Waterborne mobility service in sustainable regional planning

- A holistic study approach for new mobility services in North Western Skåne, Sweden

Author:
Michael Johansson
ISM/Environmental Strategy
Campus Helsingborg
Lund University
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Innehåll

1. Introduction

1.1. Background

It is expected that climate will dramatically change, namely by increase of cold temperatures and warm temperatures extremes, more severe rainfall and flooding, and higher frequency of related storms. The impacts of climate change are of course regionally different. But investments are surely needed to make transport infrastructures more robust against the expected future severe weather conditions.

Nevertheless, in recent years waterborne mobility has become an integral part of the urban landscape in many places, cities and regions around Europe and the World. There is also in many places a renewed interest in waterfront development and urban redevelopment especially in old harbor areas. Coupled with increased traffic difficulties with congestion on land-based transportation resources, it has provided an opportunity for waterborne mobility to play a significant role in future urban sustainable mobility schemes.

In many regions in for example Sweden today, mainly in medium-sized and larger cities, there is subsequently heavy traffic congestion both on roads, streets and on the railroad. This means not only a forced focus on policy restrictions on car traffic in urban areas, but also on improved public transport schemes to cope with the future sustainable transport demand. Often with mentioned traffic congestion and delays as well as an unreliable and fragile transport system as a result. These challenges are expected to grow even more with urbanization and building of new housing development areas and if land-based public transport should be expanded extensively. This study presents at least in the region of Skåne different innovative waterborne alternatives to complement already existing land-based public transport and other sustainable mobility modes. Waterborne mobility, i.e. public transport on water, can, in many cases, be an effective complementary link in a regional system of public transport for sustainable development.

This study is thus intended to act as a regional inspiration and hot bed in which waterborne mobility can be compared and implemented with other means of transport on land. This study therefore also includes facilities (i.e. related infrastructure) and external effects of the sustainable urban planning system. For example, a big boat terminal cannot be built in the middle of a residential area, or for that matter right in the city centre, in the same way as a bus stop. It must be planned already in detailed development plan. On the other hand, different forms of boat related traffic can offer fast cross links over water, where it today may be unreasonably expensive to build other forms of infrastructure.

Furthermore, where the bus as an alternative may take too long to travel to be an attractive alternative to the private car. In many Swedish coastal cities, but also abroad, existing residential areas are in many places just waiting to be renovated, but also to be exploited for new house construction (due to urban densification processes). At the same time, there is a great potential in already existing waterborne areas for a combination of land-based and water-borne public transport, which is still unused in many areas.

1.2. Problematization

First – many cities and regions have serious issues with heavy traffic congestion. Congestion not only wastes time, but it also increases pollution and crashes. Hence, the most obvious congestions problem occurs when demand (traffic) is in excess of supply to expand capacity. If our house is too small, we make it bigger. If the internet is too slow, we add capacity. In roads and urban planning, this usually means adding lanes to already existing roads. The first problem with this solution is that it is expensive. Further, if you expand capacity, demand will respond. New (induced) developments will be built, and much of the capacity will quickly be used up by new travellers.

Often the problem is not the actual width of the road, but where it goes. A new road that goes directly to the right place can replace a longer route that does not. So, reducing the circuity (indirectness) of the network through selected connections can reduce congestion and total traffic by taking traffic off longer routes. Even when there is nominal connectivity, it might not be very good. A bridge can in this case for example replace much slower and lower capacity ferries, eliminating a bottleneck. But as with capacity expansions above, it can be very expensive. In a mature network, all the cheap and useful roads have been built already.

A new connection may be cheap, or it may be useful, but it will not be both. The induced demand outcome also applies. If people cannot get across a River, they won't drive from Home to the River either, reducing traffic along that path. Just as there is induced demand when capacity is added, there is reduced demand when it is taken away. But, with waterborne mobility across the river this issue will prevail. Just as widening a road is in theory a solution to a congestion problem, building a competing mode is also a theoretical solution. By implementing a waterborne mobility system or a rapid transit line or even building sidewalks and bike lanes, other people may switch off the road, leaving the roads faster for the rest using it.

Today there is also many challenges associated with the practical implementation of waterborne mobility in the region of Skåne (Sweden), e.g. since harbour possibilities for waterborne mobility systems in many ways have been removed or replaced by other means. Moreover, this is mainly due to the focus of new housing development areas close to waterfronts, often are on beach or sea-level housing. There has also not been any specific political focus on waterborne mobility in the region which clearly indicates by todays poor political interest in the subject. Land-based public transport has for a long time been a very important function for passenger transport and is thus a natural part of the concept of sustainable mobility. At the same time, land-based public transport also creates favourable conditions for a reduction of e.g. passenger car traffic, with its negative effects in the form of mentioned congestion and delays.

At the same time, waterborne public transport has gradually begun to be regarded as an alternative in more cities located by the sea, rivers and lakes (Deurell, 2016). At the same time, the fully potential is not yet sufficiently determined. However, several subject-related research projects have been started, which aim to strengthen the conditions for increased use of city waterways.

1.3. The aim and purpose of the study

The purpose of this study is through a holistic south Swedish regional approach, identify opportunities and challenges for a reliable and capacity-strong, waterborne public transport mobility services. This study thus intends to give an overall assessment of the potential for waterborne mobility, in a transport system together with land-based public transport. Subsequently, this study aims to achieve most argued value in sustainable urban planning in city-centre locations with already high traffic congestion situations.

The aim of the study is therefore to clarify the overall challenges, opportunities, and innovative solutions between different sustainable mobility services. As well as indicate the possibility of supplementing water- and land-based, surface-efficient passenger transport in the region of Skåne. For related boat traffic services there are today no really developed standards for harbours or design of bridges in relation to certain specific vessel and boat types.

1.4. Expected effects and results of the study

Based on a literature study, the study will provide a comprehensive overall picture of merged traffic challenges, as well as clarify the relationship between different transportation modes and system. This will also be done by clarifying how sustainable transport and municipality urban planning are achieved through a conglomerate of climate- and energy-efficient land and waterborne mobility services, as well as illustrate urban planning effects on energy consumption (transfer of travel), need for hard infrastructure (parking areas and other infrastructure) and climate - and emissions (carbon dioxide emissions).

1.5. Method

The study is mentioned as a holistic case study, based on a subject-relevant literature review, which is an approach characterized by one or a few related objects being investigated in detail and others not so specific. Case studies are often criticized for being too subjective for any generalizations to be based on them (Flyvbjerg, 2006). Thus, the study can inevitably result in subjective assessments since social planning as a phenomenon is in many cases in the viewer's perspective and its ability to interpret reality.

The study consists of an overall research and knowledge overview within the subject area waterborne mobility, and freight transport on water. This also includes identifying examples of "best practice", so-called. good international examples, including examples based on how exchanges between boat and other modes of travel have been designed in other cities.

2. Public transportation

2.1. Public transport

Public transport is defined in the Swedish Public Transport Act (2010: 1065) with reference to the EU public transport regulation 1370/2007, such as:

"Passenger transport services of general economic interest offered to the public on an ongoing basis and without discrimination" (Swedish Transport Agency, 2014).

