and the limited resources available to get things started. The most important thing to do is try to motivate the policy makers to invest in the infrastructure needed for the modal shift to take place. In order to do that, the one thing that should be clear is to identify which agency owns what; the interviewee commented that according to her personal opinion, it would be better if one administration/agency is responsible for everything. Furthermore, she believes that a document should exist for everyone to know how to use the waterways.

When asked about the different actors that should participate in a project like that, she mentioned that the triple helix model (government, industry, academia) is the preferred way to move forward. Construction companies need to participate, along with real estate

industries, and cooperate with public authorities and academia. Moreover, the role of the local public authorities is very influential in such a venture, and it is the municipality's responsibility to provide what the society and the industry needs. However, the interviewee mentioned that the role of the public authorities is not to start those initiatives, but rather facilitate them.

Adding to her previous statement about the role of the public authorities, the interviewee mentioned that the Swedish Transport Administration (Trafikverket) is probably the most influential stakeholder, since they have great bargaining power and their opinion matters when they set requirements.

When asked for a final comment, the interviewee stated that the municipality is trying to build a sustainable city and is aware that this task requires innovative thinking; it is, therefore, the municipality's will to participate in projects in order to find the solutions that are needed. However, everything has to be set early, before the project starts, because once an area is built the opportunity is lost forever. When asked to clarify that comment, she said that if for example, we need to have a consolidation center that will facilitate IWT after the development is finished, that has to be decided during the procurement phase and be part of the contract; if the development project starts that opportunity is lost.

Figure 10: Map showcasing the ownership problem across Göta Älv; different colours indicate different agencies responsible (For complete map and agencies' information see appendix, Exhibit 2)

4.2.10 Interview J

Interviewee J is absolutely convinced that IWT is a suitable solution that could be implemented in Gothenburg. She also commented that the timing is right, due to the fact that the swedish administration is committed to the task and has prioritised the modal shift since 2014. The government, especially the national government, wants to promote maritime transportation due to the fact that it deals with climate change and the rising congestion levels especially in the big cities, including Gothenburg.

When asked to identify the reason why the modal shift has not happened so far (it is 9 years since the EU issued the relative White Paper and 6 years since the commitment of the swedish administration), she pointed out that historically the automotive industry is a huge part of the city's economy and identity; that affect not only the decision making process, but also the resources available for research. However, she mentioned that until the 1980's there was a strong shipping industry in the area, but since most of the shipyards have closed during the last 30-40 years, the momentum was lost. Local citizens do not consider Gothenburg to be a city with a shipping tradition, although that was not always the case; the fact that the port is located in an area that is not visible by the citizens only strengthens their mindset not considering that there is a strong shipping tradition. Moreover, the technological progress in the automotive industry has made the trucks very reliable and in most cases the actors involved do not even consider maritime solutions.

However, the bigger value from the implementation of IWT is for society, and that is the reason why the municipality has to set guidelines regarding procurement practices for everyone to follow. Finally, one of the barriers is that the waterways are difficult to administrate, due to the fact that many agencies are involved.

When asked about the problems that entrepreneurs have to face, she commented that the biggest problems for them are the registration fees, which are really high, and the strict regulation set by the swedish government (in case one wants to sail under the swedish flag). She mentioned examples of shipping companies operating under other EU flags, and commented that although it looks bad for the swedish administration, she can see the reason behind that move. The swedish administration should take those incidents into consideration.

As far as the role of the public authorities is concerned, the interviewee stated that the waterways are a huge asset for the city and, therefore, the local authorities have to be engaged more, since it is also the society that will benefit on a local level. And since the public is going to benefit to a degree, the public authorities need to take and risk and invest to a degree as well. But in order for that to happen, the authorities need to change their perspective,

which leads to the general public being more informed, change their perspectives in the first place, and influence the policy makers.

When asked about the most influential stakeholders, the interviewee referred to the public authorities once more. She mentioned that the public authorities have the money and make the research needed for the modal shift to take place. To a certain extent, the implementation of IWT is a political decision. Then, the private sector needs to get on board, since they will create the market for the service. The interviewee commented that according to her opinion, formed from identifying success factors in similar projects across Europe, projects that are successful involve few big players. The projects in Sweden, however, have involved smaller players, and the problem is that smaller players need to make a profit from the start in order to sustain business. Big organisations, on the other hand, can make investments and commit to a project that is initially unprofitable, if they see that there is future potential.

When asked for factors that could promote the success of the modal shift, other than the involvement of big companies and the political decision, the interviewee mentioned the need for a consolidation center that could facilitate the whole process and make it easier for the companies to work. She also mentioned a case from Belgium, where there is an online platform in place that helps the companies manage their operations in a simple, easy and seamless way, pointing out that something similar could work in Gothenburg as well, facilitating IWT.

When asked for her final thoughts, the interviewee commented that a collaboration among the different stakeholders involved and the public authorities is essential for the success of the project, and that municipalities should set requirements and provide support at the same time. She, finally, noted that the existence of an overall (national level) policy could be extremely helpful.

4.3 Summarising Analysis

As presented in the data collection and analysis, some of the concepts that were identified during the literature review were mentioned by the interviewees, while others did not. That outcome was expected by the authors, since the report examined a phenomenon (i.e. the implementation of IWT), and its application in a specific geographical area, by a specific sector of the industry (i.e. construction logistics). In order to provide a better understanding of the concepts that were identified and examined during the data collection and their analysis, a summarising table has been made to provide a clear viewpoint of the concepts discussed.

