The effects of introducing light rail on urban development

An assessment on the introduction of light rail on tramline 1, The Hague

Master's thesis

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Executive Summary

The aim of this master thesis is to determine the wider economic effects of the introduction of a light rail system on urban development. The paper focuses on tramline 1 in The Hague, proposed for an upgrade to light rail and was done upon the request and with the cooperation of The Hague Region Authority (Stadsgewest Haaglanden), which wants to get an insight about the added value of the project for the quality of urban life. The study is narrowed down to a specific intersection of the line route, namely Hollands Spoor-Scheveningen. This part of the route is of particular interest because it includes key economic areas of the city that could be affected by the upgrade in various aspects. As a first step of the assessment, the stakeholder groups concerned with the upgrade and the potential effect of the upgrade on them are identified. As a result, two particular stakeholders are chosen for further study: businesses and (international) organizations located in proximity to the line, and the real estate market (i.e. properties within the catchment area of the upgrade). In order to evaluate the effects of introducing light rail on these parties, a survey was conducted. Semi-structured interviews were collected with employers aiming to reveal in what way the upgrade will affect their performance and what would be the added value for them. Also, interviews with real estate agencies were done, in order to determine the impact of the project on the real estate values. The findings revealed that the main benefit of the upgrade is perceived to be an improvement of the accessibility to the area through solving/reducing current issues the employers experience with regard to accessibility, mobility and the quality of the current tram service. Also, the upgrade is considered to be beneficial for the city image, as it would increase the attractiveness of the entire area. The expert judgment of real estate agents recognized that the upgrade can affect positively the property prices, as the status of a location is a key factor in the property price formation. However, the real estate agencies could not make a precise forecast of the effect of the upgrade on the property values. One reason is that often the effect of the project is indirect and also the results could be seen in the long term, rather immediately. Moreover, the assessment that real estate agencies use when forming the asking property prices takes into account general factors regarding the environment, thus do not look at the quality of public transport. Hence, the approach taken in this respect does not give an in depth prediction. As a general conclusion of this master thesis, it can be said that the introduction of light rail will add value to the urban development on the long term through increased accessibility, which has beneficial effects on the stakeholders.

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1.Introduction

The introduction of this master thesis will make the reader familiar with the research topic, the goal of the research and the research questions the paper will answer. The research framework and methodology will be briefly presented followed by a list of the chapters included in this study.

1.1. Background

What is a light rail transport (LRT) system? What is the role of light rail implementation in the development of urban areas? When is the introduction of LRT beneficial for the urban economy?

A straightforward definition of the light rail concept is hardly to be found in the literature. Yet a large number of new urban rail transport systems are being developed in cities all around the world (Macket et al. 1997). A basic definition of the concept describes *light rail as a rail-associated transport system that can be positioned in the triangle between train, tram and metro* (Priemus, 2001).This definition does not clarify the role of light rail in the urban development and the goals it should achieve, though.

According the Dutch Ministry of Transport, light rail implementation aims at achieving public transport growth at the cost of car use. Macket (1997) states the main purpose of building such systems is to reduce car usage, and as a consequence to reduce road congestion. He adds that in many cases light rail is expected to stimulate urban development. Konning (2001) further extends this view, by pointing light rail as a means that could create synergy between high quality public transport, real estate development and urban vitality, above its main objective (e.g. ridership increase).

Although light rail is portrayed to have a wider effect on the urban economy, than simply attracting passengers, one should ask in what circumstances implementing light rail would be beneficial for a particular location. Handy (2000) points that positive development impacts of LRT are limited to regions that are rapidly growing and have demand for high- density, mixed- use development; in those conditions light rail can positively impact the quality of urban life.

Introducing light rail in The Hague, The Netherlands
The main mode of public transport in The Hague is a traditional tram system, which currently is undergoing a transition into a light rail system. The upgrade of the service aims to cope with issues the city experiences with traffic, congestion, population growth etc. The improvement of the urban rail system includes replacement of the old-fashioned trams with light rail vehicles, reconstruction of public transport stops, better information provision etc. These changes are expected to provide better service quality for passengers in terms of accessibility, comfort, safety and security, and overall satisfaction of the service, which would

eventually increase ridership. Furthermore, the upgrade is seen to positively impact the city's living and working climate, thus benefit the urban development.

Light rail network in The Hague (RandstadRail Network)

The Hague region has already introduced light rail on a number of lines since 2007 (Stadsgewest Haaglanden, 2013). According to the results of a survey, conducted annually by the transport provider (HTM), the overall appreciation of the service quality of the light rail lines (RandstadRail) is 25% higher relative to the traditional tram lines (HTM, Annual barometer survey). At the present, light rail and traditional trams are operating simultaneously, thus travelers can experience and compare the service quality of both systems. HTM and The Hague Regional Authority observe a positive effect of upgrading the system with regard to travelers' satisfaction; thus consider that introducing light rail for the entire urban rail network will be an effective step towards improving the overall quality of the urban rail transit.

1.2. Goal of the research

The Hague Region Authority (Stadsgewest Haaglanden) wants to gain deeper insight at the effects of introducing light rail (RandstadRail) on the urban development. Therefore, determining the benefits of the upgrade for the stakeholders concerned is of particular interest, because it will shed light on the added value such a transition would have not only on ridership, but on the urban economy. Hence, the research aims to identify and evaluate the wider economic effects of upgrading the current tram system to an advanced light rail system.

The focus of the research will be narrowed down to a specific case, namely, the case of tramline 1 (Delft-Scheveningen), which is proposed for an upgrade. The case study will be done only for the line intersection Hollands Spoor – Scheveningen. This part of the route is selected for the research, because the area includes major city locations of economic, historical and touristic importance (e.g. city center, the International zone and the beach area).

1.3. Research question

This master thesis aims to answer the following research question:

What would be the wider economic effects of upgrading tramline 1 on the urban development?

In order to answer the main question of the research, two sub-questions are addressed.

- *'Which are the relevant stakeholders affected by the upgrade of tramline 1, intersection HS-Scheveningen?'*

By answering this sub-question, the stakeholders who are of particular relevance for the case study analysis will be identified. This will help in building up the research framework and the methodology for the research.

- *'What would be the effects of upgrading tramline 1, intersection HS-Scheveningen, on the relevant stakeholders?'*

The main goal of the research is to determine the effects of upgrading tramline 1 on urban development. Answering the main research question will be done by determining the effects of the upgrade on the main stakeholders in the catchment area of the upgrade, and translating those effects in the context of the urban development.

1.4. Methodology

Throughout the literature focused on transport impact evaluation (Leleur 1995, Turró 1999, Sugden and Williams 1978, Layard and Glaister 1996, Pearce and Hett 1999), three main types of assessment are identified:

- *Ex ante evaluation* – evaluation before the implementation of a transport project
- *Intermediate evaluation* – evaluation during a phase of the implementation of a transit project
- *Ex post evaluation* – evaluation after the completion of a project implementation

The thesis research will perform *ex ante evaluation* of the wider economic effects of the upgrade of tramline 1, as it is proposed for an upgrade but the implementation has not yet started. Accordingly, the study will exploit methods for analysis, which will allow evaluating the impacts of the upgrade in advance. A review of the most common methods applied for transport projects assessment is provided in Appendix A. Based on this review, the following methods have been employed, in order to meet the objectives of this paper.

Background information from scientific sources and reports

Scientific literature and various reports were used for several purposes in different stages of the research, in order to:

- Provide background information about the urban rail transit in The Hague
- Give an insight about the current tramway system characteristics and the reasons for transition of the system into light rail
- Understand the light rail concept and describe the features that offer advanced service
- Identify the stakeholders affected by the upgrade and the implications on them

- Determine the catchment area of the upgrade, as light rail differs from other types of urban rail systems (e.g. tram, metro and train)

Interviews and consultancy with transport experts and the transport provider (HTM)

Interviews and consultancy meetings with transport experts from The Hague Region Authority (Stadsgewest Haaglanden) and representatives of HTM at managerial positions were done, in order to:

- Understand the specific conditions under which the upgrade will be introduced.
- Understand the current issues/barriers HTM encounters with respect to the operation of tramline 1 and the prospects for development of the line (e.g. ridership, accessibility, marketing etc.)
- Get familiar with the technical specifications of the upgrade requirements for the case of tramline 1 and the city's urban rail transit in general.

Survey

A survey is conducted among two stakeholder groups, which were selected for analysis, in order to determine the effects of the upgrade on them, and to determine whether the upgrade will add value to their activities and consequently to the overall development of the city. The survey is executed by collecting interviews with the relevant stakeholders. As ex-ante evaluation is applied, this research method will make it possible to examine and analyze the perception of the stakeholders about introducing light rail on tramline 1 beforehand. Hence, the main objective of the interviews is:

- Obtaining the respondents' opinions regarding the quality of the current tram service and the change in their perception after the line upgrade.
- Determining whether and in what ways introducing light rail on tramline 1 would be beneficial for the respondents; again based on their own judgment.

A discussion of the survey results is done in the last part of the thesis, aiming to reveal the effects of the upgrade on stakeholders participating in the survey, and to determine the implications on urban development. Based on the survey findings, recommendations to the city authorities and transport provider are addressed.

1.5. List of chapters

Chapter 1 commenced this master thesis by presenting the topic of the research and its objectives, the questions that it will answer, and the methodology that will be applied for that purpose. Chapter 2 dives the reader into the main issue this paper is dedicated to, namely the necessity for upgrading the current tramway system into an advanced light rail system and the effects of such a step on urban development. As the paper studies this matter for a particular tramline proposed for an upgrade (tramline 1) – the characteristics of the line and the arguments supporting the upgrade are presented. Chapter 3 defines the stakeholder groups affected by the tramline upgrade, together with the potential effects of the upgrade on them. Based on this, a choice of stakeholders for further analysis is made. In Chapter 4, the focus is fully narrowed to tramline 1, where the catchment area of the upgrade is defined and spatial analysis regarding the property and

commercial use is done. Then, in Chapter 5 a survey on the effects of upgrading tramline 1 for the chosen stakeholders is conducted. Chapter 6 presents the survey findings while Chapter 7 includes a discussion of the results. Lastly, Chapter 8 outlines the conclusions and recommendations of the study.

2.Urban rail transit upgrade in The Hague

2.1. Introduction

This chapter gives an overview of the urban rail transit upgrade in The Hague. Section 2.2 describes the characteristics of the urban rail transit and the reasons for upgrading the current system. Section 2.3 provides a review of the current tramway system characteristics, while section 2.4 explains the light rail concept and its role for improving the state of the system. In section 2.5 the key features of the present light rail system in The Hague (RandstadRail), and the benefits it is expected to provide in terms of service quality are identified. Section 2.6 focuses on tramline 1 by reviewing the characteristics of the line, the issues regarding its operation and the main arguments for upgrading the line. Finally, section 2.7 summarizes the main points discussed in the chapter, in support of the need for the upgrade of the tramway system in The Hague.

2.2. Urban rail transit in The Hague

The Hague region facilitates over 1 million citizens and shows a continuous population growth since 2005[1], which reflects the necessity to cope with issues regarding traffic, accessibility, mobility; hence to respond adequately to the transportation needs of the citizens. The Hague Region has the ambition tackle those problems by increasing the number of passengers using public transport by 40% in 2020 compared to 2005, thus aiming to alleviate car traffic and introduce a viable alternative to the car. In this sense, RandstadRail, the urban light rail network, is seen as an appropriate tool to trigger future passenger growth (Stadsgewest Haaglanden, 2013). Therefore, the upgrade of the current tram system into an advanced light rail is considered as a necessary step for solving current and future issues related to the passenger flow and traffic.

The Hague, as the center of the region, is the densest area where a complex urban transit network aims to facilitate increased travel demand mainly by its urban rail system. The main characteristics of the current urban transit network are as following:

- Two main hub/railway stations serving the region: Hollands Spoor (HS) and Centraal Station (CS)
- Each district has a link to the city center, HS and/or CS via urban rail or /and bus
- Top city stops with high passenger flows
- Access to a public transport stop at mx. 500m distance form each dwelling

The current urban rail system includes trams and light rail and consists of:

- Two light rail lines (RandstadRail) - №3 and №4, linked with the city tram network
- One light rail line, connected with the Rotterdam metro system
- Two tramlines operating with light rail vehicles (RandstadRail)- №2 and №19
- Eight classical tramway lines

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[1] Table A 1 (Appendix A) Total population change for the period 2005-2013 – Stadsgewest Haaglanden; Source CBS

Upgrading the current tramway system into light rail is considered as a key step in order to provide high quality public transport. The transition into light rail involves vehicle replacement and physical transformation of the supporting infrastructure (e.g. stops, platforms, bicycle parking facilities, P + R, travel information improvements). As a result, better integration with other transport modes and improved accessibility and ease at interchanges will be achieved. The plan for the complete transition of the entire system into light rail is scheduled for the year of 2022 (Stadsgewest Haaglanden, 2013).

2.3. Current Tramway system characteristics

The current tram fleet is facing the need of replacement, given the fact that the largest share of the vehicles are near the end of their life cycle. The trams' technical characteristics do not allow optimal performance with respect to capacity, accessibility, comfort, safety and security, travel time etc. in comparison to more modern systems The supporting superstructure also does not match with the trends and perceptions for a high quality service. Next to that, the operational efficiency of the vehicles plays a major role in the lifecycle costs. Hence, minimizing running costs is crucial for satisfactory return on investment[2]. The maintenance of the current trams is costly and in some cases difficult (e.g. the supply of the spare parts for the old types). Thus, it affects the decision making for the composition of a specific urban transit system).
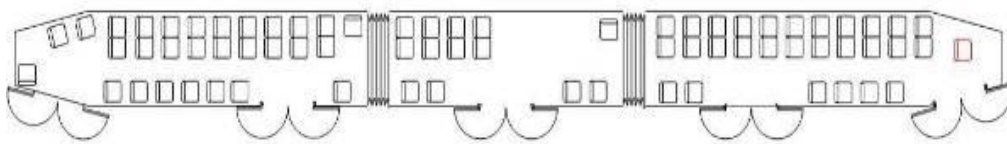
Figure 1 Schematic illustration of GTL 8 tram vehicle

Vehicle specifications (GTL8 tram)	
Length	28 m
Width	2,35 m
Floor height	80cm
Seat capacity	70 seats/ 118 standing
Movement	One direction

Table 1 Vehicle specifications of GTL 8 tram

2.4. The "Light Rail" concept – A way towards an upgrade

The "light rail" term is widely used to describe a broad variety of urban railway transit systems. The "Light Rail Transit Association" (LRTA)[3] states: *Light Rail embraces tramways but goes further - and faster - than*

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[2] Source: http://www.bombardier.com/en/home.html
[3] The LRTA is a not–for–profit UK based organisation and has members throughout the world. Free of any trade or political affiliation; it is the world's leading organisation concerned with the achievement of better public transport through light rail, tramway and metro systems in towns and cities world–wide.

traditional tramways - and so much more smoothly and even with style and 'pizazz'". The Transportation Research Board (TRB) defines light rail transit as*: "A metropolitan electric railway system characterized by its ability to operate single cars or short trains along exclusive rights-of-way at ground level, on aerial structures, in subways or, occasionally, in streets, and to board and discharge passengers at track or car-floor level."* Another definition describes it as *"railway operations using smaller vehicles which have a lower capacity and lower speed than the conventional railways. Also the infrastructure needed for light rail is cheaper in terms of building and maintenance[4]".* Without doubt, all definitions portray aspects of the nature of light rail transit. However, the definition of light rail adopted for this research is:

"Light Rail is a rail-borne form of transport that can be developed in stages from a modern tramway to a form of transport operating underground or on viaducts (Groche, 1979; p1). Each stage of the development can be the final stage, but should permit further development to the next higher stage"

Altogether, binding in one pivotal point, the definitions explain the core of the light rail concept. It can be concluded that light rail has a mimicry nature, giving operational flexibility and space for adjustments tailored with the specific urban requirements, resources and circumstances.

2.5. Light rail in The Hague – RandstadRail Network

RandstadRail Network is a project aiming to enhance the quality of the urban rail network by introducing a light rail system. The light rail system brings improvement in six main components: 1) speed, namely fast connection between stops; 2) reliability (on time service); 3) comfort on board; 4) vehicle capacity; 5) accessibility and 6) multimodal mobility and easy interchanges.[5] RandstadRail achieves these features trough two main components:

- Introduction of new light rail vehicles
- Superstructure improvement

Upgraded components of RR vehicles and superstructure

The design of the modern light rail vehicles and infrastructure has a number of distinctive features, which differ significantly from those of the current tramway system. Based on the technical specifications, a set of elements can be defined, that ensure high quality in the six areas listed above; thus justifying the benefits of the introduction of the light rail system. The distinctive features of The Hague's light rail system are discussed below.

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[4] Source: http://www.thetrams.co.uk/whatisatram.php
[5] Source: Visie Netwerk RandstadRail, 2010
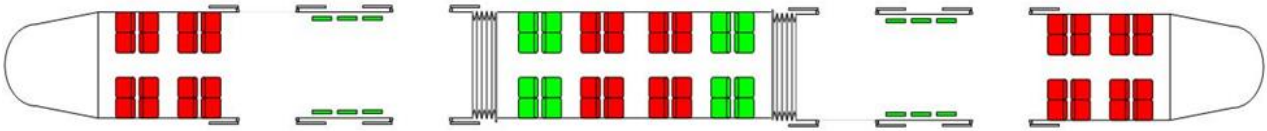
Figure 2 Schematic illustration of RandstadRail (RR) light rail vehicle

Vehicle specifications (RandstadRail)

Length	35m -37m
Width	2,55m -2,65m
Floor height	35 cm
Seat capacity	70-86 seats/ 140 standing
Movement	Two ways -direction

Table 2 Vehicle specifications of RR vehicle

Vehicle size increase reflects on additional capacity by 25 % with efficient space for wheelchairs, prams, luggage etc., thus providing comfortable seating and leg space.

Low floors affect the accessibility, capacity, comfort and speed of the vehicles. The low-floor design improves the accessibility for travelers, and provides a higher ceiling relative to the vehicle floor, which allows for larger windows and more air[6]. Furthermore, the capacity is increased, as there is more free space at the doors. Next to that, the low-floors have an effect on speed, by shortening the boarding time due to lack of stair steps, which on its turn decreases the travel time between stops; thus providing faster service to customers. Consequently, it affects the service frequency and the number of vehicles needed on the line. For example, one second saved on each stop, due to reduced boarding time, would result in approximately one minute saved along the line, meaning that a reduction in the number of vehicles needed for the line can be achieved, or a higher frequency can be supplied without the need of extra vehicles. All in all, this feature provides both, increase in travel comfort and opportunities for service cost reduction.

Two-direction movement eliminates the necessity for loop space, thus saves urban space and reduces infrastructure costs. Besides, the ability to move backwards is an advantage in case of road accidents or a technical malfunction, as the vehicle can retrieve easier.

Top cooling system is an important feature for supplying high quality transit service. It ensures travel comfort and is a substantial improvement compared to the current trams, which have just a regular heating.

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[6] Source: *"The joy of high ceilings (also called low-floors)"*. http://www.humantransit.org/2009/05/the-joy-of-high-ceilings-also-called-low-floors.html

Whilst ensuring travel comfort, this feature is also a main reason for the high energy consumption of the light rail vehicles.

Travel information, ticketing and crew play an important role for passengers' satisfaction, comfort and high quality service. Real- time travel information is supplied in the vehicles and also at the stops. In terms of ticketing, vending machines and smart card readers are used (OV-chipkaart machines). Besides, making the travel easier, these features contribute to the safety and security in the vehicles. While the drivers of the classical trams are in constant interaction with passengers, selling tickets or providing travel information, the modern vehicles have an isolated driver cabin. Limiting interaction between crew and travelers is necessary, in order to avoid distraction of the crew, thus contributing to the overall travel comfort and safety.

Superstructure design improvements mainly aim to provide higher accessibility. The design complies with the standards[7] for high quality transport provision. For instance, stops are wider, enabling free movement of wheelchairs, prams, luggage and convenient passenger circulation. Better-quality shelters, bicycle parking spaces and surveillance are also supplied in order to provide comfort and higher level of accessibility for passengers.

2.6. Tramline 1 (Delft - Scheveningen) – a line for an upgrade

This study focuses on tramline 1, as a line proposed for an upgrade. So far, other urban rail lines have undergone transition into light rail and a few more are in a process of upgrading (Stadsgewest Haaglanden, 2013). However, this research was started to examine the economic effects of upgrading the line on the area it serves, with a specific focus on the intersection HS- Scheveningen. This case is of a specific interest, because the area along the tramline has characteristics that differ in nature from the city parts served by the other lines in transition.

Characteristics of tramline 1, intersection HS-Scheveningen
Tramline № 1 serves The Hague region since 1905 and today links The Hague and Delft via the hub station Hollands Spoor. The intersection Hollands Spoor – Scheveningen serves the International Zone of the city, the City Center and Scheveningen (the city's major beach and touristic location). Within that area, numerous international organizations and institutions are located, as for instance, embassies, courts, NATO Agency, Europol etc. The International zone of the city facilitates organizations and institutions like the International Criminal Court, the Organization for the Prohibition of Chemical Weapons, the United Nations' top legal instrument, the International Court of Justice among others. Furthermore, Scheveningen attracts visitors and tourist, featuring a long beach line, seaside boulevard and plenty of cultural and leisure offerings (e.g. museums, hotels, restaurants, bars, casino, theater, landmarks etc.). The beach is also a popular destination

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[7] R-Net standard- a set of quality specifications for the entire transit network. Compliance with R-Net standard is agreed by all transport authorities involved in the network upgrade

for watersports such as kiteboarding and windsurfing. All said above gives a clear idea, why the area is an interesting subject to be studied, with respect to the effects of upgrading tramline 1 on the overall development of the area.

Interesting facts & figures

- *The length of tramline 1 is 20·4 km, thus the third longest urban rail line*
- *Tramline 1 has 41 stops, out of which 18 are located with the intersection HS-Scheveningen*
- *Tramline 1 serves the 20 major recreational hotspots between Delft and Scheveningen, 10 of which are found within the intersection HS- Scheveningen*

From the introductory paragraph, aiming to get the reader familiar with tramline 1 and the specific area that will be studied further on, it becomes evident that the line serves an area with a mixed land use, including residential, commercial and tourist areas with diverse activities and consequently various travel purposes.

Issues regarding the operation of tramline 1

The line facilitates substantial passenger flows, and classifies as "a busy line" Currently, the line experiences various issues regarding the quality of service provision and operation (HTM, 2013). The main weak points in the performance of the line are as following:

- Insufficient capacity during rush hours
- Seasonality in ridership, resulting in overcrowding during the day in the summer season
- Setting the "right" frequency in order to facilitate passengers (e.g. due to seasonality)
- Limited accessibility for boarding the trams, due to high floors
- There is NO specific marketing focus on the line, mainly because the current service quality does not allow for advertising it, which on the other hand limits the opportunities to attract potential passengers (A. Koop, HTM, 2013).

Transition of tramline 1 into a light rail line (RandstadRail)

The Hague Region Authority and HTM see the upgrade of tramline 1 as an effective step for improving the service quality and consequently attracting passengers. Introducing light rail (RandstadRail) is perceived to tackle the issues the line experience, already discussed above. Moreover, according to H. Rodrigo, product manager at HTM, the line upgrade will also contribute to the flexibility and efficiency of the entire urban rail network. Next to that, it will make the public transport more representative, thus aids for raising the modern look of the city and its image.

2.7. Conclusion

Introducing a light rail system in The Hague is seen as a means to cope with traffic, congestion and population growth, by increasing the number of passengers using public transport. RanstadRail aims at providing advanced service quality in order to increase the attractiveness of the urban rail system for travelers. This will be achieved through supplying new light rail vehicles and modifying the existent infrastructure. The features that these two components include, are supposed to improve the service provision with respect to travel comfort, accessibility, safety etc. In this line of thought, the transition of tramline 1 into a light rail line is a step to solve the issues the line experiences in these aspects. Further, upgrading the line is viewed as beneficial for the overall city image and modern look.

3. Stakeholder groups of the upgrade

3.1. Introduction

The objective of the chapter is to identify the stakeholders of the tramline 1 upgrade, and the possible effects of the upgrade on these parties. Section 3.2 looks at the scientific literature, deriving two main types of effects on stakeholder groups occurring from the implementation of similar transit projects, namely direct and indirect. Also, in this section the key stakeholder groups of the upgrade are identified. Then, section 3.3 focuses on describing the potential direct effects on stakeholders, while section 3.4 discusses the potential indirect effects. Afterwards in section 3.5, operationalization of the effects on the relevant stakeholders is done, which aims to select which of them will be further studied. Finally, section 3.6 includes a synthesis of the chapter, in which a summary of the potential effects (and benefits) on each stakeholder group is given together with a list of operational indicators, which will be examined later in the paper.

3.2. Effects of light rail systems on stakeholder groups

Stakeholders can be defined as parties who have an interest in an issue, and affect or are being affected by the issue because of their position. Stakeholders can include an individual, a group or organization, individuals within an organization and/or networks (Varvazovszky and Brugha, 2000). Topalovic et al (2012) states that all stakeholders in a transit project stand to benefit financially, socially and environmentally. These benefits are due to connectivity and accessibility, coming from station access and travel time savings. This view is supported by the notion that light rail is able to solve not only transport related problems, but non- transport related problems as well (Banister, 2011).

Throughout the reviewed literature, it became clear that various classifications of the impacts of light rail systems are used. LiRa (The international Network of Light Rail Cities) is a project which objectives are to exchange ideas, knowledge and conduct research on the development and the effects of light rail systems throughout Europe. The project included eleven European partners regions[8] from four Western European countries (NL, BE, UK, GE) implementing light rail systems (the projects are in various phases of completion). The LiRa pilot 3 study examines the effects light rail would have on the economic, spatial and social sphere, nevertheless, it classifies the effects into two main categories – *direct effects* and *indirect effects*. Yet, there is a tight link between those two groups, because the indirect effects are caused by the direct effects (Lira 3 pilot, 2000).