The duty and responsibility of public transport is on The regional public transport authorities. The regional public transport authorities are to offer public accessibility to work, school, education, community service in Sweden. The regional public transport authority shall regularly - at least once per fourth year - prepare regional traffic supply programs with the goals and requirements for public transport that shall apply in the specific county and/or region. Based on the requirements of the traffic supply program, there will be formal decisions on public service obligations for individual traffic lines or certain areas. The decisions will be formalized according to the demands for supply the proposed area or traffic line in a certain period.

As public transport being an alternative to the car for many (SKL, et al., 2007). At the same time, the new public transport law, which came into force in 2012, opens up the possibility for different actors to start "competing" in public transport, which of course further increases the need for coordination (Elmquist et al., 2011). The law now also applies, among other things, to waterborne public transport (Deurell, 2016). Waterborne public transport in Sweden includes vessels that transport passengers in scheduled services in urban areas. In most cases, for example Waxholmsbolaget's traffic to and from the Stockholm archipelago is regarded as sparsely populated traffic, where passenger boats are used. (SLL, 2013a).

2.2. Public transport in Skåne

Skånetrafiken is The regional public transport authority in the region of Skåne. Skånetrafiken is the public transport administration within the Region of Skåne (Skåne (Scania) County Council and its main tasks include planning, procurement, and marketing of public transport in Skåne County.

The regional public transport authority in Region Skåne is therefore responsible for planning and implementing local and regional scheduled services mainly today for currently land-based public transport-based passenger transport. If one look at land-based public transport, it includes the local (green busses) and regional system (yellow busses) but it also includes rail traffic in the form of commuter trains that are carried on the Swedish Transport Administration's railways and also to Denmark via the Öresund Bridge. Skånetrafiken is responsible for all mentioned trains and buses in Skåne county which; The "Pågatågen" (regional commuter trains only within Skåne county) stop in more places than the Öresund trains.

The county's green buses usually operate within the county's cities (urban areas), while the yellow buses are so-called regional buses, which travel between Skåne's cities or out to suburbs or to smaller rural villages.

The Öresund trains (international regional trains to Denmark, the region of Blekinge and to Gothenburg) arrive from and continue to other cities in Southern Sweden such as mentioned Gothenburg, but also to Kalmar and Karlskrona. The schemed train routes with the Öresund trains in Denmark is the responsibility of the Danish Ministry of Transport. The buses in Landskrona can be mentioned as they also includes electric trolley busses. Green City buses operate within Helsingborg, Malmö, Landskrona, Kristianstad, Lund, Eslöv, Hässleholm, Ystad, Trelleborg and Ängelholm. Regional buses are available throughout the county.

Today, existing waterborne mobility takes the form and shape of international ferry services between Helsingborg (Sweden) – Helsingör (Denmark). As the ferry line is no longer owned by Scandferries, the brand was changed to ForSea. In connection with the formal brand change, the ferry line is now operated as a sustainable ferry connection because the ferries are now powered by electric power with uploaded batteries. This is to reduce the environmental and climate impact. The core business for ForSea is thus to offer efficient and reliable transport services for both passengers and freight customers. ForSea currently has five ferries available: Aurora, Tycho Brahe, Hamlet, Mercandia IV and Mercandia VIII. ForSea has introduced battery operation on the two ferries Tycho Brahe and Aurora.

Furthermore, regional related boat traffic takes also place between Ystad (Sweden) – Bornholm (an Island that belongs to Denmark south of Skåne), as well as between Trelleborg (Sweden) / Ystad (Sweden) and Germany and Poland. Other waterborne connections in Skåne worth mentioning include Ventrafiken to a Swedish island also in the Öresund just outside Landskrona, and as well as the ferry traffic to Hallands Väderö on the west coast of Skåne. In addition, there is frequent tourist traffic services that is carried out with tour boats on the canals and in the harbour areas in Malmö in the summertime. Today, however, public transport in Skåne does not include waterborne mobility, which is thus carried out on water from city to city or within cities. This is except for Ventrafiken between Landskrona and Ven, but which is only partly included in Skånetrafiken's ticket system.

2.3. Boat traffic in Sweden

In Sweden, there are about 35 million local boat and ferry trips made each year, with just over 350 smaller vessels carrying a maximum of 500 passengers. Ferry traffic has previously been completely unregulated, and anyone who meets the formal regulatory requirements regarding vessels and crew's skills has been able to transport passengers on water in Sweden.

The ferry traffic in the archipelago counties mainly: SL (Stockholm), West traffic (Gothenburg) and Blekinge have under a long period of time procured different boat traffic services. According to this, important major national boat and ferry connections in sweden are:

- boat traffic in Stockholm region – much thanks to its geographical location, Stockholm has boat traffic. Although commuting by boat accounts for a remarkably small proportion of the total amount of travel in the region. Maritime traffic consists of different archipelago traffic, as well as more central/city based traffic services for commuting in the inner city and its nearby suburbs. Boat traffic also includes local boat connections within Stockholm (for example to Djurgården and Slussen), as well as traffic to the Mälar Islands.
- boat traffic in the Gothenburg region - Gothenburg has boat commuting services on the Göta River, and to / from the islands in the southern and northern archipelago. The responsible authorities for this ferry traffic are West Traffic (Västtrafik) and the Swedish Transport Administration (Trafikverket). At Göta Älv, through central Gothenburg, commuting by boat is possible with the ferry line Älvsnabben.
- To this is added other archipelago traffic in Sweden, such as for example traffic Gränna-Visingsö in lake Vättern, etc.

Public transport on water is now in Sweden a part of the Public Transport Act (Chapter 1, Section 1), which in practice entails regulation of a previously free market. From a historical perspective, public transport at sea has not been regulated in the same way as land-based public transport. Waterborne mobility today has perhaps therefore a low initial investment cost, at least in comparison to rail-bound traffic, and its investment cost is equal to bus (Traffic Analysis, 2013). The traffic type can offer transport on distances where other modes of transport do not pay off, since the waterway is already there, limiting the cost of infrastructure to bridges, vessels and waiting rooms with possible service such as bicycle parking. (Traffic Analysis, 2013).

2.4. The importance of waterways

Around the world, most major cities (and of course many other cities) are situated around a body of water (London, Liverpool, Gothenburg, Oslo, Amsterdam, Istanbul, Lisbon, Stockholm, Hong Kong, New York, and Hamburg just to mention a few). The importance of water as a route to move goods and people has set up cities around rivers, lakes, and the oceans.

Before the construction of the ground-based infrastructure we depend on today, water was the only way to make these connections between important destinations and commerce centers. In obvious cities like Venice, Italy, water-based transportation through canals is still the main way to get around. We can take advantage of the waterways to move people and decrease road congestion. As our urban transportation routes are experiencing more demand every day, we have come to a problem of how to deal with all the traffic. People who live in or near cities depend on public transportation to get to work and around the city. Trains and buses are the most popular option for land-based transportation, but they require a lot of infrastructure.

You must build roads and rail lines to accommodate these in cities, most of which is of course already built. But they are getting older, require routine maintenance and are in many cities at their carrying capacity. Public transportation via waterways can decrease road congestion by taking advantage of a natural resource to provide a unique alternative for commuters to get around. Waterborne mobility is the specific use of ferries or other waterborne vessels in the transportation of passengers via waterways (sea, rivers, lakes, lagoons, canals, etc.). Long before urban sprawl and motorways, waterways represented the original corridors of commerce and transportation.

