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Back to the Water?

**Commercial Feasibility of Urban Waterway Transportation in
Gothenburg**

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Abstract

Urban freight transport is vital in sustaining urban economies and life, since it carries the required goods and the generated waste in cities. Meanwhile, it also has several negative external impacts, which are considerably affecting the lives and well-being of local populations. As urbanization continues throughout the world, these negative effects will be further enhanced because of growing transportation needs. The city of Gothenburg is also expanding, which prompted stakeholders, who are directly and indirectly involved in the freight transport system, to explore more sustainable urban freight transport solutions. One of these possible solutions is urban waterway transportation, as the city provides suitable infrastructure to accommodate both goods and waste transportation over the river. However, for a successful implementation of a transport service it's not enough to prove the technical feasibility, the long-term economic feasibility also has to be demonstrated to convince the financially involved actors, which means the solution needs a viable business model. Therefore, the purpose of this thesis is to analyse the business aspects of operating an urban waterway transport service of goods and waste in Gothenburg, and to examine which are the critical parts of the business model that influence the commercial feasibility of this service. In order to fulfil this purpose, a scenario analysis was conducted with observations and in-depth interviews with several actors who are knowledgeable about the Gothenburg freight transport situation, as well as have specialised experience concerning waterway transport. The findings suggest that the critical parts are the value proposition and externalities, key partners and cost structure of the business model. As a result, the thesis contributes to the research field of waterway transport business aspects and aid the city of Gothenburg in its search for possible sustainable freight transport solutions.

Keywords: urban waterway transport, business model, sustainability, urban freight transport, intermodality, Gothenburg

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Table of Contents

- 1. Introduction 1**
 - 1.1 Background 1**
 - 1.2 Problem description 2**
 - 1.3 Research purpose and question 3**
 - 1.4 Delimitations 4**
- 2. Literature review 5**
 - 2.1 City logistics and inland waterway transport 5**
 - 2.1.1 Urban freight transport 5**
 - 2.1.2 Actors in an urban transport system 6**
 - 2.1.3 Impacts of urban freight transport 8**
 - 2.1.4 Sustainable urban freight transport 9**
 - 2.1.5 Initiatives towards sustainable urban freight transport 12**
 - 2.1.6 Intermodal urban transport 14**
 - 2.1.7 Policy schemes in urban freight 16**
 - 2.1.8 Urban waterway transport and existing practices 18**
 - 2.1.9 Advantages and limitations of urban waterway transport 22**
 - 2.2 Gothenburg circumstances 23**
 - 2.2.1 Transport situation, strategy and regulations 23**
 - 2.2.2 Waterways in Gothenburg 27**
 - 2.2.3 Background description of actors 28**
 - 2.3 Summary 30**
- 3. Analytical framework 32**
 - 3.1 Business model concept background and definition 32**
 - 3.2 The Business Model Canvas 34**
 - 3.3 Limitations of the Business Model Canvas 37**
 - 3.4 Business model for sustainable urban logistics 38**
- 4. Methodology 40**
 - 4.1 Research philosophy 40**
 - 4.2 Research approach 40**
 - 4.3 Research method 41**
 - 4.4 Research design 43**
 - 4.5 Data collection 44**
 - 4.6 Data Analysis 46**
 - 4.7 Research quality 47**

5. Findings	49
5.1 Business model	49
5.1.1 Key resources & key activities	50
5.1.2 Key partners	51
5.1.3 Externalities	51
5.1.4 Value proposition	52
5.1.5 Customer segments	52
5.1.6 Customer relationships & channels	53
5.1.7 Cost structure and revenue streams	54
6. Analysis	55
6.1 Waste transport	56
6.1.1 Possible operations	56
6.1.2 Barriers	57
6.1.3 Facilitators for implementation	57
6.1.4 Future possibilities and research prospects	58
6.2 Goods transport	59
6.2.1 Competitiveness	59
6.2.2 Facilitators for implementation	62
6.2.3 Possible operations in the future	63
6.3 Investment	65
7. Conclusions	66
7.1 Possible broader implications	67
7.2 Potential for future research	68
References	69

List of Figures

- Figure 1.** Stakeholders in an urban transport system..... 7
- Figure 2.** Stakeholders’ interests in an urban freight transport perspective 8
- Figure 3.** Actors and their roles in sustainable development 10
- Figure 4.** Illustration of the Vokoli barge..... 20
- Figure 5.** Map of pay stations in Gothenburg..... 25
- Figure 6.** Low Emission Zone – Gothenburg 26
- Figure 7.** Map of Gothenburg..... 28
- Figure 8.** The Business Model Canvas 35
- Figure 9.** Sustainable Urban logistics business model 38
- Figure 10.** Urban waterway service business model 49

List of Tables

- Table 1.** Planned and implemented initiatives towards SUFT by several OECD countries ... 12
- Table 2.** Interviewees..... 45

1. Introduction

This chapter describes the trends and issues in urban freight transport that have created the identified problem the thesis aims to answer, which is the business feasibility of an urban waterway transport service in Gothenburg, aimed to bring forth a more sustainable urban freight transport in the city. In relation to this problem the research purpose, as well as the research question are presented. Lastly, the chapter also contains the delimitations concerning the focus and scope of the study.

1.1 Background

While the trend of urbanization still continues globally, cities become more populated and denser, which means more and more people living and working, thus commuting in cities (Browne, Allen, Nemoto, Patier & Visser, 2012). Similarly to global tendencies, Gothenburg is also expanding, as there are plans to build around 25.000 apartments and 45.000 workplaces in Älvstaden (Backaplan, Centralen-area, Frihamnen, Gullbergsvass, Lindholmen, Ringön and Södra Älvstranden) and in several of these, the construction is already starting (City of Gothenburg, 2012).

However, not only people are in need of transportation, the urban population is in need of a freight transport system that supports it (Quak, 2008). An efficient logistics system is very important for the competitiveness of urban areas and it is a significant part of the urban economic system (Quak, 2008). As a result of the huge number of people and businesses these urban districts require large amounts of goods and services, both for domestic and commercial usage (Browne et al., 2012). In addition to the supply of necessary goods and services, cities also need to take care of the created waste, thus they are extremely reliant on urban freight transport (Browne et al., 2012). Consequently, the larger populations and continued growth of consumption, implies that increased amount of goods and waste will be needed to be transported to and from the city (Browne et al., 2012).

However, despite being critical in sustaining urban life, freight transport also has several unsustainable effects (Quak, 2008). It has numerous negative social, economic and environmental impacts in cities around the world (Dablanc, 2008). These impacts include for example traffic congestion, accidents connected to congestion, noise pollution, as well as air

pollution causing health risks in humans and contributing to global warming through greenhouse gas emissions (Browne et al., 2012). The growing transportation need of expanding cities will further enhance the negative environmental impacts of urban freight transport.

In order to overcome this problem, the transport system of the city needs to be effectively and efficiently planned in advance. A possible solution to reduce the environmental impact of the growing transport need is to utilize additional transport modes besides roads (Huschebeck, 2016). Urban waterway shipping, compared to road transportation, can significantly reduce emissions and congestion in the city, thus offers a desirable option for environmental purposes (Rohács & Simongati, 2007).

In Gothenburg, numerous public, private actors and stakeholders, in collaboration within the project named DenCity, are currently trying to address this issue, through seven work-packages concerned with adopting more sustainable urban freight transport solutions (Closer, 2017). One of the work-packages aims to examine the feasibility of utilizing inland waterways for combined transport of goods and waste in the city (Closer, 2017). Gothenburg is suitable for the use of urban waterway shipping, as the river and the canals provide infrastructural potential to accommodate both goods and waste transportation to a much larger extent.

1.2 Problem description

The section above shows that urban freight transport is critical in supporting the urban economy and society, however it also has substantial negative external effects, which are greatly affecting local populations. Following global trends, the city of Gothenburg is also expanding, accordingly the municipality and local authorities are in need of implementing more sustainable urban transport solutions to mitigate the growing negative impacts on local citizens and businesses.

One possibility to develop more sustainable freight transport is to utilize alternative transport modes besides the predominant road transportation. As the cooperation within the project DenCity in Gothenburg demonstrates, stakeholders who are involved in and affected by the freight transport system are willing to explore these possible options, such as inland waterways (Closer, 2017). However, despite the potential improvements it can bring forth for the city in

terms of less impactful transportation, implementing this transport system also faces some challenges.

As Quak, Balm & Posthumus (2014) describes, the issues in urban logistics are not new, many initiatives have been demonstrated and tested in practice, but large scale, long term implementations are rare. Many of these experiments try to prove the technical and operational feasibility of the urban logistics solution, however the economic feasibility is frequently not considered (Quak et al., 2014). Willingness to continue these initiatives with own investments is low, since the actual value of the benefits for the involved actors is uncertain (Quak et al., 2014). Therefore Quak et al. (2014) argues that for successful implementations of urban freight transport solutions, economic feasibility, thus a viable business model is needed.

Moreover, academic research about a potential business model for an urban inland waterway service, as well as the business aspects of inland waterway transport services in general is very limited. There is clearly a need, not just for cities and local authorities, who are in search of more sustainable transport solutions, but also for a wider audience, to investigate the business side of such transport service in the urban setting. In addition, since such service is presently non-existent operationally in the city of Gothenburg, there is no direct example to draw conclusions from in this specific setting.

1.3 Research purpose and question

In order to address the problem concerning the commercial viability of an urban waterway transport service in Gothenburg, the thesis inspects the perspectives of different actors involved in and affected by urban freight transport. It is of high importance to investigate a waterway transport operator's relations to local partners and potential customers, in order to analyse the possibility of constructing a business model that makes the service commercially operable. More precisely, it is necessary to examine which parts and relationships of a possible business model for this service are the ones that greatly influence its future success.

Because of the aforementioned reasons, it would be favourable for the city if a proportion of both goods and household waste could be shifted to inland waterways, thus it is investigated if the combined transportation of both could optimally fit into the business model framework.

Accordingly, the purpose of this research is to analyse the business aspects of operating an urban waterway shipping transport system of goods and waste in Gothenburg, and to explore which are the critical components of the business model framework that play a key role in the commercial feasibility of this service. As a result, the thesis can aid the city in its exploration of possible long-term transport solutions that can reduce the negative impacts of urban freight transport, in addition it also contributes to the research field, where a gap was identified by the authors.

Considering the purpose of the thesis, the following research question was formulated:

Which parts of a business model for an urban waterway transport of goods and waste are critical to its feasibility in Gothenburg?

1.4 Delimitations

It is important to note the boundaries of the thesis. Since the actors involved and interviewed are based in Gothenburg, the focus of the study is more tailored to this area and its characteristics. In addition, the scope of the research only encompasses the transport of goods and household waste in the city, thus other types of freight are not explored in the business model. Furthermore, during the research a certain business model framework will be utilized to construct a possible business model scenario, which implies some limitations.

2. Literature review

2.1 City logistics and inland waterway transport

In this section the characteristics of freight transport in the urban setting are described, including its external impacts. Additionally, it is also necessary to show the actors involved and affected by urban freight transport, as well as their roles in the system. Furthermore, sustainable development is defined and connected to the impacts of city logistics, as well as initiatives for more sustainable urban freight transport are also presented, highlighting intermodal urban transport and public policy schemes. Lastly, urban waterway transport is defined and a handful of successful waterway transport projects are presented, in addition the advantages and limitations of this transport mode are also explained.

2.1.1 Urban freight transport

According to OECD (2003), transport of goods in urban areas has a significant influence on *“the economic power, quality of life, accessibility and attractiveness of the local community”* (OECD, 2003, p. 7). The precise definition of urban freight transport (UFT) varies by author(s). Ogden (1992) defined urban freight transport as follows *“the movement of things (as distinct from people) to, from, within, and through urban areas”* (p.14). MDS Transmodal Limited (2012) has a similar definition *“The movement of freight vehicles whose primary purpose is to carry goods into, out of and within urban areas”* (p.2). These definitions have a focus on transporting goods to and from urban areas, and it is not clear if waste is considered as goods. To serve the purpose of this thesis, waste transportation within urban areas has to be included in the definition. OECD (2003) defined urban freight transport as *“The delivery of consumer goods (not only by retail, but also by other sectors such as manufacturing) in city and suburban areas, including the reverse flow of used goods in terms of clean waste”* (p. 7). The definition provided by OECD (2003) cover goods and waste transport which is a suitable definition to be used in this research.

One notable aspect of urban freight transport is last mile delivery, which according to Gevaers, Van de Voorde & Vanelslander (2011) refers to the final section of the supply chain, from goods leaving the warehouse to being delivered to their end receivers. Due to the growth of

ecommerce, direct sales to consumers are growing significantly, which increased last mile deliveries. However, the last mile is considered as a more expensive, least efficient and most polluting part in the logistics flow. Two natural factors contributing to the issues are high delivery failure and lack of critical mass in some regions (Gevaers et al., 2011).

Vehicle fleet is an important element for logistic service providers to reduce their costs during last mile deliveries in different ways (e.g. through fuel consumption, utilization of loading capacity, efficient loading and unloading methods) (Gevaers et al., 2011). Communication technology is another significant factor in order to cut costs and fuel consumption by accomplishing optimum routing, which enables the transport company to respond quickly and accurately to fluctuations in the course of collection and delivery of parcels (Gevaers et al., 2011).

2.1.2 Actors in an urban transport system

When defining the actors or stakeholders who are involved in an urban transport system, different authors have their own definitions of who these actors are. Authors Boerkamps, Van Binsbergen & Bovy (2000) stated four main stakeholders in an urban freight transport system: shippers, carriers, customers and administrators. MDS Transmodal Limited (2012) presented a broader perspective, there are stakeholders within an urban context who are not directly involved in the freight movements, but are affected by it, such as public authorities, residents and visitors. As Gammelgaard (2015) pointed out *“urban transport planning are no longer those of optimizing transport companies’ goods flows and government regulation”* (p. 348) and stated that involvement and participation from all relevant stakeholders are necessary in urban transport planning. In order to serve the purpose of this thesis, a wider perspective of stakeholders needs to be taken into account. The definitions provided by MDS Transmodal Limited (2012) deemed to fit and will be used.

Figure 1 illustrates the stakeholders, which are sorted into four main categories: supply chain, resource supply, other stakeholders and public authorities. Actors under the supply chain category are directly involved in the transport movements while the others are indirectly involved.

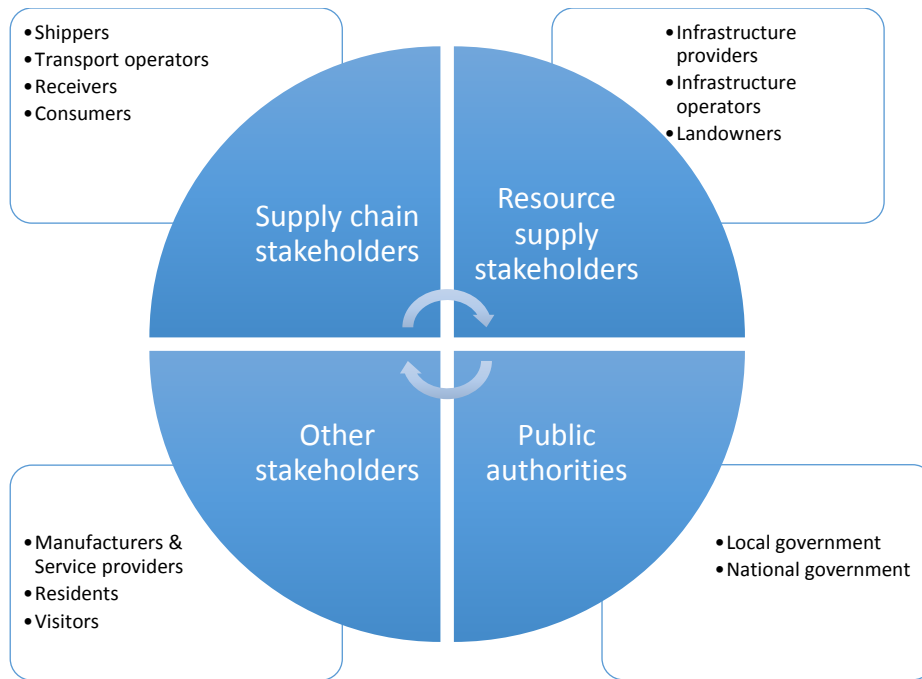


Figure 1. Stakeholders in an urban transport system
(adapted from MDS Transmodal Limited, 2012, p. 27-28)

According to Stathopoulos, Valeri & Marcucci (2012) urban freight transport is a complex and intricate activity, as it involves a plentiful of stakeholders, has complex routing patterns and broad variety of goods to be delivered. Figure 2 on the next page presents the interests of different stakeholders in an urban freight transport viewpoint. Stathopoulos et al. (2012) pointed out that new measures or technology for urban freight problems must include the interests of all relevant stakeholders. Furthermore, the authors emphasized *“a failure to account for stakeholder-specific problem perceptions and interaction among operators not only jeopardises the successful introduction of innovative policies also their continuation in time”* Stathopoulos et al. (2012, p.35).