Direct effects refer to the instant consequences of the operation of the system. Therefore, travelers and transport supplier will be the parties primarily affected by changes in the urban transit system. ***Indirect***

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[8] The European partner regions taking part in the LiRa project are: City Region of Haaglanden (NL); Province of North- Holland (NL); Province of Limburg (NL); Province of Gelderland/KAN region(NL);Greater Manchester Passenger Transport Authority (UK); East Lancashire Partnership (UK); Cardriff County Council (UK); Ministryfor the Walloon Region (BE); Ministry of the Flemish Region(BE); City of Kaiserslautern (GE).

effects on the other hand, cover a wider range of impacts such as business location decision, real estate market, city image etc. Accordingly, the relevant stakeholder groups affected by a light rail project would be society, businesses and organizations/institutions and real estate market. Based on the discussion above, the main stakeholder groups affected by the upgrade into light rail are identified and illustrated in the figure below.
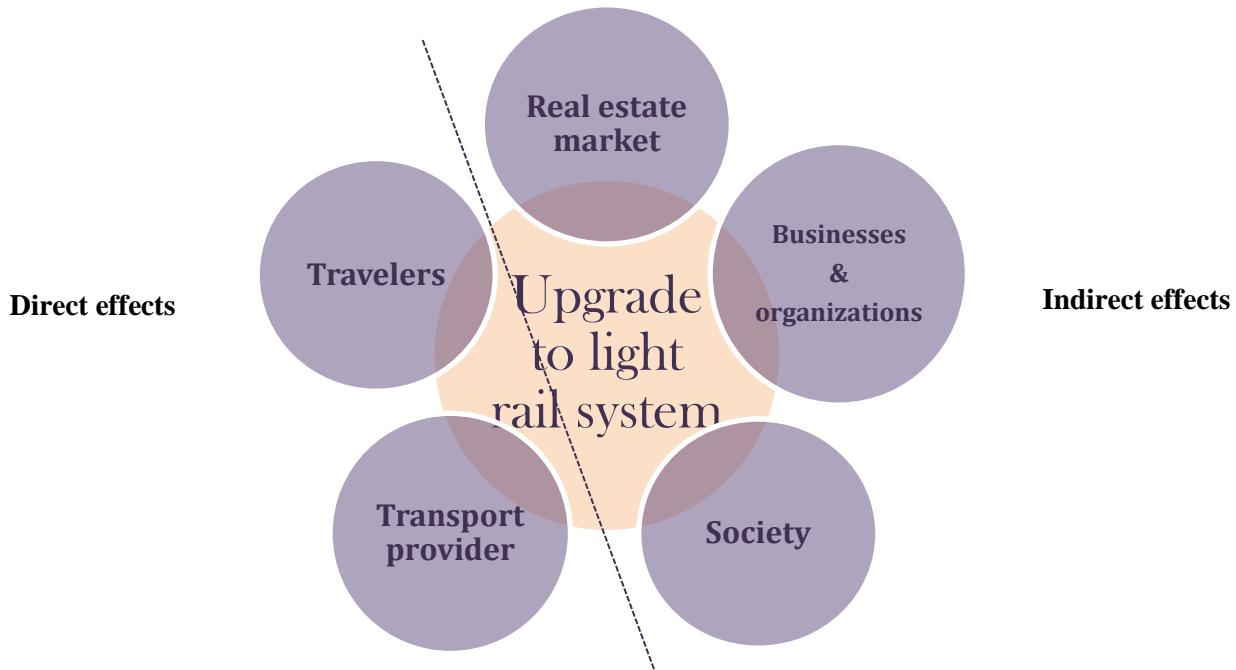
Figure 3 Stakeholder groups affected by an upgrade to light rail

3.3. Direct effects

3.3.1. Travelers

Litman (2013) states that travel demand refers to the number and types of trips people make under particular conditions. Kittleson et al. (2003a) define a set of factors affecting the demand for public transport, shown in Table 3.

Factors	Using these factors to increase Ridership & Benefits
Convenience	Increase transit service coverage and frequency
Information	Provide information on where, when and how to use transit
Price	Keep fares low and offer targeted discount, such as commuter passes
Speed	Provide express commuter services and transit priority measures
Accessibility	Develop more accessible land use patterns and more diverse transportation system
Integration	Provide P+R facilities, transit service to major transportation terminals
Comfort	Provide adequate service so transit vehicles are not crowded
Security	Insure that transit vehicles, facilities and service areas are considered secure
Prestige	Treat transit riders with respect, and promote transit as a desirable travel option

Table 3 Factors affecting the demand for public transit

The quality of public transit system depends on numerous factors, such as comfort and safety in the vehicle, time needed to cover routes, the convenience and existence of supporting infrastructure (dell 'Olio et al., 2011). Although potential users and active users give weight to different factors, when evaluating high-quality public transit service (dell 'Olio et al., 2011), some factors influencing the transport service quality stand out when looking at the relevant literature:

- Waiting time – the time spent waiting for the vehicle. Highly influenced by frequency and reliability.
- Waiting environment – the physical condition of the public transit stop.
- In-vehicle time – the time spent on board during the travel.
- Comfort in vehicle – determined by the vehicle characteristics (e.g. capacity, seats, air-conditioning, cleanliness, travel information etc.)
- Reliability – determined by following schedule on time and delays
- Information provision – ensuring real-time information of arrival times, routes, maps etc.

Waiting time, in-vehicle time, reliability re *quantitative variables* and their effect on ridership and benefits for the travelers can be measured, for instance, through estimation of the generalized cost for the users. The generalized cost is the sum of monetary (fares) and non-monetary (travel time) costs for a trip. For example, the elasticity of transit use with respect to frequency averages about 0.5, meaning that each percent increase in frequency increases ridership by 0.5 percent (Litman, 2008). Thus improving these factors would decrease the travel time cost for users and consequently their generalized transport cost and make public transport more competitive with relation to other modes of traffic.

Comfort, waiting environment, information provision are *qualitative variables* that users value and add to the perception of the overall quality of the service. The assessment of these factors is highly determined by the perception of users. Hence, it can be measured through collecting perception surveys, interviews, questionnaires etc. However, studies have quantified and monetized the qualitative factors of travel time costs (Mackie et al. 2003, Wardman 2004). Brundell- Frei, 2006 states that perceived travel time costs tend to be higher for uncomfortable, unsafe and stressful conditions.

3.3.2.   Transport provider

Light rail is a hybrid form of public transit standing between the metro and conventional tram. It enables penetration into the city center without the need of heavy investments in underground infrastructure, which metro requires. Furthermore, due to the lesser weight and smaller scale of the light rail vehicles, the operation and construction costs are less relative to heavy rail (De Bruijn, Veenman, 2011). Light rail can be adopted to run on tracks used from other types of rail systems, as in the case of RandstadRail (Priemus et al., 2001). Hence, upgrading the tramway system into light rail will not require substantial investments in infrastructure, while at the same time it improves the service provided by the transport operator. Overall, urban rail is considered as a mode of transport that has high fixed costs and low marginal costs of carrying

additional passengers (Kahn, 2007). Therefore, making the service attractive for new users would be profitable for the transport provider in a long term. However, according to Winston and Maheshri (2007) a common issue of the rail transit is its failure to attract enough patronage, in order to reduce its high average costs, which is especially valid for areas with low population density (Andersson et al.,2010).

The literature review above proves that the implementation of light rail would certainly have an effect on the transport provider. In order to understand the implications of introducing light rail on the urban transit system for the transport operator, it is logical to look at the potential revenues and costs that may occur.

Revenue items are ***fares***, which are fundamental for the operation of public transport, since they are the main source of income to operators. As a general rule, if fares increase, the patronage will decrease; thus whether the revenues increases or decreases after an increase in fares, is a functional relationship between fares and patronage (Paulley,2006). Another source of income is the ***auxiliary revenues*** from marketing, advertising etc., and ***penalties*** imposed to irregular passengers.

Cost items can be divided in two main categories, namely fixed and operating costs. ***Fixed costs*** refer to the initial investment in infrastructure, purchase of land if it is required for construction of facilities, stops, platforms etc. and vehicle capital costs. ***Operating costs*** include crew costs, energy consumption costs, maintenance and repair of vehicle, infrastructure maintenance, marketing and promotion of the system and overhead costs (e.g. human resources).

In conclusion, the transport provider is one of the main stakeholders affecting and being affected by an upgrade of the current urban rail system. While light rail seems to be a practical tool for providing advanced urban rail service, the effects on the transport provider to a large extent depend on the specific circumstances under which the project is implemented.

3.4. Indirect effects

3.4.1.   Businesses & (International) Organizations

Economic theory suggests that the level of development that one place will attract depends on the accessibility of that place relative to other (Handy, 2005). Conducting a study on the non-transport benefits of a rail investment, Banister and Goodwin, found that an improved level of urban rail accessibility will have an impact on the number of people entering a particular labor market. Hence, businesses benefit from increased access to employees and customers due to accessible transit nodes (Cervero and Sullivan, 2011), as they can attract employees from wider region (Lira pilot 3, 2000).

Furthermore, the implementation of light rail can trigger investment in new housing, offices, services and shops (Topalovic, 2012). Cities who have successfully implemented light rail systems have reported an increase in shopping commerce, development of residential and commercial areas and increased employment nodes (Crampton, 2003).

Businesses can realize cost reduction in terms of time and money, by reducing their overall car use. These cost reductions are achieved by reducing travel cost and need for parking space (TfL, 2007). An upgrade of the urban transit can trigger more employees to go to work by public transport instead of by car, which can result in costs savings for businesses. For instance, the commute expenses of employees can be reduced by using travel products from the transport provider (e.g. year or monthly passes, discount cards).

All in all, light rail associates with generating investment, employment and income. While the literature discussed above shows that businesses (and respectively organizations, institutions and other commercial entities) are surely affected by light rail projects, it turned out that scientific sources examining the benefits for businesses are scarce. Hence, there could be other factors that have beneficial effect on the business communities located in proximity to light rail, which were not revealed in here. However, it was possible to identify businesses (and organizations) as relevant stakeholder group that is interesting to be studied further.

3.4.2.   Real Estate Market

The effect of proximity to transit on property values is widely researched in the literature and has become a key factor when looking at the relationship between public transit investment and economic development (Ko et al., 2013). The impact on property values is considered as one of the most significant effects of a rail transit project implementation (Diaz et al., 1999).

Light rail is a relatively permanent investment along a specific route, thus as such can encourage urban development, affect land uses and increase nearby property values (Topalovic, 2012). Higher value land parcels will produce additional property taxes for the municipality and thus aid to pay for the capital and operating cost of the system (Cervero and Duncan, 2002).

Jong and Declercq (2012) examined the economic evaluation of urban track systems within Europe based on case studies, which showed a positive long term effect of urban rail on the city development and especially on the housing and the businesses along the rail lines. LiRa pilot 3 report (2001), also pays attention to the link of light rail transport implementation and property values. It states that in theory the presence of a light rail system means better accessibility for locations near light rail stations. Also it suggests that better accessibility provides better production conditions and thus consequently businesses are prepared to pay higher real estate rents in order to use the advantage of more accessible locations. Furthermore, higher real estate values cause higher land values. Ko and Cao (2013) further support this idea stating that investments

in transit on a specific corridor increase its accessibility compared to the entire transportation network, and as urban economics imply, this increase is likely to be capitalized in properties located in a proximity. However, most of the studies focus on residential property values and much fewer have analyzed the effect on commercial property. Capturing businesses' willingness to pay more for increased proximity and accessibility is a challenging task. The difficulty to collect data is main reason for the limited research in that direction (Ko et al., 2011).

Moreover light rail, as a TOD[9] means, aims to increase ridership and the associated gains with it (Kim, 2007). If it succeeds in attracting more passengers and more specifically car users, a reduction in the parking space could be achieved. In TOD, less parking surface is desirable because of reduction of land separation and increases infill development. This also increases residential property values as large parking space is considered a disadvantage (Cervero, 2001).

In order to give a deeper insight of the impact of urban light rail development on property values, some examples of conducted case studies are discussed. While predominantly the study outcomes show positive impact, some cases show negative impacts (Ko and Cao, 2010). However, it is a challenge to draw more specific conclusions about the effects of light rail on property values because the studies evaluate different types of rail systems, examine diverse response and explanatory variables, define access to rail stations differently etc. (Ko and Cao, 2010). Furthermore, the effects of light rail are not identical for different places, and are dependent of the specific characteristic of the location studied. The wider range of outcomes is confirmed by Debrezion et al. (2007), reporting that the impact of light rail transit on properties extends from -62% to 145% among properties within and over 400m distance of rail stations, as the average effect is around 16 %.

Cao and Ko (2010) examine the impact of Hiawatha Light Rail implementation on commercial and industrial properties, looking on both station and sub region areas. They study the accessibility effect (firms' willingness to pay for proximity to rail transit) on the property values, by looking at the property sold before and after the implementation of light rail. As dependent variables the prices of commercial and industrial properties are used. The general conclusion of their study is that LRT has increased the nearby commercial and industrial property values and to some extent revitalized the neighborhoods and stimulated economic development along the corridor. The benefits associated with access to light rail decrease with distance. The price gradient is approx. 6000 dollars per meter for a typical property located 400 meters away from LRT station, while it drops to 4000 dollars for a property 800 m away. This equals to 33% difference in property

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[9] A **transit-oriented development** (**TOD**) is a mixed-use residential and commercial area designed to maximize access to public transport, and often incorporates features to encourage transit ridership. A TOD neighborhood typically has a center with a transit station or stop (train station, metro station, tram stop, or bus stop), surrounded by relatively high-density development with progressively lower-density development spreading outward from the center. TODs generally are located within a radius of one-quarter to one-half mile (400 to 800 m) from a transit stop, as this is considered to be an appropriate scale for pedestrians.

price per 100 meter. Thus, the price of a property located 800 meters away from LRT will be 33% lower compared to a property which is located 400 m far from the LRT station.

Chen (1997) evaluates the effects of the light rail system (MAX) in Portland, Oregon on single-family home values using the distance to a rail station (proxy for accessibility) and the distance to the line itself (proxy for nuisance effect). He takes into account both, positive and negative effects of light rail, and concludes that the positive effects are dominant. The main results show that at 100 m away from stations, each additional meter further away from the station will result in a 0.04% decrease in price of the house price (Chen, 1997). This means that the price of a house 200 meters away from the light rail station would be 4% lower, than a house 100 meters from the LRT station.

Topalovic et al. (2012) conducted a research of the potential impacts of light rail in Hamilton, Canada since launching a policy plan for designing and implementation of a LRT system. An assigned study (IBI 2009b) found that the development of light rail would increase the number of jobs per hectare and the residential units along the corridor. Land values are anticipated to increase between 5-15% at major hubs and 3-8% along other areas along the corridor. For commercial property values the forecast follows the same trend with 5-15% increase within 400 m of an LRT station and 3-8% in other areas of the corridor.

Other studies also have shown changes in property values influenced by urban light rail systems. The range of price change varies but it shows a positive effect in each case. A summary representation of the findings is illustrated in the table below including the examples given above.

City (publication source)	Rail system (type)	Property (type)	Property values impact
Hiawatha, Mineapolis (Ko and Cao, 2013)	LRT	Commercial Industrial	The price of a property located 800 meters away from LRT will be 33% lower compared to a property which is located 400 m far from the LRT station
Hamilton, Canada (Topalovic, 2012)	LRT	Commercial	An increase of 5-15% within 400 m of a LRT station and 3-8% in other areas of corridor
Portland, Oregon (Chen, 1997)	MAX	Single Family Homes	At 100 m away from stations, each additional meter further away from the station will result in a 0.04% decrease in the house price
United Kingdom	LRT	Residential Commercial	A registered increase on housing property values of 2,2% and for shops it is 16,4%
Strasbourg (LiRa,200)	Tram	Residential Commercial	A registered increase of 8,1-10% in central stations' areas and an increase of 5,2% in peripheral stations' areas
Lille (LiRA, 2000)	VAL	Offices	A registered increase of 10% in stations' areas

Table 4 Summary of case studies on the impacts of light rail systems on property values

3.4.3. Society

TODs typically mix residential and commercial land use in a way that improves access to transit and cycling infrastructure (Topalovic, 2012). Light rail thus seen as a tool for improved TOD aims to help reduction of car use and increase transit ridership (Topalovic, 2012). Litman (2003, 2004) summarizes the societal benefits of a rail transit (Table 5). Thus the higher the quality of the urban rail transit, the more these benefits are delivered to the society.

Rail transit benefits (Litman, 2003, 2004)

Benefits	Description
Congestion reduction	Reduced traffic congestion
Facility cost savings	Reduced road and parking facility costs
Consumer savings	Reduced consumer transportation costs
Transport diversity	Improved transportation options, particularly for non-drivers
Road safety	Reduced per capita traffic crash rates
Environmental quality	Reduced pollution emissions and habitat degradation
Efficient land use	More compact development, reduced sprawl
Economic development	Efficiencies of agglomeration, increases productivity and wealth
Community cohesion	Positive interactions among people in a community
Public health	More physical activity (particularly walking) increases fitness and health

Table 5 Benefits of rail transit for society

The availability of integrated public transport systems is a key component in reducing car dependence and provides more opportunities for physical activity. A research estimating the effect of LRT on health care costs shows that it has part in decreasing the health care costs. When people choose rapid transit over car they walk on average 30 minutes more per day. Thus, better urban rail transit would benefit the public health and reduce negative externalities (e.g. pollution, emissions, accidents etc.).

Congestion is a common issue in dynamic, high dense urban areas. Litman (2004) explains that per capita congestion delay is significantly lower in cities with high quality rail transit systems than in otherwise comparable cities with little or no rail service. The congestion relief occurs mainly due to reduction of travel time costs. Hence rail-based systems can be seen as an important tool in helping cities to overcome the problems posed by car (Newman 1995). Rail transit tends to reduce per capita vehicle ownership and use, and encourage more compact, walkable development patterns, which can provide variety of benefits for society (Litman, 2007).

Furthermore, Litman (2007) states that if there is no time saving, perceived costs per hour tend to be lower than driving if the transit service is comfortable, allowing passengers to relax or work. Travelers will choose the mode that best suits their needs and preferences for each trip. Thus a provision of high quality urban transit has higher propensity to attract potential users and thus decrease the use of the car.

City attractiveness and image is a major reason for new systems implementation. Looking at the examples of light rail presence, it is clear that large numbers of cities around the globe are adopting light rail transit. Recently, the presence of a light rail urban transit system seems to be associated as a feature of a "World City" (e.g. Dallas rationale to promote modern public transit). Pagliara (2011) says that urban rail can improve the attractiveness of a location by its image effect e.g. by making a stop/station appear modern and dynamic. During an interview with A. Koop (HTM), she states that "the *state of public transport is one important feature of the city. High quality public transport would make the whole city look more modern and attractive"*. Hence, it would raise the status of the location. Consequently, it seems that the image of a city tends to be affected by the level of the state-of-art transit system.

3.5. Choice of stakeholder groups for analysis on tramline 1 upgrade

So far in this chapter, it became clear there are multiple stakeholders that would be impacted by an upgrade in the urban transit system. However, this study focuses on the effects of the upgrade of tramline 1, thus it is necessary to select the relevant stakeholders who will be further examined with respect to the case study. The choice of the stakeholder for analysis is dependent on various factors, such as data availability, limitations for research, the objective of the thesis etc. Hence, reasoning for choosing or not a party for analysis is given for each stakeholder group.

3.5.1. Travelers

Travelers are the stakeholders, who would be directly affected by the upgrade of tramline 1, especially as the ultimate goal of introducing light rail is to improve the service quality for passengers, and thus to increase ridership. Unfortunately, there is no sufficient data available on ridership for tramline 1 or any other upgraded line so far. Thus the research is restricted to look at the effects of light rail on ridership, and concludes what would be the change after the upgrade on the number of passengers using the line.

Nevertheless, an indication of the effect on travelers can be given through a survey conducted annually by the transport provider (HTM) that assesses the appreciation level of the public transport quality by travelers. The survey (OV-Klantenbarometer) aims to reveal the travelers' opinion on the performance of the city- and regional- public transit. Regarding The Hague, an evaluation of the public transport system is provided for both light rail service (RandstadRail) and trams. The survey report includes the results for a six year period (2007 – 2012), where a questionnaire consisting of 27 questions is clustered into 4 main categories, namely: 1) travel comfort; 2) information and safety &security; 3) travel time and reliability; 4) price of fares. The travelers have to rank various items on a 10-point "likert scale" or give their opinion on items with regard to the quality of the transit service provision. The traditional trams and RandstadRail are evaluated separately, thus giving a base to compare the performance of both systems. In the table below the indicators evaluated

for each category are shown. The survey results show that travelers' appreciation of the overall light rail service quality (RandstadRail) is 20-25 % higher than for the traditional trams[10]. Detailed review of the items and the scoring by travelers can be found in Appendix A. In conclusion, the light rail is indeed perceived to improve the travel comfort, information provision and the overall satisfaction of travelers. This provides enough evidence that travelers prefer light rail over the current tramway system, thus the upgrade will be beneficial for this stakeholder group, and hence the study will not further examine it. However, later on the study will refer to the HTM survey for the analysis of the upgrade on the stakeholders selected for analysis.

Travel comfort	*Information, safety and security*	*Travel time and reliability*	*Price & Purchase*
• Seat availability	• Overall information provision	• Punctuality	• Fare
• Cleanliness	• Information about delays	• Speed	• Ease of ticket purchase
• Friendliness	• Overall safety & security	• Frequency	
• Driving style	• Safety & security during travel	• Interchange time	
• Noise in the vehicle	• Safety & security on waiting stop		
• Ease of boarding the vehicles (accessibility)			

Table 6 Indicators evaluated in HMT survey on traveler satisfaction of the urban transit in The Hague

3.5.2.   Transport provider

The transport provider, in this case HTM, is responsible for the introduction, operation and marketing of the upgraded urban rail system. This means that it should supply, maintain and operate the light rail vehicles and the supporting infrastructure. Thus the quality of the service provision will certainly have implications on its activities. The final goal of the transport supplier is to attract as much travelers as possible, hence a tradeoff between costs, revenues and customer satisfaction should be done. H. Rodrigo, commercial manager at HTM, gave his opinion on this matter in an interview conducted for the research. He explained that *"HTM does not seek maximum profitability. There is no genuine drive for money. There is a drive to have more happy passengers. Thus, the benefits of upgraded system are not in terms of only high profit, but to have satisfied passengers and increase ridership with a reasonable profit."* Hence the transport provider may be seen as the initial drive that ignites the follow up effect of the upgrade with respect to the rest of the stakeholders. In conclusion from the discussion above, the upgrade is supported by HTM, as a means to fulfill its strategy and objectives. Therefore, it is considered as a beneficial step towards improvement of the current service. This thesis will not dive more into this stakeholder, as the main picture is already clear and there is no reason to further examine it.

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[10] Regarding the results for RandstadRail, the figures since the year of 2008 are considered. The survey of 2007 with respect to RR is not sufficient because it reflects only a few months of operation of RR light rail. Source: HTM, 2013

3.5.3. Businesses and (International) Organizations

'Micro, small and medium-sized enterprises (SMEs) are the engine of the European economy. They are an essential source of jobs, create entrepreneurial spirit and innovation in the EU and are thus crucial for fostering competitiveness and employment"

> *Günter Verheugen,*
> *Member of the European Commission*
> *Responsible for Enterprise and Industry*

The statement of the EU Commission illustrates the importance of the efficient operation of SMEs for the urban development and competitiveness. Business units represent a distinguishing feature of tramline 1's route for the intersection HS-Scheveningen, as the area facilitates over 10 000 SME's with diverse business activities. Thus, taking into consideration the objective of the paper, looking at the effects of upgrading the urban transit service on the local business community seems an appropriate approach. Furthermore, large business entities located in the area contribute to the employment, providing large number of work placements, as well as bringing numerous clients/ visitors to the city (and the area in particular). Hence, they are also an interesting group to pay attention to. Regarding the use of public transport, employees would be concerned with service quality in terms of reliability, frequency, and comfort among other factors that affect their commuting. On the other hand clients/ visitors (e.g. business clients, tourists) often can make a single trip to a location. Hence, it could be that they can get much of the impression of a city's image by the quality of the urban transit. For instance, Thompson (2007) draws attention to the association between public transport and destination satisfaction, focusing on tourism in particular. He claims that numerous studies have recognized the transport availability and performance are noteworthy attributes of the overall destination satisfaction. Hence, the quality of transport, although as a secondary factor, affects the visitors' perception about their stay and ease of reaching destinations.

Therefore, the research will try to determine the effects of tramline 1 upgrade on the activities of businesses/ (international) organizations, with regard their employees, clients/visitors and overall performance. Furthermore, the effects of the upgrade for this stakeholder group will be translated to the urban development. In conclusion, choosing this group for analysis is seen as interesting approach to evaluate the effects of the upgrade on the area and urban development, especially given the fact that the scientific literature on this matter is hardly found. This gives space for this master thesis to make contribution, in a sense that it will enrich the existent concept in that direction.

3.5.4.   Real Estate Market

The impact of light rail on the real estate in proximity is broadly researched and analyzed. From the literature review done earlier in the paper, several facts should be highlighted. Firstly, there are numerous research methods applied and the range of results differs substantially. Secondly, the outcomes of various studies are not uniform as each study depends on specific circumstances (e.g. area characteristics, phase of light rail development, objective of the project etc.). Thirdly, based on the review done on different cases, assessing the impact of light rail on property values, it can be concluded that in general the real estate is positively affected by such transit projects implementation. However, property values increase vary substantially and illustrates the impact for the specific case examined. Therefore, although the scientific literature indicates that there should be a positive effect of tramline 1 upgrade on the real estate along the line, this assumption is not reasonable, because the impact of the upgrade should be determined when considering the specific characteristics of this particular case. In this sense, it is interesting for the research to examine the effect of upgrading tramline 1 on the real estate in proximity of the line for the intersection HS - Scheveningen, and determine whether a change would occur due to light rail implementation. Thus, this stakeholder group is chosen for further study,

3.5.5.   Society

Societal effects would be difficult to measure in the case of tramline 1 because, it is narrowed to a specific urban area, and therefore looks at the economic impact on a micro scale. Furthermore, there is no data available for analysis of the social effects that can occur from upgrading the line. However, it should not be excluded, that while examining effects on the other stakeholders of the upgrade, there could be findings that as well can concern society at large. In such case, the research will discuss the implications of the upgrade found for this party.

To conclude this section, multiple stakeholders were considered for analysis. Out of all, two were chosen to be further studied, particularly businesses and (international) organizations, and real estate market. The stakeholder groups: travelers, transport provider and society are excluded from the analysis due to various reasons, which make the analysis unnecessary or not possible.