Many cities in the latter part of the 20th century experienced a decline in industrial activity on their waterfronts which, in turn, resulted in a decline in waterfront commerce and transportation. As cities turned inland and developed motorways, thus contributing to urban sprawl development, many cities turned their backs on their waterways, resulting in further decline.

Waterborne mobility, at one time the primary mode of transport for cities on water, also experienced declining use, with many cities reducing or curtailing services. Urban redevelopment especially with focus on watershed development and revitalizing waterfronts, has only been focused on over the past 30 years. Today, the waterfronts of many cities are the main attraction, and have become integrated with many urban city centres. Due to renewal of waterfront urban redevelopment many authorities have worked hard to ensure that waterborne mobility contributes to the overall mobility schemes.

Waterborne mobility can, if needed easily be adapted to new conditions. (Deurell, 2016). This gives waterborne traffic a flexibility that cannot be matched by either rail or road traffic (Thompson, et al., 2006). Since congestion does not exist as a risk of affecting water-borne public transport to the same extent as other public transport, it can more easily keep the timetable and when it is congested elsewhere in the traffic, boat traffic thus can provide additional capacity. (Kamen & Barry, 2007).

It has been argued that travel time by boat should be valued lower than for other types of traffic, as the comfort and experience during the journey does not make it feel as irritating and stressing as with other types of traffic (Deurell, 2016). SL (Stockholm county local traffic) in their investigations has adopted a so called "Boat factor" to be -20% during the ride (SL, 2012). Public transport on water, or waterborne mobility is considered to have two main general purposes:

- partly to develop traffic for residents and visitors along the coast and its vicinity, and
- partly to develop public transport for commuting purposes and thus develop the possibility of sustainable travel in the region.

Public transport journeys on water, mainly for work commuting purposes, have long been a relatively marginal phenomenon, at least in relation to other public transport, and perhaps especially in the Stockholm region. Nowadays, discussions are underway to increase the possibility of being transported on water in public transport in more places. This is to relieve the otherwise heavily used public transport on land. At the same time, another positive factor regarding public transport on water is perceived to be its great potential. This is especially true in connection with coastal municipal development plans and densification processes in attractive water locations. In these cases, waterborne mobility may be part of a continuous conglomerate of public transport systems, together with existing pedestrian and bicycle networks, but also different car sharing concepts.

In Stockholm, for example, it is easy to bring a bike on the boats, which can give some time savings compared to cycling on land. At the same time, maritime traffic can be an alternative to accessibility in connection with major road and street works, which raises concerns for both car and bicycle and public transport.

2.5. Waterbased Infrastructure

There are, for obvious reasons a couple of different waterways making infrastructure system services worth mentioning:

Rivers:

Rivers are a natural waterway which can be used as a means of transport. Rivers are one of the most important factors that have dictated where major cities are located today. Rivers are suitable for small types of boats and ferries. River transport has played a very important role prior to the development of modern means of land-based transport. Speaking of goods, the importance of rivers has gradually declined on behalf of cheaper transport services offered by the railways. So many cities are situated around two or more rivers because it provides the most efficient spot to provide access to multiple places. Today, this gives us the opportunity to use rivers as a transportation route because it just makes sense.

Canals:

Canals are often artificial waterways made for the purpose of irrigation of crops and fields, navigation, or both. Canal transport can in some cases require an amount of capital investment in construction, and in maintenance of its infrastructure i.e., the artificial waterways. The cost of the canal transport is, therefore, often higher than of other river transport. In addition, the cost of providing water supply for the canals is also a problem of canal transport, especially in the time of dry summers.

Lakes:

Lakes can be either natural like rivers or artificial like canals. Often can lakes be a good way (infrastructure) to make trips in an urban context more effective and reliable.

2.6. Making waterborne mobility services attractive

As already has been said, commuting by boat has some potential to increase the attractiveness of the entire public transport system. This is done by offering alternatives to already existing public transport in coastal municipalities. The basic competition factor is that waterborne mobility can very well compare with other similar transport alternatives over time. It is therefore important that the boat service lines are designed in a way that can continue to contribute to competitive travel times and completes set goals of travel time in regional traffic supply programs.

At the same time, an attractive alternative to land-based public transport should also mean other attractiveness factors, such as comfort, but also the possibility of comfortable combination travel with e.g. bike. Unlike land-based traffic, there is an unused infrastructure. However, maritime traffic obviously needs to be supplemented by more attractive and logical switching points (MobilityHubs), where land-based traffic can easily reach, and seem like a good alternative.

For example, buses should be able to turn easily at end-stations without being hindered by, for example, parked cars, and they should also be able to wait for connecting boats. At some switching points there may also be a need for entrance and commuter parking. For public transport on water, it is important that the traffic carried out is precisely attractive, and works well with other public transport (SLL, 2013).

Public transport on water can be an important factor in keeping the different parts of the region together, as well as providing citizens with access to increased transport services. At the same time, the supply of traffic can also be adapted to on demand. This would mean that boat traffic during e.g. the summer season, when the demand is high from summer tourists and temporary visitors, can bring an extra resource and capacity, thus supplementing existing traffic. At the same time, the range of traffic is considerably more extensive.

Boat traffic should be planned and designed according to the same principles as land-based public transport. Therefore, the goals for accessibility and cohesion in the region that are developed in the regional traffic supply program should also apply to public transport on water (SLL, 2013). At the same time, attractive public transport, even on water, also means that the requirements for increased accessibility for travellers with disabilities are adapted to the objectives of other public transport, i.e. requirements for full accessibility by 2020. Bridges are important parts of the accessibility adjustment.

A standardization of quays and bridges from the beginning thus facilitates the work on accessibility adaptation for waterborne public transport. A desirable development is thus felt to be that coastal municipalities, together with in this case Skånetrafiken, and commercial boat operators take a joint responsibility for the design and standardization of Skåne boat terminal areas. Another form of accessibility that must work for waterborne public transport is that it must be easy to plan in digital search tools and other places (such as websites, vending machines, service points, etc.) for the waterborne journey, as part of the whole trip.

Of course, it is important to facilitate the planning of the trip even before the actual journey is carried out no matter what sustainable transport mode. It should then also be easy to buy and use a ticket in the transport system itself. It can, for example, be offered in emergency kiosks, and other sales and information sites, also accessible to people with disabilities. It should also be easy to get to and from a terminal, quay or jetty.

This is achieved through clear walkways and logical connectivity to other forms of land-based transport. In connection to this, it should also be simple "way-finding", through simplicity and clarity regarding information at terminal, port area or pier. Of course, just as with land-based public transport, short, quick, and easy exchanges between modes of transport should be sought. A fully accessible line or switching point means that utilization is possible for all travellers.