The findings of a recent study done by Gammelgaard (2015), with the purpose of getting a better insight of how city logistics develops, reinforced the previous statements that participation from stakeholders is key towards successful city logistics projects and the major challenge is to satisfy their own interests and objectives.

Shippers	<ul style="list-style-type: none"> • Strive to deliver and collect goods and meet the needs of their customers with lowest cost.
Transport operators	<ul style="list-style-type: none"> • Provide high quality transportation and satisfy shippers and receivers interests.
Receivers	<ul style="list-style-type: none"> • Expect on-time deliveries with short lead-time
Consumers	<ul style="list-style-type: none"> • Availability of goods in shops at the city centre
Infrastructure providers	<ul style="list-style-type: none"> • Cost recovery and infrastructure
Infrastructure operators	<ul style="list-style-type: none"> • Accessibility and use of infrastructure
Landowners	<ul style="list-style-type: none"> • Profitability of local areas
Local government	<ul style="list-style-type: none"> • Attractive city for citizens and tourists while having an efficient transport system that cause least inconveniences.
National government	<ul style="list-style-type: none"> • Minimum externalities from freight transport, while maximising economic efficiency and effectiveness
Manufacturers & Service providers	<ul style="list-style-type: none"> • Site accessibility and on-time deliveries
Residents	<ul style="list-style-type: none"> • Minimum inconvenience caused by urban freight transport
Visitors	<ul style="list-style-type: none"> • Minimum inconvenience caused by urban freight transport and wide variety of products in the shops.

Figure 2. Stakeholders' interests in an urban freight transport perspective
(adapted from MDS Transmodal Limited, 2012, p. 27-28)

2.1.3 Impacts of urban freight transport

As mentioned earlier, transport of goods and waste in urban areas plays a significant role in the local community. In similar vein, Quak (2008) argued that urban civilization is dependent on a functional freight transport in order to be sustained. Various developments in how businesses optimize their supply chains (i.e. utilising information and communications technologies and implementation of just-in-time deliveries) and changes in customer behaviour (i.e. a more varied and often-changing customer demand) have boosted the growth of freight transport (OECD, 2003).

Although UFT is imperative for urban areas, at the same time it also threatens their habitability. The current urban transport practices are not sustainable (Lindholm, 2012) and the activities and effects created by urban transport have a negative impact on the planet, people and profits (Quak, 2008).

Anderson, Allen & Browne (2005) in their paper discussed the various economic (profit), environmental (planet) and social (people) impacts caused by UFT and these are:

Economic impacts:

- Congestion
- Inefficiency
- Resource waste

Environmental impacts:

- Pollutant emissions including the primary greenhouse gas carbon dioxide
- The use of non-renewable fossil-fuel, land and aggregates
- Waste products such as tyres, oil and other materials
- The loss of wildlife habitats and associated threat to wild species

Social impacts:

- The physical consequences of pollutant emissions on public health (death, illness, hazards, etc.)
- The injuries and death resulting from traffic accidents
- Noise
- Visual intrusion
- The difficulty of making essential journeys without a car or suitable public transport
- Other quality of life issues (including the loss of greenfield sites and open spaces in urban areas as a result of transport infrastructure developments)

(Anderson et al. 2005, p. 72)

2.1.4 Sustainable urban freight transport

Under this section, the term sustainable urban freight transport will be defined for this study, however, the definition of sustainable development has to be explained first, as the prior term is derived from sustainable development.

The term sustainable development was first being used in the academic literature in the 1960s. In 1987, a report funded by the United Nations increased the popularity of this term. The report is known as “the Brundtland Report” (McKinnon, Browne, Whiteing & Piecyk, 2015) and it defined sustainable development as follows:

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland, 1987, p.54).

Sustainable development rests in the politicians’ hands (Brundtland, 1987), McKinnon et al. (2015) argued that this duty is shared between a great number of actors (i.e. international regulatory agencies, national governments, local authorities, and business, consumers and research and education institutions). In addition, each of these stakeholders have a specific role (supporting and interacting) to achieve sustainable development. Figure 3 illustrates how authorities, businesses, consumers and academia influence sustainable development. Authorities, which are chosen by the society, set laws and regulations for others to follow. Businesses’ daily operations affect the environment and society. Consumers affect the environment and society either through changing the business behaviour by creating demand for specific products/services or the way consumers choose to buy, transport, store, use and discard a product. The academia has the role to create and disseminate knowledge *“for instance the economic, social, and environmental impact from business operations, sustainable management strategies, consumer behaviour, and the impact of laws and regulations.”* (McKinnon et al., 2015, p.109).

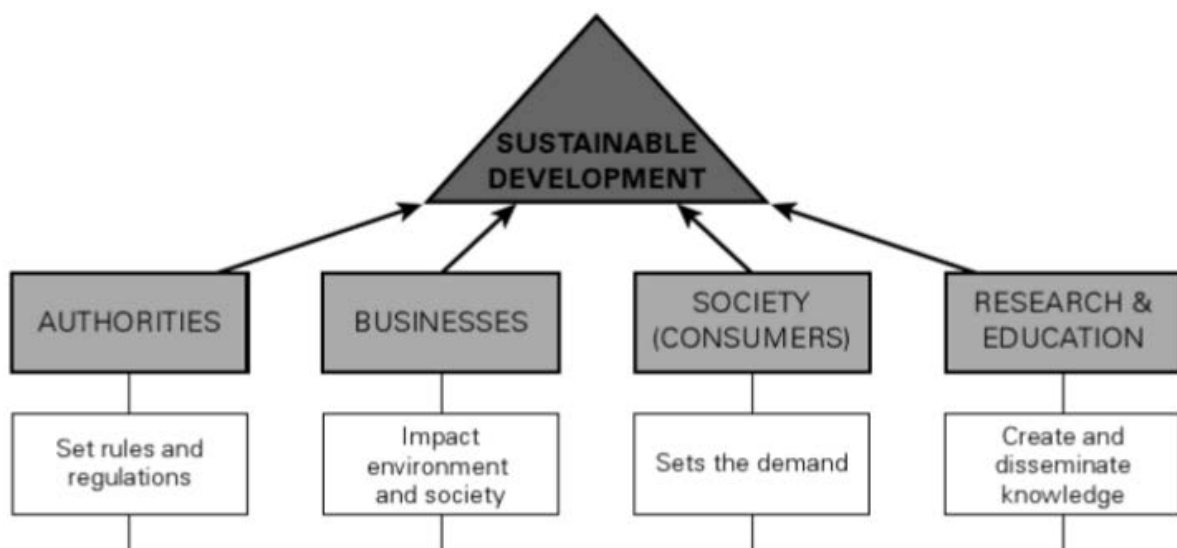


Figure 3. Actors and their roles in sustainable development
(Source: McKinnon et al., 2015, p.109)

The different aspects of UFT and rationale of sustainable development has been presented. Black (1996) argued transportation by fossil fuelled vehicles was not sustainable and defined sustainable transportation as, based on the definition of sustainable development by the

Brundtland report: “*satisfying current transport and mobility needs without compromising the ability of future generations to meet these needs*” (p. 151). However, this definition was mainly applied to transportation in general, thus it is not applicable for this study.

Richardson (2005) had a similar definition, but more importantly, the author stated an interesting notion that sustainable transport has to embrace the three aspects of sustainability (economic, social and environmental prosperity). Shortly afterwards, Behrends, Lindholm & Woxenius (2008) precisely defined sustainable urban freight transport (SUFT) by combining several definitions of sustainable transport, urban freight transport and sustainable urban transport. The authors proposed SUFT system has to achieve all the following criteria:

- to ensure the accessibility offered by the transport system to all categories of freight transport;
- to reduce air pollution, greenhouse gas emissions, waste and noise to levels without negative impacts on the health of the citizens or nature;
- to improve the resource- and energy-efficiency and cost-effectiveness of the transportation of goods, taking into account the external costs and;
- to contribute to the enhancement of the attractiveness and quality of the urban environment, by avoiding accidents, minimising the use of land and without compromising the mobility of citizens. (p. 704)

The definition SUFT by Behrends et al. (2008) is comprehensive and the objectives defined take into account of the three dimensions of sustainability. Therefore, the definition of SUFT by Behrends et al. (2008) is appropriate for this thesis.

Gevaers et al. (2011) note that consumers and businesses are becoming more aware of the environmental impacts of logistics and transport activities, therefore they increasingly expect logistics service providers to be more sustainable in their operations (e.g. reduce carbon emissions footprint). However, the customers are not inclined to either pay more or accept a longer delivery time for a greener transport service (Gevaers et al., 2011). This implies that freight forwarders have to offer various delivery alternatives, as well as have to make customers conscious about the additional costs associated with greener delivery methods (Gevaers et al., 2011)

2.1.5 Initiatives towards sustainable urban freight transport

Macharis and Kin (2016) argue sustainable freight practices in urban areas are lacking, referring mainly to European cities, primarily because the issue has been ignored by city planners in the past. However, as the undesirable effects by transport activities become more transparent, such as hampered mobility (i.e. congestion) and lowered quality of life (i.e. increased noise level & visual intrusion), initiatives and attention towards sustainable urban freight transports have increased in recent years (Stathopoulos et al., 2012; Lagorio, Pinto & Golini, 2016). With that said, planned and implemented measures on national level by authorities, relevant solutions discussed by academics, successful projects, incentives & funding options are presented.

OECD (2003) published a report which covers numerous methods, as well as recommendations for governments and policy makers to establish a SUFT system. In order to do so, the researchers identified the measures that are already implemented by different countries. An overview of this data showing measures adopted by each country is presented by Table 1.

Planned and implemented initiatives towards SUFT by several OECD countries						
Measures /Country	France	Belgium	Netherlands	United Kingdom	Japan	United States
Access restrictions	x					
Parking restrictions		x				
Harmonising/relaxing restrictions			x	x (planned)		
Provision of loading/unloading zones					x	
Distribution centres			x		x	
Roads to detour through traffic				x (planned)	x	x
Noise reduction measures			x	x	x	
Pricing/taxes		x (planned)			x	
Subsidies/tax incentives				x	x	
Support for R&D		x	x	x		
Support for pilot projects				x (planned)	x	
Dissemination of best practices and other information		x	x	x	x	

Table 1. Planned and implemented initiatives towards SUFT by several OECD countries (adapted from OECD, 2003)

By analysing the constructed table, the most common three of the implemented measures adopted by countries were identified (excluding planned measures):

1. Dissemination of best practices and other information
2. Noise reduction measures
3. Support for R&D

(OECD, 2003)

Belgium, the Netherlands, the United Kingdom and Japan believe that spreading knowledge of sustainable transports and best practices is the key towards SUFT.

Countries that aimed to reduce noise pollution have used different approaches. For instance, Japan implemented vehicle regulations; the Netherlands promoted different noise reduction solutions and the United Kingdom developed a so called Ten-Year Plan towards quieter road surfaces on 60% of its road network. Support for R&D, authorities of Belgium, the Netherlands and the United Kingdom financially support a varied of research programmes and projects related to SUFT. (OECD, 2003)

Sustainable freight transport has not only caught the attention of governments, but also the community of academics (Lagorio et al. 2016). According to the findings from the systematic literature review of urban logistics by Lagorio et al. (2016), the following topics tend to be discussed the most by researchers:

(1) Vehicle routing problems solutions: adaptation of VRP models to urban logistics problems (e.g. the location of a UCC, location of loading/unloading bays, optimal vehicle routing from the UCC, etc.).

(2) Stakeholder involvement: as stakeholders are fundamental to the success of CL (city logistics) projects, several papers describe how to engage stakeholders in the development of CL projects.

(3) Solutions performance assessment and comparison: definition and assessment of quantitative (e.g. CO₂ emissions and other air pollutants, congestion, load factors, delivery times, etc.) and qualitative (e.g. liveability, accessibility, etc.) indicators to measure the impact or compare CL projects. (p. 913)

The BESTFACT consortium consists of 18 partners including European research institutes, universities, international associations and industry partners (BESTFACT, 2017). The objective of this consortium is to “*develop, disseminate and enhance the utilization of best practices and innovations in freight transport and logistics that contribute to meeting European transport*

policy objectives with regard to competitiveness and environmental impact” (Huschebeck, 2016, p. 3). The best practices towards SUFT are focused on four themes:

1. Low emission and emission free road vehicles
2. Alternative modes instead of road transport
3. Urban distribution centres, freight consolidation and loading areas
4. Policy schemes in urban freight

(Huschebeck, 2016, p. 7)

A brief description of theme 1 and 3 is presented below. Considering the relevance of theme 2 and 4, these will be described under sections 2.1.5 Intermodal urban transport and 2.1.6 Policy schemes in urban freight.

1. Low emission and emission free road vehicles

The case of ‘Use of battery-electric tricycles and vans for retail distribution in London: Gnewt Cargo’ turned out to be one of the successful projects. The start-up company Gnewt Cargo was profitable after three months of operations. It delivers small parcels to customers in the centre of London by electric vehicles (vans or tricycles). The electric vehicles are smaller compared to diesel trucks and do not consume any fossil fuel, because the electricity is produced from renewable sources. The result is emission free road vehicles. (BESTFACT, 2013a)

3. Urban distribution centers, freight consolidation and loading areas

The case of ‘Binnenstadservice Nederland: Inner city deliveries in the Netherlands were proved to be very effective and have been implemented in 15 cities in the Netherlands. The idea of Binnenstadservice is to set up a consolidation center outside the city center. The goods are then bundled and transported by trucks into the city for delivery. The result of this concept is higher load factor of the vehicles, thus reduced amount of trucks on the road and emissions, as well as increased efficiency of logistics processes. (BESTFACT, 2013c)

2.1.6 Intermodal urban transport

As stated in the previous section, the theme “Alternative modes instead of road transport” is highly relevant for this study, thus a more thorough description of it is needed. Since alternative transport modes are usually used combined with road transportation in cities, this section

describes intermodal transport in the urban setting and issues associated with it, as well as motives to promote intermodal urban transport.

According to OECD (2002a), intermodal transport includes the utilization of at least two different modes of transport incorporated in a door-to-door transport chain. Diziain, Taniguchi & Dablanc (2014) argues one of the main issue of implementing intermodal transport in urban areas is connected to the volumes it usually handles. Transport modes such as waterways and rails are common in intermodal transport, but these modes are more suited for high volume flows, thus it is a challenge to implement intermodal services for last mile deliveries (Diziain et al., 2014). Diziain et al. (2014) also pointed out that due to urban growth, many intermodal sites (e.g. terminals and ports) are either being transformed for other purposes or aren't connected to traffic any longer.

Diziain et al. (2014) discussed that regional, city authorities and the European Commission are trying to promote non-road transports (i.e. waterways and rails) through policies, incentives and subsidies, additionally also by building and modernizing infrastructures. The authors also mentioned, businesses and other private actors are interested to utilize intermodal transport within the urban areas to avoid congestion, as well as because they expect further regulations restricting trucks to enter city centres in the future, thus they can get competitive advantage by gaining experience in intermodal transports ahead of others (Diziain et al., 2014).

According to Diziain et al. (2014, p.170) waste and construction materials seem to be the most suitable for intermodal transport, but manufactured and food products also have potential. Although transshipment operations and change of modes in terminals are costly, by studying successful examples, the authors concluded that urban intermodal transport is able to develop under the following conditions:

- congested road networks,
- existing multimodal infrastructure
- available terminals in the urban core, and
- relevant siting of industrial activities.

(Diziain et al., 2014, p.170)

2.1.7 Policy schemes in urban freight

As the previous section shows businesses and private actors are interested to utilize intermodal transports, however Dablanc & Rakotonarivo (2010) noted it is a slow process for these actors to change their transport practices. Therefore public policies for intermodal freight are desired (Dablanc & Rakotonarivo, 2010), as a consequence public authorities might have a strategic role in promoting intermodal urban transport (Diziain et al., 2014).