3.6. Synthesis

The impact of implementing advanced urban rail systems like light rail spreads far beyond the primary objective to increase ridership. Multiple stakeholder groups are affected by such projects either directly or indirectly. Travelers, transport provider, businesses and (international) organizations, real estate market and society are actors that are concerned by a change in the service provision. In the table below, a synthesis of the effects and potential benefits of light rail upgrade for each stakeholder group is presented. Also as this is a two-direction relationship, the influences that stakeholders can have on such project are pointed out.

Stakeholders	Characteristics		
	Effect of upgrade on actor	**Benefits from upgrade**	**Influence/power**
Travelers	**Direct** Travel time Comfort in vehicle Reliability Information provision	Travel time cost reduction Improved comfort on vehicle Convenience Accessibility	Decision for usage Setting requirements for good service Assessment of the quality of the service
Transport provider	**Direct** Ridership change Operational and maintenance costs Revenues	Attraction of travelers Revenue increase Provision of better service Flexibility in service provision	Supply and maintenance of vehicles and infrastructure Set up frequency Efficiency in service provision
Businesses &Organizations	**Indirect** Accessibility Labor pool Business costs Generate investments Visitors, customers access	Increased accessibility Wider labor pool Reduction in business travel costs Facilitate more visitors and customers	Give incentives or not their employees to use the service Promotion of the service or not Limit other means of travel for their employees
Real Estate Market	**Indirect** Property and land values Real estate rents Reshape space usage	Increase property and land values Increase in rents Increase willingness to pay Higher prices for the location	Create a property assessment including the benefits of the upgrade (accessibility, proximity etc.)
Society	**Indirect** Congestion and traffic relief Public health Car use City image	Alleviate traffic issues Increase public health Reduce car use/ownership Improve attractiveness of the location	Evaluate the service quality Build perception of the entire transit system of a city

Table 7 Synthesis of possible effects of tramline 1 upgrade on stakeholder groups

All in all, as the ultimate goal of the upgrade of tramline 1 is to bring benefits to stakeholders, a set of main operational indicators that add value for those groups are summarized and listed as follows:

1) *Benefits from the direct effects* of such an upgrade are unified in:
   - Ridership increase
   - Accessibility improvement for travelers
   - Travel time cost reduction
   - Flexibility increase on the line and strengthening of the entire urban rail transit network

2) *Benefits from indirect effects* can be narrowed down to:
   - Accessibility improvement to businesses and (international) organizations
   - Business travel costs reduction (e.g. business travel, commuting)
   - Increase in labor pool and job opportunities
   - Positive effect on nearby property and rent values
   - Relief in traffic, congestion and reduce of car use
   - Positive effect on public health
   - Boost of the city image and attractiveness of the catchment area of the upgrade

The indicators pointed as key benefits of the upgrade are selected assuming that they have a solid impact on stakeholders, while taking into account that those indicators do not affect only one specific stakeholder group but might apply for more actors. Besides, this set of benefits may include indirectly other benefits pointed in the summary table above (Table 7). Thus, it can be assumed that in some cases, the benefits are interrelated and/ or interdependent to each other. In this sense it might be useful to briefly discuss the arguments for selecting those specific indicators.

Ridership increase is an important benefit for the transport provider, whose main goal is to supply service that attracts more customers, which on its turn would positively affect the revenue side of the transit operation. Customers' attraction on the other hand, is subordinate to the quality of service provided, thus influenced by the characteristics of the transit service: accessibility, comfort, reliability, convenience.

Accessibility improvement for passengers is a key indicator that would affect the ridership, but also the social aspects of the upgrade. Increased accessibility could affect the decision for using the service or not, thus indirectly reflecting on the congestion and traffic relief, public health, car use etc.

Travel time cost reduction is seen as another important benefit from improved service quality. Travel time cost is non-monetary cost for a trip, which is affected by the quality of service provided. Comfort, waiting environment, information provision, waiting time, in-vehicle time, reliability etc. are all factors that affect the travel time of passengers. Hence this indicator is important for assessing the benefits of the upgrade, as it contains numerous other factors that benefit the travelers.

Flexibility increase on the line and strengthening of the entire urban rail transit network is indicator that mostly relates to the efficiency of the service provision by the transport operator. Consequently, the condition of the whole network would have implications on all other indicators.

Accessibility improvement to businesses and organizations is important for companies as it would ease the access to the business location for employees, customers and visitors. Furthermore*, increase in labor pool and job opportunities* for citizens is important for the performance of businesses, as they have better access to human capital. Additionally, the upgrade could benefit the businesses by reducing *their business travel costs* related to their employees.

One major effect of the implementation of urban light rail systems extensively studied in the scientific literature is the impact on nearby property values. Property prices and rents tend to increase due to improved accessibility to light rail. This positive effect is beneficial for the real estate agencies and market. However, whether it is beneficial for owners and users depends mainly on their willingness to pay a higher price for the improved accessibility.

With regard to wider social benefits of the upgrade, we consider that the most relevant indicators are relief in traffic and congestion, car use and benefits for public health. These effects can be seen as an outcome of the quality of total service provision and the extent to which it managed to provide benefits with respect to all indicators mentioned so far.

Lastly, *city image and attractiveness* is selected because the condition of the urban transit system could play a durable role in building up the perception of a city in general. The public transit facilitates travelers with different background, activities and reasons to live/ work in and visit a city. Therefore, it could be seen as a representative feature of the status of the city.

4.Tramline № 1 – catchment area of the upgrade

4.1. Introduction

The objective of this chapter is to define the catchment area of tramline 1 upgrade, intersection HS - Scheveningen, and provide a spatial analysis regarding the real estate and commercial use in the area. The space use analysis is done through a GIS software application on a data provided by the municipality of The Hague. Thus, section 4.2 defines the boundaries of the catchment area and sets the geographical perimeter for the space use analysis. Section 4.3 presents the space use analysis on the property usage, while section 4.4 describes the commercial usage of the catchment area. Section 4.5 presents the results of the analysis on for these two stakeholders (real estate market and businesses/international organizations) and helps to select specific features for further study on both parties.

4.2. Catchment area

The case study on the upgrade of tramline 1 focuses on the intersection HS-Scheveningen, which is a part of the line's route. A first step in defining the catchment area of the upgrade for this intersection is to pinpoint the neighborhoods located along the line. As a result, sixteen neighborhoods were identified, that are directly served by the line. An illustration of the selected zones is shown in fugue 4. This type of classification provides a general overview of the catchment area. However, it is necessary to determine the perimeter of the line, where the upgrade will have an impact on the area. Thus as a second step, a brief overview of literature discussing the proximity level, capturing the impact of light rail is done, aiming to determine the geographical perimeter for the space use analysis. Subsequently, the precise catchment area of the tramline 1 upgrade is defined and illustrated in figure 5.

Literature background

The distance of origins and from transit stations has a strong influence on the willingness of people to use transit (Guerra, 2011). A one-half mile circle (800 m) has become the common acceptable distance for determining a transit station's catchment area in the U.S, adopted in TOD. It corresponds to the distance, which a person being at the edge of the circle can reach the station in 10 minutes walking with 5km/h (Guerra, 2011). O'Sullivan and Morrall (1996) conducted a study in Calgary, Canada developing a quantifiable basis for designing guidelines for pedestrian access to light rail transit. The research indicated that people are willing to walk further to reach a light rail station than a bus stop; thus using the standards for an access to a bus station (400-500m) would underestimate the attractiveness of light rail. The results show that "the average walking distance to LRT station is 649 m with a 75th percentile of 840 m".

Zhao et al. (2003) finds that the transit use decreases exponentially with walking distance to a transit stop, thus walking distance has a negative impact on the use of public transport. He also states that 800 m distance

is the upper limit when calculating the transit service catchment area and service population. Increasing this distance limit (800 m) does not produce noticeable increase in transit walk accessibility, implying that considering a longer distance is not necessary.

Hence, the study will adopt 800m circle distance, in order to define the boundaries of the catchment area of the tramline 1 upgrade (Figure 5). This perimeter covers most of the neighborhoods surrounding the line, but at the same time adds or excludes some parts; thus reshaping the area according to the scientific literature looking at the geographical range of light rail impacts. Consequently, the boundaries of the catchment area are defined by creating an 800 m circle from each stop, thus accounting for 18 stops located along the line intercept. This step allows a detailed description of the land use and the activities within 800 m distance from/to each stop. The stop spacing referring to the average distance between two consecutive stops along the route is 455 m (Stadsgewest Haaglanden, 2014), thus there is an overlap of the circles for each stop. However, if the overlapping should be avoided, the circle distances to a light rail stop should be reduced by half, which is not in compliance with the light rail concept; hence result in incorrect data collection and analysis.
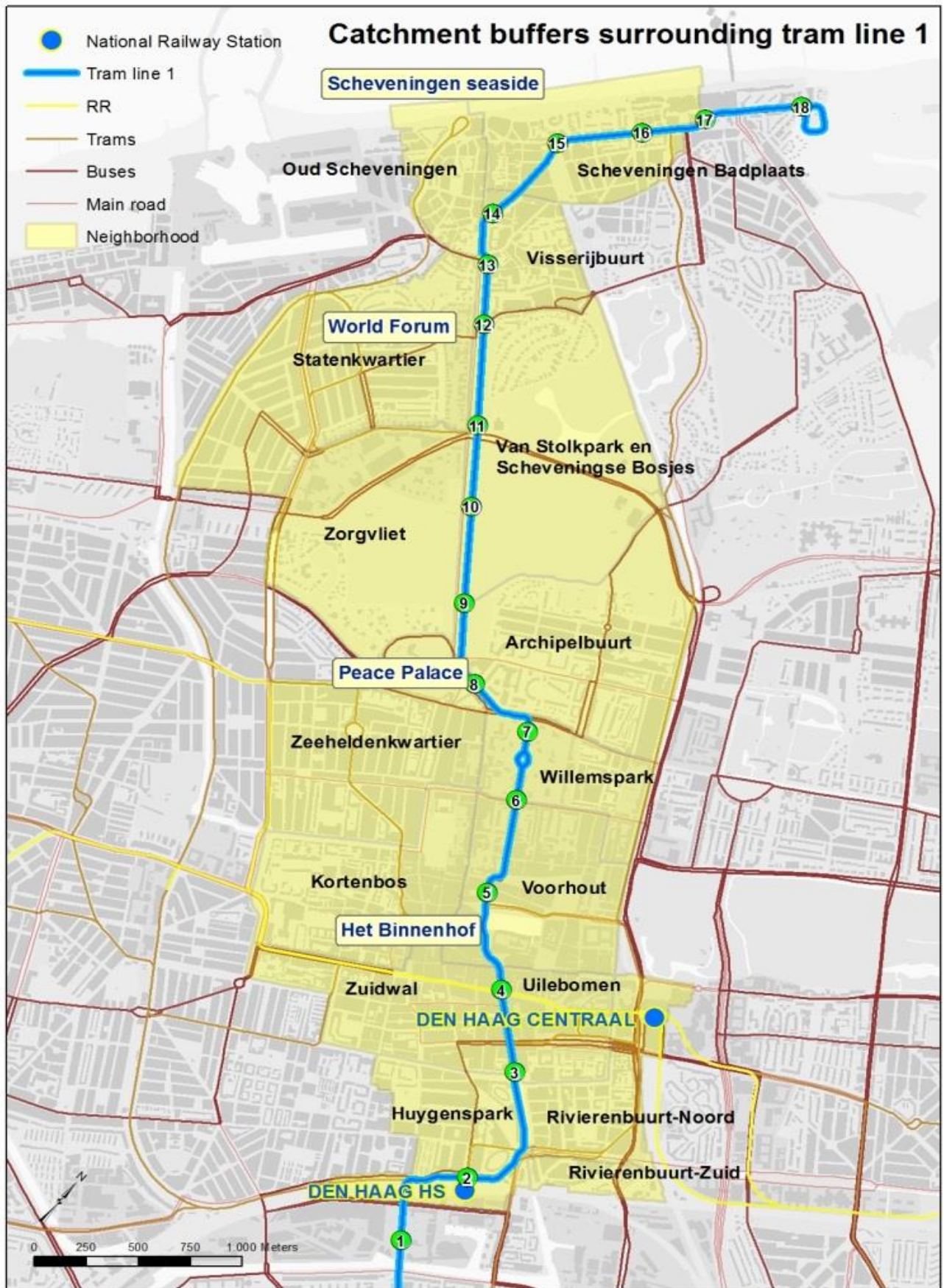
Figure 4 Neighborhoods surrounding tramline 1, intersection HS- Scheveningen
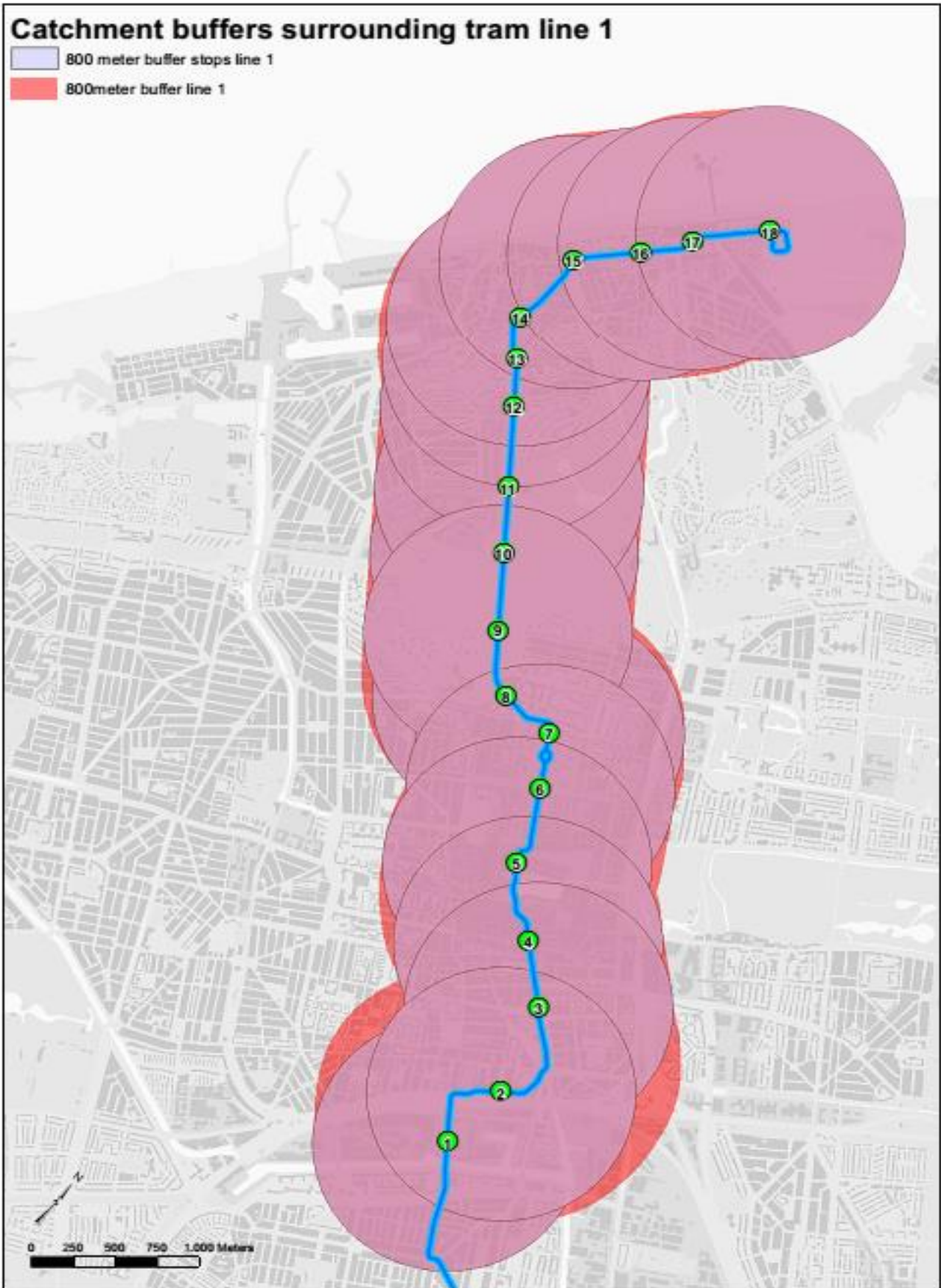
Figure 5 Catchment buffers surrounding tramline 1, intersection HS- Scheveningen

4.3. Space use analysis

The real estate market is a stakeholder chosen for analysis with respect to the impact of introducing light rail in the catchment area. Determining the property types and their present share in the area is necessary for building up the methodology for analysis on the real estate along the tramline 1 intercept.

Hence, screening of the area's space use is done by applying GIS analysis. The analysis aims to describe the distribution and the property types characterizing the area. The space use is determined by the occupied surface of building blocks in square meters within 800m from each tramline stop. Thus, actual four-dimensional information is obtained, considering not only the surface at ground level but also in height as often building blocks include floor levels. All the data used for the analysis is from year 2012, provided by the municipality of The Hague.

Total space use

The surface of the area mainly facilitates commercial and residential property, various types of facilities, green space (parks), parking space and other features. Commercial and residential property is predominant in the area, accounting for 49 % of the total space use, whilst facilities comprise only 3%. Green space takes 16% of the area, mainly due to the presence of a park (Scheveningse Bosjes).

Figure 6 Total space use of the catchment area
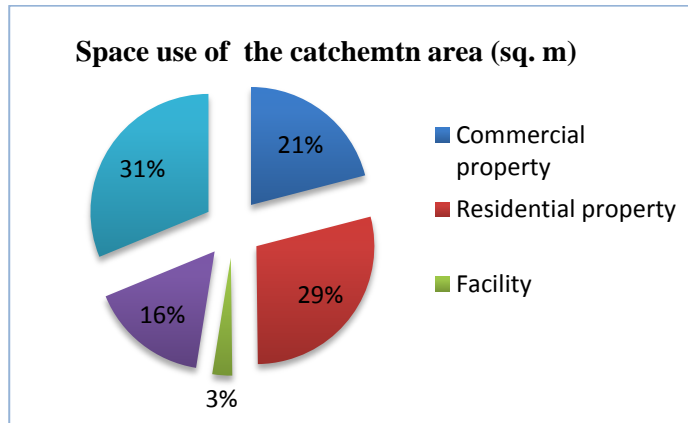
Type of space use	Space use catchment area (sq. m)
Commercial property	3596272
Residential property	4947121
Facilities	466930
Green space/ Parks	2788113
Other	5355957
Total	16906433

Table 8 Total space use of the catchment area

Commercial property use

The commercial property use is spread among offices, leisure facilities (sport and outgoing–related activities), retail, restaurants and bars/ cafes, and health care. The space use for offices is prevalent (66%), followed by retail (19%). The other categories a have minor share, thus showing relatively little presence in the area compared to the distribution of the total space use.

Commercial property use (sq. m)

Offices 66%, Leisure 3%, Retail 20%, Accomodation (hotels etc) 4%, 4%, 3%
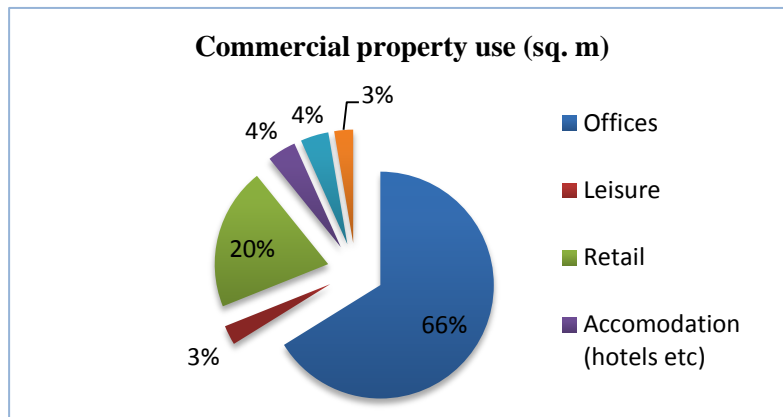
Figure 7 Commercial property uses in the catchment area

The analysis shows that mainly offices characterize the commercial property use of the area. The commercial office space is mainly used by businesses, which main activity is done in regular offices and only a minor share belongs to companies, which use offices as a supportive function next to their core activity (storage, production, workshop, sale etc.).

Office types in the catchment area (sq.m)

Company 8%, Office 92%
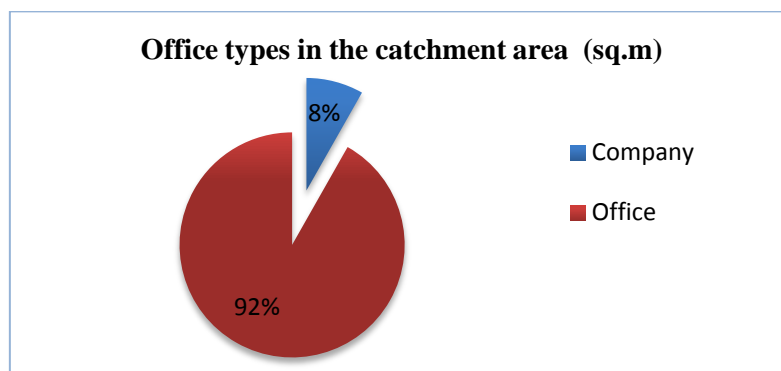
Figure 8 Types of offices in the catchment area

Residential property use

The residential property in the area includes owned, rented and social housing. The figure below shows the distribution of the residential property use for those three types of dwellings, by looking at number of registered housing.

Residential property use

Own housing 14%, Rent housing 29%, Social housing 57%
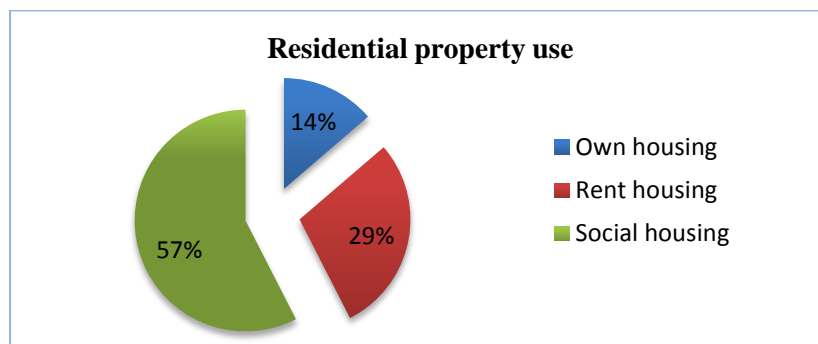
Figure 9 Residential property uses in the catchment area

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Social housing is the predominant residential use (57%) followed by rent housing (29%). Hence, the upgrade of the tramline could be of a significant relevance for the residents in the area assuming that people living in social housing would rely regularly on public transport because they have low income and does not necessarily own or use car on daily basis. Rented livings could be affected by the accessibility of the area, as when someone chooses to rent a place, the quality of public transit can be a decisive factor, especially as regard home-work travel.

Facilities in the area

The share of facilities within the area is 3 % of the total use of space surface. The majority of facilities are educational related, thus representing schools and other knowledge activities. Cultural facilities account for 30% of the total share including theaters, cinemas, museums etc. The facilities in the area do not seem to be relevant for measuring the added value of the line upgrade, as in general they aim to serve the local community.
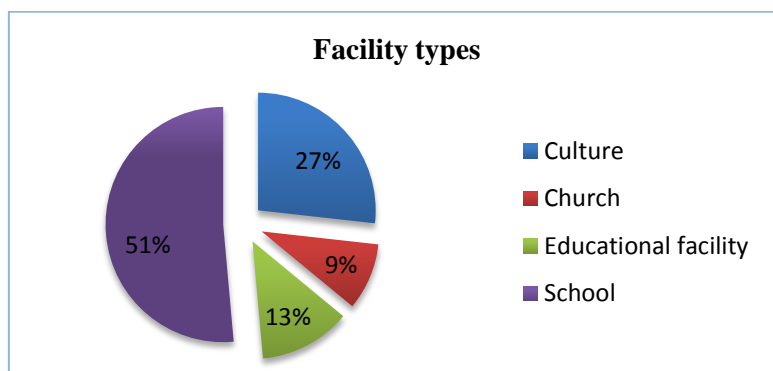
Figure 10 Facilities located in the catchment area

Other space use

One third (30%) of the total area surface is used for other purposes than the categories discussed above. This category mainly includes car and bicycle parking spaces and garages, a public transport depot, infrastructure constructions (e.g. bridges), gardens etc. Hence, this category does not present a particular interest for the research and will not be further considered for analysis.

4.4. Commercial use analysis

Businesses and (International) Organizations are selected to be studied with respect to the effect of tramline 1 upgrade on their overall performance. Hence, screening of the commercial activities within the catchment area seems an appropriate approach, in order to get insight about the economic activities present in the area. The area facilitates approximately 10 000 registered businesses and organizations. In this sense, a look at their characteristics (e.g. size, type of activity) is useful, in order to determine the entities that are interesting and relevant for further study. Hence, the commercial space use analysis will serve as a base for setting the

methodology for evaluating the effects of the upgrade on this stakeholder group. Again, GIS application is used for analyzing data on the enterprises registered in the area. The data is from 2010 and is provided by the municipality of The Hague.

Size of businesses and (international) organizations

The businesses are classified by size, applying the definition of the size of enterprises adopted by the European Commission since 2005. The EU commission defines the size of micro, small and medium-sized enterprises (SMEs) taking into account three factors: staff headcount, annual turnover and annual balance sheet. According to the definition of SMEs, there are three enterprise categories:

- Micro size – employs less than 10 persons and has annual turnover or annual balance sheet not exceeding 2 million euro.
- Small size - employs fewer than 50 persons and has annual turnover or annual balance sheet not exceeding 10 million euro.
- Medium-sized – employs fewer than 250 persons and has annual turnover or annual balance sheet not exceeding 50 million euro.
- Large-sized business on it turn is organization that has grown beyond the limits of medium- sized business, employing 250 or more persons.

In the classification, the staff headcount is the central criterion for determining the size of SME. It covers full- time, part-time and seasonal staff (incl. employees, owner-managers, partners involved in business regular activity and employees considered as such under the national law). In the research, the staff headcount is used for defining the size of companies as most relevant with respect to the use of public transit by employees.