2.7. Waterbased route types

Many cities are increasingly looking at new ways to expand their public transport offering and development of transport networks on urban waterways is one method that is being considered (Chemakurty et al, 2017). Chemakurty et al (2017) has identified three different route types for waterborne mobility:

- Type A refers to routes where boat services traverse along a river or water body stopping at multiple destinations connecting points of interest along a waterfront,
- Type B refers to shorter routes with two or three stops either in a simple river crossing or triangular three-point stop configuration. This was previously the most common form of ferry that was developed primarily in the absence of land-based transport connection, and
- Type C routes can be found in many cities and there have been some interesting strategies to counteract the lack of passenger demand outside peak hours.

Type A services have also been referred to linear ferry systems (Chemakurty et al, 2017; Soltani et al. 2015). This alternative seems to be the choice of waterborne route service when trying to maximize efficiencies and trying to stimulate waterfront development by providing waterfront transit stops (Chemakurty et al, 2017). A good example of Type B is Copenhagen, which operates high frequency cross river services in the inner-city area between popular destinations (Chemakurty et al, 2017). Type B services can be identified as short travel times with larger capacity rather than on board services. Type C routes are according to Chemakurty et al (2017) those services that link suburbs and the surroundings with the inner-city area. This service type does not usually operate at a high frequency. Due to the often-long journeys. The quality on those services is often higher due to the mentioned longer journeys. The challenge is to maintain a constant high demand even outside peak hour (Chemakurty et al, 2017).

2.8. Sustainable public transport on water

That waterborne mobility, just like land-based public transport, should strive to offer environmentally and climate-sustainable public transport and is considered highly relevant. This mean different requirements for renewable fuels, and at the same time substantially reduce both particles and nitrogen oxides. In the past, boat traffic has generally found it difficult to achieve the environmental standards of public transport on land. Therefore, to reach set environmental goals, investments in the boat fleet are required. Public transport on water is judged to be equivalent to land-based public transport, so that evaluation is carried out from the same goal as far as possible. E.g. For example, electric-powered boat traffic or the use of biogas can be a factor in reducing the environmental impact.

Waterborne mobility is not considered to cause any major accidents, congestion, or major costs. This is disregarded due because the wave movements that are judged to be insignificant at the low speed, 12 knots, and accidents with this type of boat traffic services are considered negligible. Congestion on the waterways is also considered negligible at present. To achieve a successful and sustainable public transport on water it is required:

- *As straight service as possible.* This is to take advantage of one of the biggest competitive advantages that waterborne public transport can offer, i.e. avoiding queuing and congestion.
- *Attractive part of existing public transport*. This is to create realistic possibilities for continuous door-to-door travel
- *Favourable distances to Mobility Hub (changing points)*. This is so that the distance from the travellers' starting and destination points to boat docks should not be too long, so that the traveller can thus reach the docks by walking or cycling, as an alternative to any necessary bus supply.

Public transport on water should not necessarily be seen merely as means of relieving other, already existing commuting routes. Public transport on water should instead be means of improving the quality of the other public transport systems. However, it would be rare for a boat to act as the only means of transport from start to finish. The normal thing is that a combination of different sustainable modes of transport may be required, where boats could form a link throughout the chain. The experience speaks, among other things, for boat and bicycle is an interesting combination. Thus, by means of boat connections, new bicycle lanes can also be created.

3. Urban waterfront development

3.1. An Historical Perspective on urban waterbased space

Urban qualities, specifically of the urban water spatial interface have regularly meant that waterfront development has been distinct from general urban development. Over recent decades, previously large industrial waterfront spaces have been redeveloped into attractive urban spaces, which also are symbolic for post-industrial urbanism in many cities.

The earliest forms of waterfront development occurred as various societies began to utilize waterborne transit in different perspectives. This meant that up until 50 years ago, waterfront urban development largely occurred where physical relief was conducive to harborage and shelter, i.e. the Roman settlement of Londinium, which obviously later became London.

London is just one of many examples of early settlements in areas with surrounding water. Many of the cities along the Öresund coast is perhaps more local examples of early waterfront development. Waterfront space was also developed for military and strategic reasons. Different port cities were also, for that reason, important centers of economic and political power, and therefore required means of protection.

Although imperial international trade and strategic military expansion lie at the origins of much urban waterfront development, it is the industrial development which took place in waterfront areas during the 19th and also 20th centuries, that has left the greatest legacy for post-industrial urbanism.
Due to industrialization expanding ports was a fact. As industrialization brought with it increased demand for raw materials and new streams of export products, port facilities had to be expanded. As processes of globalization and industrialization increased

waterfront industry growth, the supporting physical infrastructure which surrounded also had to be expanded.

Dockland areas gradually became larger and larger. In addition, huge warehouses were also built to store the vast amounts of goods that flowed into many port cities. This resulted, for obvious reasons, in many cities losing their waterfronts as public spaces. Waterfront areas simply became the domain of heavy industry, rarely seen by most city residents.

Around the globe during the 19th and 20th centuries many waterfront cities, developed waterfronts for the types of industrial purposes described above. However, as urban economies began to make a post-industrial transition, many of these once highly productive waterfront spaces went into decline and became redundant.

3.2. The effects on the industrial decline

As industrialized nations underwent industrial decline in the second half of the 20th century, many of their urban waterfronts fell into negligence. This was because many of the ports which were built in the 19th and early 20th century became unprofitable and eventually redundant in the late 20th century as the shipping industry began to use containers to transport goods. Container shipping, greatly reduced the costs of handling goods at ports and simplified the logistics of shipping, drastically cutting the labor and time involved compared to the previously used bulk break method of shipping.

The economic and social effects of the transition to container-based shipping were drastic. Container shipping required large areas of land to store and organize shipping containers, large docks to hold container ships, and different labor practices. This meant that the many waterfront industries and communities that developed during the previous decades quickly became unprofitable and obsolete. This decline created a lot of complex problems for effected cities, many of which are still felt today.

As large dock facilities and surrounding communities fell into decline, city and national governments were presented with the question of how to deal with the resulting problems. Initially, many governments logically attempted to reform and restructure port industries to make them more competitive. As industries abandoned urban waterfronts, a consequence of the character of many dock and waterfront industries, such as gas stations, chemical plants and oil refining, large swathes of land were left highly contaminated. Because of such practices, many waterfront sites have required significant expenditure on remediation to make them fit for reuse.

3.3. The explosion of waterfront (re)development

As waterfront cities finally began to develop post-industrial urban development strategies throughout the 1970s, 1980s and 1990s, urban waterfronts became central to urban renewal and regeneration throughout the world. Waterfront redevelopment has been at the forefront of some of the urban redevelopment schemes which have come to characterize post-industrial urban renewal, such as for example London Docklands and of course Battery Park City, New York City.

Finally, waterside residential development has focused upon providing residencies for the post-industrial cities an attractive waterborne livability. The dynamic created by water and urban space has greatly influenced the nature of waterfront redevelopment in the post-industrial era. Furthermore, due to many central locations, these sites are also highly visible, often close to the central business districts. This has meant that waterfront sites have become important spaces within the context of place marketing redevelopment agendas, where highly visible demonstrations of post-industrial renewal and consumption are central to determining urban prosperity.