Respondent	Benefits	Barriers	Prerequisites	Influential Actors
Interviewee A	- Reduce congestion	- Initial investment - Transhipment costs	- Collaboration among stakeholders - Consolidation center	- Local public authorities
Interviewee B	- Reduce CO2 emissions - Reduce congestion	- Bureaucracy - Lack of knowledge	- Consolidation center - Set demands during procurement	- Buyers
Interviewee C	- Reduce CO2 emissions - Reduce congestion	- Funding/Costs - Knowledge deficit	- Consolidation center - Proximity to the water	- Local public authorities
Interviewee D	- Reduce congestion - Reduce global warming	- Costs - Delivery times - Behavioral challenges - Lack of resources - Technology - Regulations & lack of competence in the public sector	- Consolidation center - Knowledge - Competence	- Buyers
Interviewee E	- Reduce costs	- Costs - Regulations - Time limitations	- Consolidation center - Demonstrate results	- Buyers
Interviewee F	- Reduce CO2 emissions - Reduce congestion	- Information incompetence - Costs - Technology	- Collaboration among actors - Regulations	- Local public authorities - Academia
Interviewee G	- Reduce emissions - Reduce congestion	- Delays - Cost of investment - The industry does not see environmental benefits	- Collaboration among actors - Infrastructure, including consolidation center - Political decision	- Local public authorities
Interviewee H	- Reduce congestion	- Costs, including transhipment costs - Lack of knowledge	- Ensure longevity of the solution - Collaboration among actors	- Local public authorities - Buyers

Interviewee I	- Reduce congestion	- Ownership of infrastructure - Investment costs - Lack of resources	- Mandate ownership of infrastructure	- Local public authorities - Swedish Transport Administration
Interviewee J	- Reduce congestion	- Ownership of infrastructure - Technology - High registration fees	- Mandate ownership of infrastructure - Collaboration among actors - Involvement of big companies - Political decision	- Local public authorities

Table 4: Key findings in data collection & analysis

5. Conclusion & Recommendations

The following chapter tries to provide a conclusion (Chapter 5.1) based on the information obtained during the interviews (Chapter 4), taking the literature review that was conducted (Chapter 2) into consideration. Furthermore, the authors attempt to give some recommendations regarding the successful implementation of IWT in a local context (Chapter 5.2). Chapter 5.3 tries to provide further recommendations regarding innovation-friendly regulations and the role of the public sector, since it was a topic that all stakeholders mentioned and found important, but they were unclear on how it should be handled in a way that could boost the competitiveness of the industry without the public authorities directly intervening in the operations of specific companies. Finally, since the scope of this thesis was to investigate the transport solution only, Chapter 5.4 focuses on further research that could be valuable to obtain a holistic perspective and clearly conclude whether the implementation of IWT for construction logistics is a feasible and sustainable solution that could be implemented in the future.

5.1 Conclusion

The purpose of this thesis was to investigate the implementation of inland waterways as a transport mode for construction logistics in Gothenburg, and come up with new knowledge, inputs and perspectives regarding the implementation of the waterways in that context. A literature review was conducted to identify relevant concepts and formulate a theoretical framework that would facilitate the research. In order to complete the research, the literature review was complemented with data from semi-structured interviews with various stakeholders holding key positions within relevant organisations. In general, the stakeholders that took part in the interviews hold key positions in the public as well as the private sector of the economy. Consequently, that provided great insight and the best possible understanding of the situation in a local context. More specifically, stakeholders that hold positions within the shipping, real estate and construction industries were chosen and their input was examined in relation to the views of various stakeholders from the local public authorities.

To answer the first research question, *What is the potential for the implementation of the waterways, as a transport mode for construction logistics, in Gothenburg?*, the authors concluded that inland waterway transportation has a great potential, as a transport solution, in Gothenburg, and that potential is even greater when it comes to construction logistics. That statement is justified by various reasons. First, the timing is right when it comes to national and international politics; the EU has been trying to promote environmentally friendly

transport solutions since 2011, prioritising inland waterway transportation across Europe. Moreover, the national government has prioritised the same thing since 2014 and is completely aligned with the European policies. That means that there will be a growing amount of regulations promoting the modal shift across Sweden.

Gothenburg, on the other hand, is a city with a great shipping tradition. Not only is it the biggest port in Scandinavia, but the city has access to a navigable river (Göta Älv) that runs across the city. The river, along with the canals, was used in the past to transport freight; as a solution is not new and has been used in the past quite successfully. However, at some point it was (deliberately) left behind and nowadays there are problems that have to be addressed, mainly regarding the condition of the infrastructure. But for the most part, the river is free infrastructure, it is easily accessible, since it runs across the city, and is currently severely underutilised, meaning that even the slightest transport activity could make a great difference in making the transport system more sustainable, relieving the city from congestion and pollution.

Furthermore, there is a growing "movement" in Sweden and worldwide, with people demanding greener solutions and organisations trying to innovate to overcome the current problems in order to provide those solutions. The real estate (and construction) industry is no different; most real estate companies are striving to transform their business, so that they can be environmentally friendly and set standards of corporate citizenship that could benefit the local community and society at large to a greater extent. One information that derived from the interviews was that there is going to be a law in Sweden, which will hold companies accountable for the damage they inflict on the environment. Besides operations, the biggest part of their carbon footprint comes from transportation; that could motivate them to set certain demands towards their contractors during the procurement phase so that the latter meet certain standards. IWT could play a significant role in a system like that (intermodal or not) that benefits society at large, either by reducing the amount of air pollutant emissions, or by relieving the city from the congestion problems that it is facing.

Finally, there is a lot of construction activity in the area, and the development projects will keep adding pressure to the current transport system for the next 20 years at least. However, that is also a great opportunity; if IWT succeeds in becoming an established solution, it could be a transport mode that could be used for a period of time that exceeds the development of the area. It could also change the perception of the general public, restoring the shipping tradition that was part of the city's identity in the past.

To sum up, the authors believe that IWT has a great potential as a transport mode in Gothenburg. The potential is even greater for construction logistics, due to the fact that the timing is perfect (in terms of political decisions and awareness from society) and development projects in Gothenburg provide a first-class opportunity to implement a transport solution that will be used to a great extent after the biggest part of the development

is completed, in order to facilitate construction logistics in the future. Society could be the biggest beneficiary from the implementation of the mode that could help reduce air pollutant emissions and relieve the city from its current congestion problems.

5.2 Recommendations

When it comes to answering the second research question, *Are the waterways a solution, when it comes to construction logistics, that could complement or serve as an alternative to the current road network?*, the authors concluded that although IWT has a great potential to become a solution that could serve as an alternative, right now the situation is far from optimal; the barriers are significant and most of the preconditions that were identified during the literature review and pointed out by the interviewees are far from being satisfied.

5.2.1 Overcoming the Barriers

The main barriers that were identified were the costs, including initial investments, costs of operations and maintenance of the infrastructure, as well as the lack of knowledge that is evident within the policy-makers and the professionals within the industry alike. Last but not least, a problem that was also mentioned multiple times, was the administration of the waterways, with far too many agencies in charge of different parts of the waterways at the same time.