Dablanc & Rakotonarivo (2010) pointed out that policies have to consider aspects like reserving land for logistic activities, subsidies for new transport projects and setting up necessary infrastructure. Dablanc (2007) explained that intermodal urban transport services require extra financial aid to be successfully implemented, because the prices for land acquisition in urban areas are higher than in other non-urban regions, in addition the volume of goods might be lower as urban customers often receive small shipments. Furthermore, the author emphasised subsidisation is most crucial in the initial stages of implementing this kind of service (Dablanc, 2007). According to Diziain et al. (2014) another way of promoting intermodal transport is to include it as a requirement during the procurement process for operations managed by publicly owned corporations.

A comprehensive policy issued by European Commission in 2007, covers many aspects in connection with promoting intermodal transports (e.g. investment in infrastructure, technologies, competition rules and standards for equipment), though it only has partial effect on intermodal transport in an urban setting, as the policy is mainly created for long distance transports (Diziain et al., 2014). Therefore Diziain et al. (2014) stated that specific schemes and policies by authorities, which cover the options like subsidies and incentives, are necessary to promote intermodal urban transport services.

Although not specifically designed for urban transport, a notable example of an incentive system is the 'Eco bonus' (Tilskudd for godsoverføring) implemented in Norway (Saxton, Olsson, Tilegrim & Bergdahl, 2017). It encourages modal shift from road to sea by supporting new intermodal transport solutions, through compensating the additional costs related to the inclusion of maritime transport as part of the whole transport chain (Saxton et al., 2017). Saxton et al. (2017) describe the key idea of Eco bonus is to compensate the ship-owner by an amount accounting for the difference in external effects between sea and road transport, and also for

the reduced amount of trucks from the roads. The maximum reimbursement is limited by the project's costs (i.e. operating costs and investments of transshipment equipment) and only the ship owner can benefit due to the EU guide lines of short sea shipping support (Saxton et al., 2017). Projects are defined by their routes, types of goods being transported, all the related services and the volume of road transport shifted to sea transport (Saxton et al., 2017). In order to be qualified for Eco bonus, a project has to clearly demonstrate its socio-economic benefits, the amount of road transport that can be shifted to sea transport in Norwegian soil and also be able to continue after the end of the 3-year support period (Saxton et al., 2017).

Although subsidies are important to set up intermodal services in urban areas, Diziain et al. (2014) noted that members of the EU have to follow EU competition laws, which consider subsidies illegal if they favour particular private companies or distort the competition. Subsidies under 200,000 euros and distributed over a period of 3 years are allowed, because the amounts are not considered significant (Diziain et al., 2014).

Consequently, by being anti-competitive and sometimes expensive for the municipalities, direct funding from local authorities to transport operators is not always the best solution to develop sustainable urban freight transport solutions. Instead, regulatory restrictions can be applied to drive transport operators towards sustainable urban distribution. For instance, low and zero emission vehicles in London are exempted from congestion charges creating a cost advantage for them, while in Utrecht these vehicles are allowed to use priority lanes (BESTFACT, 2015a). Another similar case is the 'Low emission zone Rotterdam', in which the authority in Rotterdam marked the city centre as a low emission zone, meaning that only trucks with engines that are compliant to the EURO IV norm or higher are allowed to enter, emissions inside the city centre were reduced thanks to the regulation (BESTFACT, 2015a).

Lastly, another scheme aiding the implementation of more sustainable transport solutions is the EU funding programme named European Regional Development Fund (ERDF), which "*aims to strengthen economic and social cohesion in the European Union by correcting imbalances between its regions*" (European Commission, 2014a) and together with the European Social Fund (ESF), they share a budget of 256 billion Euros. Each member state of the EU will receive a unique share of this budget which is decided on the EU level.

The ERDF focuses on four key areas and one of them is the promotion of low-carbon economy (Lecarte, 2016). Furthermore, the ERDF gives special attention to sustainable urban development, with at least 5% of the ERDF's resources set aside for each Member State's integrated actions to deal with environmental, economic and social challenges in urban areas (Lecarte, 2016). The EU member states are sorted into three regions based on their GDP per capita, more developed regions whose GDP per capita is above 90% of the EU average must focus on two of the mentioned key areas with at least 80% of the received budget and assign a minimum of 20% to the low-carbon economy (Lecarte, 2016). Projects initiated in more developed regions can be financed by ERDF resources up to 50% of the project cost (Lecarte, 2016).

Various organisations (i.e. public bodies, private businesses, universities, associations, non-governmental organisations and voluntary organisations) are eligible to apply for the ERDF by contacting the responsible local authority (European Commission, 2014b), organisations in Sweden should contact the Swedish Agency for Economic and Regional Growth (Tillväxtverket) in order to apply for funding (Tillväxtverket, 2017). A relevant example of ERDF funding is the case of the Beer Boat in Utrecht (presented later in section 2.1.8), where the acquisition of the emission-free vessel costing 800,000 euros was partly funded by the ERDF (Maes, Sys & Vanelslander, 2015).

2.1.8 Urban waterway transport and existing practices

The term 'urban waterway transport' is defined as: "*transport carried out on inland waterways located within the boundaries of a built-up area*" (OECD, 2002b). Waterway transport has a long history, however its market share has been reduced dramatically due to the popularity of other transport modes (Beelen, 2011). During the mid-20th century, road haulage became a more attractive transport mode because it was cheaper, faster, more efficient and flexible (Beelen, 2011).

Due to the increased focus on sustainability, waterway transport is starting to play an important role for goods transport within Europe (European Commission, 2017a), because of its advantages. Firstly, it is considered competitive with road and rail transport, due to less energy consumption, as well as being more environmentally friendly and generating less noise pollution compared to the other two (Lowe, 2005; European Commission, 2017a). Secondly, this transport mode has a higher degree of safety, in addition reduces congestion in urban areas

(Lowe, 2005; European Commission, 2017a). Statistics of the market shares of transport modes (road, rail and inland waterway) in the EU, show that inland waterway transport has 6.9% share (Eurostat, 2014). Mobility in urban areas is a critical factor to promote growth, employment and sustainable development (European Commission, 2017b), in order to enhance urban mobility, inland waterway transport can be a possible solution (European Commission, 2017a). However, according to Diziain et al. (2014) one problem is that the initial investment is high because ships are costly and there are some other challenges with operating an urban waterway transport service. These challenges are:

- Total costs including transshipment
- Technical capacity suitable for shipping: depth of water, clearance under bridges and width at gate
- Level of reliability of barge transport due to natural conditions (e.g. floods in France)
- Urban insertion of facilities (docks and storage)

(Diziain et al., 2014, p.165)

In the meantime, there are several successful examples of urban waterway transport services around the world, which can provide valuable information considering the scope of the thesis, therefore some notable projects are presented below.

Vert chez Vous – Floating Distribution Centre

The delivery company Vert chez Vous combined bicycle and waterway transport for last mile delivery utilizing the Seine River in Paris. Each morning at 7am, the “Vokoli” barge (Figure 4) is loaded with 18 electrically assisted delivery cargo cycles at port of Tolbiac and starts navigating along the river. It makes 5 stops during the trip and turns around at the port of Grenelle. Meanwhile, at each stopover a team is dispatched for delivery and collection of goods in that area and return to the barge two stops further down the river. (Janjevic, Ndiaye & Brebbia, 2014)

The known success factors are the following:

- Public policy promotes the emergence of this type of initiative: heavy goods eco-tax (above 3.5t), air priority action zones (ZAPA), urban tolls, zones where speed is limited to 20kph, limitation of delivery times by conventionally fueled vehicles in the very centre

- Information and communication systems guarantee following day delivery (BESTFACT, 2014)



Figure 4. Illustration of the Vokoli barge
(Source: Diziain, Taniguchi & Dablanc, 2014, p. 164)

Franprix

The project of ‘Franprix entre en Seine’ was initiated in 2012 by the French food retail company Franprix (BESTFACT, 2013b). In this project, a new multimodal and urban transport chain solution was used, in order to deliver goods from the warehouse to 80 stores in central Paris (Diziain et al., 2014).

The regional warehouse is located in Chennevières-sur-Marne which is about 20 km away from Paris. On daily basis, in the morning from 05.00 to 11.30 about 450 pallets of goods are arranged and then loaded into 26 containers customized for intermodal waterways transport. Afterwards, between 12.30 and 18.30 the containers are transported by truck to the Port of Bonneuil and then loaded onto the barge. Later on the barge sails 20 km to reach its destination, Quai de la Bourdonnais. In the following day, the final deliveries of less than 4 km are done by ordinary diesel trucks. Empty containers are loaded back onto the barge and shipped back to the warehouses. (BESTFACT, 2013b)

By adopting this multimodal transport solution, approximately 450 000 vehicle-kilometres by road is avoided per year and a reduction of 250 tons of carbon dioxide is achieved (BESTFACT, 2013b). Although, despite the mentioned benefits of this project, it is still more expensive

overall compared to pure road transport (Trojanowski & Iwan, 2014). The success factors for this project were identified:

- The willingness of a retail company (Franprix) to experiment with more sustainable deliveries
- The availability of a quay in the centre of Paris that was fitted out by Port Authority of Paris
- A public-private partnership to reduce truck traffic inside Paris, and the technical feasibility of the solution
- The know-how of the door-to-door, multimodal logistics service provider Norbert Dentressangle

(BESTFACT, 2013b)

Mokum Mariteam

The project of Mokum Mariteam was initiated by two companies, Saan, a company focused on logistics operations and Icova, a waste and recycling firm. The common goal of these two companies was to make their business cleaner and waterway transport through the canals of Amsterdam was identified as a possible solution. A custom-made barge was required in order to navigate in all places of Amsterdam. Due to the limitation of the canals, the vessel was built 20 meters long, 4.25 m wide and has a load capacity of 85 cubic meters. (BESTFACT, 2015b)

Since then, a self-propelling barge equipped with an electric engine navigates through the city canals in order to deliver goods and collect waste at the point of delivery. In addition, different kinds of transport units are transported through this service, such as rolling containers, pallets and mesh containers, therefore the potential of being implemented by other customers and the possibility to scale up this transport service is increased. (BESTFACT, 2015b) The identified success factors were:

- Better use of the available infrastructure in Amsterdam
 - Reduction of trucks in the city centre
 - Reverse logistics operations reduce road freight traffic even further
 - Organisations involved understood the advantages of sustainable transport by barge
- (BESTFACT, 2015b)

Zero-Emission Beer Boat in Utrecht

The local authorities of Utrecht implemented some measures to limit and alleviate the road traffic in the city centre due to the negative effects caused by trucks. One solution was to shift

the traffic from road to waterways, which brought the Beer Boat to life. After the realization of the project, the transport service was subsidised by the municipality of Utrecht. The service was to mainly deliver the last mile deliveries from 4 breweries and 1 catering industry wholesaler to 65 small businesses located closely by the canals. The beer boat was built 18,8m long, 4,2m wide and a load capacity of 18 tonnes. In addition, the boat is equipped with an electric hydraulic crane for unloading purposes. (BESTFACT, 2013d)

For the case of Utrecht, the success factors were:

- The practice is cost- and time-efficient
 - The transport costs have decreased, the city accommodates the last mile deliveries using one vessel
 - The delivery time window for the centre has been extended
 - The end-customer costs are low as it is publicly subsidised
- (BESTFACT, 2013d)

2.1.9 Advantages and limitations of urban waterway transport

Some advantages of waterway transport have been mentioned (i.e. less energy consumption, lower noise pollution) in previous chapters. The purpose of this chapter is to look more closely into the advantages and more importantly the limitations of urban waterway transport.

Rohács & Simongati (2007) measured the performance, regarding sustainability, of waterway transport and compared it to other modes such as road haulage and rail transport. The study concludes that waterway transport is environmentally friendly (in terms of CO₂ emission and noise level), very safe for the society (in terms of accidents) and efficient (in terms of energy consumption etc.) (Rohács & Simongati, 2007).

Indeed, waterway transport provides many benefits but there are also some limitations. Rohács & Simongati (2007) also highlighted that: (1) the technology development of road transport is fast and the current negative effects generated by trucks could be changed; (2) Rail transport could replace inland waterway transport in an intermodal transport chain since rail transport has similar performance; (3) Waterway may not be cost-effective for forwarders since it requires pre and post haulage and more administrative work; (4) Waterway transport is slow.

While road haulage has been known to be flexible, waterway transport is limited to the inland waterways. In addition, in many cases the conditions of the inland waterways are inadequate.

According to Salter (n.d.) in order for proper functioning of a waterway transport system, certain improvements on the infrastructure need to be undertaken:

- Dredging and channel widening
- Maintaining banks
- Confirming bridges built over waterways are able to let vessels pass
- Ensuring water level is high enough during dry seasons
- Make sure the passage along waterways is not blocked by irrigation or water management structures

2.2 Gothenburg circumstances

This section briefly describes Gothenburg's transport situation, including the city's transport strategy and regulations, as well as circumstances concerning waterway transport in the city. A short background description is also given about the main actors interested and involved in the project.

2.2.1 Transport situation, strategy and regulations

At the end of 2016, the Swedish population reached up to 9 995 153 inhabitants (SCB, 2017a). Statistics Sweden (Statistiska centralbyrån) projects the population will increase rapidly and by 2024 the Swedish population will be over 11 million (SCB, 2017b). A report published by the United Nations (2014) stated 54% of the world's population lives in urban areas and this trend is growing. Furthermore, in 2014 86% of the Swedish population lives in an urban setting and by 2050 this will be increased to 90% (United Nations, 2014). At the end of 2016 Gothenburg had 581 822 inhabitants and was ranked as the second biggest city in Sweden (SCB, 2017c). According to Olsson & Woxenius (2014), the Gothenburg region is one of Sweden's primary freight region, which has caused traffic issues like congestion within the city.

According to the Transport Strategy by Hellberg, Bergström Jonsson, Jäderberg, Sunnemar & Arby (2014), Gothenburg is under the process of transforming into a larger city as more and more people live and work in the area, thus Gothenburg will become a denser city. In the future, Gothenburg aims to be a *“large, close-knit city with successful businesses, environmental qualities, a vibrant urban landscape and a simpler everyday life”* (Hellberg et al., 2014, p.3).

The objective of the Transport Strategy is to illustrate how the transport system and streetscape in the city are going to be developed in the future (Hellberg et al., 2014) and it is mainly for officials and politicians to take into consideration when planning and making decisions for investments and actions. In addition, other stakeholders (such as businesses) can use this report to make important choices and investment that is coherent with the city's vision (Göteborgs Stad, n.d.a).

Transport of goods is one of the most important element, which plays a significant role for the future development of Gothenburg (Hellberg et al., 2014). As mentioned earlier by Olsson & Woxenius (2014), Gothenburg is one of the biggest freight region in Sweden, therefore the city strives to handle goods in the most efficient and climate-smart manner. As a result, three strategies were mentioned in the Transport Strategy:

1. *"Ensuring good accessibility for goods transport in Gothenburg while at the same time reducing negative local environmental effects"*

The first strategy entails an increased rail network capacity, prioritisation of specific freight routes, optimised choice of transport and use of intermodal transport. The results of these actions could potentially lead to improved and more efficient freight flow, as well as increased effectiveness of implementing different measurements to reduce climate impact and various effects, such as noise and emissions.

2. *"Collaborating regionally in the establishment of logistics centres and transport-intensive operations"*

The second strategy refers to the inclusion of goods transport in the urban planning process and having a regional perspective when implementing transport intensive operations, thus conflicts between industry, retailing and logistics can be averted.

3. *"Stimulating innovation in collaboration with academic institutions and businesses"*

The third strategy involves having an innovation platform for the city to be able to communicate with businesses and public actors. As a result, joint solutions can be obtained and implemented instantaneously.