4. The importance of physical planning and possible exchange points (MobilityHubs)

4.1. Mobility Hubs a service for changing transport mode

Physical planning of course lays the base for our urban land use and future spatial organization. Furthermore, we must understand the need for increased local resource efficiency, and how to reduce the use of fossil fuels and by that stimulate positive effects on people's health. Moreover, it is of high importance to promote the immediate environment of walking and cycling which contribute to an increased need for well-functioning public transport. The city's design and its public transport need therefore to support each other, since it is in the city's exchange points or MobilityHubs that the public transport journey has its beginning and its end (Bjerkemo & Serder, 2011).

In many coastal cities, the waterborne mobility has the potential, as mentioned earlier, to open up entirely new traffic opportunities even for walking and cycling, as well as being a strong complement to the city's other public transport, thus supporting a city development that is increasingly looking down to the water (Deurell, 2016). Unfortunately, waterborne mobility tends to have long distances to change connections from one mode to another (Thompson, et al., 2006).

By Mobility Hubs are meant all the places where transfer between modes of transport takes place; thus, transfer between different forms of mode of transport, including pedestrian and bicycle traffic. A journey by public transport is always part of a journey and includes other modes of transport to get to and from the current public transport medium. (Bjerkemo & Serder, 2011) A transfer requires a movement, small or large, in this essay called exchange distance, sometimes just described as a walking distance (Deurell, 2016).

4.2. Requirements of waterborne mobility hubs

One of the most essential key aspects that earlier has been identified in waterborne mobility services is the essential connection with other existing public transport modes (Soltani et al. 2015). The design of the Mobility Hubs is also important for other reasons. Mainly to increase accessibility in a whole-travel-trip perspective (i.e. from door to door and from morning to evening). Depending on the actual distance of the mobility service, and other social service preferences needed, the mobility hub could be designed in different ways. In some cases, there could be a need for space for seating, food kiosk and toilet facilities. In other cases, there perhaps is no certain need except for good wayfinding possibilities. To increase the service attractiveness there should at least be free Wi-Fi.

Thus, regardless of whether the public transport journey takes place on land or water, it is required that the journey works from start to finish (Elmquist, et al., 2011; SKL et al., 2007). It thus means the whole trip (as mentioned before door-to-door / morning-to-evening / trip-to-trip / first mile / last mile), is about value-creating services in connection with public transport. A good exchange point should strive for (Deurell, 2016):

- Short walking distance within the exchange point / MobilityHub, preferably with easy wayfinding opportunities,
- An easy-to-understand and logically placed information, that ensures that it is easy to find the right place, to and from the exchange point. The information should include all exchange options (including walking and cycling), as well as presenting the departures in real time,
- A variety of exchange opportunities, basically the more the better, with short waiting times and preferably with different service, and
- The exchange point should be well integrated with surrounding walking and bicycling traffic and the overall city life.

The waterborne mobility is based on its natural conditions, and in many places lack of adequate infrastructure and opportunities for reasonable exchange points, especially exposed as it in many places touches the edge of built-up areas. As a result, it does not come as close to current target points as land-based traffic. Nor is the same travel data reached because the water-borne public transport also depends on the size of the catchment area. (Thompson, et al., 2006; Deurell, 2016).

Strategically placed transfer points are thus of great relevance to waterborne public transport (Bjerkemo & Serder, 2011), and this because waterborne public transport usually has significantly fewer stops than, for example, buses. At the same time, waterborne public transport can be run where other traffic is not possible, can be deployed quickly if needed and thus has the potential to be an important complement to the city's other traffic (Deurell, 2016). However, this requires that the exchange points allow for smooth exchanges between different modes of transport (Weisbrod & Lawson, 2003).

Infrastructure for boats and ferrys is in many ways less complicated than for example. trams and buses on a street. For boats, quays and possibly certain waiting lanes could be required, as well as probably bicycle parking. If a boat connection requires a connection with a bus, which is often very probable, as previously mentioned, a bus stop for the bus is also required. This is, of course, entirely dependent on given local conditions. However, costs for such infrastructure are normally very low compared to infrastructure costs for other means of transport. One question that should also be discussed is whether boats can be given so called "boat files" at sea, corresponding to reserved lanes for buses and trams. For the boat files at sea, it is not primarily accessibility that is desired but permission to drive faster in certain files than other boat traffic. Other forms of associated infrastructure that will be required for public transport on water, include the need for depots for service, repair and maintenance of the vehicles.

Assessment of the public benefit of a future waterborne public transport is of course difficult, and is not directly given, because development is neglected in a number of areas, such as environmental performance and production cost. Furthermore, today's traditional vessels, which operate among other places such as for example Gothenburg and Stockholm, can be supplemented by large units that may otherwise provide less flexibility, lower frequency and low fill rate.

Thus, any economies of scale are lost, which means high investment costs. Standardization solutions and serial production like other public transport types would have a significant impact on the cost side of social calculations. The water-borne public transport with two lines in Copenhagen (the "Havnebussen") can serve as an example.

4.3. International examples on waterbased MobilityHubs

There is a wide range of different standards and services included in MobilityHubs. The conditions of the international examples naturally differ from place to place depending on the actual purpose of the Mobilityhub. The examples below show all from sophisticated and expensive ferry terminals to more simpler piers that can be easily moved when needed and thus form a flexible system:

Picture 1. Water taxi between Coal Harbour and Bowen Island. The water taxi commuter service between Bowen Island and downtown Vancouver, Canada.

Picture 2. The Greenwich pier, River Thames, London, UK.

Picture 3. LaGuardia's (New York) 35 Gate Central Terminal with Water Taxi Landing.

Picture 4. Water Taxi in Rotterdam on the Maas

5. Good examples of sustainable mobility services in urban and regional aquatic environments

As a result of the report's research and knowledge overview compilation, several good and interesting international examples have outlined. The good examples come from major cities around the world, all of which, though in different ways, have a serious developed public transport services on the water. Either the cities have water connection through rivers, or through proximity to larger water, and the waterway often means a shortcut in relation to fixed connections over or over the waterway.

5.1. Electrically powered ferry across the river in Gothenburg

Västtrafik (Gothenburg, Sweden) has a new electrically powered river shuttle. It is Gothenburg's electrically powered passenger ferry to provide great environmental benefits.

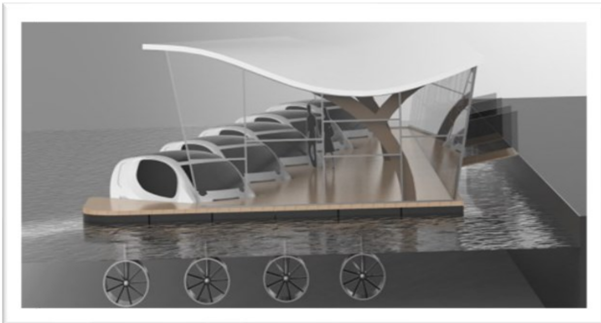
Picture 5. The river shuttle is purchased for commuter services across the Göta Älv river is an electric hybrid that runs on both electricity and conventional fuel. It operates the route between Stenpiren and Lindholmspiren, alongside its sister vessels Älveli and Älvfrida.

As the shuttle only stops for a few minutes on each side of the river, it is unable to recharge during service operation, and therefore needs to run on other fuel when the batteries run down. The ferry can operate for around four hours on a charge. When the battery has run down, it can be charged during operation or with electricity at the quayside. The river shuttle reduces emissions of carbon dioxide, nitric oxides and particles by a third. The batteries are charged using renewable electricity from wind and waterpower.