Furthermore, during the interviews that were conducted for the needs of this thesis, it was made clear that certain preconditions could facilitate the transition towards IWT; most notably the idea that a consolidation center could help the transition by assuring the volumes needed for IWT to be economically sustainable, the fact that a level of collaboration among the different actors could be extremely helpful, and, finally, that there should be a change in the behaviours adopted by all the stakeholders (industry, public sector, and society at large).

The identified barriers and the preconditions mentioned are correlated and in most cases an improvement of one leads to the implementation of the other and vice versa. Following, this concept will be elaborated upon, in order to come up with recommendations that build on the preconditions already mentioned, to minimize the barriers that were identified.

The authors believe that the existence of a consolidation center is one of the preconditions that could make the solution feasible, if implemented. The use of the consolidation center should be mandatory (regulated by the local public authorities) and set as a demand during the procurement phase by real estate companies. That way, the field would be even for all the actors involved and “business as usual” will not lead to competitive advantages.

Funding could also be provided, in order to research the way that the modal shift will be made possible. The funding could be provided either by the public authorities, through the local universities, or by the companies involved in the construction industry through pilot projects similar to DenCity. A move like that could be beneficial in two major ways; first, the knowledge needed to implement IWT could be reached, leading to better solutions (in the technology sector and the policies needed), and second, it could help change the behaviour of the stakeholders involved (industry, public sector, and society) by demonstrating tangible results and also providing the socio-technical framework under which the solution could be implemented successfully.

Furthermore, there should be a collaboration among the different actors; that could help raise awareness and also deal with the practical problems of the implementation, in a way that takes every opinion into consideration. A way to achieve a level of collaboration among stakeholders was described in Chapter 2, under *Partnerships among stakeholders* and *Cooperative freight transport system*. The collaboration could be initiated by any stakeholder with bargaining power. However, the authors believe that it should be facilitated by the local public authorities, in cooperation with the local universities, since they seem to have the power, the legitimacy and the urgency to do so, and are, thus, presented as the most suitable stakeholder to take action.

Moreover, one of the barriers that should be dealt with is the administrative process regarding the waterways. The fact that there are too many agencies responsible for different parts of the waterways makes it difficult to implement IWT for two reasons. First, it is complicated for the different authorities to reach consensus regarding (i) the funding for the construction and maintenance of the infrastructure, as well as (ii) the policies needed for the modal shift to take place successfully. The second reason has to do with the problems of the industry; when an entrepreneur wants to invest in IWT he or she has to go through various agencies facing a complicated and uncomfortable situation, with one agency directing him or her to the other in a never-ending loop. That causes frustration, is often perceived as bureaucracy and discourages investments from organisations that may have the knowledge and the resources to move IWT forward. Thus, the authors are convinced that one agency should be responsible for the ownership of the navigable waterways. However, a document that could set the guidelines regarding the ownership of the infrastructure across the waterways and the way IWT should be administered could be equally beneficial, giving the perception that the different agencies work as one body to facilitate the modal shift.

Finally, the local public authorities are believed to be those that should invest in the infrastructure needed for IWT, since it is them that own the waterways and the land that surrounds them; the authors believe so as well. By investing in infrastructure, the public authorities make it clear that they support the transition towards IWT, not only in principle, but also by taking specific actions. The investment needed is totally justified, due to the fact

that the biggest benefits will be for society (by eliminating the effects of the externalities of transportation, i.e. emissions, congestion, etc.). However, the authors also believe that since it is tax-payers money that will be used for these investments, the authorities also have a duty to be proactive and set very specific demands for the industry to follow, in order to make sure that the investments not only improve the performance of the industry, but also benefit society as expected.

5.2.2 Innovation-Friendly Regulation

During the interviews, the role of the local public authorities was mentioned by all respondents. Not everyone has the same expectations from the authorities, but there is some common ground found among them. According to the overall opinion, the local public authorities should provide the framework within which the industry shall operate. However, the regulations should not aim to punish certain modes, but rather promote the modal shift by making the field even for everyone and encouraging the industry to innovate. The regulations in Gothenburg are limited to access restriction that are inefficient, since they either fail to target freight transport (i.e. road pricing targets citizens as well), or they have the opposite result than expected (i.e. access restrictions eventually increased congestion, with more lighter vehicles replacing the fewer heavy ones).

The expectations of every stakeholder seem to be aligned with the Porter Hypothesis; according to the Porter hypothesis, rigorous environmental regulations can stimulate efficiency and encourage innovation that will eventually improve the performance of the sector and tackle sustainability problems at the same time.

The authors believe that the set of guidelines that was discussed in Chapter 2.7.2 could serve as a good starting point for policy-makers to trigger innovation within the construction industry without driving up the costs. It is also consistent with the views of the respondents from the private and public sector alike, as they were expressed during the interviews conducted for the needs of this thesis.

5.3 Future Research

The aim of this thesis was to investigate a specific transport solution and discuss its potential for implementation. However, the technical aspects of IWT were neither investigated nor discussed. Consequently, a possibility for further research could be concerned with the technical aspects, including the technology, the types of vessels, and the equipment needed to facilitate the modal shift in a sustainable way, thus, increasing its feasibility.

Secondly, further research could be conducted to determine the logistics chain that would make IWT available in the specific geographic area (West Sweden in general and Gothenburg specifically), elaborating more on concepts (e.g. logistics solutions like construction consolidation centers) that could facilitate the operations of IWT.

6. References

Achmadi, T., Nur, H.I. and Rahmadhon, L.R., 2018, March. Analysis Of Inland Waterway Transport For Container Shipping: Cikarang To Port Of TanjungPriok. In IOP Conference Series: Earth and Environmental Science (Vol. 135, No. 1, p. 012015). IOP Publishing.

Agapiou, A., Clausen, L. E., Flanagan, R., Norman, G. & Notman, D. 1998a. The role of logistics in the materials flow control process. Construction Management and Economics, 16, 131-137.

Anderson, S., Allen, J. and Browne, M., 2005. Urban logistics—how can it meet policy makers' sustainability objectives?. Journal of transport geography, 13(1), pp.71-81.

Baird, A. J., 1998, Fast freight ferries as an instrument of modal shift. In Proceedings of the Conference on Fast Seaborne Transportation (London: Royal Institution of Naval Architects).

Baird, A.J., 2007. The economics of Motorways of the Sea. Maritime Policy & Management, 34(4), pp.287-310.

Bampton, R. and Cowton, C.J., 2002. 'The E-interview'. Forum Qualitative Sozial.