(Hellberg et al., 2014, p.7)

In order to deal with the traffic issues, two major regulations were implemented by the authorities. First, a time-of-day dependent cordon-based congestion charging scheme was

implemented in 2013 and affects all vehicles (Börjesson & Kristoffersson, 2015). The design of the congestion tax has the following objectives:

- Raising revenues for the investments in the West Swedish Agreement
- Reducing congestion and improving the environment

(Börjesson & Kristoffersson, 2015, p.135)

According to Transport Styrelsen (n.d.a) (The Swedish Transport Agency) a vehicle is charged for passing through one of the pay stations (showed in Figure 5 below) and the amount charged is dependent on time of the day. For instance, in the morning from 07.00 to 07.59, a vehicle is charged 22 SEK and between 18.00 and 18.30 the amount is lowered to 9 SEK. In addition, this system uses a single charge rule, which means a vehicle can only be charged once under one hour and the maximum accumulated amount per day is 60 SEK. (Transport Styrelsen, n.d.a)

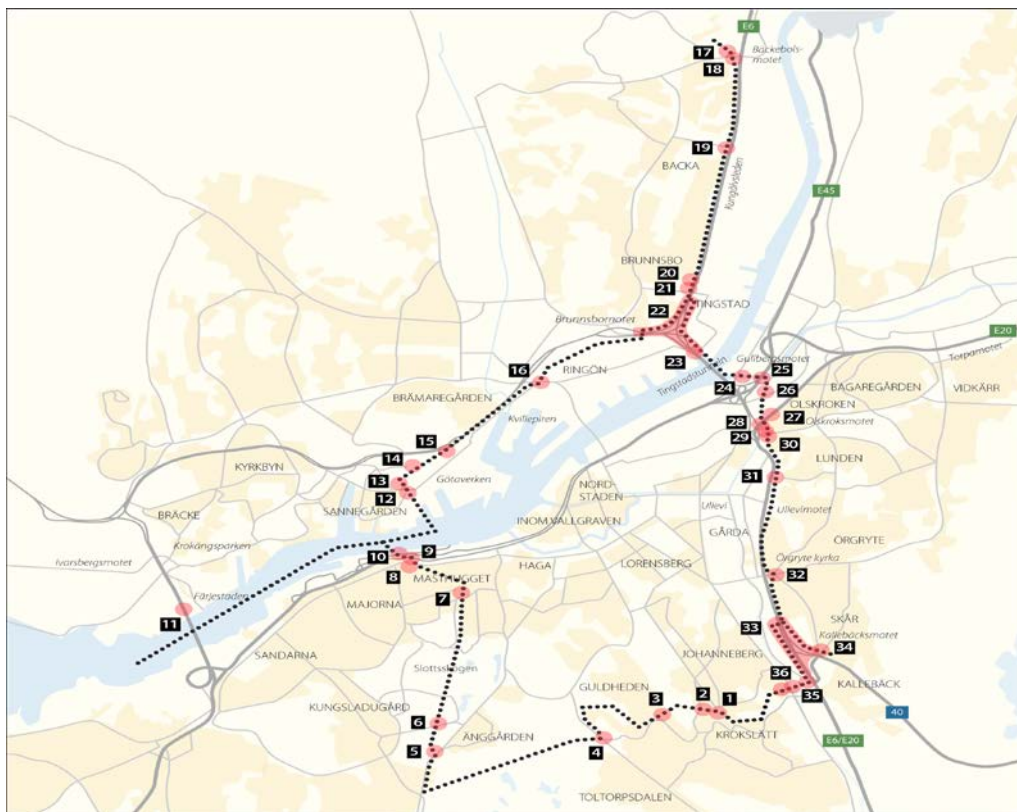


Figure 5. Map of pay stations in Gothenburg (Source: Transport Styrelsen, n.d.b)

The second regulation is called Low Emission Zone (LEZ) and affects trucks and buses. It was implemented to improve the air quality inside the city centre. Currently, vehicles with engines that are compliant to the Euro 5 norm are allowed to enter the LEZ until the end of 2020 and

Euro 6 engine vehicles are unrestricted (Transport Styrelsen, n.d.c). In Figure 6 below, the marked area is the Low Emission Zone.



Figure 6. Low Emission Zone – Gothenburg (Source: Göteborgs Stad, n.d.b)

At the end of 2016, Transport Styrelsen proposed to apply the LEZ for passenger cars, light buses and trucks, as well as to extend the classifications of LEZ, integrating class 2 and 3. (Transport Styrelsen, 2016)

- Low Emission Zone class 2 is applied to passenger cars, light buses and trucks. In order for these vehicles to enter the zone, diesel powered vehicles must fulfil Euro 6 engine requirements and petrol, ethanol or gas driven vehicles shall meet the requisite of Euro 5 norm.
- Low Emission Zone class 3 includes passenger transport (cars, motorcycles, moped of class I), light and heavy trucks and buses. In this zone, light vehicles must be powered

by electricity or hydrogen gas. Heavy trucks have the same requisites and heavy hybrid electrical vehicles are also acceptable if they meet the requirements of Euro 6.

These regulations can have a negative impact on some citizens and businesses (in a financial aspect connected to transport costs) depending on the size of these zones. The transport agency predicts LEZ class 2 will contribute to better air quality until year 2030, the contribution afterwards is insignificant as the majority of the Swedish vehicles fulfil these requirements. Therefore, LEZ class 3 is required to promote cleaner air and less noise in the city in a longer timeframe. (Transport Styrelsen, 2016)

2.2.2 Waterways in Gothenburg

As mentioned in previous chapters, urban waterway transport is an alternative to road transport and utilized to tackle congestion in various cities. In recent years, Sweden has adopted the EU regulations regarding inland waterway transport due to increased interests from the country's shipping industry. At the end of 2014, the following waters in Sweden are considered as inland waterways: Göta älv, Vänern and Mälaren. (Transport Styrelsen, n.d.c)

A stream named Sävån runs down from the lake Aspen and flows into Göta älv, though there are a few small bridges built over it which affect the dimensions of the barge that can sail through Sävån, the measurements are the following: minimum air draught is 2 m high and minimum breadth is 10 m. The dimensions of the stream should be taken into account when implementing waterway transport according to Salter (n.d.). Sävån is a valuable nature area and classified as a Natura 2000 zone (Länsstyrelsen, 2017). Any activities and operations which can damage the environment and disturb the wildlife in this zone are requiring permission from the County Administrative Board (Länsstyrelsen). Furthermore, the river is shore protected which means activities such as digging and building are prohibited without permission (Länsstyrelsen, 2017).

The map of Gothenburg is presented in Figure 7. The map is marked with the possible quays and the facilities of different actors. Thereafter, a brief description is given about the actors involved in the DenCity project.

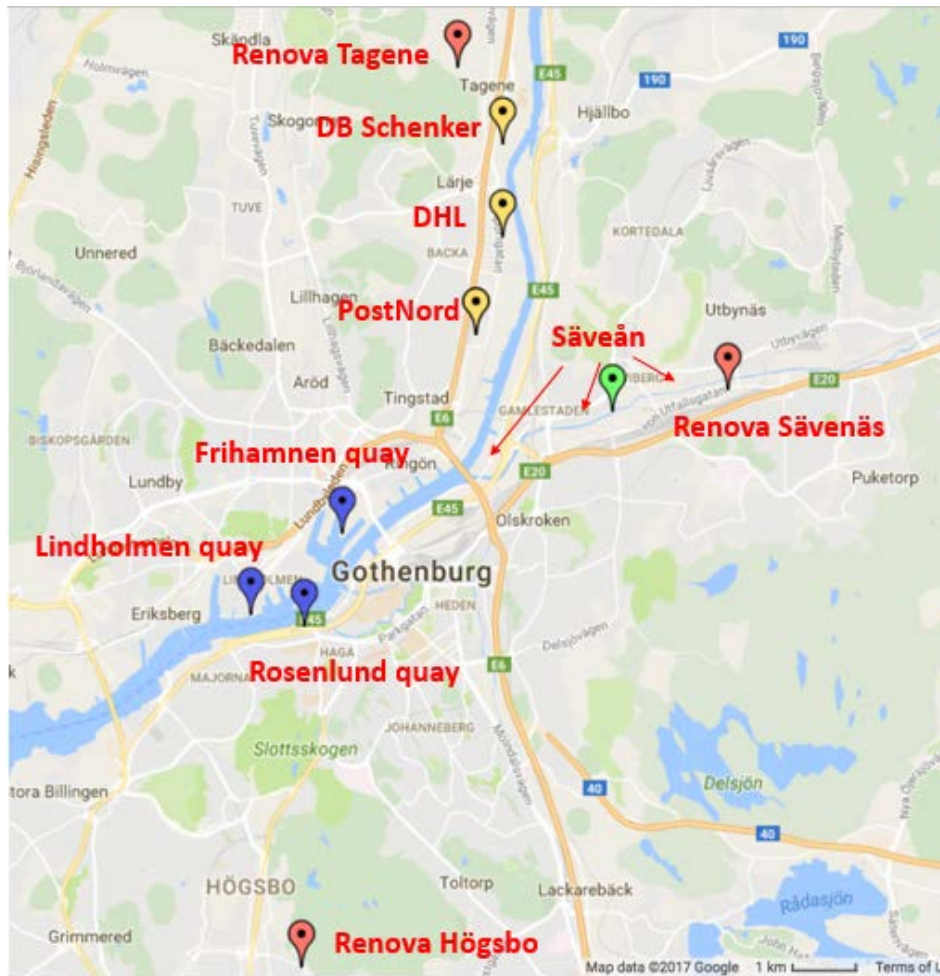


Figure 7. Map of Gothenburg (adapted from Zeemaps, 2017)

2.2.3 Background description of actors

Trafikkontoret

Trafikkontoret is a local transport committee in Gothenburg. Its responsibilities are to satisfy the transport needs of the citizens and businesses, improve traffic safety and reduce the negative environmental effects caused by traffic. Furthermore, Trafikkontoret is also responsible for the expansion and maintenance of the city's roads, streets, bicycle paths and tram network in order to enhance the mobility within the city. To achieve its goals, the committee collaborates with several governmental actors and diverse stakeholders. (Göteborgs Stad, n.d.f)

Sandinge Bogsering & Sjötransport (SBS)

SBS is a family owned sea transport company based in Lysekil, Sweden. The company offers numerous water transport services such as towing, shipping project cargo by barge and icebreaking. Additionally, it also offers charter of equipment and barges for particular unique

purposes. Currently SBS have barges stationed in Sweden (i.e. Gothenburg, Uddevalla, Lysekil and Krokstrand) and Norway (Halden and Tofte). (Sandinge Bogsering & Sjötransport, 2017)

Kretslopp & Vatten (K&V)

Gothenburg has several committees with each of them having their own focus and responsible area to take care of (Göteborgs Stad, n.d.c). Kretslopp & Vatten is the committee responsible for providing citizens and businesses with a secure, efficient and environmentally friendly water and waste management. In addition, K&V is also responsible to take care of the household waste in an efficient and environmentally friendly way (Göteborgs Stad, n.d.d). K&V procures these tasks to qualified business actors, for instance, a big part of waste collection and processing in the city is done by Renova (Göteborgs Stad, n.d.e).

Renova

Renova Group is a waste management company owned by ten municipalities including Ale, Gothenburg, Härryda, Kungälv, Lerum, Mölndal, Partille, Stenungsund, Tjörn and Öckerö and offers various services, such as collection and transportation of all types of waste, recycling products and waste management (Renova, n.d.a).

Renova has several facilities which serves different purposes. Renova Tagene is used as a landfill site for ash from waste combustion and also as a waste consolidation centre. Similarly, Renova Högsbo is a waste sorting facility, all kinds of wastes from businesses, construction sites and households are gathered, then sorted in this plant and transported in 34 m³ containers to other sites for further processing. Renova Sävenäs is a waste-to-energy plant, where waste is incinerated to generate electricity and heating. (Renova, n.d.b)

DHL

DHL is one of the biggest freight forwarder globally providing supply chain management services and freight transports services (i.e. Express air freight, Ocean freight and European road freight contract logistics) to businesses and end customers. (DHL, 2017a)

The marked road terminal in Bäckebo is one of 180 DHL's road terminals across the world and handles diverse road freight services. Customers are offered three categories of services, which are consolidated groupage, direct full truck loads and part loads, as well as dedicated full

truck load network. These services range from a simple (door-to-door) pickup and delivery to the consignee, to tailored transport solutions for customers. (DHL, 2017b)

PostNord

In 2009, the Swedish and Danish mail service (Posten AB and PostDanmark A/S) joined forces to meet the cross border logistics demands. PostNord was created in order to offer a wide range of logistic and transport services to its customers in the Nordic countries. Moreover, PostNord is responsible for the mail services to private persons and businesses in Sweden and Denmark. (PostNord, 2017)

DB Schenker

DB Schenker is a freight forwarder company offering numerous freight transport services to its customers, for example land, sea and air transport. Additionally, it also offers integrated supply chain solutions. (DB Schenker, 2017)

Pling Transport

Pling is a transport company that was established 2012 in Gothenburg. The company offers various services, such as distribution of goods, pickup of recyclable wastes and event based taxi (Pling Transport, 2017). The company mainly operates in the city centre and the distribution operations are performed with a cargo cycle (Pling Transport, 2017) named Armadillo which has a cargo capacity of 150 kg and is able to carry one loading unit called “1 m3 City Container”, referring to its capacity (Velove, 2017). The company states that there are many benefits provided for the citizens and the city, if they use Pling’s services, for instance less space utilization, lowered noise level, reduced risk of causing serious traffic accidents and less energy consumption compared to an electric van (Pling Transport, 2017).

2.3 Summary

As the literature review shows, urban freight transport plays a critical role in sustaining urban civilization, however current practices are considered unsustainable, inefficient and costly. Subsequently, urban freight presents a challenge, which requires effort and collaboration of actors directly and indirectly involved in it, to help society deal with the issues. Sustainable urban freight transport encompasses several objectives, such as ensuring accessibility of

transport system, reducing pollution and emissions, improving resource and energy efficiency, as well as enhancing the quality of urban environment and life.

Numerous practices and initiatives are being implemented or planned towards sustainable urban freight transport, most notably low emission road vehicles, alternative modes instead of road transport, urban distribution and consolidation centres, as well as public policy schemes. Combining road transport with other transport modes presents an intermodal solution, which can be utilized in cities to mitigate negative impacts. It can also help freight forwarders in avoiding congestion and restrictive regulations, however there are certain conditions needed in order for it to be a viable option. One of these conditions can be public policies facilitated by authorities, by either incentivizing cleaner transportation (subsidization, e.g. Eco bonus) or by restricting more negatively impactful transport options (e.g. emission zones, congestion taxes). The European Regional Development Fund also gives financial aid for implementing projects concerned with sustainability in urban areas.

Urban waterway transportation is getting increasingly attractive due to the increased focus on sustainability, as it alleviates many of the current issues in urban freight. Even though there are several successful examples (Vert chez Vous, Franprix, Mokum Mariteam, Beer Boat), there are also numerous challenges associated with this transport mode, for example high initial investment, transshipment costs, suitable technical and natural conditions, as well as available infrastructure in urban areas.

Concerning the situation in Gothenburg, the city is struggling with traffic issues such as congestion, because it is Sweden's major freight generating region and it is also becoming denser due to growth. To tackle this problem, two regulations are already implemented, to reduce traffic within the city centre (congestion tax, emission zone). In addition, the city authorities also issued a report which covers transport strategies for Gothenburg to deal with future transport challenges. Concerning the physical circumstances of waterways in Gothenburg, Göta älv and Sävån are identified as suitable for waterway transport. However, some challenges are also identified in connection with sailing through Sävån. First, the capacity of a vessel is limited due to Sävån's physical restraints. Second, the stream is a protected nature area and permission from Länsstyrelsen is required for building infrastructure and conducting operations on Sävån. Lastly, the second part of the literature review ends with a description of various organisations and actors involved in the project.

3. Analytical framework

This chapter provides a review of the business model concept, particularly focusing on using business models as conceptual tools through business model frameworks or canvases, which can be utilized as tools in designing and applying business models in practice, working as a link between theory and practice. As a result of this chapter, the aim is to present a framework, which is applicable and suitable for an urban waterway shipping service.

3.1 Business model concept background and definition

The business model concept can be considered a relatively new part of the business research field, and its emergence is mostly due to technological advance and the rise of the Internet, which enabled the spread of electronic commerce and called for a revenue making scheme for the web-based firms (Morris, Schindehutte & Allen, 2005). Although, since its appearance, the business model theory gets significant attention from academics and practitioners, there is no generally accepted consensus on the terminology of the business model (Morris et al., 2005; Zott, Amit & Massa, 2010). Differences in the interpretation of the term leads to complications in identifying the components of the model and limiting the nature of it (Morris et al., 2005). Therefore, a business model can be referred to as design, pattern, plan, architecture, method, assumption, conceptual tool or statement (Morris et al., 2005; Zott et al., 2010). Terms such as business model, strategy, economic or revenue model are often used interchangeably, which generates further confusion (Morris et al., 2005)

In spite of the growing attention business models have recently got from both researchers and practitioners, the lack of an agreement on a common and widely accepted terminology is hindering the progress of the research on the concept (Zott et al., 2010). The available literature is quite segmented according to the fields of interest for the various researchers (Zott et al., 2010). Zott et al. (2010) identifies three main interest areas: e-business and the utilization of information technology in organizations; strategic matters, for example competitive advantage, company performance and value creation; innovation and technology management.