Type of businesses and (international) organizations

The businesses and (international) organizations within the area occupy various activity branches. Therefore, in order to identify the types of companies and international bodies, a classification into specific categories is done, giving a clear overview of the activities taking place within the catchment area. The paper adopts the Standard Classification of Enterprises (SBI) for this purpose. SBI is a system of classifying enterprises on the basis of their economic activity which is in use in the Netherlands since 1974 and complies with the United Nations system (ISIC).

4.4.1.   Businesses in the catchment area

Size of businesses

The businesses are fully commerce oriented and do not include international organizations and institutions of any type. When looking at the share of the companies' size, it is clear that the micro businesses are

predominant, accounting for 90% of the total number of businesses, followed by the small (8%), medium-sized (2%) and large (less than 1 %) businesses (Figure 11).

Figure 11 Distribution of businesses in the catchment area by size
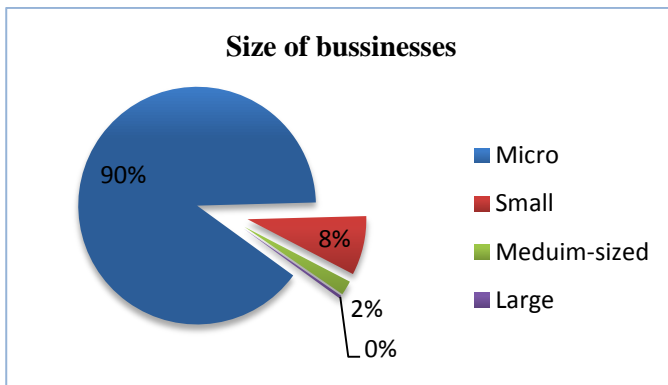
Size of businesses catchment area	Number of businesses catchment area
Micro	9530
Small	857
Medium-sized	209
Large	43
Total number of bussiness	10639

Table 8 Number of businesses in the catchment area by size

Furthermore, as the largest share consists of micro companies, it is interesting to have a closer look at the distribution of the number of employees. The micro companies which have 1 employee comprise 65% of all micro businesses, representing self-employed enterprises. Businesses with 1 to 4 employees taken together comprise 90% of all micro companies in the area (Appendix D).

Another important feature, when looking at the size of the companies within the catchment area, is the workforce that each category employs. The employees are a group that mainly travell during rush hours to/from work on daily basis, and their travel patterns can be affected by the line upgrade. The share of the workforce for each business size (Figure 12) shows that micro enterprises comprise 21% of the total employemnt in the area. Small businesses account for 19% of the employment as each company employs at least 10 workers and up to 49, where a change in the current urban rail system could have an effect on the travel policy of the company. Medium-sized (50-249 employees) and large businesses (250 or more employees) comprise 25% and 35% of the total workforce, respectively

Figure 12 Distribution of number of employees per business size in the catchment area
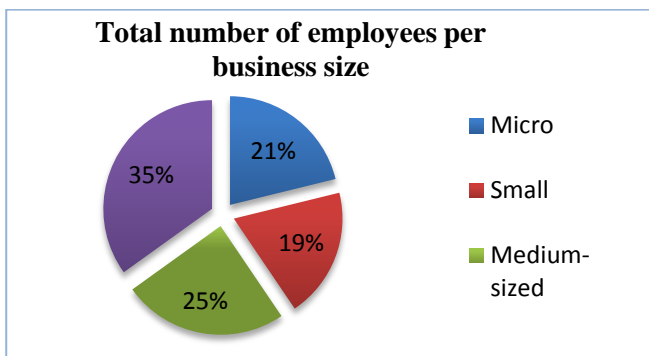
Business size	Total number of employees
Micro	18486
Small	16901
Medium-sized	21445
Large	30492
Total employment	87324

Table 9 Number of employees per business size in the catchment area

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Type of businesses

The area includes numerous business activities in different branches, which contributes to the diversified spatial use of the area. Businesses active in the branches (M) Consultancy, R&D and other specialized services,(G) Wholesale and retail, (R) Culture, sport and recreation, (F) Construction and (I) Accommodation and food service comprise the highest share of business activities within the area by number of companies.

Number of businesses and organizations by branch

Branch	Number
A	155
B	2
C	215
D	1
E	7
F	873
G	1967
H	109
I	828
J	596
K	150
L	258
M	2439
N	488
O	355
Q	553
R	969
S	674
U	126
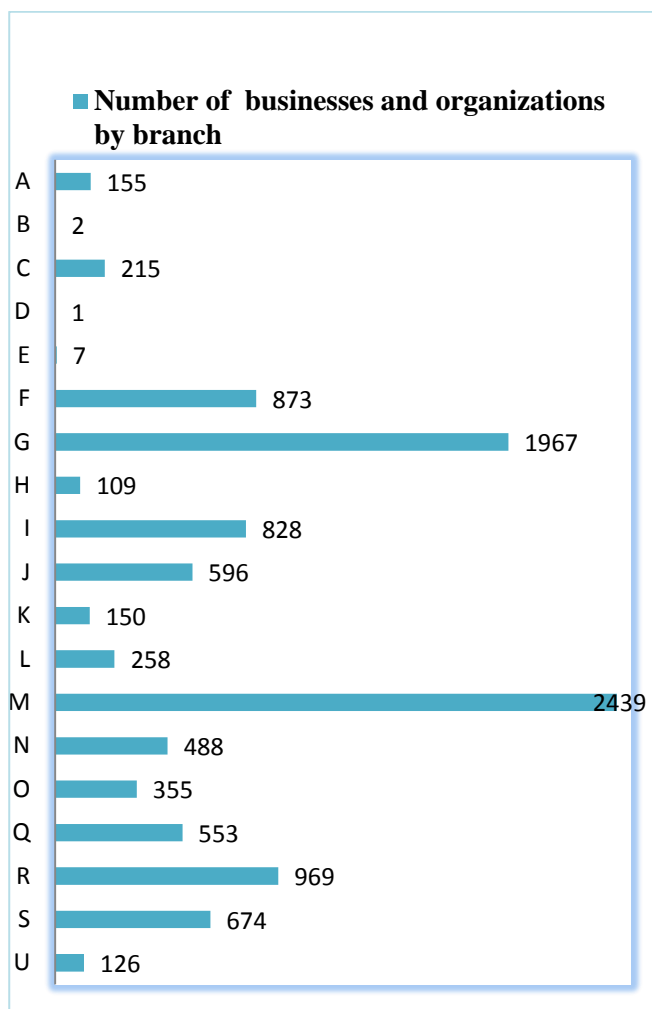
Figure 13 Number of businesses and international organizations by activity branch

Branch	Registered type of business activities within the catchment area by SBI
A	Agriculture, forestry and fishing
B	Mining and quarrying
C	Manufacturing
D	Electricity, gas, steam and air conditioning supply
E	Water supply; sewerage, waste management and remediation activities
F	Construction
G	Wholesale and retail trade; repair of motor vehicles and motorcycles
H	Transportation and storage
I	Accommodation and food service activities
J	Information and communication
K	Financial institutions
L	Renting, buying and selling of real estate
M	Consultancy, research and other specialized business services
N	Renting and leasing of tangible goods and other business support services
O	Public administration, public services and compulsory social security
Q	Human health and social work activities
R	Culture, sports and recreation
S	Other service activities
U	International organisations and bodies

Table 10 List of activity branches present in the catchment area

4.4.2. International organizations in the catchment area

Size of international organizations

There are 126 international organizations and bodies within the area. The biggest share (58%) is of micro size and includes predominantly embassies. Small size organizations are 37% of the total organizations and there are only a few medium-sized and large ones.

Size of international organizations

- 58% Micro
- 37% Small
- 3% Medium-sized
- 2% Large
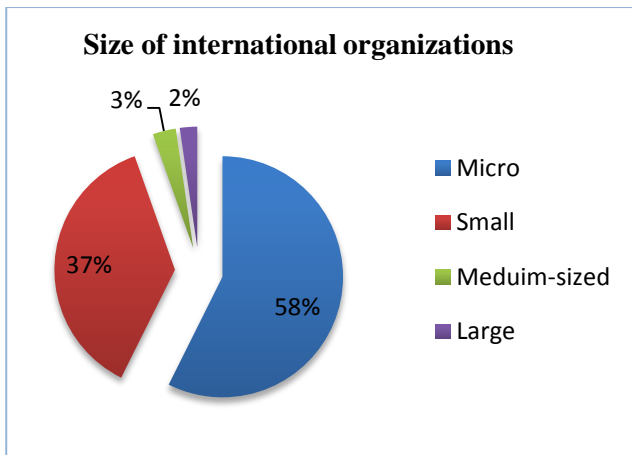
Size of organizations catchment area	Number of organizations catchment area
Micro	74
Small	48
Medium-sized	4
Large	3
Total number of organizations	126

Table 11 Number of international organizations in the catchment area by size

Figure 14 Distribution of international organizations in the catchment area by size

Type of international organizations

The international organizations and bodies include two main types of activities[11].

- Activities of international organizations and agencies, regional bodies etc. (E.g. Europol, European Commission, ICTY United Nations, Bureau of the European Parliament etc.)

- Activities of diplomatic and consular missions when being determined by the country of their location rather than by the country they represent (e.g. embassies and consulates)

Within the area 76% of all international organizations are embassies and 24% include non-profit organizations, European institutions, International institutions, United Nations legal-related organizations etc.

Embassies and organizations catchmen area

- 96; 76% Embassy
- 30; 24% Organizations
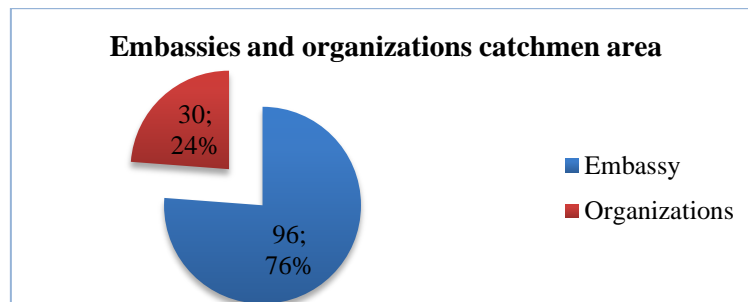
Figure 15 Distribution of international organizations in the catchment area by activity branch

4.5. Results of the space use analysis

The space use analysis aimed to provide insight on the real estate in the catchment area, thus describe the types of properties and their distribution. Hence, based on the results of the analysis, a selection of the property types relevant for *assessing the effects of tramline 1 upgrade on the real estate market* in the area is made.

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[11] Source: http://www.siccodewiki.org/pmwiki.php?n=ISICv4.UExtraterritorialBodies

The area has *mixed-land use* with commercial and residential property having a dominant share. Hence, both should be considered when measuring the effect of the line upgrade on the real estate market. The commercial property mainly comprises of businesses offices. Therefore, it is appropriate to look at the effects of introducing light rail on offices' rent/sale prices and the willingness of businesses to pay a higher price if there is an uplift effect (as the literature suggest). Likewise, residential property primarily includes rented and social livings. The social dwellings have the biggest share (57%) of the total residential property; however the prices of social dwellings are to big extent regulated by government policy. Hence, the upgrade of the urban transport would hardly have any effect on the formation of the social rent prices; thus the social residential property will not be considered, when evaluating the impact of the upgrade. On the other hand, the effect of introducing light rail on regular home values (e.g. rent/sale prices) is relevant for further examination, as the price formation of these properties is affected by various factors of the location, and is determined by the real estate agencies active on the real estate market.

Based on the results discussed above, the properties considered for analysis with respect to the impact of tramline 1 upgrade on the real estate market are:
- Commercial property values (rent and sale prices)
- Residential property values (rent and sale prices of regular livings)

4.6. Results of the commercial use analysis

Small, medium and large businesses and (international) organizations, although comprising small share of the total number, facilitate the biggest share of employment. Besides, the businesses/organizations of this size are more likely to have a mobility policy regarding the travel for their employees; thus may have an interest to stimulate employees to use the upgraded transit service, as they could benefit from travel cost reduction, saving from parking costs and solve travel issues associated with the accessibility to their location for employees, clients and visitors. Given the fact that one of the research objectives is to determine whether the line upgrade will manage to attract more passengers, assessing the added value of the upgrade for these groups would be appropriate when attempting to capture the impact of the line upgrade for the overall performance of the companies in the area.

The branches *consultancy, public administration and services, finance and international organizations* have the strongest presence in the catchment area. The sphere of action to large extent determines whether the business/organizations are visitor/client-, or employee-oriented (or both). In any case, the overall performance of an enterprise seems to be affected by the accessibility to its location, no matter of the branch. However, in some cases the specific activity of a company/organization may influence the demand of urban

transit, as for instance, business busy in accommodation or healthcare will be concerned whether its clients/ visitors have easy access to their location.

From the discussion above, criteria for *selecting businesses/ (international) organizations for analysis* were identified, based on size, presence in the area (defined by branch share) and travel behavior. The criteria are:

- Small, medium and large businesses/ organizations located within 800m from a tramline 1 stop (intersection HS- Scheveningen)
- The accessibility to business/organization's location is essential for (international) visitors, clients and employees
- Businesses/(international) organizations are busy in branch, which has relatively high share in the catchment area and show high presence of small, medium and large size

As a result of the selection criteria, the branches included for analysis are:

- Consultancy, research and other specialized business services
- Public administration, public services and compulsory social security
- Financial institutions
- (International) organizations
- Accommodation
- Other - which are of specific importance for the area; allow assessing specific aspects of the upgrade that could be beneficial for the businesses/organizations in the area (e.g. conference halls, health centers etc.)

Consequently, the following *businesses/organizations* are *excluded from the analysis*, as they do not meet the selection criteria discussed above:

- Micro businesses/organizations, although prevailing in the catchment area, because the majority consists of self-employed enterprises (or with few employees). For this group it is difficult to determine travel patterns, whether using public transport or if they have permanent office/working location settled in the catchment area. Furthermore, it will be time consuming to conduct interviews. Also the results will not provide a sufficient sample for analysis and firm conclusions with respect to the objective of the research

- Businesses/(international) organizations active in Agriculture (A),Mining and quarrying (B), Manufacturing(C), Electricity(D), Water supply(E), Construction (F), Wholesale (G), Transportation (H), Information and communication(J), are excluded for analysis because they have little presence in the area and/or consist of small enterprises (e.g. self- employed); or for other reasons do not serve the purpose of the analysis.

5. Survey – Tramline 1, intersection HS-Scheveningen

5.1. Introduction

In this chapter the methodology and the framework of the research are presented. Section 5.2 includes the operative indicators selected for analysis on both stakeholders (real estate market and businesses/ (international) organizations. Section 5.3 describes the methodology that will be used for conducting the survey. Furthermore, the research framework is presented, aiming to explain the steps taken for applying the methods for analysis.

5.2. Operative indicators for analysis

5.2.1.   Indicators for Businesses and (International) Organizations

In order to assess the effect of the tramline 1 upgrade on the performance of the businesses/ (international) organizations along the line and further to determine the potential benefits for them, the study will turn a look at the travel behavior of employees, how the companies engage in this process, the accessibility to their location and in what aspects the upgrade could be beneficial or the overall performance. Hence, the operative indicators selected for analysis, already mentioned in chapter 3, are:

- Business travel costs reduction (e.g. costs for business trips, commuting costs)
- Parking costs reduction
- Accessibility improvement (for employees, visitors and customers)
- Wider labor pool and job opportunities
- Travel time cost savings
- Improvement of the city image

5.2.2.   Indicators for Real Estate Market

Real Estate Agencies will be used for the analysis of the effect of upgrading tramline 1 on the commercial and residential rent/sale prices. This approach is chosen, considering that they are engaged in the evaluation and formation of property values in practice, and can give a representative professional judgment on the topic. Based on the discussion in chapter 3, regarding the potential effects and expected benefits of light rail on the property values, and also on the results of the space use analysis in chapter 4, the following indicators for analysis were selected:

- Increase of rent/ sale values for residential and commercial properties
- Willingness to pay higher prices for a particular location (due to increase in attractiveness of the location)

5.3. Methodology and research framework

5.3.1.   Methodology

The survey will be conducted through interviews with both stakeholder groups. This method is well-established tool in a qualitative research, as it can be adapted to fulfil many different research objectives. Interviews can be utilized at any point in the data collection process and may be used together with other techniques within the same research topic (Brewerton and Millward, 2001). The scientific literature distinguished three main interview types used for a research, depending on the information that should be extracted. A description of the interview types is provided in Table 11.

Interview designs	
Structured interview	Use interview schedule that is similar to the survey questionnaire (could phrase the question that have a limited range of responses)
Semi-structured interviews	Consist of a list of open- ended questions based on the topic are the researcher need to study- provide the opportunities for more detailed discussion. • Use of probes 1) detail- oriented probe; 2)Elaboration probe; 3)Clarification probe
Unstructured interviews	Aim to obtain in depth interviews of persons interviewed. Only few topic are discussed but in great detail
Focus group	Gather together individuals who are unfamiliar with each other. All discuss an issue- the interviewer is a moderator, listener

Table 11 Types of interviews used in qualitative research

The methodology that will be used for the survey will apply ***semi-structured interviews*** for both stakeholders. *A semi-structured interview is a qualitative method of inquiry that combines a pre-determined set of open questions requiring extensive discussion, with the opportunity for the interviewer to explore particular themes or responses further.* The semi-structured interview does not limit respondents to a set of pre-determined answers (unlike a structured questionnaire). They are used in order to understand how interventions work and how they could be improved. It also allows respondents to discuss and raise issues that the interviewer may not have considered. Moreover, a semi-structured interview is suitable technique when the interviewer gets only one chance to interview someone and collect data (Bernard, 1988). This type of interview provide opportunity for collecting reliable and comparable qualitative data and the opportunity to identify new ways of seeing and understanding the examined topic (Cohen, 2006). The advantages and disadvantages of using semi-structured as a research method are summarized in Table 12.

Advantages	*Disadvantages*
Provides valuable information from the context of participants (and stakeholder) experiences	Can be time consuming to collect and analyze data
Use of pre-determined questions provides uniformity	Requires some level of training or practice in order to prevent interviewer suggesting answers
Complex questions/issues can be discussed/clarified	Samples tent to be small, thus can be unreliable

Table 12 Advantages and disadvantages of semi-structured interviews

The main reason for using semi-structured interviews for the survey is that the assessment of the operational indicators for both stakeholders requires detailed information about their perception of the effects of the upgrade of tramline 1. It can be assumed that, the stakeholders may not have enough knowledge in the field of transportation, thus about the current tramway system and especially regarding the transition into light rail. Hence, it will be necessary to conduct the interviews face-to-face, as the interviewer can explain any information regarding the survey and to make sure, respondents understand the essence of the questions discussed. The reasoning for using semi-structured interviews for each stakeholder is given below, considering the specific objectives of the survey for each group.

Applying semi-structured interview for businesses and (international) organizations is suitable because:

- We want to get detailed information about their current travel behavior and whether the upgrade will have effect on it
- We want to know whether they have a mobility policy and to discuss it in detail; hence to examine whether the upgrade will have an effect on their mobility behavior
- We want to get insight about the current accessibility to their location and discuss existing issues in that respect; hence to examine whether the upgrade will improve the level of accessibility
- We want to discuss specific indicators that are considered as potential benefits of the upgrade for their performance; hence to evaluate whether the upgrade will be beneficial for their activities

In order to get in-depth look at those factors, it is necessary to have a face-to-face discussion with the participants and elaborate on all questions in detail. As we want to evaluate the effects of a future project, we can only examine the perception of the respondents towards it. Thus, collecting primary source data for analysis is needed. Furthermore, the choice for semi-structured interview is driven by additional factors, such as:

- Most likely the respondents will not be familiar with the specific project and the technical aspects of the tramline upgrade (e.g. route, technical characteristics, change in quality of service etc.) Therefore, face-to-face interview will allow the interviewer to introduce the research objective and to guide the respondent throughout the interview; thus ensuring to collect accurate information.
- Semi-structured interviews permit addressing of open questions, where respondents can freely express opinion, use examples, refer to specific cases etc. This is especially needed when discussing mobility policy, accessibility and the perception about a change in those aspects due to the improvement of tram service
- Semi-structured interview allows for closed-up questions, where ranking or scoring indicators can be used. This way of measurement is suitable for the analysis as it will make possible to quantify the perception of the upgrade and to obtain straightforward information

Applying semi-structured interviews for Real Estate Agencies will be done through gathering the expert judgment of real estate agents, representing their agency. This approach seems appropriate for evaluating the effects of the tramline 1upgrade on the property values in the catchment area, because:

- We want to collect expert opinion and judgment with regard the effects of the upgrade on the property values and the reasons standing behind; thus to give a forecast about the changes that might occur in property values
- During an interview, real estate experts can elaborate in detail the indicators that they consider when forming prices and where the public transport provision stands in this respect
- A discussion with regard to tramline 1 and its catchment area can refer to factors that we couldn't account for in advance. Therefore, experts can provide valuable information that wouldn't be considered otherwise

Additionally, semi-structured interviews are appropriate in the case of tramline 1 because:

- The real estate experts first should get familiar with the upgrade project and all the details in terms of service quality provision that could play a role in the property price formation in order to give an expert opinion. Hence, the interviewer can explain and clarify any information that is needed by the expert to make a judgment
- The semi-structured interview allows to collect primary data from real estate agencies by both open questions and closed-up questions and to quantify the overall perception of the experts about the impact of the upgrade
- In face-to face interaction experts can freely express their opinion and guided by the interviewer to elaborate in detail on a specific topic, issue etc.
- Real Estate experts apply their expertise in practice, therefore the information they provide will be driven by their practical experience, which is especially relevant for the research as we want to assess what the actual effect of the line upgrade might be

Questionnaires set up and distribution

Two types of questionnaires will be prepared for surveying real estate agencies and businesses/ (international) organizations. Both questionnaires will include *open questions* as well as *closed up questions*. The closed up questions will ask the participants to score or rank particular indicators of interest, using *"likert scales"* for that purpose.

Furthermore, both questionnaires will start with a *recommendation letter* provided by The Hague Region Authority, briefly explaining the research topic and the objective of the interview. Also a statement that the information discussed during the interview will not be made public in any way will be made, in order to avoid any disturbance of the respondents.

Next to that, a brief overview of the HTM annual survey will be included in both questionnaires, in order to give a concise impression about the difference in service quality provision between the light rail system and the current trams perceived by travelers. Including a brief synthesis of the HTM survey results will aim to:

- Provide interview respondents with simple but concise overall view of the service quality perception by travelers
- Provide interview respondents with insight on specific indicators that make the difference in the service quality (between light rail and trams)

For this purpose, Table 13 giving a summary of the indicators of light rail (RandstadRail) assessed by travelers, that receive higher score compared to trams, will be included in the questionnaires.

Performance feature	Level of difference	Clarification Notes
Ease of access	50 % higher	Refers to the ease of boarding the vehicle (low floors, physical condition of the stop)
Frequency	20% higher	Assesses the frequency of the service
Punctuality	30 % higher	Assesses the accuracy of the travel schedule
Noise	25 % higher	Refers to the level of noise that travelers feel in the vehicle during travel. Higher score means less noise disturbance
Cleanliness	45 % higher	Refers to the cleanliness in the vehicle
Overall information provision	15 % higher	Refers to information in the vehicle and at the stops
Information about delays	30% higher	Refers to information provision mainly at the stops
Overall safety and security	20 % higher	Including on-board in vehicle and at the stops

Table 13 Performance features of the service quality scored higher for RandstadRail compared to trams

This steps aims to:

- Make sure respondents are aware of the travelers perception about the light rail service and the tram service; thus making it easy to understand the objective of the upgrade of tramline 1 and the outcomes for travelers in terms of service provision; thus aiming to increase reliability of the interviews
- To give a base to the respondents to evaluate the effects and potential benefits of the upgrade for their activities
- To point specific indicators of the service that have high appreciation, as some of the indicators might be of particular importance for the respondents when answering questions with regard the effects and added value from the upgrade of tramline 1 for them

Finally, the ***questionnaires will be distributed to the participants in the survey in advance***, thus before the actual interview. This will allow the respondents to check any background information, they consider necessary in order to answer all the questions during the interview.

5.3.2.   Research framework

An illustration of the outline of the research framework is presented in figure 16 below. A detailed description of the steps that will be made for conducting the survey is also presented. The survey will be executed in four stages, as each stage is briefly showed below.