Bayles, M., 2012. Is Physical Proximity Essential to the Psychoanalytic Process? An Exploration Through the Lens of Skype? Psychoanalytic Dialogues, 22/5: p. 569-85.

Benson, J. K., 1975. The Interorganizational Network as a Political Economy. Administrative Science Quarterly, 20, 229-249.

Bergqvist, Rickard, and Johan Woxenius., 2011. "Hinterland Transport by Rail – The Story of Scandinavia and Port of Gothenburg." Journal of Interdisciplinary Economics 23 (2): 161–175.

Bestfact,. 2013a. Supermarket stores deliveries using waterways in Paris. Available: http://www.bestfact.net/wp-content/uploads/2016/01/CL1_051_QuickInfo_Franprix-en-Seine-16Dec2015.pdf. Last accessed 31st March 2020.

Bestfact, 2013b. Zero-Emission Beer Boat in Utrecht. Available: http://www.bestfact.net/wpcontent/uploads/2016/01/CL1_151_QuickInfo_ZeroEmissionBoat-16Dec2015.pdf. Last accessed 31st March 2020.

Bestfact, 2014. Vert chez vous, an urban logistics with 100% environmentally friendly vehicles, and offering multimodal transport combining bicycle and river transport. Available: http://www.bestfact.net/wp-content/uploads/2014/02/Bestfact_Quick_Info_GreenLogistics_VertChezVous.pdf. Last accessed 31st March 2020.

Bestfact, 2015. Barge transport in inner city of Amsterdam, the case of Mokum Mariteam. Available:http://www.bestfact.net/wp-content/uploads/2016/01/CL1_127_QuickInfo_Mokum Mariteam-16Dec2015.pdf. Last accessed 31st March 2020.

Breuil, D., and Sprunt, D., 2009. Cities of La Rochelle and Norwich—Goods distribution and city logistics. CIVITAS Initiative. Austria. www.civitas.eu

Brinkmann, S., 2013. Qualitative interviewing. Oxford university press.

Browne, M., Lindholm, M., and Allen, J., 2014. Partnership Among Stakeholders. In: Taniguchi, E., and Thompson, R.G. City Logistics; Mapping The Future. Boca Raton: CRC Press. P13-24.

Browne, M., Sweet, M., Woodburn, A., and Allen, J., 2005. Urban freight consolidation centres, final report, University of Westminster.

Brundtland, G.H., Khalid, M., Agnelli, S., Al-Athel, S. and Chidzero, B., 1987. Our common future. New York, p.8.

Brunge, K., 2013. Förbättrad logistik för byggmaterial i Norra Djurgårdsstaden. Master of Science Master of Science, Royal Institute of Technology.

Bryman, A. and Becker, S., 2012. Qualitative research.

Bryman, A., & Bell, E., 2015. Business research methods. Oxford University Press, USA.

Buchanan, E. A., & Zimmer, M., 2012. Internet Research Ethics.The Stanford Encyclopedia of Philosophy (Spring 2015 Edition)

Caris, A., Limbourg, S., Macharis, C., van Lier, T. and Cools, M., 2014. Integration of inland waterway transport in the intermodal supply chain: a taxonomy of research challenges. Journal of Transport Geography, 41, pp.126-136.

Carlén, V., Josefsson, A. and Olsson, L., 2013. The potential role of urban waterways in sustainable urban freight transport-A case study of mass transport from the construction of Västlänken (Master's thesis).

Cater, J., 2011. Skype – A Cost-effective Method for Qualitative Research.Rehabilitation Counselors & Educators Journal, 4/2: p. 3.

Cohen, L., Manion, L., & Morrison, K., 2007. Research methods in education, 6th ed. London; New York: Routledge

Collis, J., & Hussey, R., 2013 . Business research: A practical guide for undergraduate and postgraduate students. Palgrave macmillan.

Crainic, T.G., Ricciardi, N., and Storchi, G., 2009. Models for evaluating and planning city logistic transportation systems. Transportation Science, 43(4):432–454.

Deakin, H., & Wakefield, K., 2013. Skype interviewing: reflections of two PhD researchers.Qualitative Research, 14/5: p. 1-14.

Dreborg, K. H., 1996. Essence of backcasting. Futures, 28(9), 813-828.

Dubois, A. & Gadde, L.-E., 2000. Supply strategy and network effects – Purchasing behaviour in the construction industry. European Journal of Purchasing and Supply Management, 6, 207-215.

Dubois, A. and Gadde, L.E., 2002. Systematic combining: an abductive approach to case research. Journal of business research, 55(7), pp.553-560.

European Commission, 2001a. The Transport Policy – as the April Resolution – adopted by the Ministers responsible for Transport and Communications at the 2340th meeting of the European Union's Council of Ministers.

European Commission., 2001b. European Transport Policy for 2010: Time to Decide. Luxembourg: European Commission.

European Commission., 2011. Transport White Paper: Roadmap to a Single European Transport Area – Towards a Competitive and Resource Efficient Transport System.

Eurostat., 2013. Key figures on Europe; 2013 digest of the online Eurostat yearbook, Publications Office of the European Union, Luxembourg.

Fazi, Stefano, Jan C Fransoo, and Tom Van Woensel., 2015. "A Decision Support System Tool for the Transportation by Barge of Import Containers: A Case Study." Decision Support Systems 79: 33–45.

Fernie, S. & Thorpe, A. 2007. Exploring change in construction: supply chain management. Engineering, Construction and Architectural Management, 14, 319-333.

Fleitas, J., 1998. Spinning Tales from the World Wide Web: Qualitative Research in an Electronic Environment. Qualitative Health Research, 8/2: p. 283-92.

Flodén, J., Bärthel, F. and Sorkina, E., 2017. Transport buyers choice of transport service–A literature review of empirical results. Research in Transportation Business & Management, 100(23), pp.35-45.

Garcia, A. C., Standlee, A. I., Bechkoff, J., & Yan, C., 2009. Ethnographic Approaches to the Internet and Computer-Mediated Communication. Journal of Contemporary Ethnography, 38/1: p. 52-84.

Göteborgs Stad,. 2015. Stadsutveckling 2035 [Online]. Available: http://goteborg.se/wps/portal/enheter/projekt/stadsutveckling-2035 [Accessed 2nd March 2020].

Guldbrand, S., Johansson, L. and Westblom, L., 2015. Estimating freight deliveries in urban environments-An application to Frihamnen (Master's thesis).