According to Zott et al. (2010) there are four main themes surrounding the theory: the business model is a new unit of analysis besides products, companies or network levels; business models have a system-level, holistic approach in explaining how companies conduct business;

organizational activity perspective is recurrent in many business model definitions; both value creation and value capture is a main objective of business models.

However, as Coes (2014) describes, there is inconsistency between business model literature and business practice. The academic literature about business models is primarily focusing on describing and defining business models, in addition there is a lack of consensus on identifying parts of an ideal business model structure (Coes, 2014). Thus, there is a gap between business literature and practice, as the latter lacks academic consensus and support on determining the ideal business model construct (Coes, 2014). This void is being filled out by academics and practitioners by debating necessary components of the business model and creating business model tools (Coes, 2014).

Teece (2010) also states that the business model concept lacks theoretical foundation in economics and business academics. Considering that textbook economic theory assumes fully developed markets, as well as customers buying according to the price and utility yielded, defining value propositions to customers, structuring revenues and costs or value capture mechanisms become unnecessary, just as creating business models for products or services (Teece, 2010). However, in reality entrepreneurs and managers have to pay huge attention to forming business models, especially in businesses that bring new value to the markets (Teece, 2010).

According to Teece (2010) the new era of global trading systems, that enabled customers to have more varied needs and much more available choices, has called for businesses to be more customer oriented and to rethink the value propositions they present to customers. Companies need to adapt in addressing customers more wisely and also in capturing value from providing new products or services (Teece, 2010). Thus, a business model articulates how a business creates and delivers value to customers, as well as specifies the structure of costs, revenues and profits in connection with providing that value (Teece, 2010). Teece (2010, p.173) points out that: *“a business model defines how the enterprise creates and delivers value to customers, and then converts payments received to profits.”* Subsequently, the business model represents a company’s assumption on what are customer needs and willingness to pay, and how to organize the firm to meet those needs while earning revenues (Teece, 2010).

Osterwalder & Pigneur (2010, p.14) has a similar definition for a business model: “*A business model describes the rationale of how an organization creates, delivers, and captures value* “. In order to fill out the gap surrounding business model theory and practice, as well as to facilitate discussion and improve analysability of the concept by constructing a standardized framework, Osterwalder & Pigneur (2010) created the Business Model Canvas (BMC). Zott et al. (2010) describes the BMC as a business model ontology, which characterizes and forms the quintessential parts of a business model into components, relationships, meanings and vocabulary. The BMC aims to provide a common language for practitioners, not just to describe or discuss business models, but to utilize it as a tool in designing them (Osterwalder & Pigneur, 2010). According to Osterwalder & Pigneur (2010) the framework covers the four main areas of business: customers, offer, financial aspects and infrastructure. These four areas together are represented by nine co-related building blocks, which together build up the BMC (Osterwalder & Pigneur, 2010). As the BMC is one of the most widely used standardized framework for business model creation (Coes, 2014), and the thesis aims to utilize a suitable framework for an inland waterway transport service, the next section will present and elaborate on the nine building blocks, which together form the BMC.

3.2 The Business Model Canvas

Deriving from the business model definition made by Osterwalder & Pigneur (2010), the value proposition is the focal point of the nine building blocks, as the other blocks are supportive in capturing and delivering that value (Osterwalder & Pigneur, 2010). Customer segments, customer relationships, channels and key partnerships together compose the network of the company’s relations to commercial partners (Osterwalder & Pigneur, 2010). Key activities and key resources make up the infrastructure of the firm that enables them to capture and deliver the value, while cost structure and revenue streams represent the financial aspects (Osterwalder & Pigneur, 2010). It is important to note that the building blocks are not meant to be focused on separately, the relationships and mechanics between them are bringing the actual business model to life (Osterwalder & Pigneur, 2010). Figure 8 illustrates the BMC and the contributing nine building blocks.

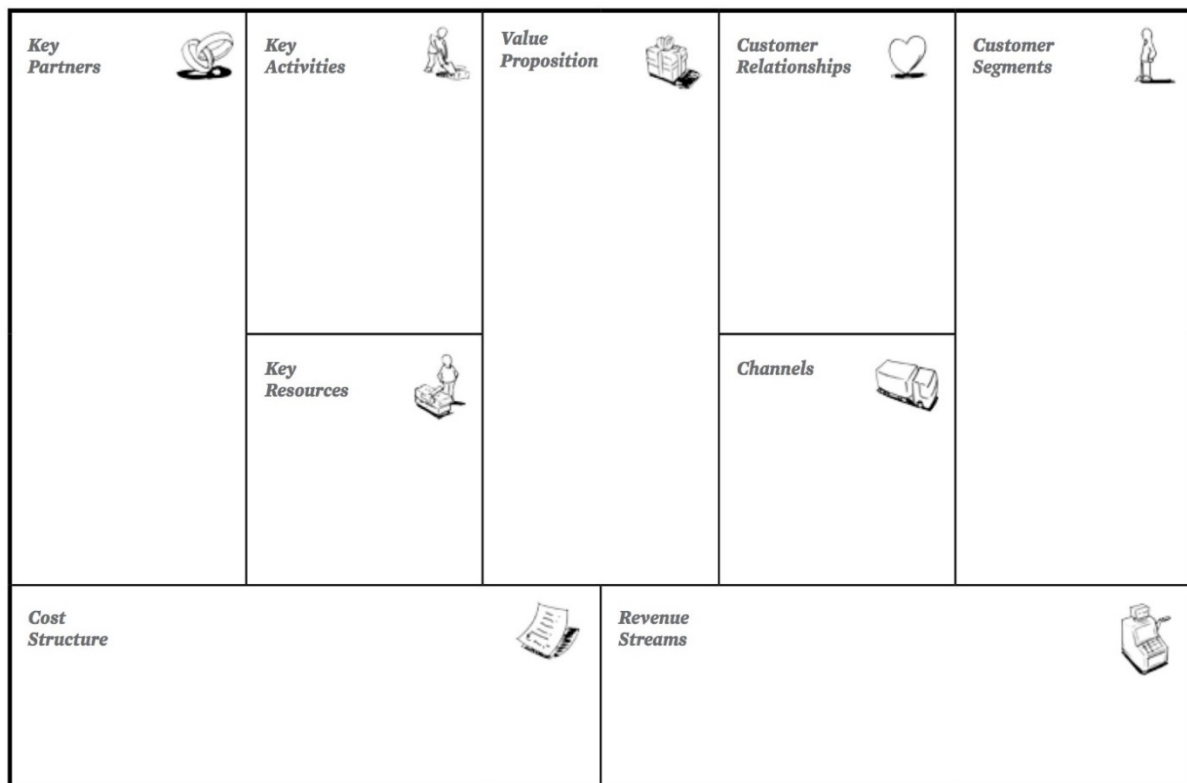


Figure 8. The Business Model Canvas (Source: Osterwalder & Pigneur, 2010)

Value proposition: The value proposition is a company’s answer to specific customer needs or problems by offering products or services that provide value for a specific customer segment. It is very important that the values offered by the firm matches the targeted customer profile, if it fails to solve the problems or satisfy the needs of the customer segment, then the company’s business model won’t be successful. (Osterwalder & Pigneur, 2010)

Customer segments: Customer segments represent the specific groups of people, organizations or other firms that the company targets with their product or service. In order to decide on and refine the firm’s value proposition, it needs to segment these groups according to their common needs and attributes, and select which segment is targeted. The offered value and the entire business model is designed then according to this targeted customer segment. (Osterwalder & Pigneur, 2010)

Channels: The way a company reaches and communicates with its targeted customer segment is described by channels. They raise awareness and inform customers about a company’s value proposition and also help in delivering it. Therefore, channels are connecting the value

proposition with the customer segments, through communicating, selling and distributing the firm's value proposition to the customers. (Osterwalder & Pigneur, 2010)

Customer relationships: Similarly to channels, customer relationships also link value proposition and customer segments, by putting emphasis on the type of relationship the company maintains with its customers. Differences in how closely the firm interacts with the customers and how is this interaction maintained can really affect overall customer perception. (Osterwalder & Pigneur, 2010)

Key partners: Along with channels and customer relationships, key partners also describe a network of interactions and relationships. Although in this case these relationships are established with external partners and suppliers who provide resources and activities that are necessary for the company to create and deliver its value proposition. These partners can complement the firm's business model, but can also receive value from it besides the customers. (Osterwalder & Pigneur, 2010)

Key resources: These are the most important resources that make a company's business model operable, as they are necessary for nearly every building block of the model. Different types of key resources can be physical, intellectual, financial or human, and they are either owned, leased by the company or provided by key partners. (Osterwalder & Pigneur, 2010)

Key activities: Besides resources, a company also needs to undertake activities, which are crucial in the successful operation of the business model. These activities related to value creation can be production, problem solving or network activities. (Osterwalder & Pigneur, 2010)

Revenue streams: Obviously, companies usually aim to earn profits, thus they need to capture the delivered value through making revenues. Revenue streams represent the money generated by delivering the value proposition to customers. Revenues can be obtained by utilizing different kinds of pricing methods, however in order to maximize revenues the firm needs to have information about how much the customer is willing to pay for the provided value. Revenues can be classified as transactional, collected through one-time payments, or recurring, thus resulting from continuous payments. (Osterwalder & Pigneur, 2010)

Cost structure: It encompasses all the costs that are generated by operating the business model. These costs are mostly characterized by key resources, key activities and key partners, as these parts generate costs while they create and deliver value to customers. Two extremes of business models can be differentiated according to their cost structure: cost-driven, which focuses on minimizing costs and value-driven, which concentrates on maximizing value creation. Costs can be further broken down into variable and fixed costs. (Osterwalder & Pigneur, 2010)

Despite being a widely used, solid standard framework for business models, the BMC also has limitations, in addition received criticism from both academics and practitioners. The following section will elaborate on these issues, in order to help determining if the BMC is suitable for the purposes of the research.

3.3 Limitations of the Business Model Canvas

Coes (2014) identifies several limitations to the BMC, firstly, there is an absence of external factors, such as competition or other market forces. It doesn't take market competition into account, instead focuses on the company's internal business objectives (Coes, 2014). Secondly, there is confusion among practitioners about the role of key activities, key resources, channels and customer relationships, as well as about the level of detail the individual building blocks should have compared to each other (Coes, 2014). Lastly and most importantly for this research, a major limitation is the lack of usability for various organizations, because the BMC is built for providing value to make revenues, thus it is built for earning profits (Coes, 2014). In this way, social, environmental values and non-profit purposes are excluded from the framework.

Similarly Joyce & Paquin (2016) note that the BMC is suitable for developing profit oriented business models and can include sustainability-oriented values in its framework, however environmental and social value are overshadowed by its profit-making and economic value capture objectives. Accordingly, a more sustainability focused business model might require a different framework, which integrates economic, social and environmental value into its structure (Joyce & Paquin, 2016). According to Lüdeke-Freund (2010), a sustainable business model is: "*a business model that creates competitive advantage through superior customer value and contributes to a sustainable development of the company and society*". Business models that take sustainability into account besides delivering and capturing economic value,

have a broader range of value perspective, as they aim to capture social and environmental values for a wider range of stakeholders (Bocken, Short, Rana & Evans, 2013).

As mentioned above, the BMC is a profit-oriented framework, however in an urban logistics setting, cities and public organizations design policies that require business models to consider environmental and social impacts (TURBLOG, 2011). In TURBLOG (2011) the policies identified for urban logistics can be:

- Environmental impacts: reducing pollution, freight vehicle trips and noise
- Social impacts: improving quality of life and working conditions; reducing accidents, congestion

These impacts are referred to as ‘externalities’ and were added to the original BMC as a 10th building block, in order to adapt it to an urban logistics use (TURBLOG, 2011).

3.4 Business model for sustainable urban logistics

Figure 9 shows the modified BMC for urban logistics with the added ‘externalities’ building block, besides the nine ‘original’ blocks described earlier in the thesis, that aims to capture social and environmental impacts caused by the business model (TURBLOG, 2011).

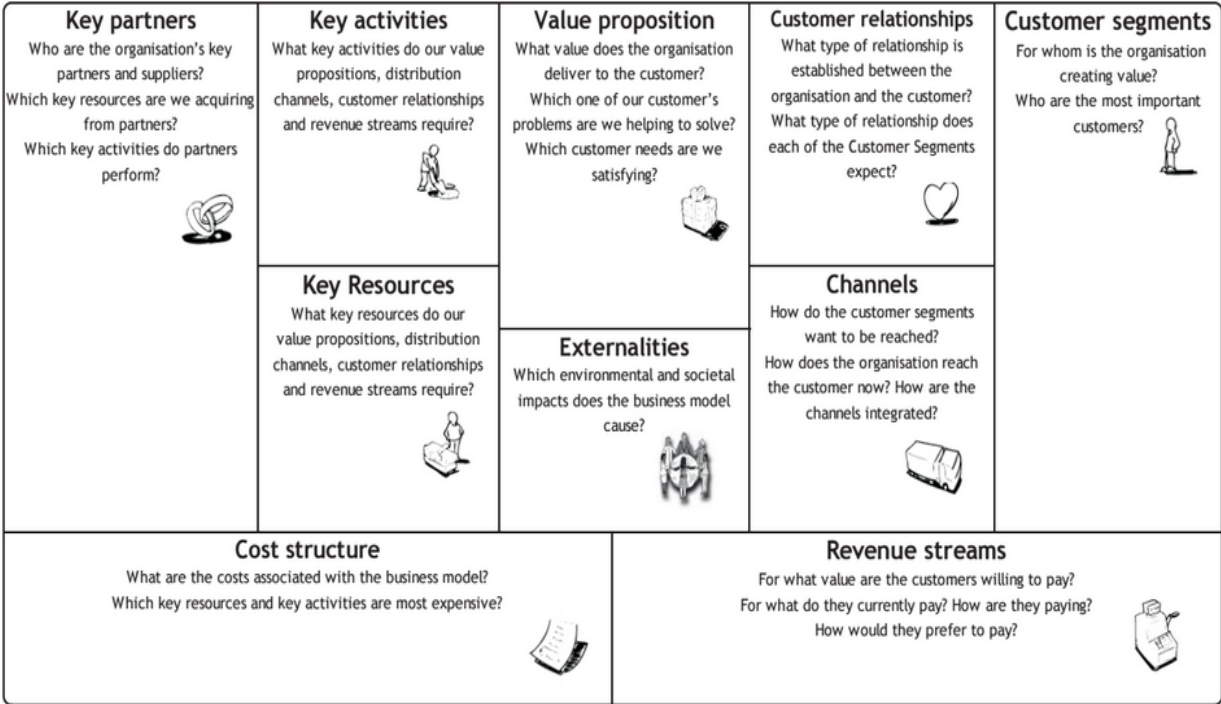


Figure 9. Sustainable Urban logistics business model (Source: TURBLOG, 2011)

As the presented arguments show, the business model concept is still a fairly new research area in academics, thus there is a lack of consensus between researchers and practitioners on the terminology and role of business models. Although, it is a very essential element of business practice, it lacks theoretical foundation in academics.

In order to bridge the gap between theory and practice, Osterwalder & Pigneur (2010) created the BMC, which not only helps to identify the basic components of a business model and creates a common ground between practitioners and academics, but also serves as a framework that can be utilized as a tool to design them.

However, the BMC also has its own limitations due to its generalized nature, most notably it fails to address external factors on the market that considerably influence its feasibility. Additionally, it is essentially a revenue and profit oriented framework designed to capture economic value, which means environmental and social values don't have a meaningful role in the model.

As described throughout section 2.1, urban freight transport has several negative impacts concerning the environment and society. Therefore, more sustainable urban freight transport solutions are highly desirable for cities, and as shown in section 2.2, the city of Gothenburg also strives to become better this area. An urban waterway transport service's main advantage is reducing or improving on some of the negative impacts and is not solely focused on profit-making. Accordingly, the enhanced version of the original standard BMC presented by TURBLOG (2011), which encompasses the external effects of the model as an additional block, is more suitable as a business model framework in carrying out the research objectives of the thesis.