- *1st Stage of analysis – Evaluation of Real Estate Market dimension*
  1. Preparation of semi-structured interview questionnaire
  2. Contacting real estate agencies for interviewing
  3. Sending out the questionnaire in advance aiming to give time to the experts to prepare on the questions and consider additional information that they consider important
  4. Conducting interviews
  5. Analysis of the results
- *2nd Stage of the analysis – Evaluation of Businesses and (International) organization dimension*
  1. Preparation of semi-structured interview questionnaire
  2. Contacting businesses and organizations for interviewing
  3. Sending out the questionnaire in advance aiding the preparation of the company's representative for the conversation
  4. Conducting interviews
  5. Analysis of the results
- *3rd Stage of analysis –Discussion of the interviews' results from both dimensions*
- *4th Stage of analysis- Presenting main findings and drawing conclusions and recommendations*
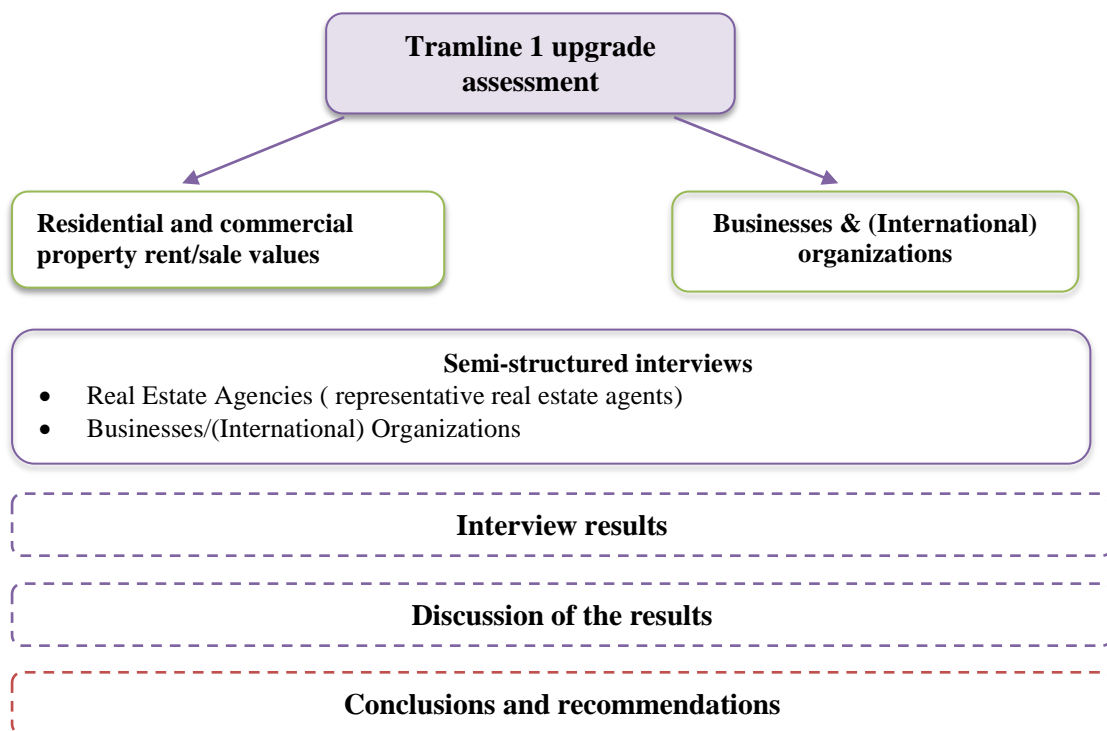
Figure16 Research framework of tramline 1 survey on stakeholder groups chosen for analysis

6. Survey results

6.1. Results Businesses and (International) Organizations

Participants in the survey

Semi-structured interviews were conducted with 11 companies and (international) organizations of small, medium and large size, active in several branches. All respondents are located along tramline 1, intersection HS-Scheveningen, with a tram stop in close proximity. The employers participating in the survey are:

- Tullow Exploration& Production Netherlands B.V.
- Nederlandse-Vlaamse Accreditatieorgansatie (NVAO)
- Schlumberger (HQ for the Netherlands)
- GBA Accountancy
- Crown Plaza Hotel
- World Forum
- Police Bureau Karnebeek, The Hague (HQ)
- NIBC Bank N.V.
- Centrum Jeugd & Gezin Scheveningen (CJG)
- EUROPOL (HQ)
- Pax Ludens Foundation (NGO)

The employers that took part in the survey showed active interest in the research and were open to provide any confidential information necessary in order to complete the interview questionnaire. The respondents recognized that factors such as accessibility, mobility and the state of the urban transit influence their activities and travel behavior. Here it should be highlighted that although the respondents are aware about the role of the urban transit in their performance, they have no sufficient knowledge in the field of transportation and the opportunities and benefits that might occur for them from the upgrade of the tram service. Therefore, during the interviews it was necessary to explain in detail, what would be the specific changes in the current service quality from introducing light rail on tramline 1. Even though light rail is already a part of the urban rail network, the respondents were not always familiar with it (e.g. didn't make use of it). In many cases, light rail (RandstadRail) and the trams were perceived by the respondents as two different modes of public transport. Therefore, some the employers did not perceive the transition of the tramline as an improvement of the current tram system but as introducing new urban rail system.

Interview collection and representatives of employers

All respondents were invited for an interview via e-mail and/or phone call by the interviewer. For establishing contact with some employers, first introduction of the research and its objectives was done by external persons. Thus, the interviewer used a professional network in order to get access for further communication with an employer. The interview questionnaire was sent to the survey participants in advance

(at least a couple of days before the actual interview). This step was taken because some questions require collecting quantitative data about employees, car and parking usage, mobility policy, travel costs etc. This information couldn't be provided during the interviews or it would be difficult for the interviewee to give accurate information without checking it beforehand. Consequently, the respondents managed to complete all the questions during the interviews.

The employers selected the representative for the interview by themselves. We chose this approach because each business/organization has its own organizational structure and the employer can refer to the appropriate department/professional for the interview. Besides, the employers often pointed out that the personnel available for a meeting is limited, which was also a reason to let the employers choose the representative for the interview. The interviews were done with professionals at managerial positions such as facility managers, general managers, human resources managers, commercial managers etc.

Structure of the questionnaire and survey results

The semi-structured interview questionnaire is divided into five topics: 1) General information about the businesses/ (international) organizations; 2) Employees and travel behavior; 3) Mobility; 4) Accessibility and 5) Benefits from the upgrade of tramline 1 (introduction of light rail). In this chapter, the survey results will be presented, structured as follows:

- ✓ General information about the interviewed company/(international) organization
- ✓ Employees and travel behavior
- ✓ Mobility and the impact of tramline 1 upgrade on the employers' mobility behavior
- ✓ Accessibility and the impact of tramline 1 upgrade on the perceived accessibility by employers

6.1.1. General information about companies/ organizations

Size and activity

Respondent ID code	Company name	Branch	Core activity	Size	Number of employees
1	Tullow Exploration & Production B.V.	Consultancy	Oil & gas exploration and production	Small	10
2	GBA Accountancy	Consultancy	Tax and finance	Small	35
3	CJG Scheveningen	Health care	Health consultancy	Medium	50
4	World Forum	Culture	Conferences and events management	Medium	50
5	Crown Plaza Hotel	Accommodation	Accommodation	Medium	75
6	NVAO	Public administration and services	Government accreditation	Medium	55
7	Police Bureau Karnebeek	Public administration and services	Criminality and security	Medium	100
8	Schlumberger	Consultancy	Gas & oil field services	Medium	80
9	NIBC Bank	Financial institutions	Financial services	Large	524
10	Europol	Intern. organization	Law enforcement	Large	850
11	Pax Ludens Foundation	Other service activities	Education and training	Micro	5

Table 14 General characteristics of businesses/ (international) organizations participating in the survey

In total, the respondents represent eight activity branches (Table 15), where the entities active in Consultancy have the highest share. We do not aim to analyze the survey results by activity branch, however for some respondents it can define their travel and mobility behavior and the needs they have in terms of public transport service.

Table 16 shows the distribution of the respondents by size. The majority of the interviewed companies/organizations are of medium size. There are two respondents of large size and two of small size. As an exception, an NGO of micro size was interviewed because it showed interest in the research topic and wanted to participate in the survey. NGO organizations are a distinctive feature of the catchment area, thus we included it in the sample.

Respondents active in branch	Nr. respondents
Accommodation and food service activities	1
Consultancy, research and other specialized business services	3
Public administration, public services and compulsory social security	2
Financial institutions	1
Human health and social work activities	1
Culture, sports and recreation	1
International organizations and bodies	1
Other service activities	1

Table 15 Frequency distribution of number of respondents per activity branch

Nr. Respondents per size			
Micro	Small	Medium	Large
1	2	**6**	2

Table 16 Frequency distribution of number of respondent by size

Time of operation

The time of operation is between 8:00h and 18:00h for the majority of the respondents. 64% of the surveyed businesses and organizations in the area have regular working hours and 36% have continuous or not strictly regulated hours of operation (statistics seen in Appendix D).

Extra info box

- *EUROPOL headquarters and Police Bureau Karnebeek have continuous working hours due to the nature of the activities they execute*
- *Crown Plaza Hotel is open 24/7 and is representative for the Accommodation branch (e.g. hotels, hostels) accommodating tourists/visitors non-stop*
- *World Forum has irregular working hours depending on the events facilitated. Its main working hours are from 09:00h till 21:00h. However in many cases this time frame is extended, thus we include this respondent in the 24/7 working category*

Years of operation

On average, the respondents are located in the area for 22, 5 years. The newest employer has established its office three years ago and the oldest is located at its site for 60 years (statistics seen in Appendix D). In the last years the area goes through changes. For instance, Europol has established its office in the area three years ago. Also, in close future another international organization, namely Eurojust, is going to move its activities in the area.

Extra info box

- *EUROPOL has established its worldwide headquarters three years ago at its current location. The international organization has 850 employees and facilitates over 20 000 visitors annually (Europol, 2014).*
- *In 2016, EUROJUST is going to move its activities in a new facility in The International Zone, next to Europol. Currently its activities are split into two facilities in Binckhorst. Eurojust hosts meetings for investigators and prosecutors and provides all kinds of information to the authorities in the Member States. Today it has become a very important European organization that employs a staff of 103 people.*

Property status of the employers' location within the catchment area

The share of rent and own office s is nearly equal as 55% of the facilities are owned and 45% rented (statistics seen in Appendix D). During the interviews, the participants did not point any specific reasons for choosing to own or rent their office. Hence, we cannot make any assumptions relating the property status to the accessibility and the mobility or the state of public transport in the area.

6.1.2. Employees and travel behavior

Number of employees and working patterns

Total number of employees	Full time	Part time
1834	1417	427
100%	77%	23%

Table 17 Distribution of full time/part time employees of the total number of employees

	Obs	Mean	Std. Dev.	Min	Max
Employees	11	166.7273	268.8305	5	850

Table 18 Statistics of the staff, employed by the respondents

The total number of employees working at the interviewed companies and (international) organizations is 1834 with a minimum number of 5 employees and maximum of 850. Of all employees, 77% work full- time and 23% part time. Hence, the majority of the employees commute on daily basis. As 64% of the respondents have regular working hours, we can assume that a large share of the employees commute during peak hours.

Car usage and parking space

Lease car usage

	Obs	Mean	Std. Dev.	Min	Max	Total number of lease cars
Lease car usage	11	**21.36364**	58.13308	0	196	**235**

Table 19 Statistics of lease car usage by respondents

The results regarding the use of lease cars show that a minor share of the respondents use lease cars for their work activities (e.g. for business trips, as benefit for employees etc.). The minimum lease car usage by respondents is zero and the maximum is 196 lease cars. On average, 21 lease cars are used by all respondents of the area. All participants state that lease cars are used for work-related trips. However, the distribution of lease car usage by respondents (figure 17), shows that there is one employer that show an extreme value compared to the population. In this case, the employer provides the option to the employees to get a lease car as a work benefit. Based on the survey sample, it can be suggested that the use of lease cars by employers is rather limited and there is not significant interest in using lease cars for work-related activities. However, in case of larger sample the results might not lead to this conclusion as there could be more employers with a substantially higher use of lease cars.
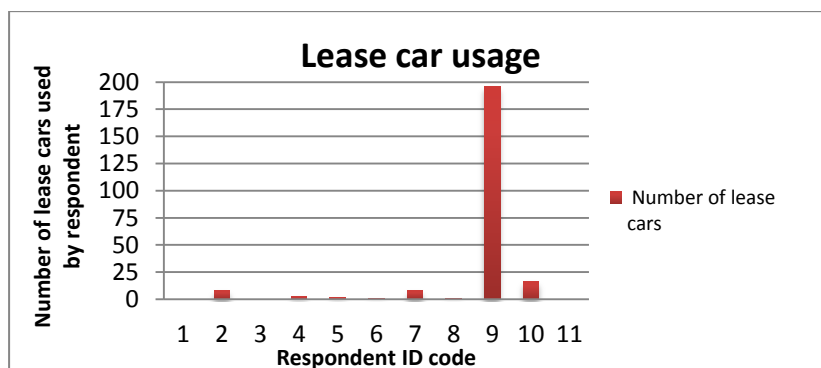
Figure 17 Distribution of number of lease cars used by respondents

Extra info box

- *NIBC bank has the highest use of lease cars (196 cars) because it provides to employees the option to get a lease car as a benefit. There is an option for the employees not use a lease car but to receive its monetary value instead.*
- *Police bureau Karnebeek has 8 lease cars, which are used only for police operations and duty trips.*
- *Europol has 16 lease cars used for business trips, however relative to the total number of their employees (850 employees), the usage of lease cars is rather low.*

Private car usage for work related trips

	Obs	Mean	Std. Dev.	Min	Max	Total number of private cars
Private car usage	11	**2.454545**	5.502066	0	15	27

Table 20 Statistics of private car usage for work related trips by respondents

Of all employers, only two make use of private cars for work- related trips, which together comprise the total number of private cars used for business trips: 27. The highly limited use of private cars for business activities suggests that the employees are not forced by any means to use private cars for their duties (e.g. business trips). For business trips, the employers provide company cars or the trips are done by public transport or bicycle. Therefore, the choice to commute by car (if they do) is not influenced by their work-related activities.

Parking space usage

All respondents make use of parking space as the minimum number of used parking places is 1 and the maximum is 445. The total number of parking places used by the respondents is 1433. The descriptive statistics can be seen in Appendix D. Each respondent has its own parking policy. Some employers do not allow the personnel to use the parking places or in other cases the use of parking slots by clients is not allowed. Overall, the use of parking is done by both employees and clients/visitors. Many of the respondents have complaints regarding the insufficient parking space, which restricts the accessibility to the area by car. When asked whether the upgrade of the tramline 1 would have an effect on their parking space usage (e.g. by reducing the number of parking places) all respondents reply negatively. None of the employers is willing to reduce the current available parking space even if that would reduce the costs for parking. In this sense, the upgrade of the line is hardly perceived to have influence on the use of parking in the area, but it might alleviate current issues related to the scarcity of parking space by stimulating employees and visitors/client to use the tramline instead of cars.

Commuting by employees

Figure 18 shows the modal split for commuting by the employees in the catchment area. Car is used by 46% of the total number of employees included in the sample. 26% of the employees make home-work related trips by public transport and slightly less use bicycle (24%). Other way of commuting is by walking or scooter used by 4 % of all employees. The use of car is twice the use of urban transit. One reason for this result could be the level of accessibility in the area. If commuting by the urban transit service is perceived as less accessible relative to car, it is more likely that commuters use car. Another reason might be that employees who work for businesses/ organizations with continuous time of operation may not be able to use the public transit due to earlier starting/ late end shifts than the starting/ending hours of the public transport service. Nevertheless, there could be other "dissatisfiers" affecting the use of the urban transit and

particularly tram line 1. Hence, through the interviews we aim to identify and analyze the factors that hinder the use of the urban transit and to determine whether the tramline upgrade will contribute to a change the modal split in favor of PT.
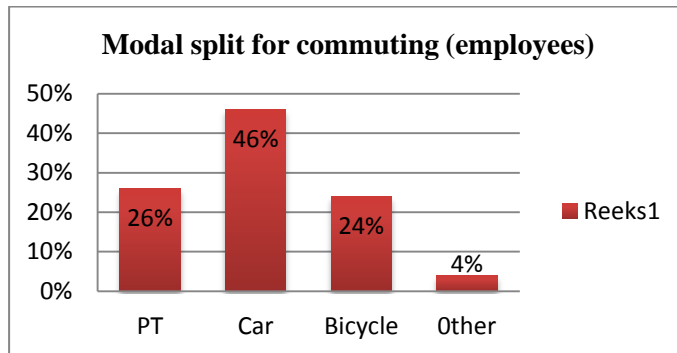
Figure 18 Modal split of commuting by employees

6.1.3.   Mobility

Mobility policy

Table 21 shows the share of respondents that have a mobility policy and those who do not have any specific regulation regarding the mobility of their employees. Of all employers, 64% have mobility policy that stimulates, incentivized or restricts the use of a particular transit mode. Vice-versa 36% do not have any specific policy regarding the mobility behavior of their employees. No matter whether the respondents have a mobility policy or not, all respondents recognize the benefits of stimulating their employees to reduce car usage and to travel either by bicycle or public transport.

Mobility policy	Frequency	Percent	Cum
Yes	7	**63.64%**	63.55%
No	4	**36.36%**	100.00%
Total	11	100.00%	

Table 21 Statistics of the presence of mobility policy of respondents

✓ *National Bicycle Plan (National Fiets Plan) is a widely used means for stimulating the use of bicycle by employers*

The employers who have a mobility policy most often have implemented the National Bicycle Plan, which provides fiscal discount on a bicycle purchase and tax reduction on the income. Employers sometimes provide bicycle racks for safe storage of bicycles. Thus, in terms of stimulating bicycle use, the respondents are straightforward and aware how to incentivize their employees.

✓ *Stimulating public transport use is rather weak and employers experience difficulties to build a policy with regard to PT use*

During the interviews, we observed that the respondents are willing to encourage the use of public transport but they find it difficult to design a mobility policy that corresponds to the travel behavior/needs of the employees. We asked the employers how they stimulate the PT use in case they do. Their answers were vague and often unclear, maybe because none of the respondents had a strict regulation in that respect. The ways to stimulate the use of PT applied by respondents are:

- Covering the expenses for 1st class train tickets
- Reimbursement of work/home travel expenses only when using public transport
- There is only one respondent who requires the employees to commute by public transport and it is strictly stated in the organization's work contract.

From all above used means, the National Bicycle Plan is the most frequently implemented while the incentives for public transport use are less used by employers (statistics seen in Appendix D). None of the respondents has an agreement or a contract with HTM for the commute of employees (e.g. "abonnementen", discount or other travel offering), except the employer who has strict requirement for PT use for commuting. Also, none of the participants so far have had an informative session/consultation with a representative of HTM about possible product offerings; or with a mobility manager who can offer an optimized scheme for employees'commute. Moreover, during the discussions with the participants, we observed that the methods used to stimulate the PT use are unsystematic, meaning that the employers use randomly selected means for stimulating PT use that may not actually satisfy the needs of employees for commuting.

✓ *Hindrances that might restrict the employers to stimulate PT use effectively*

The respondents are not aware of the opportunities that the transport provider (HTM) can provide in terms of product offerings and travel cost reduction (e.g. discounts). Some of the employees face difficulty to design effective mobility policy for commuting and thus the efforts towards stimulating PT use might be ineffective. The lack of information and knowledge could be a reason for the weak stimulation of the use of public transport. Consequently, the employers who do not have implemented a mobility policy about commuting cannot influence the employees to use PT instead of car.

Commuting costs coverage by employers

Cost coverage	Obs	Mean	Std. Dev.	Min	Max	Percentage
Full	11	0.5454545	.522233	0	1	**54%**
Partial	11	0.1818182	.4045199	0	1	**18%**
No	11	0.2727273	.4670994	0	1	**27%**

Table 22 Statistics of commuting cost coverage by respondents

The interviewed firms/organizations were asked whether they cover the commute expenses for their employees and in what way. Of all respondents, 54% cover fully home/work trips no matter the mode of transport the employees use and the distance they travel. 18% of the employers cover partially the commuting costs meaning that they cover fully the expenses only for full-time employees and/or cover the costs only for commute by PT.

The respondents who fully cover the home/work travel costs for their employees use in a several ways, depending on the firms' own decision. We categorize the methods of coverage in three groups as follows:

- Reimbursement of commute expenses by 0,19 euro/km   (home/work distance) no matter the mode of transport used and the distance travelled
- 100% reimbursement of the commute expenses done by PT (providing receipt as there is no specific requirement to purchase "abonnement")
- Reimbursement of commute expenses by car by 0,19 euro/km
- The employer purchases an annual "abonnement" for PT for its employees

It is interesting to note that most of the employees use the standard amount for the travel expenses coverage (0.19 euro/km) no matter of the used transport mode. This means that even someone who commutes by bike got paid without actually having travel expenses. It is also interesting that only one respondent make a differentiation in terms of travel cost reimbursement depending whether the employee uses car or PT. In this sense, the employers do not restrict the use of car in favor of PT as the reimbursements are the same. These results could be a sign for the weak presence of mobility policy that stimulates the PT use or an inefficiently designed one.

Impact of tramline 1 upgrade on businesses and (international) organizations' mobility behavior

Impact of the tramline 1 upgrade on employers' current mobility policy
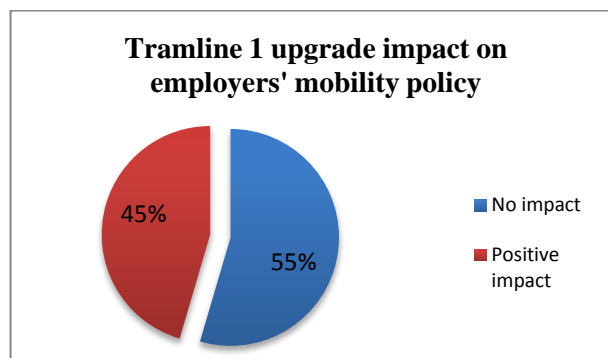
Figure 18 Opinion of respondent about the impact of
tramline 1 upgrade on their mobility policy

The businesses and organizations were asked whether the upgrade of tramline 1 will impact their current mobility policy. The figure above shows that 45% of the respondents find that the upgrade will have a positive impact. This result includes 75% of the employers who currently do not have a mobility policy. These employers share that they would start stimulating their employees to use PT if the quality of the tram service improves. 29% of the respondents who currently have a mobility policy, state that they would consider to make changes mainly with the aim to reduce the travel costs for their employees.

The upgrade is perceived to have no or weak impact by 55 % of the respondents. The reason for this result is that the employers do not intend to change their mobility policy or would make a slight change only if some conditions are met through the upgrade (e.g. increase in frequency, connection to CS). Hence, a change in the mobility policy for those employers toward stimulating PT use may happen in case the tramline service meets the travel needs of their employees.

Employers' opinion about entering in an agreement with HTM for product offerings after the upgrade of tramline 1

The businesses and (international) organizations in the survey scored the likelihood to get into agreement with the transport provider (HTM) after introducing light rail on tramline 1. The idea is that the employers can offer their employees travel products (e.g. discounts, abonnement), and thus stimulate them to use public transport (and tramline 1 in particular), while at the same time realize travel costs reduction.

According to the results, on average, the respondents seem to have neutral attitude towards such a step. Nevertheless, when having a look at the distribution of the responses, it can be seen that 36% of the employers find it likely to cooperate with HTM. 18% of the participants state that it is extremely likely to make use of travel offerings. Therefore, taken together, 54% of the interviewed entities stay on the positive side and are open to new opportunities after the upgrade of the line. Given the fact, that so far none of the respondents have established agreement with HTM, the results give indication that there is a potential for developing relationships between the transport provider and the businesses/organizations within the catchment area.

Likelihood entering into agreement with HTM				
Extremely unlikely	Unlikely	Neutral	Likely	Extremely likely
9,09% (1 resp)	18,18% (2 resp)	18,18% (2 resp)	**36,6% (4resp)**	18,18%(2resp)

Table 23 Likelihood of entering into agreement with HTM of respondents

Summary statistics	Obs	Mean	Std. Dev.	Min	Max
Enter into agreement with HTM	11	**3.363636**	1.286291	1	5

Table 24 Statistics of respondents' opinion about entering into agreement with HTM

Tramline 1 upgrade influence on current/future mobility issues perceived by employers in the catchment area

The upgrade is perceived to positively influence mobility issues the respondents experience by 63% of the participants in the survey. The upgrade is seen to contribute in solving issues related to the accessibility and the congestion in the area. An improvement of the accessibility is considered to reduce complaints of clients/visitor in that respect. At the same time employers think that the upgrade will allow all groups of people to travel with ease. Furthermore, the upgrade is perceived to help reducing traffic and congestion, which is a common concern of all respondents. However, 37% of the businesses/ organization find that the upgrade will have no influence on their mobility and it will make no difference for the mobility in the catchment area.

6.1.4.   Accessibility

The respondents assessed the level of perceived accessibility to their office location by car, public transport and bicycle for their employees, clients and visitors. They had to score the level of accessibility on a five point "likert scale" where the minimum value 1 means "Hardly accessible" and maximum value 5 means "Very easy accessible". For each value", we set a lower and upper limit, thus a margin of 0.5 is defined for interpreting the results. It means that score above the 0.5 margin falls in the next consequent value. This method of assessment is applied because it is important for the research to analyze the change of the perception before and after the upgrade; thus a change that varies within the lower or upper limit of a value still can be a significant for the objective of the research.

Accessibility to employer's location **by public transport**

Summary statistics	Obs	Mean	Std. Dev.	Min	Max
Employees	11	**3.363636**	.9244163	2	5
Clients	11	**3.363636**	1.206045	2	5
Visitors	11	**3.545455**	1.128152	2	5

Table 25 Statistics of respondents' opinion about the accessibility by public transport

Table 25 show the summary statistics of the perceived current accessibility as regard traveling by urban transit. During the interviews, the respondents referred to tramline 1 as well, when scoring the level of accessibility. Hence, we assume that this assessment gives valuable information not only about the overall urban transit provision in the area, but also for tramline 1 in particular. The mean of the results is 3.36 for both employees and clients and 3.55 for visitors. The minimum score given by respondents is 2 – "Not easy accessible" and the maximum is 5 – "Very easy accessible".

On average, the employers perceive their location as ***accessible*** by public transport for their employees and clients. The mean shows slightly higher value, implying that respondents find the accessibility level slightly higher than accessible but still not easy accessible. Interestingly, the accessibility for visitors is perceived a bit higher compared to clients and employees. It falls just on the lowest margin limit of the score "Easy accessible". In general, the employers did not make difference between clients and visitors except one. When looking at the distribution of the answers (Table 26) it can be seen that the results deviate substantially, scoring equally "Not easy accessible" and "Easy accessible". The accessibility perception for clients and visitors mostly depends on the type of clients/visitors that travel to the employers' location. Here it is important to highlight that employers mutually stated, that the accessibility for international clients/visitors is perceived worse than for natives. This explains the deviation in the scores for visitors/clients. Employers find the information provision as not well enough adjusted for internationals. The employers came across this factor because they work in the International zone and the accessibility for internationals is highly important for them.

	Hardly accessible	Not easy accessible	Accessible	Easy accessible	Very easy accessible
Employees	0%	18,18% (2 resp)	**36,36%** (4 resp)	**36,36%** (4 resp)	9,09% (1 resp)
Clients	0%	**36,36%** (4 resp)	9,09% (1 resp)	**36,36%** (4 resp)	18,18% (2 resp)
Visitors	0%	27,27% (3 resp)	9,09% (1 resp)	**45,45%** (4 resp)	18,18% (2 resp)

Table 26 Frequency distribution of respondents' opinion about the accessibility by public transport

*Accessibility to employers' location by PT **after introducing light rail on tramline 1***

Summary statistics	Obs	Mean	Std. Dev.	Min	Max
Employees	11	**4.090909**	.8312094	3	5
Clients	11	**4.181818**	.8738629	3	5
Visitors	11	**4.181818**	.8738629	3	5

Table 27 Statistics of respondents' opinion about the accessibility by public transport after upgrading tramline 1

The perceived accessibility was again scored by the businesses/organizations giving an opinion whether and how it would change after introducing light rail on tramline 1. Table 27 shows the summary statistic results of the perceived accessibility after the upgrade. The mean for employees is 4.09 and for both clients/visitors is 4.18. The minimum scored value is 3 –"Accessible" and the maximum 5- "Very easy accessible".