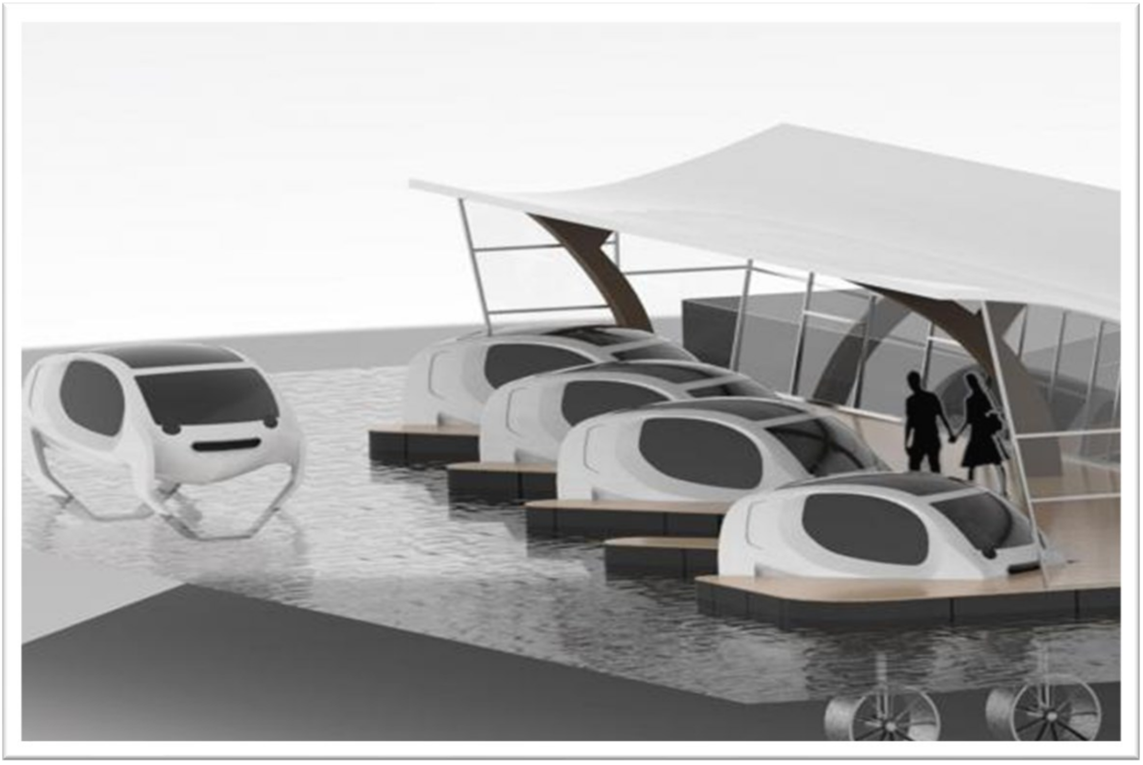
5.2. Sea Bubbles

Sea Bubbles is an exciting new innovative design of mobility system services for urban environments and can almost be compared to land-based car- and bikesharing, though on water. The boats are electrically powered, and can currently operate a distance of 80-100 km. The speed is recommended at 6-8 knots, which does not directly generate any significant waves that can create negative effects in the form of erosion.

Picture 6. Prototype of a Sea Bubbles boat with place for 4 people.



Picture 7 and 8. The pictures show a prototype of a Sea Bubbles boat (left picture), but also their termina (the right picture).



Picture 9. Prototype of a Roboat vessel., including their terminal.

Picture 10. Illustration of how the terminal for Sea bubbles could look like in Paris.

5.3. Roboat

Roboat, unlike Sea Bubbles, is instead an autonomous and flexible waterborne freight and passenger transport system. Roboat is currently being developed in Amsterdam, the Netherlands. Amsterdam has great potential for the system, with its approximately 1000 km of canals and 1500 bridges. The great advantage of the Roboat system is its potential in various ways to adapt the system to peak hours, but also to temporary activities such as festivals, etc. The system can also be used as temporary bridge solutions, or temporary gathering and meeting places, alternatively surface for serving, pop-up stage or concert venue, etc. The multifunctional meaning thus creates a multifaceted development potential.

Picture 11 and 12. The picture shows how Roboat could be used for goods transportation (the picture above), but also as a temporary bridge construction during road work (the picture below).

Picture 13. Illustration of how Roboat also can serve for transport of people.

5.4. Other good examples of waterborne mobility services and system solutions

Of course, apart from the international system solutions, there are of course plenty of other exciting and interesting system solutions for waterborne mobility. However, here is a small set or examples:

Picture 14. Water transportation in Nigeria.

Picture 15. water Taxi in Sydney, Australia

As an example, there is an extensive network across the Rotterdam waters, provided by various service providers such as water taxi and waterbus. Water taxi service operate between Hotel New York, the Veerhaven and the Leuvehaven. The Waterbus's frequent scheduled services travel between Rotterdam, the Drecht towns, Ridderkerk, Krimpen a/d Lek and Kinderdijk. The Waterbus also operates between the stops Rotterdam Erasmusbrug, St. Jobshaven and Heijplaat-RDM and sails from Katendrecht.

Picture 16. Water Bus in Rotterdam.

Picture 17 and 18. Municipal transportation on water in Rotterdam.

Picture 19 and 20. Water Taxi in Rotterdam

6. Case study -waterborne mobility in North Western Skåne, Sweden

6.1. A holistic approach

A waterborne mobility system service needs to have multiple stops with developed MobilityHubs to bring people to and from the city center. And a lot of business districts in cities are not directly near a river or body of water, so this also raises some concern of its potential. It is also hard to adapt to a new paradigm shift of mobility. Using water can be extremely beneficial to certain cities, regions, destinations and for certain commuters, but it will take a while to change our current mindset and possibility to open up to the idea.

Hence, change does not happen overnight. We can see a few cities testing out the idea, but they are mostly private companies that have small-scale operations and there are some difficulties in maintaining good economy. With funding concerns, it is easy to say that using rivers will be more cost-effective because you do not have to build high-capital projects like roads, tunnels or bridges. You just take advantage of the natural resource of the water (ecosystem services).

Waterborne passenger is today from a Skåne perspective, still relatively unused and new, but is expected to be an efficient, flexible and sustainable passenger transport system, which, in conjunction with the urban densification processes, can constitute a large transport potential. Today, there is a developed water-based sparse traffic in the archipelago in, among other places. Both Stockholm and Gothenburg.

But will there be further developed traffic when the urban street space in the future becomes a scarcity? In many Skåne coastal cities, but also abroad, many water-related areas are waiting to be renovated or exploited for new construction (densification). At the same time, there is also great potential in already existing water-borne areas for a combination of land-based and water-borne coordination of public transport and freight transport.

Picture 21. Map illustration of Skåne showing the potential of fixed waterborne mobility service as the county is surrounded by water.