4. Methodology

This chapter describes the used research method in order to answer the given research question. First part of the chapter discusses the research paradigm and justifies the chosen research approach and method. The second part reveals the used methods for collecting and analysing data, as well as comments about the quality of this study regarding reliability, validity and generalizability.

4.1 Research philosophy

Every research design starts by determining the research paradigm, which is a framework that guides how research should be carried out. A researcher's view about the world and the nature of knowledge determines the research paradigm, positivism and interpretivism. (Collis & Hussey, 2013)

Interpretivism emerged as the opposite of positivism due to some shortfalls of positivism (i.e. a well-structured research design can have a negative impact on the results and the researcher may miss some other relevant findings) (Collis & Hussey, 2013). Interpretivism assumes social reality is not independent and is influenced and shaped by the people (Crossan, 2003). According to Collis & Hussey (2013) the goal of this paradigm is to gain a deeper understanding of different social phenomena which is too complex to be measured. Instead, it employs different kinds of qualitative methods that try to describe, translate and comprehend the meaning of occurring phenomenon in the social reality

The authors decided interpretivism is suitable to solve the formulated research questions of this study. Since an urban waterway transport involves different participants to function properly, therefore it acts as a complex system. By taking the stand of interpretivism, the authors aim to find and understand the critical parts in a business model for urban waterway transport.

4.2 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 a

similar vein, Creswell (2013) introduced a third category, a research approach which utilizes quantitative and qualitative methods.

A qualitative approach is often used when there is limited information about the research topic and the study has an exploratory or discovery purpose. In addition, the strength of this particular approach is: it can provide in-depth and detailed information about participants' worldviews and their individual values. (Johnson & Christensen, 2008)

In order to answer the formulated research question and fulfil its purpose, the authors apply a qualitative approach in order to gain insightful understandings of the different actors' viewpoints and opinions of the urban waterway transport service. Afterwards, the authors can make use of the gained experience to visualise a possible business model of urban waterway transportation and examine it to identify critical components.

4.3 Research method

“Scenario analysis is the process of evaluating possible future events through the consideration of alternative plausible, though not equally likely, states (scenarios)” (Liu, Mahmoud, Hartmann, Stewart, Wagener, Semmens, ... & Letcher, 2008, p. 146). Given this definition, Liu et al. (2008) argues scenarios are not forecasts nor predictions about of the future instead scenarios provide a dynamic view of the future by examining different paths that can lead to a wide range of possible futures. Thus scenarios are well suited for long term planning as the method offer a myriad of opportunities for different and unforeseen circumstances to appear. Means, Patrick, Ospina & West (2005) highlight one of the greatest value of scenario planning lies in its ability to express a shared future view hence coordinated decision making and activities can be achieved.

Liu et al. (2008) stated there are many types of scenario analysis, each technique varies according to the type of information and data applied, methods used to generate the scenarios and the approach of presenting the results. The choice of a proper scenario analysis technique is determined by the goals of the research project and the context in which the research takes place (Kosow & Gaßner, 2008).

In order to resolve the research questions of this study, a scenario analysis technique known as the backcasting method defined by Dreborg (1996) was used. The method can often be applied to solve problems connected to human activities, more specifically it can be used to analyse environmental and developmental issues (Robinson, 1990). Dreborg (1996) elaborated that backcasting is often used to solve long-term complex issues concerning sustainable development where various aspects of the society, technology and change are involved. The description of the approach fits the characteristics of this thesis, as urban waterway transport involves and affects great number of actors in the society (e.g. a transport solution to reduce congestion) and it is a long term investment in order to provide cleaner freight transport compared to other modes e.g. heavy trucks.

Robinson (1990) mentioned backcasting is designed to show the implications of different futures on the support of criteria defined externally to the analysis (e.g. criteria of social or environmental desirability). Moreover, he highlighted that

”the major distinguishing characteristic of backcasting analysis is a concern, not with what futures are likely to happen, but with how desirable futures can be attained. It is thus explicitly normative, involving working backwards from a particular desirable future end-point to the present in order to determine the physical feasibility of that future and what policy measures would be required to reach that point”

(p. 822).

According to Dreborg (1996) a backcasting study requires innovative ideas about solutions to existing problems at stake and there is no point of specifying any formal methods, as only the result of the study matters. Hereafter the details of the backcasting method are described.

The product

According to Dreborg (1996), the result of a backcasting study is alternative images of the future, which are then carefully analysed according to their feasibility and consequences. The images are made to emphasize polarities and limits to what is technologically and socially possible in order to reach these images. In addition, strategic choices for the society are also identified in backcasting study, more specifically the choices are decisions that may close or open the door to some of the identified metaphors of the future.

To decision makers

The backcasting study is performed to solve complex issues involving many actors in the society and thus its findings and results are also addressed to various actors such as political parties, governmental authorities, municipalities, organizations, private enterprises and general public. (Dreborg, 1996) The mentioned correspondent with this thesis as the findings is to clarify the financial aspects and feasibility of urban waterway in Gothenburg that various actors are involved.

The purpose

The purpose of creating the images of the future are expected to function as well worked out examples of what, for instance how sustainability can look like, and broaden the view of possible solutions among the involved actors. The second purpose of backcasting is to highlight consequences strategic choices in public community, where some future options can be closed or opened are based on these selections. Hence the result of a backcasting study is not meant to form a basis for one big decision and it is neither a plan nor blueprint. The results can work scientific material which enables actors with diverse values and goals to form an opinion and a perspective on the future. And the findings of a backcasting should be treated in the context of a case study however a few common remarks can be made. (Dreborg, 1996)

4.4 Research design

As mentioned the applied research method didn't include any prescribed steps, the design of this research was necessary. In order to gain an overall understanding of urban waterway transports, sustainable and societal issues caused by urban freight transport activities and business models, a literature review was done. A theoretical business model framework was chosen, which captures the different aspects of the market and is also suitable for the research purpose.

Afterwards, interviews with various stakeholders and market actors related to this transport service were conducted in order to gain their opinions, views and information (e.g. current transport practices, future possibilities, barriers etc.). In the meantime, the researchers also participated in meetings of the DenCity project and made observations about technicalities.

Combining the knowledge of the literature review and the gathered data from interviews, the authors defined different segments of the chosen business model framework according to the

characteristics of urban waterway transport service. The completed framework is considered as the product in regards to the defined backcasting method thus it is a projection of how a business model for urban waterway transport service can look like. Lastly, the product is then carefully analysed considering its feasibility and consequences depending on what strategic choices are made by the society and the actors in it.

4.5 Data collection

Data can be sorted into primary and secondary. Primary data are created by the researcher (Collis & Hussey, 2013) and intended for the specific study (Björklund & Paulsson, 2003). Secondary are collected through existing sources, for instance, publications, databases and internal records. Different kinds of methods can be used to gather primary research data in a qualitative study, such as interviews, diaries and observations (Collis & Hussey, 2013). In this research, primary data was collected through observations and interviews.

Observations

Throughout the research period, the researchers attended events, such as meetings, inspection of existing infrastructures (such as quays) and a small-scale demonstration proving the possibility of the waterway transport service.

The researchers attended two meetings, with the first being dedicated to the waterway work-package of DenCity, with involved actors gathering together. The contents of the meeting consisted of discussion about relevant issues and status update of the project. The researchers gained a comprehensive picture of the project and got to know all the involved actors, at the same time they presented themselves and their work for this group. In the second meeting, project leaders and members of the seven work-packages gathered to present their projects and current status. After the meeting, the researchers gained a deeper understanding of the DenCity project and its objectives.

Inspection of quays that have potential to be utilized for this project was also undertaken. The researchers were accompanied by a member of the project and inspected quays located at Lindholmen and next to DHL in Bäckebol (see Figure 7 in section 2.2.2). Lastly, the researchers also took part in a small-scale demonstration of transporting, as well as loading/unloading containers of goods and waste from a barge. The demonstration illustrated the technical

possibility of waterway transport in Gothenburg and also how a possible solution for the transshipment process could look like.

Interviews

Interviews are often utilised in order to gain knowledge of what the respondent believe, does and feel (Collis & Hussey, 2013). Semi structured interview is a flexible and appropriate method for small scale research. For this type of interview, the interviewer constructs a general structure by deciding in advance about the topics to be discussed and key questions to be asked. In addition, the respondent has a fair degree of freedom in expressing its thoughts and answering the questions. (Drever, 1995)

In this thesis, semi structured interviews with open questions were conducted individually and the majority of the interviews were executed face-to-face, lasting in average one hour. However, one interview was conducted through email as the respondent didn't have time to meet the researchers. Every interview was also recorded and transcribed which enabled the authors to thoroughly analyse the given information afterwards. The set of questions for each respondent differs somewhat, as these individuals have different professions and backgrounds. The interviewees were chosen on account of their involvement in the DenCity project, as well as their expertise and experience that provided crucial information for the researchers. Table 2 below presents the respondents, their roles and the organisation they work for.

Respondent	Role	Organisation	Interview
Andersson, Linda	Urban Planner Manager	Ramböll AB	Face-to-face
Erlandsson, Johan	Sale, Marketing, business development /CEO	Pling Transport /Velove Bikes AB	Email
Garberg, Björn	Project Manager	Sjöfartsverket	Face-to-face
Sabel, Håkan	Site Manager	DHL	Face-to-face
Sandinge, Bengt	Owner	Sandinge Bogsering och Sjötransport	Face-to-face
Södahl, Björn	Consultant	SØDAHL & PARTNERS AB	Face-to-face
Widegren, Christoffer	Consultant	Trafikkontoret	Face-to-face
Zackrisson, Hans	Development Manager at Business Logistics	Renova Miljö AB	Face-to-face
Årnes, Peter	Process Manager	Kretslopp & Vatten	Face-to-face

Table 2. Interviewees

Literature review

The literature study provided the researchers with knowledge in the areas of urban freight transport (more specifically waterway transport), EU and Swedish regulations including policies and strategies for freight transports in an urban setting, as well as business models. In addition, knowledge from similar urban waterway projects in other countries was also gathered.

The secondary data was gathered from numerous sources such as academic articles, different 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 Gothenburg University Library's Supersök were used to find the related academic articles and textbooks. Main keywords such as 'urban freight transport', 'sustainable development', 'sustainable urban freight transport', 'urban waterway transport', 'business model' and 'sustainable business model' were used extensively to find the relevant literatures in the field of logistics and business models.

Non-academic reports, articles and project reports were found through Google searches by utilizing the aforementioned and other keywords. In addition, names of urban waterway projects in other countries were found in academic articles and more specific information about them were gathered through Google searches.

4.6 Data Analysis

The recorded interviews were transcribed and analysed in the context of the research question. The overall process was inspired by Renner & Taylor-Powell (2003), although some modifications were made in order to adapt to the study. The following steps were carried out, (1) Get to know your data, (2) Categorize information and (3) Interpretation – Bringing it all together (Renner & Taylor-Powell, 2003).

Step one was to get familiarized with the data gathered by the researchers. In order to do so, the researchers re-listened to the interviews via the audio files, then relevant data were transcribed. According to Collis & Hussey (2013) this is important because a researcher cannot determine

what is important and what is not, until he or she is familiar with the data. Second step meant the categorisation of the relevant information. The authors used the components in the chosen business model framework, moreover the competitiveness and possible operations of a waterway service in Gothenburg as predefined themes. Afterwards the transcribed data was analysed and assigned to the corresponding associated theme. The last step was to interpret the data in each respective theme and translate the data into useful information, which is then used to construct the business model in chapter 5, as well as aids the researchers in their analysis.

4.7 Research quality

Under this section, the research quality is discussed in terms of reliability, validity and generalizability.

When reliability is discussed related to a research, the subject is mainly the consistency of its measures (Bryman & Bell, 2015). Reliability under an interpretivist paradigm is viewed as less important compared to its counterpart, positivism. The rationale behind is due to the fact that the researcher may have an influence on the research itself, therefore replication of the same result by another researcher would nearly be impossible (Collis & Hussey, 2013). “*Protocols and procedures that establish the authenticity of the findings*” should be focused on in an interpretivist study. In order to achieve the aforementioned objectives, the authors followed the same process for every interview to capture all relevant data in connection with the purpose of the thesis.

Validity is concerned with the assumption that the measurements and results prepared by the researcher reflect the occurrences that are under investigation (Bryman & Bell, 2015). Collis & Hussey (2013) stated several errors, such as faulty procedures, poor samples and inaccurate or misleading measurements may threaten the validity of a research. In order to gain the desired information from the respondents, various actions were undertaken. Firstly, as the research touched upon many aspects and organisations of the society, to gain a comprehensive view, interviews with these different actors were compulsory. Secondly, as these individuals may not be aware of this research, a brief presentation about the thesis and the researchers was necessary. Lastly, the authors agreed with each respondent that if there was any follow up questions after the interviews, these could be answered through emails or telephone.

Generalizability is concerned with the findings of a research, if it can be applied to other cases (population) and settings (Vogt & Johnson, 2011). Gummesson (2000) pointed out, an interpretivist study is able to generalize its findings from one setting to another with similar characteristics if the analysis has captured the interactions and essence of the case. Collis & Hussey (2013) explained in order to do so, a researcher has to gain a comprehensive and meaningful understanding of the happenings and behaviours for the chosen case.

However, Shenton (2004) has criticised the generalizability of a case study, because it is associated to a specific context and environment. Despite this critique, case studies can be used as an example of a broader perspective according to Stake (2005). Flyvbjerg (2006) argues in his paper that there are five misunderstandings about case studies and one of them is concerned with generalizability. In short, Flyvbjerg (2006) argues, it is possible to generalise from a case, depending on its details and the process of how the case is selected. According to Collis & Hussey (2013) a case study is usually used to explore and gain meaningful knowledge of a phenomenon in a natural setting. The researchers consider that the method of this study shows similarities to a case study, since it uses the Gothenburg as a specific circumstance in order to answer the given research question, thus one can argue that the above mentioned comments by Shenton (2004), Stake (2005) and Flyvbjerg (2006) can be applied to this study as well.

Based on these arguments for and against case studies, the authors consider that this project can be generalized on a broader level and give valuable information to other related projects. Although the majority of the actors who have been interviewed are mainly active in and have specialised knowledge of Gothenburg, thus the specific findings are associated with the city. Nevertheless, the outcome and knowledge produced by this paper could be used as an example and a lesson for other similar projects in this research field.

5. Findings

In this chapter, a possible future scenario of the urban waterway service business model is presented, from the viewpoint of the service operator, based on the findings of the literature review and the conducted interviews. As noted earlier, to construct and visualize this business model scenario, a framework designed for urban logistics business models will be utilized. It is also important to note, that here only the structure of the model is described. Relationships between the different parts and the context in which the model operates, as well as the conditions enabling this possible scenario to materialize will be discussed in the analysis.

5.1 Business model

The identified possible business model for the urban waterway service operator is constructed by detailing the interrelated building blocks of the model using the information gathered from the interviews and the literature. These building blocks of the business model framework are summarized and illustrated below by Figure 10.

Key partners	Key activities	Value proposition	Customer relationships	Customer segments
City of Gothenburg DHL Renova Pling	Towing/pushing barges Mooring	Cleaner transport Avoiding congestion – more reliable/predictable transport	Long term contracts	Renova/Kretslopp och Vatten (City of Gothenburg) DHL (Postnord, DB Schenker)
	Key Resources Electric tugboat Barge for waste barge for goods 2 crew members	Warehouse/distribution centre Externalities Decreasing <ul style="list-style-type: none"> • Emissions • Congestion • Noise 	Channels Online IT system to handle scheduling, orders and tracking shipments	
Cost structure		Revenue streams		
Variable costs: crew salary, charging, maintenance Fixed costs: depreciation of the investment, certificates, insurance		Goods transport: fixed daily fee Waste transport: volume based charge		

Figure 10. Urban waterway service business model
(Source: Future scenario based on findings and the BMC by TURBLOG, 2011)

5.1.1 Key resources & key activities

In order to properly establish the background for other blocks of the model, firstly it is important to identify the key resources that are utilized during the operation of the business and the key activities the company performs as part of the service offer. First of all, the service will require two separate barges, one specifically built for transporting goods and one built for waste. The reason for the separation stems from the differences in the nature of the cargoes. As Widegren (personal communication, 29-03-2017) also suggested, goods transport generates a different demand than waste, it has time constraints and requires more operational efficiency and flexibility, in addition their different carrying units call for distinctively designed barges. Moreover, S ave an puts limitations on the dimensions of the waste transporting barge that can travel through, thus separating the goods transporting barge is desirable in order to avoid the same limitations.