Hanna, P., 2012. Using internet technologies (such as Skype) as a research medium: a research note. Qualitative Research, 12/2: p. 239-42.

Hay-Gibson, N. V., 2009. 'Interviews via VoIP: Benefits and Disadvantages within a PhD study of SMEs', Library and Information Research, vol. 33, N° 105, 2009.

Holmberg, J. & Robèrt, K.-H., 2000. 'Backcasting from non-overlapping sustainability principles', International Journal of Sustainable Development and World Ecology

Holt, A., 2010. Using the telephone for narrative interviewing: A research note. Qualitative Research, 10(1), 113-121.

Jandl, O.M., 2016. Implementing Inland Waterway Transportation in Urban Logistics (Master's thesis).

Janjevic, M., Ndiaye, A.B., 2014. Inland waterways transport for city logistics: a review of experiences and the role of local public authorities. In: Brebbia, C.A. (Ed.), Urban Transport XX. WIT Press, Southampton, UK.

Janné, M., 2018. Construction logistics solutions in urban areas (Vol. 1806). Linköping University Electronic Press.

Johnson, B., & Christensen, L., 2008. Educational research: Quantitative, qualitative, and mixed approaches. Sage.

Karrbom Gustavsson, T. & Gohary, H. 2012. Boundary action in construction projects: new collaborative project practices. International Journal of Managing Projects in Business, 5, 364-376.

Karrbom Gustavsson, T. & Hallin, A. 2015. Goal seeking and goal oriented projects – trajectories of the temporary organisation. International Journal of Managing Projects in Business, 8, 368-378.

King, N., & Horrocks, C., 2010. Interviews in Qualitative Research, 1 edition. Los Angeles: Sage Publications Ltd

Konings, J.W., 2009. Intermodal barge transport: network design, nodes and competitiveness.

Larsson, J. & Holmberg, J., 2018. Learning while creating value for sustainability transitions: The case of Challenge Lab at Chalmers University of Technology. Journal of Cleaner Production, 172, 4411-4420. https://doi.org/10.1016/j.jclepro.2017.03.072

Lindholm, M., 2012. Enabling sustainable development of urban freight from a local authority perspective. PhD thesis. Chalmers University of Technology, Gothenburg, Sweden.

Lindholm, M., and Browne, M., 2013. Local authority cooperation with stakeholders: A comparison of partnership approaches. European Journal of Transport and Infrastructure Research, 13(1), 20–38.

Locatelli, G., Mancini, M. & Romano, E., 2014. Systems Engineering to improve the governance in complex project environments. International Journal of Project Management, 32, 1395-1410.

Lowe, D., 2006. Intermodal freight transport. Routledge.

Lundesjo, G. 2010. Barts Hospital, London. Banbury, Oxon, Great Britain.

Lundesjö, G., 2015. Consolidation Centers in Construction Logistics. In: Lundesjö, G. Supply Chain Management and Logistics in Construction. London: Kogan Page Limited. P225-242.

Macharis, C., and Pekin, E., 2009. "Assessing Policy Measures for the Stimulation of Intermodal Transport: A GIS-Based Policy Analysis." Journal of Transport Geography 17 (6): 500–508.

Maes, J., Sys, C., Vanelslander, T., 2012. Vervoer te water: linken met stedelijke distributie? Policy supporting paper, Steunpunt Goederen- en personenvervoer, Antwerpen, Belgium.

Mann, C. and Stewart, F., 2000. Internet Communication and Qualitative Research. London: Sage

Medda, F., and Trujillo, L., 2010. "Short-Sea Shipping: An Analysis of Its Determinants." Maritime Policy & Management 37 (3): 285–303.

Meers, D., Macharis, C., Vermeiren, T., and Van Lier, T., 2017. "Modal Choice Preferences in Short-Distance Hinterland Container Transport." Research in Transportation Business & Management 23: 46–53.

Merriam, D.F., 1988. Bibliography of computer applications in the earth sciences, 1948–1970. Computers & Geosciences, 14(6), pp.v-vi.

Merriam, S. B. (2009). Qualitative research: A guide to design and implementation. San Francisco, CA: Jossey-Bass

Mihic, Svetlana, Mirjana Golusin, and Milan Mihajlovic. 2011. “Policy and Promotion of Sustainable Inland Waterway Transport in Europe–Danube River.” Renewable and Sustainable Energy Reviews 15 (4): 1801–1809.

Mircetic, D., Nikolicic, S., Bojic, S. and Maslaric, M., 2017. Identifying the barriers for development of inland waterway transport: A case study. In MATEC Web of Conferences (Vol. 134, p. 00039). EDP Sciences.

Monios, J., and Bergqvist, R., 2017. Policy and Planning of Intermodal Transport. In: Monios J., and Bergqvist R. Intermodal Freight Transport. Boca Raton: CRC Press. P8-13.

Nolmark, H., Browne, M., Giulano, G., and Holguin-Veras, J., 2016. Why Goods Movement Matters. Available: http://library.rpa.org/pdf/Why-Goods-Movement-Matters-ENG.pdf. Last accessed 5th April 2020.

O’Connor and Madge, C., 2001. Cyber-mothers: Online synchronous interviewing using conferencing software. Sociological Research Online, 5, 4. http:// www.socresonline.org.uk/5/4/o’connor.html.

Pasquire, C. L. & Tzortzopoulos, P. (eds.) 15th Annual Conference of the International Group for Lean Construction. East Lansing, Michigan, USA.

Piecyk, M., Browne, M., Whiteing, A. and McKinnon, A. eds., 2015. Green logistics: Improving the environmental sustainability of logistics. Kogan Page Publishers.

Platz, T.E., 2009. The Efficient Integration of Inland Shipping into Continental Intermodal Transport Chains. Measures and Decisive Factors (No. T2009/7).

Plecher, H., 2020. Urbanisation in Sweden 2018. Available: https://www.statista.com/statistics/455935/urbanization-in-sweden/. Last accessed 5th April 2020.

Plummer, K., 2001. Documents of Life 2: An Invitation to a Critical Humanism, Revised Edition edition. London: Sage Publications UK.

Porter, M.E. and Van der Linde, C.G., 1995. competitive: Ending the stalemate. Harv. Bus. Rev, 73, pp.120-134.