The respondents perceive that their location would be ***easy accessible*** after the upgrade take place. For employees the value is almost fixed at the score "Easy accessible". The score for clients/visitors is

approximately 0.2 units above that score, meaning that the accessibility is perceived as slightly higher than easy accessible.

When looking at the distribution of the results for each accessibility category, it is interesting that the category "very easy accessible" receives the highest response rate – 45, 5% for visitors/clients compared to the other categories. For employees the "Easy accessible" and "Very easy accessible" is equally scored (36.6%). Hence, it can be seen that for a large share of the total respondents (40 – 50%) the accessibility after the upgrade is perceived to improve substantially.

	Hardly accessible	Not easy accessible	Accessible	Easy accessible	Very easy accessible
Employees	0%	0%	27,27%	**36,36%**	**36,36%**
Clients	0%	0%	27,27%	27,27%	**45,45%**
Visitors	0%	0%	27,27%	27,27%	**45,45%**

Table 28 Frequency distribution of respondents' opinion about the accessibility by public transport after upgrading tramline 1

Comparison of the perceived accessibility by PT before and after introducing light rail on tramline 1

The employers' perception about the level of accessibility to their location and thus to the area differ when comparing the current perceived accessibility (before the upgrade) and the perceived accessibility after introducing light rail in the area (for tramline 1 in particular). Figure 19 shows the comparison of the accessibility perception before and after the upgrade for employees, clients and visitors.
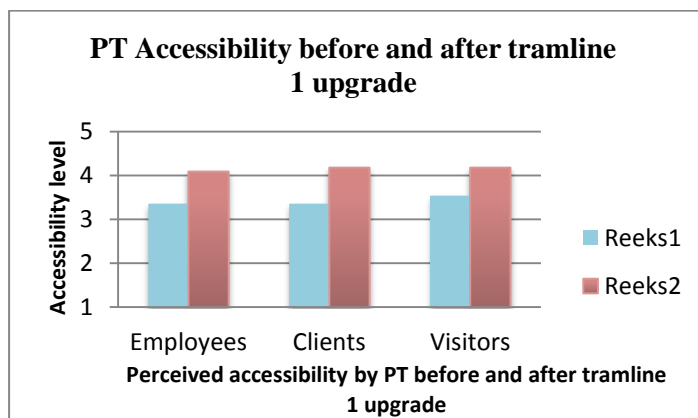
Figure 19 Comparison of the perceived accessibility by public transport before and after upgrading tramline 1

The level of accessibility is perceived higher after introducing light rail system on tramline 1. On average, the level of the perceived accessibility changes from "accessible" to "easy accessible". To be more specific, the accessibility score before and after changes with 0.73 for employees, 0.82 for clients and 0.64 for visitors. Transforming the values into percentages, shows that the ***accessibility by public transport for***

employees is perceived to be 18% higher after upgrading the tramline. Respectively, the increase *for clients is 20% and for visitors 16%.*

Other interesting remark is that while the minimum scored accessibility level before the upgrade is " Not easy accessible" , scored by 18% - 36% of the respondents, the minimum scored accessibility level after the upgrade is one level higher - "Accessible", scored by 27% of the respondents". None of the respondents perceived the accessibility after implementing light rail as less than accessible. This gives an indication about a general positive attitude of the employers towards improving the transit service.

In addition, a *T-test for statistical significance of the means* was run for each group (i.e. employees, clients and visitors) in order to compare the actual difference between the means of each group in relation to the variation in the data, expressed as the standard deviation of the difference between the means. A paired sample t-test was used, as it tests the null hypothesis that the average of the differences between a series observation is zero. Observations are paired when, for instance, they are performed on the same sample of subjects [12](e.g. calculate the difference "before and after").

The results of the T-test for all groups show that the *difference of the means is statistically significant*, as the p-values at 5% significance level for employees is 0.0236, for clients 0.0200 and for visitors 0.0107. Thus, it can be concluded that the means are statistically different, as the p-values are less than 0.05 (i.e. based on a 95% confidence interval), thus rejecting the null hypotheses (H0: mean (diff) =0).

Accessibility to employer's location by car

Summary statistics	Obs	Mean	Std. Dev.	Min	Max
Employees	11	**3.363636**	1.026911	2	5
Clients	11	**3.181818**	.7507572	2	4
Visitors	11	**3.181818**	.7507572	2	4

Table 29 Statistics of respondents' opinion about the accessibility by car

The current accessibility to the businesses/organizations locations by car is perceived as slightly above *accessible*, on average. The mean for employees is 3.36 and for clients/visitors 3.18. The minimum scored value is 2 (Not easy accessible) and the maximum is 5 (Very easy accessible) for employees and 4 (Easy accessible) for clients/ and visitors. A reason for the lower accessibility score for clients/visitor might be the insufficient of parking space provided by employers for clients/visitors as previously discussed not all employers have available parking lots (or have a limited number) for this group.

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[12] Source: http://www.sagepub.com/upm-data/40287_Chapter9.pdf, Two-sample tests, paired t-test

	Hardly accessible	Not easy accessible	Accessible	Easy accessible	Very easy accessible
Employees	0%	18.18% (2 resp)	**45.45% (5 resp)**	18.18% (2 resp)	18.18% (2 resp)
Clients	0%	18.18% (2resp)	**45.45% (4 resp)**	**36.36% (4 resp)**	0%
Visitors	0%	18.18% (2resp)	**45.45% (4 resp)**	**36.36% (4 resp)**	0%

Table 30 Frequency distribution of respondents' opinion about the accessibility by car

*Accessibility to employers' location by car **after introducing light rail on tramline 1***

Summary statistics	Obs	Mean	Std. Dev.	Min	Max
Employees	11	**3.727273**	1.190874	2	5
Clients	11	**3.545455**	.9341987	2	4
Visitors	11	**3.545455**	9341987	2	4

Table 31 Statistics of respondents' opinion about the accessibility by car
after upgrading tramline 1

The perceived accessibility by car after the upgrade of tramline 1 slightly changes in positive direction. Table 31 shows the summary statistic of the perceived accessibility by car after the upgrade. The mean for employees is 3.73 and for both clients/visitors is 3.55. The minimum scored value is 2 –"Not easy accessible" and the maximum 5 "Very easy accessible" for employees and 4 for clients/visitors.

The businesses/organizations perceive that the accessibility to their location by car after the upgrade would be *more than accessible* as the mean for employees falls in to the margin of the category "Easy accessible". The accessibility of clients/visitors also goes into the "easy accessible" score, but is fixed at the very lower margin limit. Hence, the accessibility is perceived somewhere *between accessible and easy accessible*. Thus, to give a more concrete assessment of the accessibility level, we look at the distribution of responses. It is seen that highest percentage of respondents scored "Easy accessible" (54.5% for clients/visitors) and "very easy accessible" (36,4% for employees). When collecting the interviews, the respondents pointed that they perceive that the accessibility for car would improve because the upgrade might help in alleviating traffic and congestion due to increase in the usage of the line.

	Hardly accessible	Not easy accessible	Accessible	Easy accessible	Very easy accessible
Employees	0%	18.18% (2 resp)	27.27(3resp)	18.18% (2 resp)	**36.36% (4 resp)**
Clients	0%	18.18% (2 resp)	18.18% (2resp)	**54.55% (6resp)**	9.09% (1 resp)
Visitors	0%	18.18% (2 resp)	18.18% (2resp)	**54.55% (6resp)**	9.09% (1 resp)

Table 32 Frequency distribution of respondents' opinion about the accessibility by car after upgrading tramline 1

Comparison of the perceived accessibility by car before and after introducing light rail on tramline 1

Figure 20 visualizes the change of the accessibility perception before and after the upgrade for employees, clients and visitors when travelling by car to the employers' locations. Comparing the change in the means (translated in percentage units) shows that the perceived accessibility for employees, clients and visitors increases by 9%. Hence the accessibility to the catchment area would slightly improve, but still it might be argued that the effect is rather moderate.

As a comparison of the accessibility level is done before and after the upgrade, a paired T-test indicating whether or not the difference of the means of the accessibility level for each group (i.e. employees, clients and visitors), most likely reflects an "actual" difference. The results show that the *difference of the means of the accessibility level of employees is not statistically significant* (p-value 0.1669 > 0.05) at 5% level of significance, and the result is the same at 10%. On the other hand, *the means of the accessibility level of clients and visitors are statistically different*, as the p-values are less than 0.05 (at 5% level of significance) – p-values for both groups are 0.0379. Hence, the p-value is small enough to justify rejection of the null hypothesis (i.e. H0: mean (diff) =0).
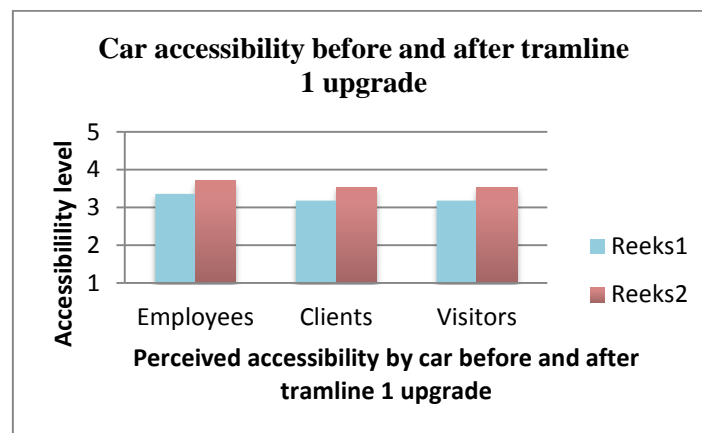
Figure 20 Comparison of the perceived accessibility by car before and after upgrading tramline 1

Accessibility to employer's location by bicycle

On average the ease of access to the employers' locations by bicycle is perceived as ***easy accessible*** with a mean of 4.45 for employees and 4.36 for clients/visitors (Appendix D). The minimum score given is 3 (Accessible) and the maximum 5 (Very easy accessible). When looking at the responses' distribution, it is seen that 54% of the employers perceive the travel by bicycle very easy accessible (Appendix D). Hence overall the area is easily to very easily accessible by bicycle.

*Accessibility to employers' location by bicycle **after introducing light rail on tramline 1***

The accessibility by bicycle after the upgrade almost does not change thus is still perceived as ***easy accessible***. The mean for employees, clients and visitors is 4.45 (statistic seen in Appendix D). The

minimum score is 3 (Accessible) and the maximum 5 (Very easy accessible). Figure 21 compares the accessibility perception before and after the upgrade. It can be clearly seen that there is almost no change in the perception. The change is less than 2% when calculating the difference in the means. When discussing this question with respondents, none of them could make a relation between the upgrade of the urban transit system in the area and its effect on the accessibility by bicycle. Consequently, the majority of respondents scored the same in both cases (before and after the upgrade). Therefore, based on the results it can be concluded that the upgrade does not have an effect on the accessibility by bicycle.

Again paired T-test was run, determining whether the means of the tested groups differ statistically. The results for employees, clients and visitors show that the null hypotheses (H0: mean (diff) =0) is not rejected, with p-values of 1.0000 for employees and 0.6761 for both, clients and visitors, based on 5% level of significance. The results remain the same when the t-test is run at 10% significance level. Thus, *there is no statistically significant difference* in the level of accessibility by bicycle for the three groups.
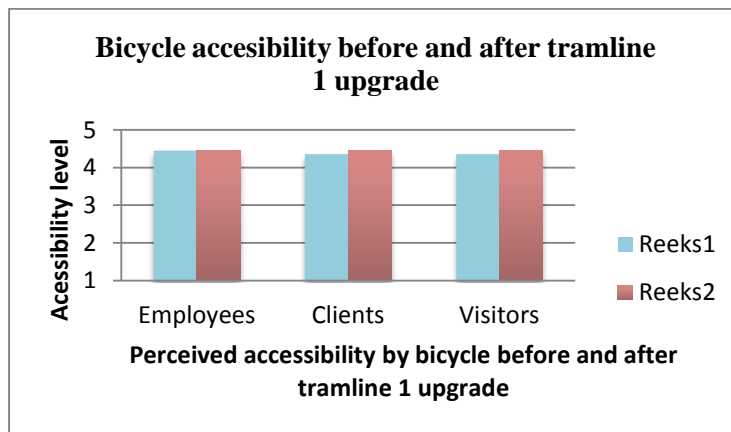
Figure 21 Comparison of the perceived accessibility by bicycle before and after upgrading tramline 1

Accessibility issues experienced by businesses and organizations in the catchment

The respondents discussed the issues they experience with the accessibility to their location with respect to the general mobility condition in the area and specifically to the tramline 1 service. Based on their responses, eleven main accessibility issues were identified (Table 33 below).

Accessibility issues	Percentage
Tramline 1 service issues	
High floor (steps)	36%
Time of operation	27%
Ticketing methods	18%
Information provision	27%
Connection to CS	55%
Frequency	27%
Capacity (Overcrowding)	36%
Limited number of tram lines serving the area	18%
General accessibility issues of the area	
Parking space	18%
Traffic	55%
Congestion	55%

Table 33 Summary and distribution of the accessibility issues respondents experience

General accessibility issues within the catchment area

Traffic and congestion are pointed as main accessibility problems within the area by 55% of the respondents. The traffic in the area is an issue especially in the afternoon, during rush hours. The respondents also state that it is congested "all the time" and there is traffic not only within the area and the city, but also when entering the city.

Insufficient parking space is pointed as an issue by 18% of the respondents. In this case the respondents are employers who do not have enough parking places in order to facilitate their clients, visitors and employees. Consequently their clients, visitors and employees have to search for available parking by themselves which rises complains about the ease of access to employers' location.

Accessibility issues with regard to tramline 1 service

The businesses and (international) organizations pointed various "dissatisfiers" regarding the current tram service. During the interviews, we noted that employers discussed issues that are closely related to their own activities and the needs of their employees, clients and visitors. Thus, some factors that are neglected or considered as not important by some employers appear to be of a high importance for other respondents. The type of activity seems to actually influence the need of the employers in terms of urban transit service provision. Therefore, the activities in the area could suggest the most important requirements for providing higher accessibility level in the area by the urban rail service.

High floor vehicles (entering steps) are pointed as an issue that limits the accessibility by 36% of the respondents. They perceive the high floors as a factor that limits the access to their location for their clients and visitors. Those businesses are highly customer- oriented and facilitate numerous people daily. The respondents are active in the branches Human health care and services, Accommodation, Financial institutions and other services. The main issue that those respondents find is the difficult access to the tram by disabled people, parents with prams, people with luggage (e.g. tourists, business visitors) and also for the employees who have to transfer work-related materials (e.g. laptops, simulation materials for educational and training purpose etc.).

"The majority of our clients/visitors are parents with small children, disabled children or adults. The access by tramline 1 is limited due to the tram steps which do not let buggies and wheelchairs to move easily."

Time of operation

The time of operation is seen as a burden for using the tramline by 27% of the employers. Those are the employers who have continuous working hours. The shifts of the employees start that very early in the morning and late shifts too, cannot be served by the trams time schedules. They point that the time of operation does not allow the employees to use the tramline even if they want to do so. None of the respondents who have regular operation time has pointed this factor as an issue.

Ticketing methods

18% of the respondents are dissatisfied with the payment methods used in the current tram system. It is an issue especially for the international visitors/clients, tourists. It is difficult for them to understand the way of payment with chip cards and it is perceived very costly. The main downside is that there is no option to purchase a ticket in the tram with a credit card. Also, the respondents note that there is a lack of locations, except the main stations, where the users can simply buy a one-way/day ticket.

Information provision

Information provision seemed to be an important factor when discussing the current tram service and the plan for introducing light rail on tramline 1. All respondents expressed the need for better information provision that makes the travel easier. In this respect 27% of the respondents encountered problems with the current information provision. The businesses and organizations pointed out the following "dissatisfiers":
- No sufficient information provision for internationals (that is communicated in English)
- No sufficient announcement when there are problems and/or delays along the line. The announcements are also not adjusted for internationals.

- In the international zone (e.g. tram stop World Forum serving Europol, World Forum etc.) there is lack of guiding signs about the location of the tram station that serves the area. Therefore, it is difficult for visitors, clients to orientate about the direction, the distance to the nearest tram stop etc.

No connection to CS

A main down point in the current tram service is that tramline 1 route does not pass by Central Station (CS). It seems that the activities in the area and the travel behavior of employees, clients and visitors are significantly affected by the connectivity to CS. 55 % of the employers see the lack of connection to CS as major drawback in the service of the line. All respondents who facilitate foreigners, state that they arrive at CS and consequently cannot make use of tramline 1, although it is the only tramline that serves their office location in proximity. The respondents state that even if the line is being upgraded, it is still not going be used by their visitors/clients in case there is no connection to CS. With regard to the employees the trend is the same. Employees who travel from outside the city by public transit mostly arrive at CS and thus do not use tramline 1 whatsoever.

Frequency, vehicle capacity and limited number of tramlines in the area

The frequency of the current tram services is seen as an issue by 27 % of the respondents. They perceive that more frequent service will make the use of the line more attractive as it would result in less waiting time. Another issue encountered by 36% of the businesses and organization is the ***insufficient capacity*** of the vehicles, which result in overcrowding. The respondents observe overcrowding on the line not only during rush hours, but in general they describe the line as busy one. One reason could be that along the route of tramline 1 in the area, there are no other lines that serve the area (for some parts) or their number is limited. Therefore, the main passenger flow is facilitated by tramline 1. Employers state that the issue with the capacity worsens especially during the summer season, as the line serves the beach (Scheveningen) and during conferences and events at World Forum. Hence, the capacity is an issue that hinders the attractiveness of the tramline and does not stimulate the usage by potential passengers. The unsatisfactory frequency and overcrowding might be a reason for the demands of the respondents for more number of lines in the area because they do not think that currently tramline 1 provides comfortable and convenient service.

"The line is overcrowded during the summer and it is not possible to travel with comfort. It is the same when there are events at World Forum. The line is extremely busy and we avoid using it."

Beneficial factors for employers' performance

A set of indicators viewed as benefits occurring from light rail implementation was selected. In the survey, the respondents were asked to rate the effect of those indicators on the overall performance of their business/ organization. The aim is to identify whether these indicators can be considered as benefits for the employers and to what extent.

The respondents to rate the effect of each indicator on a five level scales. The value 1 means – Very negative effect, value 3 – No effect and value 5 – Very positive effect. In table 34 the mean of the results for each indicator is shown. Overall, all indicators seem to have either no effect or positive effect on the performance of the businesses and organizations.

Accessibility improvement and *improvement of the city image* are the two factors that, on average, score highest (average score of 4.3*). **The effect of both is perceived as slightly higher than positive.** While discussing the benefits of the indicators for the employers, indeed they stated that the improvement of accessibility is an important factor for their performance. The city image was also pointed as factor that although indirectly benefits the employers. A reason for this can be that in general the respondents interact intensively with internationals or their work activities are on an international scale. Hence, the International zone of the city seems to be concern with the status of the city and how the city is perceived internationally.

Travel time cost reduction and *relief in traffic and congestion* are seen to have a *positive effect on employers* (mean of 4). Employers say that commuting faster or reducing the travel time for clients/visitors is seen as a benefit for them. Traffic and congestion was a factor that all respondents pointed out when discussing the issues they experience in terms of mobility in the area. Thus, it is logical that improvement of these factors will be positively assessed by the respondents.

Capacity increase is also pointed by respondents as a positive effect for their overall performance (mean of 3.9). Employers face issues with overcrowding on the tramline 1 and therefore the capacity increase is seen as improvement of the public transit service, which will be beneficial for their employees and clients/visitors.

Reduction of car usage has a mean of 3.6. It is between the categories "No effect" and "Positive effect". It can be argued that the facto has a weak effect, but still on the positive side. Reduction of car usage is related with the reduction of traffic and congestion, as a mean to alleviate the latter. Thus, although indirectly, reduction of car usage should be beneficial for the businesses/organizations located in the area.

Reduction of business travel costs has a mean of 3.8. It falls close to the score "Positive effect" within a margin of +/- 0.5. Respondents recognize that opportunities for cost saving are beneficial for their activities. However, the actual cost reduction also depends on the mobility policy each employer has, thus we cannot argue whether the employers will experience cost savings for business travel by the upgrade of the line. However as a potential benefit, employees agree that reduction of business travel cost would be beneficial.

Reduction in cost for parking space seems to have no effect for the respondents (mean of 3.2). Throughout the interviews, the businesses/organizations were not interested at all in reducing costs for parking space. In fact, they didn't have any complaints in terms of high parking costs.

Increase of labor pool and job opportunities is also considered as a factor that has no effect (mean of 3.4) on the businesses/organizations' performance. The respondents in many cases did not make a relation between this indicator and the improvement of tramline 1 (or the quality of PT in general).

Summary statistics	Mean
Accessibility improvement (for residents, visitors, clients, employees)	**4.3**
Reduction in business travel costs	**3.8**
Reduction in costs for parking space	**3.2**
Travel time cost reduction	**4**
Capacity increase	**3.9**
Reduction of car usage	**3.6**
Increase of labor pool and job opportunities	**3.4**
Relief in traffic and congestion	**4**
Improvement of the city image	**4.3**

Table 34 Statistics of respondents 'opinion about beneficial factors for their performance

6.2. Results Real Estate Market

The survey conducted on the real estate market in the catchment area aimed to determine the effect of the tramline 1 upgrade on the residential and commercial property prices. Semi-structured interviews were done with six real estate agencies, active in the catchment area. The agencies participating in the survey are:

- Frisia Makelaars B.V.
- Duinzigt Woonservice
- La Cle Makelardij
- Vesting Vastgoed
- Franke Beheer B.V
- Tettero & Wetters Makelaars

In this section the results of the interviews are presented. The interviews were conducted with a representative real estate agent of each agency. During the interviews the real estate agents elaborated on the following topics:

- General information about the type of properties that agencies manage
- Indicators used for the formation of the property prices
- Factors regarding public transport considered when forming the property prices
- The effect of upgrading tramline 1 on the property prices in the catchment area

Type of properties the real estate agencies manage

All respondents are engaged in rent/sale of both residential and commercial properties. The residential properties that agencies rent/sale in the catchment area are mainly apartments and studios. Commercial properties include offices and in some cases shops, warehouses. However, during the interviews the majority of the agents stated that they did not have any commercial properties for rent/sale recently. Thus, it should be considered that the respondents are not intensively active on the commercial property market, but mainly on the residential property market. Furthermore, none of the respondents manages social housing, thus this property type is not discussed in the survey.

Indicators used for forming property prices by the real estate agencies

The agents were asked to point out the main indicators their agency uses when forming the rent/sale price of commercial/residential properties, and whether they use a specific scoring system for their assessments. Table 35 shows the factors the agencies considered for the property price formation. Neighborhood/ location status and the state of the property are the main indicators taken into account for the price formation. The agencies also consider various amenities which in general should have an effect on the prices but do not put main focus on these items. It is seen that the public transport provision also is not perceived as main factor in the assessment of property values.

Furthermore, the real estate agencies use different scoring/ assessment system and in many cases they do not really have a specific scoring system, but use own methods for setting the prices (e.g. follow market trends, negotiations; use the price of similar properties in the same area as orientation etc.). Even those who have a scoring system, consider only basic parameters like property surface (sq. meters), furnished/ unfurnished property, year of building, extras available in the property.

Indicators considered in the property price formation	%	Times pointed
Neighborhood popularity (location)	83%	(5 times)
State of the property	100%	(6 times)
General market trends	33%	(2 times)
Shops/Supermarkets	33%	(2 times)
Green space (parks)	33%	(2 times)
Sport facilities	33%	(2 times)
Recreational facilities	33%	(2 times)
Cultural facilities	33%	(2 times)
Accessibility by car	33%	(2 times)
Public transport provision	33%	(2 times)
Distance to the beach	33%	(2 times)
Uniqueness	17%	(1 time)
Landlord demands for the price	17%	(1 time)

Table 35 Indicators included in the formation of property prices by respondents

Factors with regard to PT that influence the property price formation

All real estate agents stated that public transport is concerned as far as there is sufficient service provision, but the quality itself is not included in the price evaluation. Moreover, the agents find that the overall public transport service in The Hague is satisfactory, thus they do not pay specific attention to this factor. However, they pointed some factor of the public transport that affect the attractiveness of the location and therefore indirectly might have an effect on the property prices. Distances to public transport stop, number of lines, accessibility, frequency, reliability were listed as indicators that matter for the tenants (especially when properties are rented by students, low class workers, older people). The real estate agencies shared that, for instance, they use the distance to public transit stop, the number of tramlines etc. when advertising properties in order to make it more appealing to potential clients.

Effect of potential benefits of the tramline 1 upgrade on the property price formation

The real estate agencies gave an opinion on the effect of indicators, discussed in the literature as benefits from light rail implementation, on the property price formation. The respondents scored the effect on a five points scale as value 1 means "Very negative effect" and value 5 "Very positive effect". The results are shown in Table 36. The mean of the respondents' scores is taken in order to show the overall perceived effect by the real estate agencies.

Accessibility improvement is scored 3.8 which is the highest score given out of all indicators. The score value is 0.8 above the value 3 "No effect". It is rather close to value 4 "Positive effect", falling in the lower

margin of value 4. This we consider that accessibility improvement is perceived to have a positive effect on the property price formation.

Relief in traffic and congestion and reduction in costs for parking space are also perceived to have a positive effect on the property prices (score of 3.7). The respondents think that reduction in these factors would improve the status of the location and thus make it more attractive (especially for businesses).

Travel time cost reduction and ***reduction of car usage*** is scored 3.5 meaning that the effect could be slightly positive. Reduction of car usage is related to relief in traffic and congestion, thus some respondents also score it as a positive effect. Travel time cost reduction also is seen as a benefit but the respondents in most of the cases could not relate it to the property price formation.

The rest of the indicators seem to have no effect on the property price values, mainly because real estate agents perceive it as irrelevant for the property price assessment.