According to Sandinge (personal communication, 22-03-2017) and S odahl (personal communication, 23-03-2017) it is more efficient from the service operator viewpoint to have not self-propelled barges acting only as cargo carrying units, which are towed or pushed by a tugboat during the transportation. In this way, the operations become more flexible and less costly, since after mooring is done, the crew doesn't have to be there at the loading process and can proceed to deal with moving the other barge (Sandinge, 2017; S odahl, 2017). In addition, since the separate barges don't require manning, only the tugboat, the operator can cut down on costs by decreasing the amount of crew members needed.

Therefore, besides the barges, the service needs a tugboat for the operations, which has to be specifically built to be able to go under the low bridges along S ave an and can be electrically powered in order to maximize the benefits in external impacts (Sandinge, 2017; S odahl, 2017). The operations also require two crew members working full time (Sandinge, 2017). Depending on which actors bear the investment, the barges might be owned and provided to the service operator by key partners in the business model. Key activities performed in the service, basically only involve the transport of the barges by towing or pushing them along the waterways and mooring to the quays.

5.1.2 Key partners

Key partners are assisting the service by providing resources and complementary activities that help the company to deliver its value proposition. One of the main key partner is the city of Gothenburg, who is the main owner and provider of the necessary infrastructure, such as the quays, thus the city's support is essential for the setting up the service (Widegren, 2017). The city can also assist the business model by other actions that can facilitate the implementation and also strengthen the value proposition of the service, this will be later discussed during the analysis.

Depending on which actors bear the investment to acquire the barges for the operations they will also become key partners in the business model, as they are supplying a key resource to the service operator. Accordingly, DHL can become a partner by investing into obtaining the barge for goods, possibly even in collaboration with other freight forwarders, while Renova could financially assist the acquisition of the waste barge and also fixing the infrastructure (Zackrisson, personal communication, 05-05-2017), the issue of investment will be discussed in more detail in the analysis. Last-mile delivery companies using cargo cycles, such as Pling, can also be regarded as key partners, considering that they offer a complementary service – green last mile delivery of goods – that can be combined with the value proposition of the waterway transport service (Erlandsson, written communication, 31-03-2017).

5.1.3 Externalities

Before specifying the value proposition of the business model, it is necessary to summarize the external impacts of the waterway transport service in comparison with pure road transport. Waterway transport, according to the European Commission (2017a) and as other successful implementations described in the literature review show, decreases emissions, thus have environmental and social benefits. As Renova's heavy vehicles are running mostly on biofuels, waste transport in the city manages lower emissions, with their CO₂ emission being on average 3 kg/tonnes of waste transported through their whole route (Årnes, personal communication, 06-04-2017). According to DHL their average CO₂ emissions for their transport operations is 75 g/tonne-kilometres (Sabel, personal communication, 03-04-2017). However, diesel engines not only emit CO₂, but pollutants that are a health risk for the population (Anderson et al., 2005). Depending on the volumes of freight shifted to the waterway transport, these emissions can be lowered, especially considering that the tugboat is electrically powered.

Additionally, as volumes of freight are shifted from road transport, congestion in the city is reduced, which in turn increases urban mobility and reduces traffic accidents (Rohács & Simongati, 2007; European Commission, 2017a). Other benefits are more energy efficiency and the reduction of noise pollution (European Commission, 2017a). Altogether, the urban waterway transport service has positive environmental, economic and social impacts for the city.

5.1.4 Value proposition

As the externalities part of the business model shows the service's main offer through the value proposition is a cleaner and less negatively impactful freight transport mode compared to pure road transport in the city. In this way, besides providing the transportation of freight, the service can also produce commercial value and marketing benefits to its customers (Sabel, 2017).

Secondly, congestion during road transportation can be avoided by using the waterways that have no such infrastructural and traffic limitations as roads, therefore it can ensure stable transport flows even during rush hours, as well as with its calculated speed and transport time it can provide an overall more reliable and predictable transport option (Sabel, 2017; Södahl, 2017; Widegren, 2017).

Moreover, the barge can also potentially act as a floating warehouse and distribution /consolidation centre for the goods, because they can be arranged and loaded onto the barge in a way that aids efficient distribution, in addition the loaded goods can also be easily consolidated on the barge (Sabel, 2017; Södahl, 2017). The barge also offers a relatively free storage space compared to the alternative option of a more expensive land area, furthermore, its mobility enables the transport companies to have a warehouse located closer to the end receivers to facilitate distribution (Södahl, 2017).

5.1.5 Customer segments

Since the service offers transportation of goods and waste, there are two different customer segments targeted by its value proposition. As Renova is the biggest actor contracted to collect, transport and process household waste in the city by Kretslopp & Vatten, it becomes the targeted direct customer of the waterway transport service (Årnes, 2017; Zackrisson, 2017).

Although, considering that K&V, a committee of the city of Gothenburg, is in charge of the public procurement of the waste collection, as well as that Renova is also publicly owned by the municipalities, indirectly it's the city of Gothenburg who is the customer of the service (Årnes, 2017).

Concerning goods transport, hypothetically any freight forwarder or retailer in need of transport services could become a customer. However, as DHL's logistics terminal in Bäckebol is located right next to the river and it transports significant volumes into the city center (Sabel, 2017), it can be viewed as one of the most likely possible customer, especially if it also decides to invest into acquiring the barge. Moreover, other freight forwarders, such as PostNord or DB Schenker who are also closely located in Bäckebol could also be interested, but depending on the ownership of the barge and the infrastructural expenditure for the quay in Bäckebol they might have to negotiate access through DHL.

Consequently, a unique relationship in the business model is that, depending on the arrangement of the investment to set up the service, possible customers are also key partners for the urban waterway freight transport service operator. Additionally, the city of Gothenburg can also directly become a customer, if they choose to subsidize the service in some way, these aspects will be discussed in the analysis.

5.1.6 Customer relationships & channels

As the interconnection between key partners and customers indicates, the service operator will have close relationships with its customers, because setting up the service and planning the operations requires tight collaboration. Correspondingly, the size of the investment also calls for long term commitments and contracts with customers (Sabel, 2017). K&V signs 5 plus 2 year contracts for its waste collection procurement because of the planned depreciation of trucks, thus a similar or even longer time span could be expected for the waterway service too (Årnes, 2017).

Regarding channels, direct contact and communication is needed between the service provider and the customers to ensure smooth operation of the business model. For delivering the value proposition, possibly an online IT system is needed, which can handle scheduling and orders

from customers, as well as in which shippers and end receivers could follow the shipment (Sandinge, 2017).

5.1.7 Cost structure and revenue streams

The main variable cost in the business model is the salary of the crew, considering it is based on working hours. Fuel cost is usually also a significant variable cost, however in the case of an electrically powered tugboat the charging of the boat is representing fuel cost, thus the overall expense in comparison with a diesel engine depends on the charging system and electricity prices compared to diesel prices. In addition, some maintenance of the tugboat and barges is also needed, particularly batteries for the electric engine might require extra care or replacement during the lifetime of the tugboat. (Sandinge, 2017)

Fixed costs include the initial investment, certificates and insurance. The investment is a major cost driver as the initial investment into boats/barges is costly (Diziain et al., 2014) and it's depreciated according to the lifetime of the tugboat and barges, which is a much longer time frame in the case of waterway transport. Certificates for the crew and the vessels needed from Transport Styrelsen (Swedish Transport Agency) are also fixed costs for operating the service, moreover insurance is required for both the crew and vessels as well. (Sandinge, 2017)

Considering that the service operator's costs are not much dependent on actual transported volumes, from the operator's viewpoint the optimal pricing is to charge a fixed daily fee for the transport service based on the calculated costs and an added profit margin (Sandinge, 2017). This pricing scheme could work for the goods transport service, however, at present K&V's contracts are volume-based, as waste collection earnings are based on emptied bins and containers (Årnes, 2017). Accordingly, the waterway service operator might have to negotiate a volume-based price for the waste transport operations. In addition, having these two distinct revenue flows from both the goods and waste transport entails that the service's fixed costs would be covered more easily, which could in turn lower the fees charged for the separate customers. Moreover, as mentioned in customer segments, if the city of Gothenburg subsidizes the service, that would represent a supplementary revenue flow for the business.

6. Analysis

When analysing the presented business model of the urban waterway transport operator, the main issue that arises is regarding the actual demand it could attract from possible customers. Consequently, the attractiveness of the service's value proposition for its targeted customers is questionable, mainly due to the external factor of market competition. Since the core offering of the business is transportation of freight and road transportation is primarily used for this purpose in the urban setting, the waterway transport service's competitiveness with it has to be accounted for when examining its long-term feasibility.

Firstly, it is important to note that, unlike the waterway transport solutions implemented in the Netherlands that are described in section 2.1.8, this service can't offer door to door transport in the Gothenburg setting. This implies that customers utilizing the waterway transport option will always have to find ways to efficiently integrate it into their own transport flows and take care of land based last-mile deliveries, resulting in an intermodal transport solution.

Furthermore, as the business model shows, customers are not only important as buyers of the service, but they are also key partners because of their required investment into setting up the service, thus they have double importance in the business model. Accordingly, it is necessary to analyse the external factors surrounding the model that greatly influence its feasibility, which means the customers' actual interest in the service's value proposition and its competitiveness with other transport options, if it delivers enough benefits for them compared to its drawbacks. Subsequently, it is examined what the barriers are to incorporate the waterway transport into their transport operations, both in the case of waste and goods transport, and how can be those overcome in connection with the presented future scenario of the business model, as well as what actions can make the value proposition more enticing for customers in order to enable the business model to come into existence in the future.

Lastly, it is also important to explore the circumstances surrounding the investment structure, as without the actual investment of acquiring the key resources taking place the business model can't materialize. In addition, depending on which actors bear the initial investment it becomes a major cost contributor in their system even if it's depreciated in the long term, hence it affects the overall valuation of the service.

6.1 Waste transport

As the business model shows, for transporting household waste through the waterways in Gothenburg, the most likely direct customer would be Renova, as they are the biggest actor in the city, taking care of huge volumes of waste through the whole chain from collection to end processing. The public procurement for waste collection in the city is handled by Kretslopp & Vatten, however since the procurement is open, Renova operates on a competitive market (Zackrisson, 2017). This implies that becoming the customer of the waterway transport service has to be commercially viable for the company to remain competitive. Meanwhile, technical issues also need to be solved in order to integrate waterway transport into Renova's transport flows. Before analysing the future feasibility with barriers and enablers, it is essential to describe how the actual waste transport operations could look like combined with the waterway transport service.

6.1.1 Possible operations

Firstly, it is necessary to identify the type of waste suitable to be shifted to waterway transport. As recyclable waste is collected in a manner, where different materials need to be separated, it entails that the barge would need separate compartments, where the trucks could unload the sorted recyclables, which greatly complicates the loading process during the switching between transport modes (Zackrisson, 2017). On the other hand, residual waste, which is being transported to Renova's waste-to-energy plant in Sävenäs, is more suited for this purpose.

The residual waste collected by Renova in Gothenburg is being consolidated into bigger containers at Renova's two sorting facilities in Högsbo and Tagene shown on Figure X. in section 2.2.2 (Zackrisson, 2017). Afterwards, a truck carries three of these 34 m³ detachable containers to the waste-to-energy plant in Sävenäs, from Högsbo 18 containers, while from Tagene 12 containers of residual waste are transported daily to Sävenäs (Zackrisson, 2017).

It is technically possible to integrate waterway transport into this transport flow. The trucks from the two sorting centres can transport the containers to the nearest suitable quay instead of going straight to Sävenäs, where they need offload them one by one onto the barge using the trucks' lifting apparatus (Zackrisson, 2017). After being fully loaded the barge can be towed

and docked to a quay built next to Sävån at Renova's waste-to-energy plant, where a truck has to pick up the containers again from the barge and carry out the final delivery to the facility.

6.1.2 Barriers

Although the above presented solution is operationally possible, the usual challenges described by Diziain et al. (2014) appear, namely total costs with transshipments and technically suitable surroundings for shipping. Correspondingly, questions arise regarding the commercial viability from the customer's viewpoint. Since the trucks have to travel less distance to the quays than to Sävenäs, the company can save on fuel costs. On the other hand, as a truck can only on/offload one container at a time, loading and unloading the trucks' three containers is a timely process (Zackrisson, 2017). Considering that after arriving to Sävenäs, trucks have to pick up the containers again to take care of final delivery, waterway transport will introduce two more loading stages to the transport operations of Renova.

Even though waste transport is not really time constrained, the extra loading processes will make the company's operations more complicated and less efficient compared to the pure road transport option (Zackrisson, 2017). This issue combined with the fact that the company also has to pay for the waterway transport service and invest into setting it up will most likely make its operations more costly, even with the slightly shortened road transport distance, hence Renova's commercial interest in the service is doubtful.

Additionally, considering the limitations of Sävån described in section 2.2.2 and the dimension of the 34 m³ containers, the maximum air draft of 2 m is going to be an issue with the containers being nearly 3 m high. Accordingly, it is hard to forecast how much volume the barge can possibly accommodate, as the weight has to be balanced to reach optimal ratio between underwater and air draft. As mentioned in section 2.2.2, Sävån is also restricted because of the Natura 2000 protection, which implies that permissions are needed for the waterway transport and for building the required infrastructure.

6.1.3 Facilitators for implementation

As the literature review shows urban freight transportation has several negative impacts, while the externalities block of the business model demonstrates that waterway transport mitigates these impacts. Being a major indirect stakeholder in urban freight transport, as well as

concerned about the negative impacts of it (MDS Transmodal Limited, 2012), the city has to aid the implementation, if it wants to realize the benefits of the service's value proposition.

Since, procurement for waste collection is handled by Kretslopp & Vatten acting on behalf of the city, the most likely possible option to aid the implementation is to stipulate the use waterway transport somehow in the conditions of the open procurement (Diziain et al., 2014; Garberg, personal communication, 10-04-2017).

However, if the city takes this option for implementation it has to be prepared to bear the extra costs in the procurement contract generated by the transport mode switch, in this way the financial barrier can be overcome in order to shift some of the transport flows to waterways (Zackrisson, 2017). As the city decides the available budget for K & V for the procurement of waste collection (Årnes, 2017), the decision, concerning if the benefits are worth the extra budget expenses, lies in the city's hands. In addition, for the operations at Sävåån, the necessary permissions also need to be obtained from Länsstyrelsen (see section 2.2.2).

6.1.4 Future possibilities and research prospects

Even though the above presented solution can decrease the distance travelled by trucks through the city, it is not answering emerging problems with waste transport directly in the city centre. Renova has to deal with vehicle weight limitations imposed by the city and accessibility problems with larger trucks, which in turn will force the company to use smaller vehicles for waste collection in the centre (Zackrisson, 2017). Subsequently, increasing the amount of vehicles on the road will lead to more congestion, and with the earlier presented expansion in the city centre approaching in the future, this issue will be further aggravated.

In this case, the smaller vehicles will have to leave the centre to deliver the waste to the processing facilities, which means they will increase congestion moving in and out of the centre, in addition will also have to face traffic problems themselves. Regarding these problems, a waterway transport solution seems more attractive and might even become commercially feasible. However, as plans for how the waste collection procedure will look in the new expanded city centre are still uncertain, it is hard to design and project the integration of waterway transport into the waste transport flow. Nevertheless, using some sort of unified container for the different waste types, which could be easily switched between the different

transport modes and carried through the waterways to their end processing facilities, would make this combined transport system and the realization of the previously presented business model much more possible. Altogether, to solve the aforementioned issues and facilitate the integration of waterways into the waste transport flow, the involved actors need to work together on effectively planning the technical aspects of the new system, which will be used after the city centre's overhaul.

6.2 Goods transport

End customers of urban goods transport services (consumers and businesses) are increasingly intrigued about less impactful delivery methods, however they are not highly willing to pay extra for them (Gevaers et al., 2011). In line with this, DHL affirmed that their end customers are generally refusing any added value to their basic transport services that would mean increased costs for them (Sabel, 2017).

Accordingly, freight forwarders are only interested to become customers of the waterway transport service, if it's competitive in terms of costs with their already used transport practices or if they are forced to utilize it because of regulatory policies limiting their other options (Sabel, 2017). Therefore, if the service aims to attract demand based on the current market circumstances, the integration of waterway transport has to be smooth for the customers with their costs staying on the same level as it is today (Andersson, personal communication, 18-04-2017). Hence, it is first necessary to examine the cost competitiveness of waterway transport with its main competitor in the city, pure road transport.