Quak, H., 2008b. Sustainability of Urban Freight Transport – Retail Distribution and Local Regulations in Cities. Ph.D. Dissertation, Erasmus Universiteit, Rotterdam.

Quak, H., 2014. Access Restrictions and Local Authorities' City Logistics Regulation in Urban Areas. In: Taniguchi, E., and Thompson, R. City Logistics; Mapping The Future. Boca Raton: CRC Press. P178-198.

Rogerson, S., Santén, V., Svanberg, M., Williamsson, J. and Woxenius, J., 2019. Modal shift to inland waterways: dealing with barriers in two Swedish cases. International Journal of Logistics Research and Applications, pp.1-16.

Rohács, J. and Simongati, G., 2007. The role of inland waterway navigation in a sustainable transport system. Transport, 22(3), pp.148-153.

Seitz, S., 2015. Pixilated partnerships, overcoming obstacles in qualitative interviews via Skype: a research note. Qualitative Research, p. 1-7.

Trafikanalys., 2016. Godstransporter i Sverige - en nulägesanalys [Freight Transport in Sweden – State-of-the-art Analysis]. Stockholm: Trafikanalys.

Trafikanalys., 2018. "Shipping Goods 2017, Statistik 2017:19," Public Statistics of Sweden. Accessed 30 March 2020. www.trafa.se/en/maritime-transport/shipping-goods/.

Transmodal, M.D.S., 2012. DG MOVE European Commission: Study on urban freight transport. Quak, H.(2008, 03 20). Sustainability of Urban Freight Transport: Retail Distribution and Local Regulations in Cities. Retrieved, 6(30), p.2016.

Transport for London., 2013. Construction Logistics Plan Guidance for Developers. Windsor House, London: Transport for London.

Uhel, R., 2008. Urbanisation in Europe: limits to spatial growth. In 44th International Planning Congress.

Urban Access Regulations., 2020. Göteborg (Gothenburg) - CS. Available: https://urbanaccessregulations.eu/countries-mainmenu-147/sweden-mainmenu-248/goteborg. Last accessed 12th April 2020.

Van Duin, R., and Munuzuri, J., 2014. Urban Distribution Centers. In: Taniguchi, E., and Thompson, R. City Logistics; Mapping The Future. Boca Raton: CRC Press. P115-130.

Vergragt, P. J., & Quist, J., 2011. Backcasting for sustainability: Introduction to the special issue.

Viana, M., Hammingh, P., Colette, A., Querol, X., Degraeuwe, B., de Vlieger, I. and Van Aardenne, J., 2014. Impact of maritime transport emissions on coastal air quality in Europe. Atmospheric Environment, 90, pp.96-105.

Vierth, I., Mellin, A., Hylén, B., Karlsson, J., Karlsson, R. and Johansson, M., 2012. Kartläggning av godstransporterna i Sverige. Statens väg-och transportforskningsinstitut.

Wiegmans, B. and Konings, R., 2015. Intermodal inland waterway transport: Modelling conditions influencing its cost competitiveness. The Asian Journal of Shipping and Logistics, 31(2), pp.273-294.

Wiegmans, B., and Van Duin, R., 2017. Inland Waterway Operations. In: Monios, J., and Bergqvist, R. Intermodal Freight Transport. Boca Raton: CRC Press. P75-93.

Yamada, T., 2014. Cooperative Freight Transport Systems. In: Taniguchi, E., and Thompson, R. City Logistics; Mapping The Future. Boca Raton: CRC Press. P167-174.

7. Appendix

Exhibit 1: Interview Guide

The following set of questions was used as a guide by the authors during the semi-structured interviews conducted to gather information for the needs of this thesis. Its purpose is to provide a perspective as broad as possible, regarding the stakeholders' point of view on the concepts identified during the review of relevant literature. More specifically, the questionnaire was designed to provide knowledge about specific barriers and enablers of IWT, as well as acquire the stakeholders' perspectives on certain aspects regarding the underutilisation and future better use of the urban waterways in Gothenburg. Finally, the questionnaire was designed keeping into consideration certain time restrictions, like the fact that the stakeholders agreed to participate in meetings, the length of which was 60 minutes on average.

<u>Introduction</u>

- What do you think about the waterways as transport mode for construction material and waste?
- What is the future of urban waterways as a transport mode for construction logistics in Gothenburg?
- How would the different stakeholders in the construction industry be affected by the implementation of the waterways? How would it affect material flows and costs in urban construction projects?

<u>Barriers</u>

- What are the problems faced by the construction industry in terms of materials' transportation?
- What do you see as challenging factors for the implementation of the waterways as a transport mode for construction logistics?
- What is hindering the implementation?
- Why are the waterways in Gothenburg not used to a greater extent?

<u>Drivers</u>

- What do you see as driving factors to implement a new system?
- Which actor has greater influence to drive a new system forward?

<u>Success Factors</u>

- Which preconditions could lead in the successful implementation of the waterways as a transport mode for construction logistics in Gothenburg?
- Who needs to participate in the new system in order for it to be successful?

Exhibit 2: Map showcasing the ownership problem across Göta Älv

Following is a figure of the complete map showcased in figure 10. The different colours are related to different agencies that own the respective areas in the map. The full list of the agencies is also presented. Due to the fact that the size of the map is significantly big, the map is cut into three parts to be better exhibited in full resolution. The parts are consequent from left to right, depicting the left, center and right part of the original map respectively.