The suggested waterborne mobility service in the northwest of Skåne will operate on the northwestern coastline. It will to a large extent follow already existing regional bus number 220, which today operates between Höganäs and Landskrona via Helsingborg. The coastal service will start, for example, in Båstad in the most northern parts of the region. After that, the next stop will be Ängelholm and then Höganäs. After a stop in Höganäs, the service continues to Helsingborg and finally arrives to Landskrona. Along the entire coastline, it is possible to add either permanent stops or temporary stops if necessary. These can also be seasonal stops or changes.

The dashed red line in the picture shows the continued potential to operate the service all the way down to Malmö. It could also be an exciting waterborne mobility system that can be integrated into the Ven Ferry traffic from Landskrona and with the ferrys to Helsingör from from Helsingborg. At all mentioned stops, there is an opportunity for collaboration with land-based public transport. Other advantages with a waterborne mobility service in Skåne is that the system will most certainly not suffer from queues and very seldom from operational problems.

One of the biggest challenges that exists in the western part of Skåne is that there is often congestion situations in the existing traffic system, especially on the motorway between Helsingborg and Malmö. This also applies on the challenge with continuously full trains that often are delayed due to rail problems thanks to old and underserved system. This usually results in costly traffic disruptions in the form of traffic accidents with large queues as a result. Therefore, there is a need for additional innovative transport systems in this part of the region. Much to relieve existing infrastructure and also to create other interesting mobility options.

Waterborne mobility systems are also not as sensitive for disruptions as road and rail traffic. In the event of accidents, changed routes or other relevant disturbances, the service can easily be re-controlled, and e.g. floating bridges can be moved if needed and create new stops on other places and cities along the coast. This gives the entire traffic system increased flexibility and reduced vulnerability, which is perceived as very desirable function in Skåne's existing congested and interference-sensitive traffic systems.

Public transport on water can therefore be a relevant piece of mobility strategy to keep all parts of the region together and to provide coastal residents with access to increased service. One prerequisite, purely holistic, may be to plan waterborne public transport in accordance with the same principles as land-based public transport, which mainly are developed in the regional traffic supply program arranged by Skånetrafiken. However, this may require closer cooperation between several relevant actors in urban planning, commercial actors, The Region Skåne, Skånetrafiken not least to decide and plan for opportunities for placement of bridges and quays.

A desirable development is that the municipalities take a greater responsibility for the design of MobilityHubs for waterways. In this way, the municipalities increase their opportunities for both influence and responsibility in an area that is important to the municipalities. The main role of the Region / County Council may be to provide for the adaptation of the fleet itself. When prioritizing shuttle boat traffic, it can almost be like the corresponding bus traffic on land. This provided the shuttle boat traffic reaches the relevant municipal center.

If waterborne public transport is equated with land-based public transport, it should include the same environmental goals and objectives of economic efficiency. It can include imply requirements for renewable fuels and reduction of particulate emissions in urban environments. The difference in Skåne, compared to other parts of Sweden, is that there is currently no existing fleet of vessels that need to be replaced, but a completely new investment is required. Many existing archipelago boats in Stockholm are for example. too small to be supplemented with gas tanks for biogas operation, which instead creates the conditions for synthetic diesel.

Other, in this context, relevant environmental objectives are in various ways to increase energy efficiency in tonnage, and thus also reduce fuel consumption. Waxholmsbolaget has succeeded in this. through training efforts and installation of interceptors (surge suppressors) on certain vessels. According to the company, this is expected to lead to a reduction in wave formation which reduces damage to beaches and the surrounding area, however, with longer travel times as a result. High-speed hulls (catamaran type) can reduce wave formation problems; however, such vessels may have lower accessibility in ice conditions. Various general examples of transport solutions that can be implemented with better community planning:

- Construction transport with vessels with emphasis on bidirectional flows: outward transport of surplus mass and waste, transport of building materials and ballast
- Delivery traffic combining maritime transport and cargo bikes
- Solutions for sustainable mobility, such as public transport, car and bicycle pools and mobility subscriptions that combine different physical solutions to one service
- Increased coordination, which increases resource utilization and reduces overall transport needs.

6.2. And a practical approach

Other relevant advantages are that the total number of passenger kilometres is minimized by the routes / lines taking place across rather than around, which reduces the distance of the distance travelled. Waterborne public transport is also a complement to getting more people cycling, thus supporting the transfer from car to other more sustainable means of transport. The study includes demonstrated that the potential for water-based transport, as well as giving examples of the benefits of waterborne mobility in Northwest Skåne municipalities such as:

Båstad

to relieve Köpmansgatan from passenger and freight transport during the summer by transporting tourists / tennis visitors / residents on small tourist boats (type Rundan in Malmö or Paddan in Gothenburg) from Torekov, Ängelholm and Halmstad. This would be an attraction while reducing the parking and transport problems. Goods transport to restaurants etc. at the harbor (Skansen and everyone along the Strandpromenaden) could also receive goods deliveries by boat. Ev. the port would have to be dredged in order for this to become a reality.

Ängelholm

to be able to transport people and goods by boat transport within the city and within the region (SkåneNordväst). For Angelholm, you could also imagine commuting opportunities by boat from Helsingborg. In this way, the road infrastructure could be relieved.

Höganäs

The port in Höganäs is owned by Höganäs Båtsällskap (Höganäs boat society) and is therefore responsible for the operation. For a time ago, there was a ferry connection with Gilleleje in Denmark. Today there is a large amount of commuting from Höganäs to Helsingborg and the municipalities have cooperation in many areas.

Helsingborg

to be able to create attractive passenger and freight transport opportunities for water-based housing establishment, such as Ocean Pier. In this context, it is also important to limit parking facilities and the area's passenger and freight transport so that they do not affect Helsingborg's central parts.

Landskrona

Landskrona have a large and natural deep harbour (max 10,1 m) which is ice free all year around. There is a good infrastructure and close to railway and motorway (E4/E6) connections. The harbour also has good possibilities for expansions.

7. Discussion

Concerns

By focusing on complementing other modes of sustainable transportation together with new waterfront development projects, waterborne mobility has a bright future to be a part of the overall mobility services in many cities and regions. The aim for the study was to re-discover the potential of waterways to transport people in a region Skåne perspective. The study therefore explains the many advantages waterborne mobility has in the world of sustainable mobility systems. Waterways offers interesting alternative to heavy traffic congestions on the existing roads by offer a good, flexible, innovative, and multimodal mobility service for regions and coastal cities.

First, waterborne transportation does of course bring up some concerns. Because it is not widely developed everywhere, the fare prices will probably be high in the beginning. In many cases, boats are also still not the most environmentally friendly option because they use a high amount of diesel fuel per mile. However, with the demand for an increase in public transportation, it is more economical than constructing new ground-based transportation routes. To provide waterborne transport (i.e. watertram, waterbus and watertaxis) is an innovative alternative form of public transport used in cities or urban areas and regions. It is integrated with other modes of public transport used in the city, such as buses and bicycles. The integration of the waterborne services with other public transport modes is therefore considered a sustainable solution improving free movement by public transport. It can be a strategic toll to help people to become less car dependent.

Scheduled and fixed service

A system, based on a water bus or a water taxi, service can be scheduled with multiple stops, operating in a similar manner such a land-based bus or a taxi. A waterborne service can of course also be defined as a smaller or larger ferry or a boat. This report of holistic approach has explored the potential opportunities for waterborne mobility, as well as some concerns that may arise. As our population is increasing, urban areas are experiencing a dramatic increase in demand for affordable housing, transportation infrastructure, and job opportunities. And one exciting mode of transportation that has the potential to be more used is mobility services in waterways in an urban context.