6.2.1 Competitiveness

Analysing the competitiveness of goods transport through the waterways in Gothenburg can begin with assessing the advantages it has over road transport. As previously showed by the value proposition of the business model (see section 5.1.4), it can provide various benefits to its customers. Firstly, being a cleaner transport mode, it has an added marketing value for transport companies. In addition, it can offer a more reliable transportation, as well as a cheap, movable storage space.

Though, the impact of these advantages are hard to estimate and quantify financially, thus when evaluating the benefits, it's needed to look into the actual cost reductions it can generate. The two main variable costs of road transportation are driver salaries and fuel costs (Sabel, 2017), by switching to waterway transport the distance travelled by trucks is reduced, which can imply a reduction in the previously mentioned costs depending on the volumes shifted to barges. In addition, avoiding the congestion tax imposed by the city also entails a slight cost reduction for freight forwarders.

On the other hand, customers have to pay a fee for the waterway transport service, based on the cost structure and revenue streams described in the business model (see section 5.1.7). Furthermore, the utilization of the service will create other operational complications for forwarders, which will greatly impact their cost structure.

Firstly, as mentioned earlier, the integration of waterway transport into the flows of freight forwarders will result in an intermodal freight transport solution. As noted by Diziain et al. (2014) and Södahl (2017), transshipment associated with intermodality presents one major issue, when utilizing waterway transport. It entails that goods transported through the waterways will need to be handled two more times compared to direct road transport before they are delivered. They require loading onto the barge at the distribution centre of the freight forwarder, then offloading at the quay where the barge docks, with the chain obviously ending with loading onto a vehicle that takes care of end delivery.

Since these loading processes will necessitate additional labour from the freight forwarders, the handling costs associated with transporting the goods will be increased. The amount of these handling costs will greatly depend on how the loading/unloading process is solved technically, as well as the efficiency of the switch between the different transport modes, nevertheless they are present at any possible technical solution of the loading process. Moreover, the required extra handling will also increase overall transport time, though with the increased time predictability of waterway transport this issue can be overcome with efficient planning and scheduling, as well as picking less time constrained goods to transport over the river.

Another issue is connected to the question of how much volume can be shifted to and transported by the waterway service. According to Sabel (2017), DHL has significant amount of transport flows going into the city centre, so providing enough transportable volumes of

goods wouldn't be a problem. However, there is a volume paradox concerning urban waterway transport. As Diziain et al. (2014) and many of the interviewees commented, waterway transport is mainly competitive when it transports higher volumes, because the cost of the waterway service per transported units is evidently lower in this case for the logistics companies. In addition, with higher volumes more truckloads are shifted over to the river, decreasing the number of trucks traveling on the road, which is a desired result for the city.

On the other hand, higher volumes have some drawbacks at the same time. Foremost, the more the volume increases, the more those previously described handling costs will increase during transshipment. Furthermore, from the freight forwarders' viewpoint, it would be more cost efficient if the end delivery of those high volumes would be carried out with high-capacity heavy trucks. If smaller vehicles, for example vans or cargo cycles are used for the last mile distribution, the transport costs will increase, because compared to heavy trucks, either more of them are needed or they have to make more trips in order to carry the same volumes, and both cases result in increased labour costs.

However, considering the point of why the waterway transport would be used at the first place – cleaner transportation – it would be more reasonable to use similarly less impactful vehicles for the end deliveries instead of heavy trucks. Moreover, if heavy trucks are used for the last mile, they need to travel to the quays inside the city centre to pick up the offloaded cargo unless they are already stationed there. This would mean that actually more trucks would be drawn to the city centre or they would need to be left parking next to the quay on a regular basis. In summary, the high volumes that are on paper more desirable for the waterway transport's competitiveness would be more reasonable to be delivered in the end by high capacity vehicles, although this would create other operational difficulties in the urban setting and would also contradict the essential value of the waterway service.

Meanwhile, the waterway options are quite limited in Gothenburg, apparently there aren't many possibilities to choose for goods transport besides the main river Göta älv (Garberg, 2017). Compared to other cities and the examples presented in section 2.1.8, the waterway system of the city is not extensive enough to plan lengthy transport routes inside the city. As Figure 7 in section 2.2.2 shows, the distance from the freight forwarders' distribution centres to the city centre is not substantial, which implies that all the previously mentioned issues need to be dealt with in order to shift transport flows to a relatively short distance of waterway transport.

Additionally, freight forwarders presently have an effective routing and scheduling system for road transportation, through which they can manage a relatively efficient distribution, as well as avoid congestion and rush hours in the city, thus congestion is still not a pressing issue for them (Sabel, 2017). The infrastructure is already built for road transport and the transport systems adapted to that throughout the past decades, moreover the freight forwarding companies don't have responsibility for that infrastructure they just use it for their own purposes (Andersson, 2017). Concerning the two main traffic regulations of Gothenburg (see section 2.2.1), the congestion tax is not differentiated across vehicle sizes and is also not a substantial amount especially if the higher charged time frames are avoided, while the Low Emission Zone restriction can be overcome with an upgraded vehicle fleet. Subsequently, there don't seem to be enough critical problems yet for transport companies in the city to switch from their road based transport system and it is very hard to estimate how largely that system's efficiency will change with the future expansion of the city and its implications.

All in all, considering the presented arguments, waterway transport of goods doesn't seem to be commercially competitive with road transport presently in Gothenburg, as Diziain et al. (2014) stated public policies are required to promote these type of solutions. The examples of urban waterway transport projects described in section 2.1.8 reveal that they also needed facilitation in their cities either by subsidization or by restricting road transportation. Therefore, similarly to the case of waste transport, if the city of Gothenburg wants to achieve the external effects of the presented business model, they need to boost the waterway transport's competitiveness by policy schemes.

6.2.2 Facilitators for implementation

Beside the already implemented regulations, the city of Gothenburg acting as a key partner needs to further assist in levelling the playing field between road and waterway transport, either by using restrictive regulations or an incentive system, similarly to the ones described in section 2.1.7.

A possible way to subsidize the waterway transport is to adopt an incentive system similar to the Norwegian Eco bonus, but adjusted to the Gothenburg urban freight transport case. The use of the waterway transport service could be incentivized for freight forwarders by the city compensating them for the reduced negative impacts per transported units of goods, which are

shifted from road to water. In this way, the integration of waterway transport would become more financially viable for its customers, though the benefits of the waterway's externalities would need to be quantified and also accounted for in reality. A different approach would be if the city subsidized the waterway transport operator directly, thus it would become a quasi-customer of the transport service, in order to alleviate the operational costs of the service, thus make the waterway service cheaper for its direct customers. In both cases, the subsidization will also have to comply EU competition laws or the city needs to ask for permission from the EU to implement it.

Concerning restrictive measures, the proposal by Transport Styrelsen (see section 2.2.1) tightening the Low Emission Zone regulation by introducing a class 2 and class 3 classification can also help to limit road based transportation, because heavy trucks will need to adhere to the engine requirements. However, since this proposal's implementation is planned for long-term, there is a chance that due to advancement in engine technologies, trucks' utilized by logistics service providers will be already able to meet the requirements when the regulation comes into force. Moreover, although this regulation lowers air pollution and possibly noise pollution in the city, it doesn't reduce road traffic and solve congestion issues if vehicles will be able to comply with the engine norms.

Another option to restrict road freight transport is to expand the already used congestion tax scheme by differentiating heavy vehicles and applying different amounts of charges to them. If the charges for larger vehicles entering the city centre are increased, it could raise freight forwarders' road transport costs to a level where waterway transport becomes a more attractive secondary option.

6.2.3 Possible operations in the future

If the external factors, such as policy schemes or worsening traffic situation, make the urban waterway service more competitive, the question arises how could be the presented business model best integrated into the transport flow of goods as an intermodal solution, thus how could the possible operations look in the future.

According to Garberg (2017), areas next to the river are quite expensive and hard to acquire for logistics operations, as they are usually reserved for other purposes. This presents a problem,

especially in the case of higher volumes, if the cargo requires additional space alongside the quays, where it needs to be offloaded and stored until loading onto the end delivery vehicle takes place.

Consequently, a Roll-on/roll-off (ro-ro) barge appears to be a well-suited choice, combined with the additional utility of the barge acting as a floating warehouse described in the value proposition (see section 5.1.4). This solution could also lessen the previously described issue of transshipment, because the loading processes could be quickened. A number of city containers that are carried by cargo cycles could be pre-loaded into a cassette, which then would be swiftly rolled onto the barge (Erlandsson, 2017; section 2.2.3). Moreover, additional smaller rolling cargo units could be loaded onto and stored on the barge, which would be later loaded into smaller electric vans for last mile delivery. Beside the loaded cargo, the barge could accommodate a couple of those electric vans, depending on the transported volumes, which would roll onto the barge pre-loaded with goods at the distribution centre of the freight forwarder.

After the barge docks in the city centre, the electric vans could begin their delivery routes, while cargo cycles could access the barge to pick up the city containers from the cassettes and deliver the goods. When the electric vans finished their routes, they could return to the barge with backloads that are offloaded, meanwhile they could be loaded again with cargo from the barge and also get charged if necessary. During the distribution process the barge could be relocated by the help of the tugboat to quays at different parts of the city, in order to extend the range of operations. Following the distribution of goods, the barge could be towed back to the distribution centre with the city container cassettes and the vans, as well as with backloads inside the rolling cargo units.

This solution would mean that the transport service would only need a quay for docking and no additional land space would be needed in the city centre. Moreover, as the deliveries are done with smaller vehicles and cargo units, it indicates that the waterway transport service would be transporting goods aimed for smaller deliveries, hence private customers and small businesses rather than larger end customers. All the loading processes would obviously require extra labour, in addition, if there isn't constant personnel on the barge during distribution in the city, then the security of the cargo needs to be ensured somehow.

In order to get higher volumes onto the barge with higher capacity containers, a modularization and standardization of the unit loads used in urban freight would be necessary (Erlandsson, 2017; Södahl, 2017). Furthermore, these standardized cargo units need to be able to be directly loaded from the barge onto the vehicle handling the end delivery, to increase transshipment efficiency. However, in this case, the previously mentioned volume paradox arises, which leads to the question of what the optimal size would be for the vehicle undertaking the last-mile delivery from the barge, in order to balance between the negative impacts and the cost efficiency of higher capacity vehicles. Therefore, similarly to the previously presented possible operations, it might be reasonable for the waterway transport to remain scaled down in an urban freight context and focus on transporting smaller unit loads.

6.3 Investment

An additional problem concerning the realization of the presented business model is that the initial investment is substantial and it greatly affects the feasibility through the cost structure of the business model. For the investment to take place, a viable business model needs to be presented that is beneficial for all the financially involved actors. However, the investment cost needs to be calculated into the evaluation of the service's feasibility, because even though it's depreciated in the long-term, it is still a major fixed cost for every actor who bears it, influencing the waterway transport service's cost competitiveness. Additionally, since barges/boats have an extended lifetime compared to road vehicles, a long-term commitment is necessary from all the involved actors to ensure that the transport service is kept sustained after the investment happens.

Considering the actual investment structure, as the key partners' block of the business model shows (see section 5.1.2), DHL and Renova would be willing to invest into acquiring the barges if the service becomes cost competitive. The city of Gothenburg possibly won't contribute financially to the investment, but rather have private actors manage it (Widegren, 2017). In order to acquire the specially built electric tugboat, the waterway transport operator could apply for funding at the ERDF (see section 2.1.7), since the urban waterway transport service fits well into the sustainable urban development objective of the organization. If the acquisition gets funded by the ERDF possibly up to 50%, it would greatly lower the amount of fixed costs in the business model's cost structure, making the service cheaper for its customers.

7. Conclusions

The purpose of the thesis was to examine the business aspects of operating an urban waterway transport service of goods and waste in Gothenburg, and identify which are the critical components of the business model framework that play a key role in the commercial feasibility of this service. This chapter presents the conclusions the authors have reached, through analysing the information gathered from primary (observations, interviews) and secondary (literature review) sources, as well as by analysing the created possible scenario of the business model.

In order to fulfil the purpose of the thesis, the following research question was formulated:

Which parts of a business model for an urban waterway transport of goods and waste are critical to its feasibility in Gothenburg?

In answering the above research question, the authors conclude that one of the most critical issue affecting the commercial viability of the urban waterway transport service can be found in the value proposition of the business model. Mainly because what it offers is not valuable enough for the direct customers of the service. The reason for this is that the increased costs of integrating the service into their transport operations greatly outweighs the benefits it provides them.

As the analysis shows, in both the waste and goods transport cases, the integration of waterway transport creates numerous operational complications for the customers, thus the urban waterway transport being competitive in transport costs with road transportation is unlikely at current market circumstances. The direct customers being transport providers entails that their main interest is offering cost-efficient transport services, rather than offering cleaner and less impactful transportation, unless a change happens in their end customers' willingness to financially compensate for the latter.

In connection with the presented issues in urban freight transportation, what the waterway transport's value proposition and the externalities part of the business model offer is much more beneficial and in the interest of the city of Gothenburg. Although, as the city is not a supply chain stakeholder, accordingly not involved directly in transport movements, it can't be a direct customer to the service. Therefore a critical issue in the urban waterway service's business

model is that the value proposition doesn't match with the targeted customer segments of the service.

Accordingly, two other critical parts in the business model are the externalities and the key partners. In order to improve the feasibility of the presented business model, the city of Gothenburg, as a key partner in the model, has to facilitate the competitiveness of the waterway transport service, though before that the externalities building block of the business model has to convince the city that it's worth to aid the implementation. The facilitation could be accomplished either by becoming a customer of the service and providing additional revenue stream through an incentive system or subsidization (or in the case of waste transport, allocating higher budget to the public procurement contract) or by applying restrictive policies that make the waterway transport service's value proposition more enticing for private customers, thus levels the playing field between waterway and road transport in terms of overall costs. Though, in the case of subsidization, EU competition laws need to be taken into account, while restrictive policies can have negative economic impacts with making transportation costs higher for businesses.

Lastly, another crucial part of the business model is the cost structure, which is greatly affected by the substantial initial investment to acquire the key resources, in which customers of the service are also involved becoming key partners in the business model. In order to achieve the possible business model, the long term feasibility of it has to be proved for the investors and long term commitments are needed from the involved actors before the investment taking place. External funding obtained to aid the implementation of the service, for example from the ERDF, could alleviate the overall costs of the service making it more competitive.

7.1 Possible broader implications

As mentioned earlier, the undertaken research was specifically tailored to the city of Gothenburg and partly based on the information acquired from actors operating in this area. Moreover, the investigated business model only focused on transportation of household waste and goods.

Nevertheless, it's still possible to identify some broader implications and make general comments in connection with the commercial feasibility of urban waterway transportation. As

the conclusions show, the value proposition of the business model has to offer a cost-competitive transport option beside its main feature, the less negatively impactful transportation. Since the competitiveness is contingent on several specific factors, it is possible that the presented business model could perform in other locations. Considering larger cities with more extensive waterway systems and bigger distances, as well as more severe traffic situation could make the service more competitive with road transportation.

However, the problem of transshipments and suitable volumes still persists concerning waterway transport in the urban setting (unless the surroundings enable door-to-door waterway transport) and suitable riverside infrastructure is also a necessity at any places. Therefore, as the other previously implemented projects and this study shows, the most crucial part in the business model is connected to the particular city's contributions as a key partner, to make the service feasible by different actions.

7.2 Potential for future research

Interpreting the conclusions in a bigger picture, it's not surprising that it's the cities' responsibility to promote sustainable urban freight transport solutions, since its own citizens are the beneficiaries. On the other hand, considering that these solutions are possibly more expensive than the already utilized practices, the higher transportation costs induced by trying to achieve more sustainable freight transport can have negative economic impacts on citizens and businesses. Consequently, a possibility for further research is concerned with the type of action the city can choose to facilitate the implementation of the urban waterway transport in the most economically efficient way from the perspective of the end customers of transport services.

Secondly, since the urban waterway transport's feasibility mostly depends on its competitiveness, the factors influencing it could be further examined. These aspects are primarily connected to the technical issues of intermodality in the urban context. Particularly, the options to reach more efficient transshipment processes can be further investigated, in terms of what unit loads and handling equipment are required to make the loading of the barge and the switch between transport modes more efficient. In addition, regarding the volume problem, the choice of optimal last-mile delivery vehicle in combination with the waterway service also needs to be explored.

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