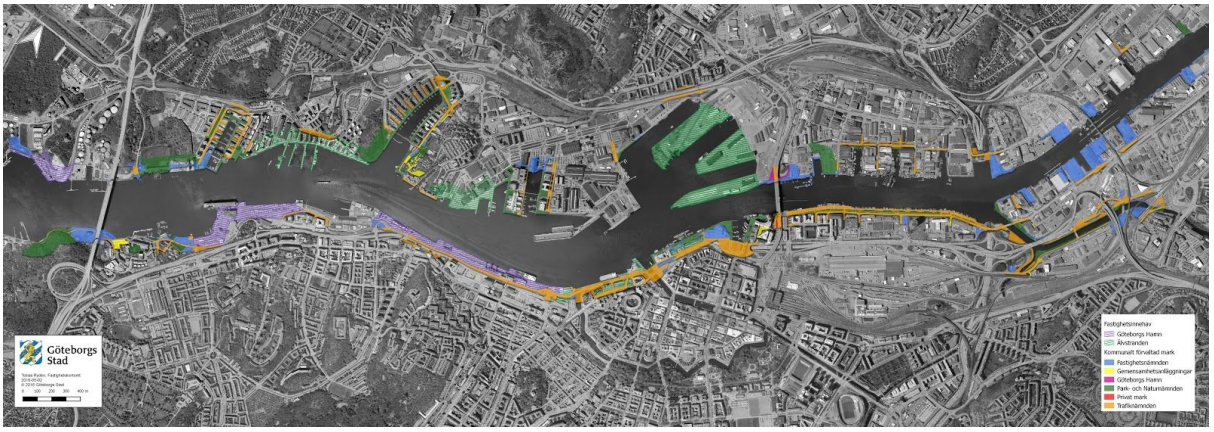

Figure 11: Initial map with adjusted size to fit in the pages of this document

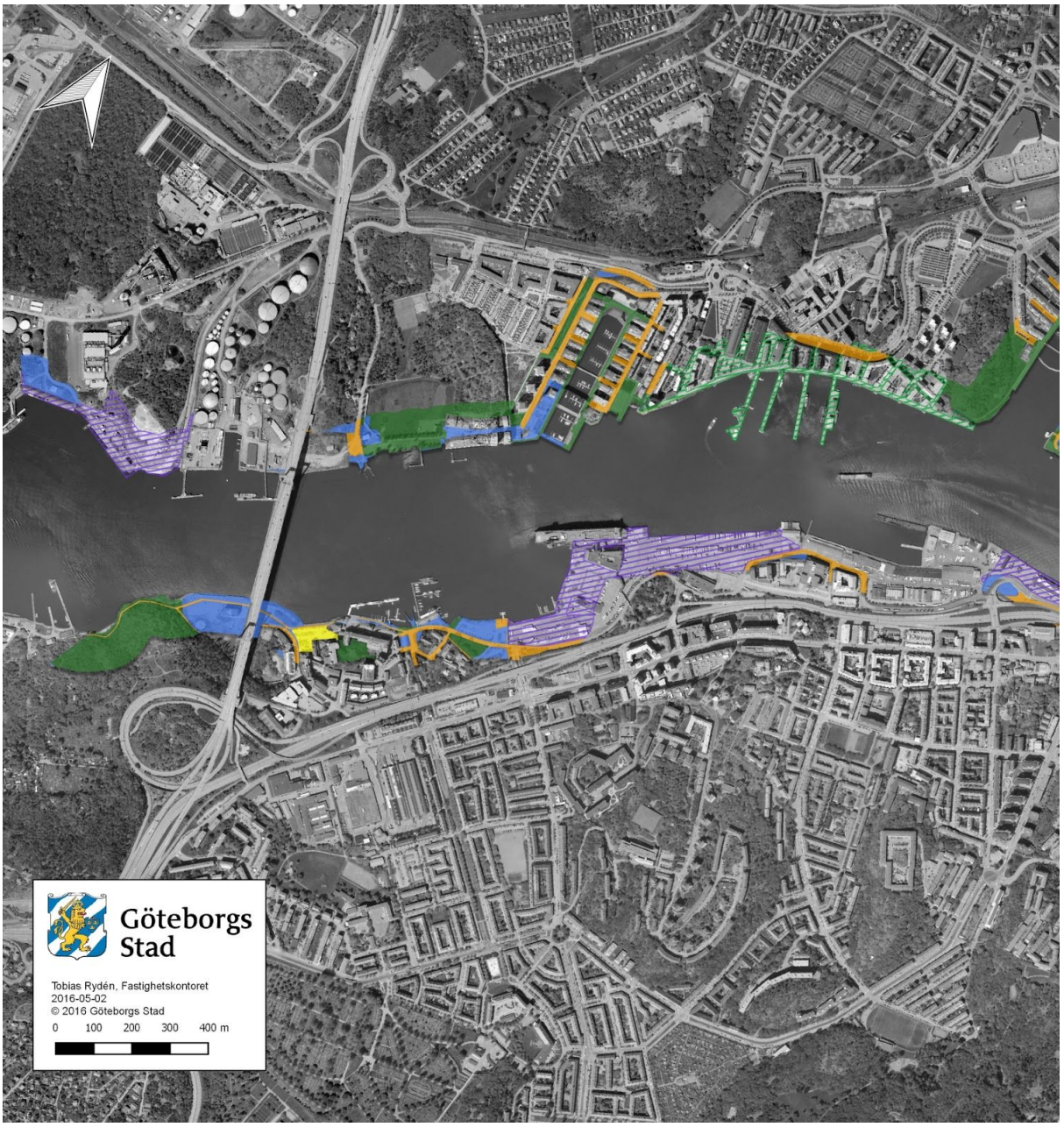

Figure 12: Part 1 (left) of the map showcased in Figure 11

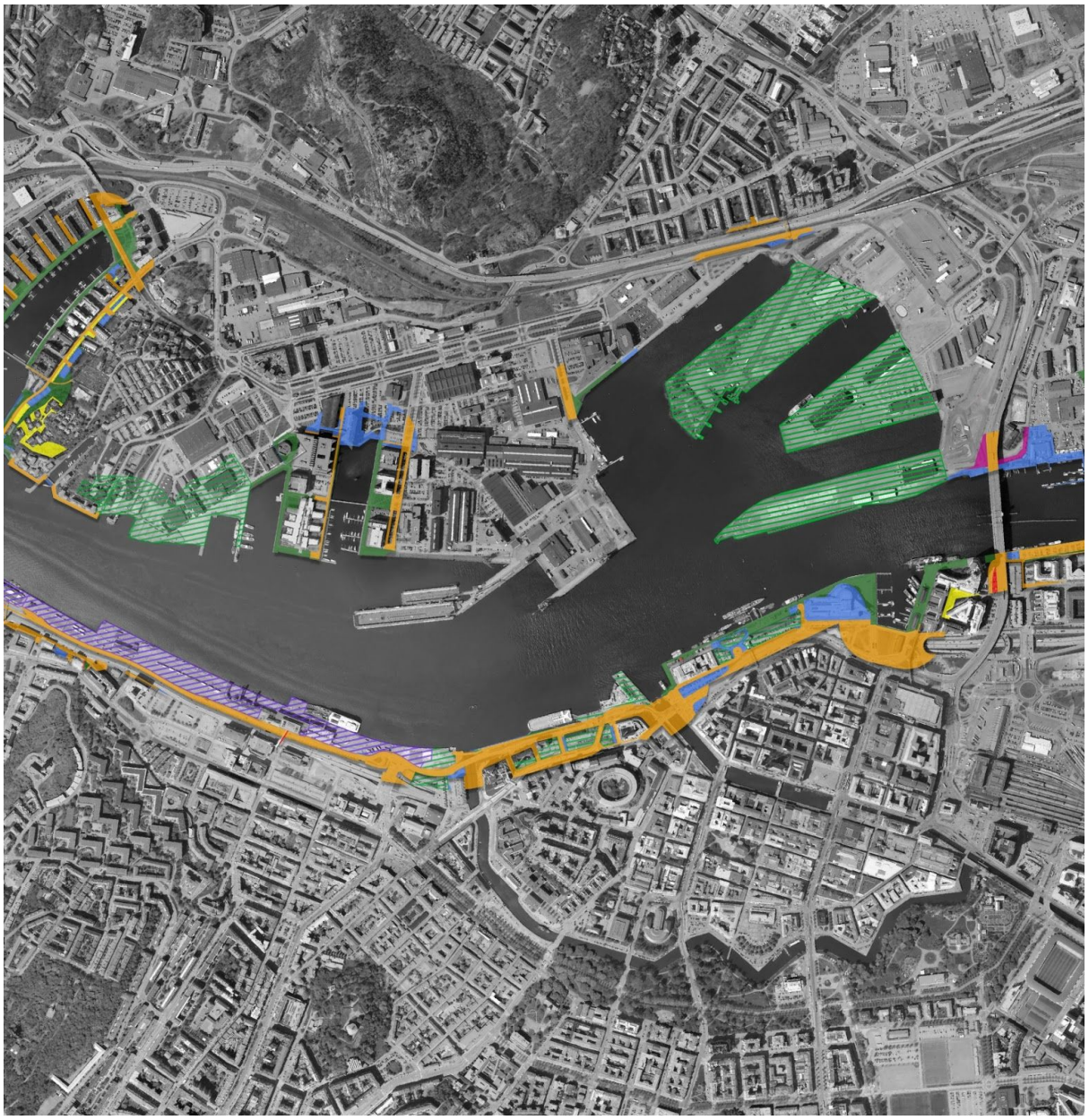