Summary statistics	Mean
Accessibility improvement (for residents, visitors, clients, employees)	3.8
Reduction in business travel costs	3.2
Reduction in costs for parking space	3.7
Travel time cost reduction	3.5
Capacity increase	3.2
Reduction of car usage	3.5
Increase of labor pool and job opportunities	3.2
Relief in traffic and congestion	3.7
Improvement of the city image	3.7

Table 36 Statistics of beneficial indicators for property price formation

Forecast of the change in property prices in the catchment area after introducing light rail system on tramline 1

The real estate agencies were asked to provide current prices of their commercial/residential properties in the catchment area and then to make a forecast about the price change for the same properties that would occur due to the upgrade of tramline 1. Although the agencies provided example cases of properties (only residential) we will not include them in the report because this information becomes not useful for the study. The respondents expressed their overall opinion about the change in property prices in the area due to introducing light rail and did not discussed on each specific case (they found it difficult to relate specific cases to the effect of the upgrade).

All in all, the real estate agencies *forecast a neutral change* in property price (commercial and residential) with respect to the upgrade of the tramline 1. They consider the change in the tramline service too small for reflecting into the real estate values. The respondents elaborated that there could be an effect on the property values if the upgrade would involve extension of the line (to other city, neighborhood etc.), or in case there was no line serving the area and a completely new line (and route) was going to be introduced.

7.Discussion

7.1. Businesses and International Organizations

The survey conducted with the business community in the catchment area of the upgrade managed to:

- Define the main issues employers experience with the accessibility to the area and their location
- Identify the main factors hindering the use of tramline 1 and additionally to detect external factors that negatively affect the use of the service.
- Point the main benefits the upgrade will bring for businesses/(international) organizations and society
- Understand how employers perceive the upgrade of tramline 1 will impact their performance
- Determine the importance of the upgrade for the urban development

Tramline 1 is proposed for an upgrade into light rail as a step to improve the quality of the service and thus to attract users. The Hague Region Authority and HTM encounter issues, discussed in chapter 2, related to the line services that deter the optimal use of the line. The interviewed businesses/ (international) organizations also identified a set of issues regarding the tram service that to a large extent match the concerns of HTM. In addition, the employers pointed out issues/dissatisfying factors that were not encountered by the transport provider.

The *main factors that hinder the use of tramline 1* (and the urban transit in general) by employees, clients and visitors, pointed out by employers with regarding to the service quality are:

- High- floor vehicles, posing a burden for disabled, old passengers, travelers with luggage or prams
- Insufficient vehicle capacity, resulting in overcrowding
- Low frequency of the service
- Inefficient information provision, especially for international employees, clients and visitors
- The time of operation of the service, which does not match with the working hours of some businesses/(international) organizations in the area
- No connection to Central Station, which is the main arrival location of employers' visitors and clients. Also, employees who commute from/to outside the city interchange at CS; thus cannot make use of tramline 1

The above listed factors have a negative effect on the use of the current tram service, making it unattractive for the users who travel to the area. The unsatisfactory level of the service provision contributes to the general accessibility issues employers experience, namely traffic and congestion, and insufficient parking space. The survey results show that the main use of car by employees is for commuting, while the business trips are done by companies' cars or public transport. Furthermore, the modal split for commuting shows that

the car use is twice higher than the use of public transport. Employers stated that many of their clients/ visitors come by car to the area, because the tram service is not a viable alternative for them. These findings give an indication for the weak usage of tramline 1, as the line is the main line serving the employers' location.

During the interviews some ***external factors that hinder the use of the tram service*** were identified as well. A factor that negatively affects the use of the tram service is the *weak presence of mobility policy*, developed by employers, towards stimulating the use of PT by employees. Although the largest share of the respondents have a mobility policy, the effort to incentivize employees is rather small. A reason for the low interest of employers to design/implement strict policy for commuting by PT might be the current tram service, which does not meet the travel needs of employees. Besides, the lack of knowledge and information about the potential cost reduction that employers' could realize trough stimulating the urban transit use leads to neglecting the stimulation of the urban transit usage.

The upgrade of tramline 1 is perceived to have ***an overall positive effect*** on the businesses/(international) organizations, mainly because it is perceived to solve/ reduce the issues employers encounter. Hence, ***introducing light rail on tramline 1 will benefit the performance of the businesses and (international) organizations*** through:

- Improvement of the accessibility to the area; thus to employers' office locations
- Increase in vehicle capacity
- Travel time cost reduction
- Relief in traffic and congestion
- Reduction of business travel costs
- Improvement of the city image

The main positive effect of the upgrade is found to be the accessibility improvement to employers' location and respectively to the entire catchment area. Accessibility improvement is observed to be a major effect of light rail implementation. Handy (2005) points that the level of urban development is dependent on the level of accessibility to a location. The benefits occurring from improved urban accessibility for businesses can be multiple, some of which are already listed in chapter 3. Here it should be clarified that the literature found on this matter is rare and covers only a few aspects of the possible impacts of light rail on business communities. Nevertheless, it gives a basic overview of the added value a business can receive from to the presence of light rail in proximity. Some of the benefits occurring from the upgrade have implications not only on the business community in the catchment area, but also on society at large. Therefore, the discussion takes into account also the scientific literature covering the societal effects of urban rail systems. Overall, the survey findings follow the main course of the literature discussed, with some exceptions.

The survey findings showed that currently the employers rate their location as "accessible" by public transport for employees, clients and visitors. The upgrade of the line is perceived to change the accessibility level to "easy accessible", with *an increase of the accessibility by 18% for employees and 16%- 20 % for clients/ visitors.* Moreover, the level of *accessibility by car is considered to improve with 9%*, thus from "accessible" towards "easy accessible". A reason for this effect is the *perceived relief in traffic and congestion, brought by the upgrade*, due to an increase in the use of the tram service, resulting in reduction of car usage. Even though at first sight the effect does not seem to be substantial, it gives an indication about the potential added value of the upgrade for the employers and the entire area.

The positive impact of light rail introduction on the issues related to traffic, congestion and car use will create benefits not only for the business community and the area, but *for society at large*. The upgrade is also seen to have a *positive effect in terms of travel time cost savings*, which except beneficial for the employees, clients and visitors of companies, also has a positive effect on society. This results support the literature review on the impacts of light rail on society in chapter 3.

Another positive effect of the tramline 1 upgrade on businesses and organizations in the area is the *improvement of the city image*. Employers perceive that providing high quality urban transit service will have a positive impact on the attractiveness of the area and consequently on their performance.

"The upgrade of the line would make the city more attractive choice for conferences and events"

World Forum

This finding corresponds to the literature review in chapter 3, regarding the effect of urban rail on city image. City attractiveness is important for businesses when choosing a place to locate their activities. Improvement of the city image is indication about the level of urban development and reflects the status of a location. Thus, the result complies with Pagliara's (2011) statement that urban rail can improve the attractiveness of a location by its image effect.

Moreover, as is one of the main issues of the current service provision is insufficient capacity, resulting in overcrowding "all the time", *increase in vehicle capacity is perceived to have a positive effect* through making travel more comfortable and the service more attractive to employees, clients and visitors. The same is true for providing higher frequency that will reduce the waiting and travel time which is a benefit for the users of the line.

Wider labor pool and increase in job opportunities are considered as major benefits occurring from the improved level accessibility due to light rail. However, the findings of the research are contradictory to this view. The employers find that indicator irrelevant for their performance, as they do not encounter issues with attracting employees. The same is the result for reduction in costs for parking space. The employers' do not have concerns regarding their costs for parking, thus the upgrade will not add value for them in that respect. Nevertheless, the upgrade is seen to help reducing the need for parking space which will be beneficial for the employers.

An additional positive effect of the upgrade is the ***willingness of employers to stimulate the use of the line*** if the line is being transformed into a light rail line. During the interviews respondents expressed an interest to re-evaluate their current mobility policy, and better stimulate the use of PT by their employees. They also stated that an arrangement with HTM for using travel products that would reduce business travel cost seems attractive, and the upgrade will make it more likely to take such a step.

7.2. Real Estate Market

One of the most substantial impacts of rail transit project implementations is considered to be on the property values along the rail lines. A detailed discussion and examples of studies on this topic were provided in chapter 3 (section 3.4). The literature review showed a trend for light rail systems to have a positive impact on the property values with a range of the increase varying substantially (Table 4, section 3.4). The main reason for the uplifting price effect is the improved accessibility to the surrounding area, caused by the presence of light rail.

The survey on the real estate market for the catchment area of tramline 1 (HS- Scheveningen) aimed to assess the effect of upgrading the tram system into a light rail system. The survey results neither confirm nor contradict the discussed literature. The approach that was taken for assessing the effects of the upgrade on the real estate market, is rather inventive, and has not been applied by any of the studies discussed in the literature review. While the case studies reviews in chapter 3 conduct quantitative research, the survey of this paper uses a qualitative method for analysis. The survey focuses on interviews with real estate agencies and relies on the expert judgment of real estate agents, who look at the issue from a practical perspective. Consequently, the results reflected the opinion and forecast of the participants, where their practical view of the topic was revealed.

The real estate agents do not consider that the upgrade of tramline 1 will have an effect on the property values within its catchment area, for both commercial and residential property. Thus, they predict a ***neutral change in property values***, including sale and rent prices. However, the interviewees could make a forecast only about the immediate effect of the upgrade, but could not foresee the impact in a long term. They also couldn't refer to other city areas that are already served by light rail and provide observations about a change

in the property values due to light rail presence. As Jong and Declerq (2012) point in their study on urban rail systems in Europe, the cases studied showed a long term effect on the urban development (e.g. housing, businesses etc.), where the effect of the upgrade on property values may not be seen straightaway, but in a long term.

Real estate agencies, in practice use rough estimate for forming the property asking prices, including only general indicators and mainly follow the market trends. In some cases the asking price of a property is formed through using as a base another property with similar characteristics and location. Furthermore, the final realized rent/sale price of a property also depends on negotiating and the general demand. Thus factors as location, state of the property, market trends, the overall attractiveness of the environment, are leading factors in the price formation. In this respect the agencies do not consider the quality of the public transport and the level of accessibility to a location when forming the property prices. Hence, the interviewees were not able to isolate the effect of introducing light rail on the property values.

However, an interesting outcome of the survey is that real estate agents, although not able to give an exact figure, gave an opinion that the property values would indeed increase if the upgrade included extension of the current line route or a completely new route was introduced. This statement complies with the results discussed in the literature, where all cases look at light rail projects implemented on completely new routes with no existent urban rail system heretofore or involve extension of existing lines. This supports the main trend that the light rail system will affect positively the property values due to improvement of the accessibility to a location. Hence, the difficulty to predict a change in prices from upgrading tramline 1 comes because the change will be too specific, while real estate agencies look at the general development of a location when properties are concerned.

Although the respondents could not provide a precise forecast for the change in property values, they pointed out factors, considered as benefits occurring from light rail that would have a positive effect on the property values. The agencies pointed out that *accessibility improvement would have a positive effect on the property values,* which is in conformity with the discussion in the literature review. Lira pilot 3 study states that businesses are willing to pay higher rents in order to use the benefits of improved accessibility. Although the respondents couldn't give an opinion on this matter, we argue that the tenants in the area would want to use the advantages of improved accessibility based on the survey conducted on the effect of the upgrade on businesses/ (international) organizations in the area. Thus in case there is no increase in the rents due to light rail, the businesses will benefit without extra costs. Furthermore, the real estate agencies indicated that the *improvement of the city im*age, brought by advanced urban rail systems, *will have a positive effect on the property values*. Examples of light rail introduction as a means to improve the attractiveness of a city is already discussed in chapter 3. Here however, the real estate agents point that the city image itself could reflect positively the property prices. Therefore, it can be suggested that the effect of the upgrade on the

property values could be conveyed indirectly through other factors. In this sense, it is logical that real estate agencies cannot make a forecast for the direct impact of the upgrade on the property values. They would be able to detect a change in property values on the market, but it is hardly plausible to make a cut off on the specific factors for this change.

To conclude, the approach used for determining the effects of light rail introduction on tramline 1, on the property values along the line, managed to reveal that positive externalities occurring from the upgrade, such as accessibility improvement and improvement of the city image, will have positive effect on the property values. As a result the upgrade will create societal economic benefits, which however tent to be captured in a long term.

The real estate agencies that participated in the survey recognized that the upgrade will add value to a location, through raising its attractiveness for the tenants. Nonetheless, real estate agencies cannot give a precise estimate of the effects of upgrading the line, as their work does not require looking in detail at specific factors forming the overall real estate market trends. Hence, they are not the right party to be approached for this type of research subject.

8. Conclusions and recommendations

The aim of this research is to determine the economic effects of light rail system implementation on the urban development. The paper focuses on a specific case, namely the upgrade of tramline 1 in The Hague from a traditional tram system into an advanced light rail. The main research question of this master thesis is: ***What would be the wider economic effects of upgrading tramline 1 on the urban development?*** In order to answer this question two sub questions were addressed. They were answered trough review of scientific literature and reports/surveys, conducting interviews and consultation with transport experts and the city's transport provider (HTM). Next to that a survey on the effects of the upgrade on the two relevant stakeholders selected for analysis was conducted. The answers of the sub questions and consequently of the main research questions are concluded below followed by authors' recommendations.

8.1. Conclusions

In order to determine the economic effects of introducing light rail on tramline 1 on the urban development, several steps were made. Firstly, the parties involved in such project were determined. As a result multiple stakeholders group, that will be directly or indirectly affected by the upgrade were defined. *Travelers, transport provider, businesses and (international) organizations, and the real estate market are the key parties concerned by the upgrade.* The potential effects of the upgrade for each stakeholder were discussed, while two particular stakeholders were selected for further study. Secondly, a survey on the effects of the upgrade on these parties was conducted, aiming to reveal the added value of the project for them. The outcomes of the study are translated into the urban development, as the business community and real estate to big extent contribute to the development of the city.

8.1.1. Implications of introducing light rail on tramline 1 for the urban development

The introduction of light rail on tramline 1 is perceived to contribute to the urban development in several ways. A prominent outcome of the project is considered to be the accessibility improvement to the catchment area of the upgrade, namely HS - Scheveningen. This part of the city includes important economic areas, e.g. the city center, Scheveningen and the International zone. Providing a higher level of accessibility to key economic zones will certainly reflect the commercial use in the area. The upgrade will add value to the performance of the business community in a way that it will solve/ reduce issues that employers experience with accessibility to their location, as it will become more accessible for employees, client and visitors. Hence, the attractiveness of the area will increase, which on its turn will positively affect the overall image of the city. An increase of the attractiveness of the area is also perceived to have a positive effect on the real estate market. A main factor affecting the formation of property prices is the popularity or the status of a

location. The real estate agencies participating in the survey recognized that the accessibility improvement will have a positive effect on the property values, as well as rise in the city image.

Moreover, the added value of the upgrade can affect external factors related to mobility. The survey revealed that the businesses/ (international) organizations experience issues, not only with the service quality of the current tramline itself, but also general mobility problems, such as traffic, congestion, scarcity of parking space etc. The upgrade is considered to alleviate those concerns, as it can aid the reduction of car usage by attracting more travelers to use the upgraded line. Hence, the upgrade will create positive externalities not only for the area, but will induce positive societal effects as well. It was not possible to measure the impact of the upgrade on society; however, the research unintentionally gave indication about the social benefits that can occur from the upgrade.

Another implication of the upgrade for the urban development is on the urban mobility management. The survey revealed that currently, businesses and (international) organizations do not have well designed mobility schemes, regarding the commuting of employees and travel cost coverage. Often the employers are not aware of the opportunities and benefits the public transport can provide to them. Also, the service quality of the current tram service (and tramline 1 in particular) is seen as not attractive enough, in order employers to put efforts to stimulate its use by employees. The survey results revealed that introducing light rail on the line, triggers the interest of the employers to develop a more strong mobility policy regarding the use of public transport (e.g. through an agreement with HTM or similar).

The urban development is a broad notion, concerning the social, cultural, economic and physical development of the city[13]. In many cases, the processes occurring in each sphere are interlinked and interdependent. This thesis aimed to shed light on the effects of light rail implementation on the development of the city of The Hague. The survey conducted for the research examined the indirect effects of the upgrade on two stakeholder groups that take prominent place in the urban development. The general conclusion for the study is that the introduction of light rail will add value to the urban development through its beneficial effects on its stakeholders.

8.1.2. Effects on Businesses and (International) Organizations

From the survey on the business community in the catchment area, regarding the effects of the upgrade for their performance, it is possible to conclude that:

- Accessibility improvement is perceived as a major benefit of the upgrade for businesses/ organizations

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[13] Source: http://www.sv.uio.no/iss/english/research/subjects/urban-development/

- The introduction of light rail on tramline 1 is perceived to solve and/ or reduce current issues that employers experience, regarding the tram service and the accessibility to their location
- The upgrade is perceived to improve the accessibility to employers' locations by public transport and car for employees, clients and visitors.
- The upgrade is perceived to provide more comfortable and convenient travel for users, by improving factors considered as "dissatsifiers" of the current service provision
- The upgrade of the line triggers the interest of the business community to develop mobility schemes that stimulate actively the use of public transport and tramline 1 in particular by their employees
- Improvement of the service provision (e.g., capacity, information, provision, connectivity to CS) seems to become more important, as new international organizations settle in the International Zone resulting in an increase in the number of employees, clients /visitors traveling to the area.

8.1.3.   Real Estate Market

The upgrade of tramline 1 was expected to impact the property values in the catchment area for both residential and commercial property. From the survey conducted in this master thesis, it can be concluded that:

- The real estate agencies forecast a neutral change in property values in a short term from upgrading tramline 1 into light rail. The respondents were not able to give a prediction in the long term. Also the real estate agencies find it difficult to give a forecast prior to the upgrade.
- The real estate agencies do not include the quality of public transit and the level of accessibility to a location in the property price formation. The scoring systems they use for forming the property price are not uniform and overall account for general factors. Thus an exact and realistic judgment of the change in property values due to public transit improvement is hard to be given.
- Accessibility improvement is seen as a factor that will positively affect the property values in the catchment area.
- Improvement in the city image is perceived to positively affect the property values (in the catchment area and in general).
- The effect of the upgrade may not be on the property values may not be direct but indirect by affecting other factors that would impact the property prices (accessibility, city image, relief in traffic and congestion, attractiveness of the location etc.).
- The impact of light rail implementation is considered to be more substantial in case of extension of an existing line/route or when a completely new line/route is introduced
- The approach used in this thesis aimed to provide a more specific and exact assessment of the effects of tramline 1 upgrade on the commercial and residential property values. However it turned out that the professional judgment of real estate agencies can provide only general indications about

these effects. The real estate agencies lack expert knowledge on this subject and thus could only give an opinion based on their work methods in practice.

8.2. Recommendations

The results of the survey, allowed drawing several recommendations for the municipality of The Hague. The recommendations regarding further monitoring of similar projects and actions that can be taken in order the upgrade to further add value to the urban development are discussed in this section

The effect of similar urban transit projects on the property values in proximity should be measured systematically before and after the project implementation. Collection and data analysis on realized sale prices for both commercial and residential properties may capture the effects more accurately than expert judgment. Furthermore, the effect should be expected to occur not immediately after the upgrade, but years later, because in general the effects of the transport projects can be captured mostly in the long term.

The recommendations regarding the service quality provision of tramline 1 and of the current urban rail transit in general are based on the improvements that the participants in the survey would like to see in that respect. Thus, the recommendations reflect the actual needs for public transit by travelers. Main factors that the transport provider and the municipality should pay attention to are:

- Convenient connection to Central Station, as the main station is main arrival/departure station for internationals (e.g. business travelers, tourists) and employees who live outside The Hague (e.g. Zoetermeer)
- Adequate information provision for non-Dutch speakers (e.g. announcements about issues, delays in English)
- Guideline signs near the stops within the International zone, informing users about the location of the stop (e.g. near Europol, World Forum etc.)
- Frequency of the current service – more frequent service is desired
- Improvement of the ticketing methods – provision of more places, where users can purchase a ticket; an option for payment with credit card in the vehicles
- Provision of sufficient capacity, thus avoiding the current issue with overcrowding
- Time of operation – reconsidering the starting and ending hours of operation

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Appendices

9.1. Appendix A

Appendix A 1
Review of methods used in transport project evaluation

Models with aggregated data	Description	Advantages	Disadvantages
Production factor models	- Focus on infrastructure in relation to capital and labor - Assumption that improving infrastructure will rise production	Direct link between investment and economic effects	- Limited detailed data for private production factors for various economic sectors - No complete production functions are available - Effects of infrastructure tend to cross regional borders
Location models	- Focus on additional infrastructure investments and their effect on private investment and extra job creation (as factor for locating activities) - Studies the effect to extension and reallocation of activities within the researched region	Direct link between investment and economic effects	- Other factors can influence location decisions that the model does not control for - Little suitable data on investment decisions - Essential parameters might be hard to define
Interregional Trade models	- Focus on the effects of infrastructure investment on interregional trade and spatial development - Represent the relationship between transport infrastructure & transport costs; transport costs & ridership'; ridership& spatial development in the region	Direct link between investment in infrastructure and trade	- Limited availability of date on intra- regional level - No specific link between investment and employment is made
General balance models	- Focus on the relationship between transport costs and the price of products and services - Assumption that transport will balance demand & supply	Direct link between transport and costs	- Balancing take place over long periods of time - No direct link to employment - Assumed that there are "perfect markets"; Transport market is imperfect market
Models with de-aggregated data	Description	Advantages	Disadvantages
Revealed preference models	- Focus on precedents of the effect *of new infrastructure* - Use effects in relation to travel time and costs	Direct link with precedents; the models are based on actual behavior	- There are no two identical situations - No direct factors are taken into account - Difficulty to acquire variability in the data that is needed to analyze all factors that have an influence - The models cannot be applied in situation where a change in transport infrastructure has not taken place

Stated preference models	- Focus on hypothetical assumptions of the effects of *new infrastructure* - Aims to predict the change in behavior	- "Open model"- can be set up according to the data available - It has transparency , there is no black box	- Risk that model is focused on the desired outcomes - The models do not necessarily have to present reality that is the actual behavior of the actors involved

Table A 1 Review of methods used in transport related projects; Source: LiRa pilot 3, 2000

Approaches for impact evaluation of light rail projects implementation

Type of data	Modelling approach	Non-modelling approach
Aggregated data	✖ Production factor approach ✖ Location models ✖ Interregional models ✖ General balance models	✖ Experimental models
De-aggregated data	✔ Revealed preference models ✔ Stated preference models	✔ Interviews and surveys ✔ Expert judgment ✖ Change in transportation costs

Table A 2 Suitable and unsuitable approaches for impact evaluation of light rail project implementations; LiRa pilot 3, 2000

Appendix A 2 HTM annual survey (Klantenbarometer, 2012), Background information of participant in the survey (e.g. travel motive, travel frequency etc.)