A water bus or taxi service usually offered cruises according to fixed schedules and routes. Although the occupancy of waterborne mobility in some places can be rather low in weekdays, very often during weekends and holidays the capacity of waterborne mobility services is increasing. Most often due to tourists, and other people visiting cities with these services. Nevertheless, the objective of this study shows that, by raising the quality of service and making it more accessible and more flexible alternative transportation modes, the rise of accessibility, capacity and flexibility of water transport encourages people to use public transportation and other shared mobility modes. Moreover, the opportunity of waterborne services encourages tourists to stop using private cars to visit the city and the surroundings.

Costs

By focusing on integration of waterborne mobility, with other modes of transport, especially in waterfront development projects, waterborne transport has a bright future in the overall mobility options for cities with water connection. This study aims at "re-discovering" the potential of waterways to transport people even in the Skåne region. The purpose of this waterborne passenger transport study can easily be explained by the many advantages this public transport mode offers: reducing congestion on roads, conveying a good, flexible, innovative, and multimodal image of the city and the region completing the existing mobility networks with an additional offer of mobility services.

Despite its cost-effective infrastructure, investing in waterborne transport systems is more costly than one might think. Boats are generally more expensive than buses. But the main investments costs, of course, depend on the type of operations required. The concern is mainly the purchase of the vessels, as well as the building of "stations" in terms of Mobility Hubs. Boats are generally more expensive than buses and their purchase often represents more of the investment costs.

The maintenance of infrastructure; pontoons, boats, stations, etc. also carries costs. However, most of the time the main expenses are generated by the cost of staff: whereas a bus only requires one driver, a boat of the same capacity generally needs two members of personnel: one pilot and one seaman in charge of passenger safety. Additionally, pilots are expensive to hire due to their high level of qualifications.

Fuel consumption also represents a large piece of the operational costs. A vessel consumes more fuel than a bus due to its bigger power engines. Similarly, to buses, boat operations tend to be increasingly opting for hybrid and electric power engines, although most of the boat fleets around the world continue to be fueled by diesel oil. In order to finance these expenses, public subsidies generally bring in a strong financial support from the very beginning. In addition to these subsides, partnerships between public and private operators (PPPs) are increasingly used, on a win-win basis: the local authority shares the costs and the risks and the private partners benefit from a new market.

Yet such partnerships often imply the contractual set up of low transport fares, which can generate financial losses for operators. To compensate, many operators diversify their revenues by applying different fares: for tickets purchased on board for example, or at off-peak hours, for non-residential users, etc. Like other transport modes, waterborne operators can generate additional revenues by renting station spaces to private shops such as coffee shops, supermarkets, bookshops, which has the advantage of bringing in money and enhancing the customer experience. Renting advertising space on boats or at stations is another source of income.

Integration in sustainable mobility services

Most certain is that in the coming years, waterborne cities will need even more innovative financing solutions to increase their incomes, fully integrate the systems into mobility networks, enhance their visibility, increase passenger numbers and last but not least invest in cleaner fueled ferries. Waterways and especially waterborne passenger transportation around in cities around the world such as London, Liverpool, Gothenburg, Oslo and Hamburg are making a comeback. Waterways have acted as transportation for thousands of years, but a reduction in industrial activity and the rise of highways meant they fell out of interest of urban planners.

But in recent years, there has been a renewed interest in waterfront development and urban development, coupled with increased congestion on land-based transportation services, has provided an opportunity for waterborne transport to play a significant role in urban mobility solutions. Many other cities with waterways are currently considering adopting a waterborne system, mainly to decongest roads built along waterways. While waterborne transport is well established in several cities, such as Venice, Amsterdam, Stockholm, Hong Kong and New York.

Until recently, many waterborne systems operated independently from policies that guide land-based urban planning and transport policies. Successful systems today, whether they be leisure or commuter services, attempt to design services that are consistent with, and integrated into, local urban transport planning and mobility schemes. But - what are the arguments in favour of waterborne transport?

Cities on water with usable natural water corridors spare the need to invest in expensive infrastructure. Waterborne transport also offers fixed and reliable travelling time since it obviously doesn't have to contend with congestion. If done properly, waterborne transport can become a fully integrated mode of travel that complements other modes of transport in urban development schemes. In cities where waterborne transport is part of the urban environment, ferry stops are often located in close proximity to land-based transportation systems, which minimizes walking distance between modes while encouraging connectivity between the modes.

Possible disadvantages and potential solutions

Waterborne transport has traditionally been seen as mentioned expensive to run: vessel construction, terminal design and fuel costs all contribute to the high cost of operating services. Nevertheless, there are methods to make it more cost effective. These include diversifying services, such as by proposing leisure transport for tourists (at a higher rate) during off-peak periods.

Waterborne transport is historically not typically considered a very environmentally friendly mode since its operations can have a negative impact on banks, sea and river life and air. Many developments are taking place in to counter these effects and make it more environmentally friendly. Hybrids boat and solar boats are being more commonly used to reduce emissions, as are fuel cell boats and supercapacitor boats, while specially designed hulls are being used to prevent wash and damages on riverbanks. There are a number of expected sustainable effects of waterborne mobility, and it is important to highlight these value-creating processes. Especially in connection with the ever-growing potential of urban sharing economies linked to sustainable mobility for offshore and coastal cities. This can be facilitated by the implementation of water-based public transport.

The report thus sees that there is some potential for a water-based public transport system. This is in collaboration with existing land-based sustainable mobility, which can create reliable, regional energy-efficient passenger transport solutions in order to reduce the need for hardened infrastructure. The report shows the prerequisites for water-based public transport, its role and function in urban sharing economy based on legislation, permits and business potential.

Finally, the report has pointed to the conditions for organizational forms of collaboration within various networks, not least internationally, and for continued business development of the concept of sustainable mobility. This through world analysis and the elucidation of international and national good examples in the subject area.

8. Result

Advantages of waterborne mobility:

1. Low Cost:

Waterways can be seen as a natural highway, which does not require any certain cost of construction and maintenance. Moreover, the cost of operation of the inland water transport is very low. Thus, it is the cheapest mode of transport for carrying and/or transporting goods and people from one place to another.

2. Large Capacity:

It can carry large quantities of good or people

3. Flexible Service:

It provides much more flexible service than railways and can be adjusted to individual requirements depending on certain needs or changes in an urban context.

4. Safety/reliability:

The risks of accidents and breakdowns, in this form of transport, are small compared to any other form of transportation mode.

Challenges:

1. Slow:

Hence, the speed of waterborne transport is in some cases slow, and therefore is this mode of transport perhaps unsuitable where time is an important factor. But, on the other hand, due to the reliability and geographic advantages (closest/fastest way) it can still be a competitive transportation mode even for commuting purposes.

2. Limited/restricted area of operation:

The service can be used only in a limited area in which is served by canals, lakes and rivers.

3. Seasonal Character:

Rivers and canals cannot in all cases be operated for transportation throughout the whole year, as water may freeze during winter.

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