Figure 13: Part 2 (center) of the map showcased in Figure 11

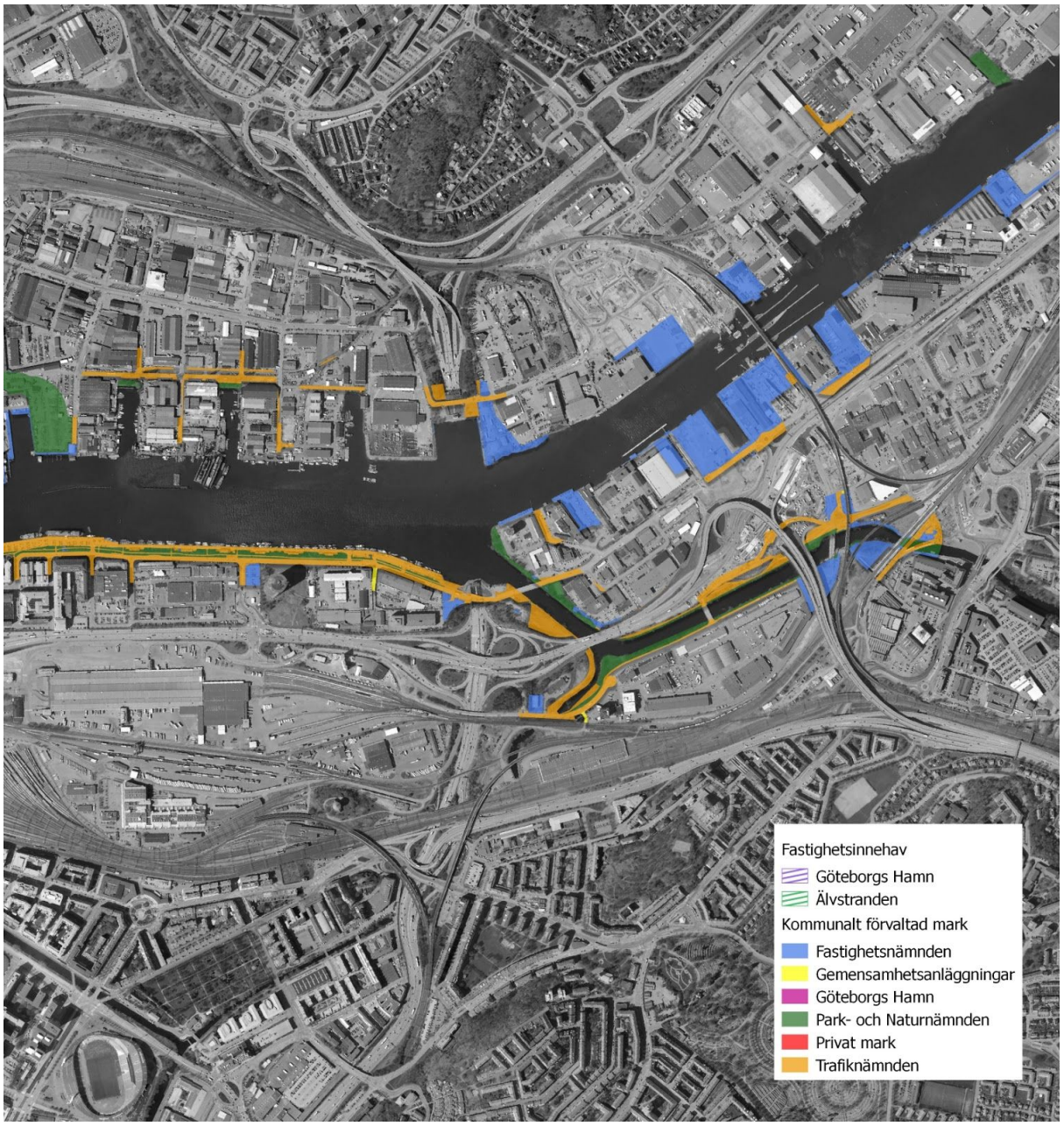

Figure 14: Part 3 (right) of the map showcased in Figure 11. The names of the organisation are visible in the bottom right corner. The names apply to figures 10, 11, 12, 13 & 14.