Table A 3 HTM annual survey – background information of participant in the survey

Achtergrondkenmerk	2007		2008		2009		2010				2011				2012			
	RR	Trams	RR	Trams	RR	Trams	RR		Trams		RR		Trams		RR		Trams	
Reismotief/ Travel motive																		
Wonen/Living	7,1	6,8	7,4	7	7,4	7	7,2	27%	7,1	28%	7,3	30%	7	29%	7,4	26%	7,3	28%
Werken/ Work	7,1	6,3	7,3	6,8	7,2	7,1	7,2	28%	7,1	21%	7	27%	7,2	24%	7,3	33%	7,1	26%
Onderwijs/ Education	7,3	6,7	7,2	6,9	7,1	7,2	7,2	15%	7	13%	6,9	15%	7	12%	7,2	13%	7,3	14%
Winkelen/ Shopping	7,4	6,5	7,7	7,3	7,2	7,1	7,5	7%	7	11%	7,3	6%	7,2	7%	8	6%	7,4	10%
Sporten/ Sport	7,3	6,3	7,1	6,3	7,4	6,4	7,1	3%	6,4	3%	7,2	2%	6,9	2%	7,6	2%	7,5	2%
Bezoek/Visit	7,4	6,9	7,4	7,2	7,6	7	7,3	8%	7,3	12%	7,4	9%	7,2	11%	7,6	8%	7,3	9%
Anders/ Other	7,3	6,7	7,4	6,7	7,5	7,4	7,5	12%	7,2	13%	7	11%	7,1	14%	7,4	12%	7,3	12%
Leeftijdklase/Age clasification																		
Jonger dan 18 jaar/ Younger than 18 years	7,2	6,8	7,6	6,8	7,4	7,4	7,4	7%	7	10%	7,1	12%	7,1	11%	7,3	7%	7,4	8%
18 tot/to 27 years	7,2	6,6	7,1	6,9	7,2	6,9	7,1	36%	7,1	40%	7	37%	6,9	36%	7,2	36%	7,1	38%
28 tot/to 40 years	7,1	6,7	7,4	6,9	7,4	7,2	7,1	23%	6,8	22%	7,3	17%	7,2	22%	7,3	22%	7,2	23%
41 tot /to 64 years	7,3	7	7,6	7,1	7,6	7,3	7,4	29%	7,3	24%	7,4	29%	7,3	26%	7,5	28%	7,3	24%
65 years or older	7,8	7,8	8,3	7,7	8	7,4	8,2	5%	7,8	5%	8,1	5%	8,1	5%	8,1	7%	8,1	6%
Geslacht/ Gender																		
Man	7,2	6,7	7,4	6,8	7,3	7,2	7,2	45%	6,9	45%	7,2	40%	7,2	41%	7,3	41%	7,4	44%
Vrouw/ Woman	7,2	6,9	7,4	7,1	7,4	7,1	7,4	55%	7,2	55%	7,3	60%	7,2	59%	7,4	59%	7,2	56%
Beschikbaarheid vervoeralternatieven/ Availability of transport alternatives																		
Ja/ Yes	7,1	6,7	7,5	6,9	7,4	7,1	7,3	41%	7	38%	7,2	40%	7,2	35%	7,2	38%	7,3	35%
Nee/ No	7,2	6,8	7,4	7	7,4	7,1	7,3	59%	7,2	62%	7,2	60%	7,1	65%	7,4	62%	7,2	65%

Vervoerbewijs/ Ticketing																		
Kaartje gekocht in teh voertuig/ Ticket purchase in vehicle	6,9	7,5	7,2	6,9	6,5	6,6	6,4	5%	7,1	4%	7,1	2%	6,6	6%	7,3	3%	7,1	6%
Op saldo met OV-chipkaart/Load saldo on chip card	7	6,6	7,3	6,8	6,8	6,9	7,3	29%	7,1	22%	7,4	33%	7,3	39%	7,6	45%	7,3	47%
OV-studentenkaart/ Student product	7,3	6,9	7,1	7	7,1	7,1	7	18%	7,2	19%	7	18%	6,9	20%	7,2	22%	7,2	21%
Sterabonnement op OV-chipkaart/ Star season ticket with chip card	*	*	*	*	*	*	7,2	5%	7,3	4%	7	11%	7	8%	7,3	19%	7,2	16%
Sterabonamment zonder chip/ Starseason ticket without chip card	7,1	6,6	7,5	7	7,4	7,1	7,3	12%	6,9	13%	6,9	14%	7,1	12%	7,6	1%	7,5	1%
Ander abonnement/ kortingproduct/ Other season ticket or discounts	7	6,7	7,5	6,9	7,4	7,1	7,4	11%	6,9	9%	7,3	15%	7,3	10%	7,4	7%	7,2	6%
Anders/ Other	7,3	6,8	7,6	6,9	7,5	7,3	7,7	4%	7,3	4%	7,5	6%	7,2	4%	7	3%	6,9	4%
Strippenkaart	7,4	6,9	7,6	7	7,6	7,3	7,5	16%	7,2	24%	7,6	0%	8,2	1%	*	*	*	*
Reisfrequentie/ Travel frequency																		
0 to 1 time per week	7,4	6,8	7,6	7	7,7	7,2	7,5	18%	7,1	####	7,6	15%	7,4	22%	7,6	18%	7,4	20%
2 times per week	7,4	7	7,7	7,1	7,3	7	7,4	14%	7,2	10%	7,4	11%	7,2	12%	7,5	14%	7,2	16%
3 times per week	7,2	6,5	7,5	7	7,4	7	7,2	13%	7,2	12%	7,5	9%	7,3	11%	7,3	11%	7,3	14%
4 times per week	7	7	7,3	6,9	7,5	7,1	7,3	14%	7	14%	7,3	11%	7,2	12%	7,6	11%	7,3	12%
5 times per week	7	6,6	7,3	7	7,1	6,9	7,2	18%	7,3	15%	7,2	22%	7	14%	7,3	20%	7,1	14%
Meer than 5 keerper week/More than 5 times per week	7,1	6,7	7,2	6,8	7,2	7,2	7,1	24%	7	25%	6,9	32%	6,9	29%	7,1	26%	7,1	23%

Customers' opinion on items regarding the travel- a comparison quality indicators for light rail (RandstadRail) and trams in The Hague

Item	2007		2008		2009		2010		2011		2012	
	RR	Trams	RR	Trams	RR	Trams	RR	Trams	RR	Trams	RR	Trams
Zitplaats/ Seat avail.	8,1	7,6	8	7,9	8	8,2	7,5	8,2	7,8	8,4	7,8	8
Netheid/ Cleanliness	7	5,6	7,1	5,9	7	5,9	6,6	5,8	6,6	6,2	6,8	6,4
Vriendelijkheid/ Friendliness	6,7	6,2	6,7	6,5	6,7	6,6	6,8	6,8	6,5	6,7	6,5	6,7
Rijstijl/ Driving style	6,8	6,5	6,7	6,7	6,7	6,8	6,9	6,9	6,8	7	6,8	6,9
Geluid/Noise	6	5,9	6,7	6,1	6,8	6,1	6,8	6,3	6,5	6,2	6,7	6,4
Gemak instapen/ Ease access	8,7	7,1	8,9	7,4	8,7	7,5	8,4	7,5	8,7	7,6	8,6	7,9
Informatie algemeen/ Information overal	6,7	6,3	7,2	6,8	7,3	6,9	7,1	6,6	7,1	6,9	7,2	7
Informatie vertragingen/Information delays	4,9	4,3	5,4	4,7	5,6	4,7	5,5	4,5	5,1	4,5	5,1	5,1
Gemak kopen vervoer bewijs/ laden reis saldo/ Ease purchase	6,2	7,2	6,3	7,2	6,3	7,3	6,4	6,6	6,2	6,5	6,7	6,9
Tarief/ Fare	5,1	4,7	4,8	5	5	5	5,1	4,9	4,6	4,5	4,5	4,6
Punctualiteit/ Punctuality	6,9	6,2	7,4	6,6	7,5	6,8	7,3	6,6	7,2	6,9	7,2	6,9
Reissnelheid/ Speed	7,4	6,8	7,5	7,1	7,5	7,1	7,4	7,1	7,4	7,2	7,6	7,3
Frequentie/ Frequency	7,1	6,4	7,4	6,8	7,3	6,8	7,3	7	7,2	7	7,3	7,1
Gebuiksgemak OV-chipkaart							6,8	6,5	6,6	6,5	7,2	7,1
Overstaptijd/ Interchange time											6,2	6,1
Totale rit/ Total travel	**7,2**	**6,8**	**7,4**	**7**	**7,4**	**7,1**	**7,3**	**7,1**	**7,2**	**7,1**	**7,4**	**7,2**

Table A 4 Comparison of quality indicators for light rail (RandstadRail) and trams in The Hague, scored by travelers

Customers' opinion on items regarding the social safety and security

Item	2007		2008		2009		2010		2011		2012	
	RR	Trams	RR	Trams	RR	Trams	RR	Trams	RR	Trams	RR	Trams
Veiligheid algemeen/ Overal safety&security	7,3	6,7	7,5	7	7,3	6,8	7,3	6,9	7,1	6,8	7,2	7
Veiligheid rit/Safety&security during travel	7,7	7	7,9	7,4	7,8	7,2	7,7	7,5	7,6	7,3	7,6	7,4
Veiligheid instaphalte/ Safety& security on waiting stop	7,5	7	7,5	7,3	7,5	7,2	7,4	7,4	7,3	7,2	7,3	7,3

Table A 5 Comparison of quality indicators regarding the social safety and security for light rail (RandstadRail) and trams in The Hague, scored by travelers

Appendix A 3 General statistical information
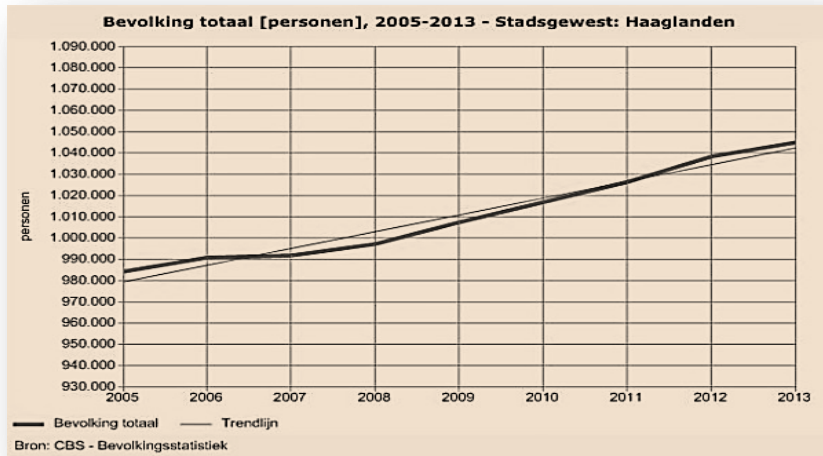
Figure A 1 Total population growth 2005-2013 Haaglanden; Source: CBS
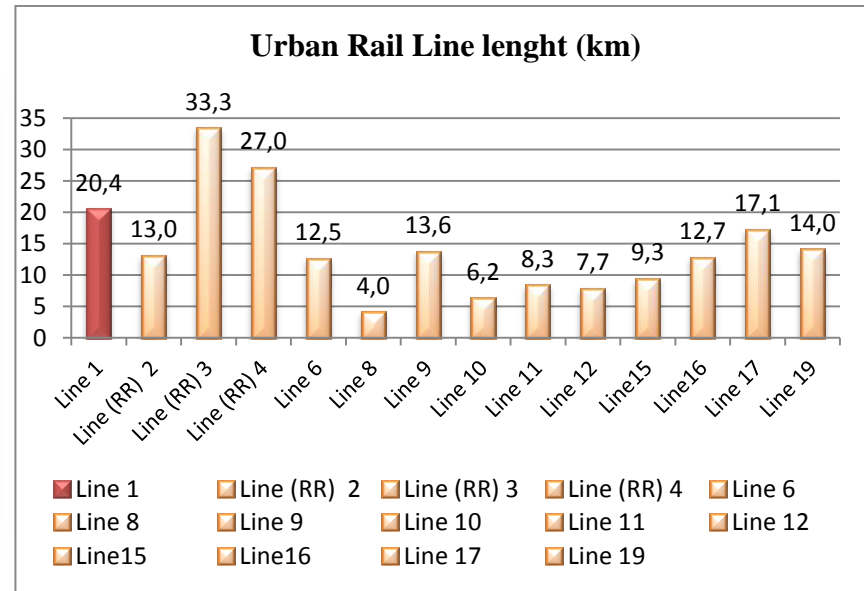
Table A 6 Length of urban rail lines in The Hagues, Source: HTM, 2013

9.2. Appendix B

Questionnaire distributed to Businesses and (International) Organizations

Dear Mr. /Mrs.,

Stadsgewest Haaglanden has the ambition to improve the quality of public transport system in The Hague. Part of this ambition is to upgrade tram line 1 (Scheveningen- Delft Tanthof) and we would like to determine how this will affect urban development. The upgrade includes replacement of the current tram fleet with new low floor vehicles (RandstadRail) and improvement of the infrastructure along the line (e.g. modifying tram stops, improving travel information provision etc.). This will improve the quality for travelers (e.g. accessibility, reliability).

Stadsgewest Haaglanden is interested whether such an upgrade would be beneficial for your business activities and your employees, visitors and clients, and very much appreciates your cooperation by giving an interview. Information discussed during the interview will only be used for our research project and will not be made public in any way.

The survey is carried out by Radoslava Toteva, a Master student at Erasmus University Rotterdam. If you want more information on this project, you can contact ir. Jan Termorshuizen, senior transport expert of Stadsgewest Haaglanden, tel. 070-7501650.

On the next page, please find the questionnaire that will be used as a guide during the interview with you!

Contact information
Organisation:
Address:
Contact person:
Phone:
E-mail:

Please, tell us about your organization

1) What is the core business of your organisation? …………………………………………

2) What are your hours of operation? ....

3) How long is the office already at the current location? ....

4) Does your organisation own or rent the office? …………………………………………....

Please, tell us about your employees

1) What is the total number of employees at this location?

2) How many of your employees work full- time and part time respectively?

3) How many lease cars does your organisation have?

4) How many private cars are used for business trips?

5) How many parking places on your own do you have available?

6) How many work-related trips do your employees make per month?

7) What is the mode of travel for commuting (**home-work**) trips?

- Public transport………………%
- Car…………………………...%
- Bicycle………………….......%
- Other…………………….......%

Your mobility policy

1) Can we discuss the mobility policy that you have for the travel of your employees?

2) Do you cover travel expenses for your employees and in what way?

Accessibility to your organization

1) How accessible do you consider the organisation for your employees, clients, visitors? Please, give a score for each transport mode.

	Employees	Clients	Visitors
Public transport			
Car			
Bicycle			

1- Hardly accessible
2- Not easy accessible
3- Accessible
4- Easy accessible
5- Very easy accessible

2) What issues do you experience with the accessibility of your current location?

3) What improvements would you like to see in this respect?

HTM conducts an annual Customer Satisfaction Survey (2008-2013) regarding the service quality of the urban rail system in The Hague. The survey focuses on the evaluation of specific items that determine the level of service quality of the system. Based on the survey results, we made a comparison between the performance of traditional trams and light rail "RandstadRail "(upgraded service).
The results show that the travelers' appreciation of the overall RR service quality is 20-25 % higher than for the traditional trams. To give deeper insight of the survey, we have selected the features of the upgraded service that travelers score higher in comparison to traditional trams:

Performance feature	Level of difference	Clarification Notes
Ease of access	50 % higher	Refers to the ease of boarding the vehicle (low floors, physical condition of the stop)
Frequency	20% higher	Assesses the frequency of the service
Punctuality	30 % higher	Assesses the accuracy of the travel schedule
Noise	25 % higher	Refers to the level of noise that travelers feel in the vehicle during travel. Higher score means less noise disturbance
Cleanliness	45 % higher	Refers to the cleanliness in the vehicle
Overall information provision	15 % higher	Refers to information in the vehicle and at the stops
Information about delays	30% higher	Refers to information provision mainly at the stops
Overall safety and security	20 % higher	Including on-board in vehicle and at the stops

Considering the given information from the HTM annual survey and the potential benefits from upgrading, please elaborate at the following questions:

Benefits from tramline 1 upgrade for your organisation

1) Please, can you score the indicators below that could benefit the performance of your organisation?

Indicator	Score
Accessibility improvement (for residents, visitors, customers, employees)	
Reduction in business travel costs	
Reduction in costs for parking space	
Travel time cost reduction	
Capacity increase	
Reduction of car usage	
Increase of labor pool and job opportunities	
Relief in traffic and congestion	
Improvement of the city image	

1-Very negative effect
2- Negative effect
3- No effect
4- Positive effect
5- Very positive effect

2) If you think that the upgrade of tramline 1 would improve the accessibility to your organisation for your employees, clients and visitors, please score the change in the table below.

	Employees	Clients	Visitors
Public transport			
Car			
Bicycle			

1- Hardly accessible
2- Not easy accessible
3- Accessible
4- Easy accessible
5- Very easy accessible

3) Do you think that the upgrade of the line will impact your current mobility policy? Please, elaborate on the possible changes.

4) Would the upgrade make it more likely that your company enters into a contract with HTM for employees (abonnement)? Please, rank the likelihood.

1	2	3	4	5
Extremely unlikely	**unlikely**	**Neutral**	**likely**	**Extremely likely**

5) Do you think that upgrading the tram service could solve current or future mobility issues that you might experience? Can you give some examples?

Thank you for your participation and the time for this interview! You will receive a report from the interview in order to check the accuracy of the report and to clarify any information if necessary.

9.3. Appendix C

Questionnaire distributed to Real Estate Agencies

Dear Mr./Mrs.,

Stadsgewest Haaglanden has the ambition to improve the quality of public transport system in The Hague. Part of this ambition is to upgrade tram line 1 (Scheveningen- Delft Tanthof) and we would like to determine how this will affect urban development. The upgrade includes replacement of the current tram fleet with new low floor vehicles (RandstadRail) and improvement of the infrastructure along the line (e.g. modifying tram stops, improving travel information provision etc.). This will improve the quality for travelers (e.g. accessibility, reliability).

Stadsgewest Haaglanden is interested whether such an upgrade would have an effect on the property values along the line and what changes the improvement of the transport service quality will bring to the formation of commercial/ residential property prices.

We very much appreciate your cooperation by giving an interview. Information discussed during the interview will only be used for our research project and will not be made public in any way.

The survey is carried out by Radoslava Toteva, a Master student at Erasmus University Rotterdam. If you want more information on this project, you can contact ir. Jan Termorshuizen, senior transport expert of Stadsgewest Haaglanden, tel. 070-7501650.

On the next page, please find the questionnaire that will be used as a guide during the interview with you!

Contact information
Real Estate Agency:
Address:
Contact person:
Phone:
E-mail:

1) What type of properties do you rent/ sell?
Residential

- Regular dwellings   Yes No Rent Sale

- Social dwellings (only for rent)   Yes No

Commercial   Yes No Rent Sale
If yes, please specify the type of property:

- Offices   Rent Sale

- Other, please specify……………   Rent Sale

2) Can we discuss the indicators your agency uses for assessing the price of commercial/ residential properties? Can you elaborate on the scoring system you use in the assessment.

3) Point out the factors with regard to public transportation that you consider when forming the property prices?

For example: quality of the transit (comfort, frequency, reliability, and accessibility), distance to public

transport stop, the number of tram/bus lines etc.

4) We provide an example of the potential benefits that could occur from upgrading tramline 1. Can you rate the effect, if any, of the indicator on property price formation?

Indicator	Score
Accessibility improvement (for residents, visitors, customers, employees)	
Reduction in business travel costs	
Reduction in costs for parking space	
Travel time cost reduction	
Capacity increase	
Reduction of car usage	
Increase of labor pool and job opportunities	
Relief in traffic and congestion	
Improvement of the city image	

1- Very negative effect
2- Negative effect
3- No effect
4- Positive effect
5- Very positive effect

HTM conducts an annual Customer Satisfaction Survey (2008-2013) regarding the service quality of the urban rail system in The Hague. The survey focuses on the evaluation of specific items that determine the level of service quality of the system. Based on the survey results, we made a comparison between the performance of traditional trams and light rail "RandstadRail "(upgraded service).

The results show that the travelers' appreciation of the overall RR service quality is 20-25 % higher than for the traditional trams. To give deeper insight of the survey, we have selected the features of the upgraded service that travelers score higher in comparison to traditional trams:

Performance feature	Level of difference	Clarification Notes
Ease of access	50 % higher	Refers to the ease of boarding the vehicle (low floors, physical condition of the stop)
Frequency	20% higher	Assesses the frequency of the service
Punctuality	30 % higher	Assesses the accuracy of the travel schedule
Noise	25 % higher	Refers to the level of noise that travelers feel in the vehicle during travel. Higher score means less noise disturbance
Cleanliness	45 % higher	Refers to the cleanliness in the vehicle
Overall information provision	15 % higher	Refers to information in the vehicle and at the stops
Information about delays	30% higher	Refers to information provision mainly at the stops
Overall safety and security	20 % higher	Including on-board in vehicle and at the stops

Considering the given information from the HTM annual survey and the potential benefits from upgrading the line listed in Question 6, please elaborate at the following questions:

Specific questions with respect HS- Schevenignen area surrounding tramline 1 route

For this section, please consider the property that you manage currently or recent examples (last year) that might be useful for answering the questions.
We are interested in the property values within the area surrounding tramline 1 route from HS to Scheveningen. For your convenience we provide a map with the area of our interest on neighborhood level and the location of the tram stops along the intersection

5) Can you point out specific cases of commercial properties within the selected area and discuss[14]:

   a) the sale price per sq. m and the location (address) of each case (property)

   b) the rent price per sq. m and the location (address) of each case (property)

   ➢ Please, specify in your answer the type of commercial property under consideration.

6) Can you point out specific cases of residential properties within the selected area and provide:

   a)   the sale price per sq. m and the location (address) of each case (property)

   b)   the rent price per sq. m and the location (address) of each case (property)

   ➢ Please, specify in your answer the type of residential property under consideration.

7) Can you provide a forecast of the change in the price (per sq. m) after introducing the system upgrade in the selected area for each case of commercial property we discussed above?

   ➢ *If you think there won't be any change in the property values (overall or for certain cases), can you elaborate on the reasons for it?*

   ➢ *If you encounter a positive change, could you make an assumption how it would affect the willingness of the tenants to pay for the property?*

---

[14] * *You can use the form in the attachment or provide your own list with information.*

8) Can you provide a forecast of the change in the price (per sq. m) after introducing the system upgrade in the selected area for each case of residential property we discussed above?

  ➢ *If you think there won't be any change in the property values (overall of for certain cases), can you elaborate on the reasons for it?*

  ➢ *If you encounter a positive change (overall of for certain cases), can you make an assumption how it would affect the willingness of the tenants to pay for the property*

9) Is there any information that you consider useful in this respect that was not included in these questions?

Thank you for your professional judgments and the time for this interview!
You will receive a report from the interview, in order to check the accuracy of the report and to clarify any information if necessary.

Catchment buffers surrounding tram line 1

Legend:
- National Railway Station
- Tram line 1
- RR
- Trams
- Buses
- Main road
- Neighborhood

№	Commercial property type (case)	Location	Sale price (sq. m)	Rent price (sq. m)	Change Sale price (sq. m)	Change Rent price (sq. m)	Additional remarks
1							
№	Residential property type (case)	Location	Sale price (sq. m)	Rent price (sq. m)	Change Sale price (sq. m)	Change Rent price (sq. m)	Additional remarks
1							

9.4. Appendix D

Appendix D1

Number of micro businesses per number of employees; total number of employees per business/nr of employees

Number of employees	Number of micro businesses	Total number of employees
1	6232	6236
2	1286	2572
3	672	2016
4	407	1628
5	321	1605
6	206	1236
7	158	1106
8	145	1160
9	103	927
Total	9530	18486

Table D 1 Number of micro businesses per number of employes
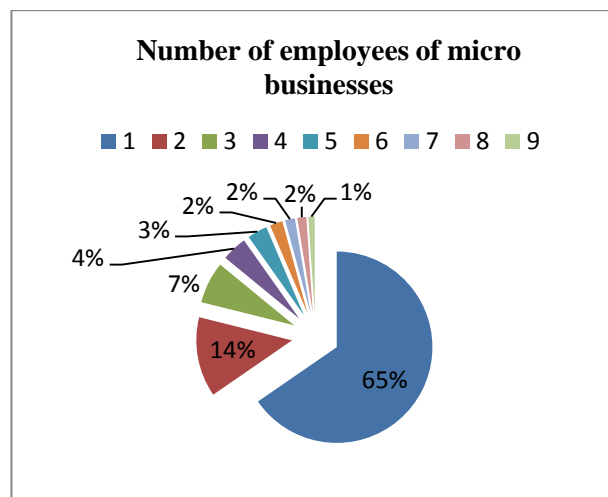
Figure D 1 Distribution of number of employees of micro businesses

Appendix D2

In the appendix additional information of the survey results is provided

- *Information of the survey on businesses and international organizations*
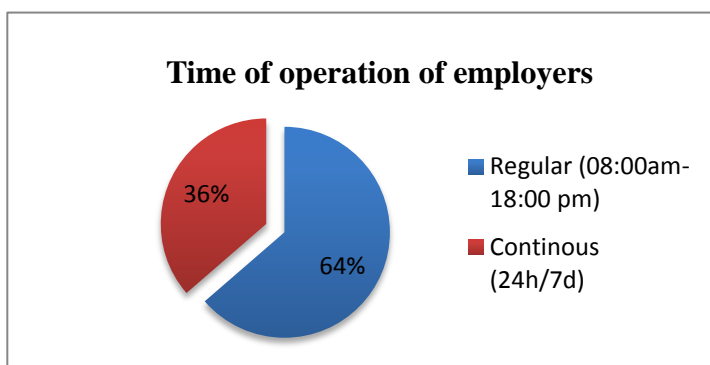
Figure D 2 Distribution of the time of operation of respondents

	Obs	Mean	Std. Dev.	Min	Max
Years of operation	11	**22.5**	22.19572	3	60

Table D 2Statistics of the years of respondents are situated on their current

Property status	Frequency	Percent	Cum
Own	6	**54.55%**	54.55%
Rent	5	**45.45%**	100.00%
Total	11	100.00%	

Table D 3 Distribution of the property status of the office location of respondents

	Obs	Mean	Std. Dev.	Min	Max	Total number of parking places
Parking space usage	11	**130.2727**	172.5503	1	445	**1433**

Table D 4 Statistics of the parking space usage by respondents

National Bicycle Plan	Bicycle racks	1st class train ticket	Required use of PT (by contract)	Cover travel cost only for PT use
✓	✓	✓	✓	✓
✓		✓		✓
✓				
✓				

Table D 5 Frequency of means used for stimulating the use of PT by respondents

Accessibility to employers' location by bicycle before the upgrade of tramline 1

	Hardly accessible	Not easy accessible	Accessible	Easy accessible	Very easy accessible
Employees	0%	0%	18.18% (2 resp)	18.18% (2 resp)	**63.64% (7 resp)**
Clients	0%	0%	18.18% (2 resp)	27,27% (3resp)	**54.55% (6 resp)**
Visitors	0%	0%	18.18% (2 resp)	27,27% (3resp)	**54.55% (6 resp)**

Table D 6 Frequency distribution of respondents' opinion about the accessibility by bicycle

Summary statistics	Obs	Mean	Std. Dev.	Min	Max
Employees	11	**4.454545**	.8201995	3	5
Clients	11	**4.363636**	.8090398	3	5
Visitors	11	**4.363636**	.8090398	3	5

Table D 7 Statistics of respondents' opinion about the accessibility by bicycle

Accessibility to employers' location by bicycle after the upgrade of tramline 1

	Hardly accessible	Not easy accessible	Accessible	Easy accessible	Very easy accessible
Employees	0%	0%	18.18% (2 resp)	18.18% (2 resp)	**63.64% (7 resp)**
Clients	0%	0%	18.18% (2 resp)	27,27% (3resp)	**54.55% (6 resp)**
Visitors	0%	0%	18.18% (2 resp)	27,27% (3resp)	**54.55% (6 resp)**

Table D 8 Frequency distribution of respondents' opinion about the accessibility by bicycle after upgrading

Summary statistics	Obs	Mean	Std. Dev.	Min	Max
Employees	11	**4.454545**	.8201995	3	5
Clients	11	**4.454545**	.8201995	3	5
Visitors	11	**4.454545**	.8201995	3	5

Table D 9 Statistics of respondents' opinion about the accessibility by bicycle after upgrading tramline 1

Summary statistics	Obs	Mean	Std. Dev.	Min	Max
Accessibility improvement (for residents, visitors, clients, employees	11	**4.272727**	.7862454	3	5
Reduction in business travel costs	11	**3.818182**	.8738629	3	5
Reduction in costs for parking space	11	**3.181818**	.6030227	2	5
Travel time cost reduction	11	**4**	.8944272	3	5
Capacity increase	11	**3.909091**	.700649	3	5
Reduction of car usage	11	**3.636364**	.8090398	3	5
Increase of labor pool and job opportunities	11	**3.454545**	.6875517	3	5
Relief in traffic and congestion	11	**4**	.8944272	3	5
Improvement of the city image	11	**4.272727**	.6466698	3	5

Table D 10 Statistics of respondents' opinion about beneficial factors for their performance

Accessibility issues	Respondent ID code										
	1	2	3	4	5	6	7	8	9	10	11
High floor (steps)			✓		✓				✓		✓
Time of operation					✓		✓			✓	
Ticketing methods	✓				✓						
Information provision					✓				✓	✓	
Access to CS	✓			✓	✓		✓		✓	✓	
Frequency		✓		✓						✓	
Capacity(Overcrowding)	✓		✓	✓		✓					
Limited number of lines		✓		✓							
General mobility issues of the area											
Parking space			✓				✓				
Traffic	✓	✓		✓			✓	✓		✓	
Congestion	✓	✓		✓			✓	✓		✓	

Table D 11 Accessibility and mobility issues respondents experience

Figure D 3 Overview of the businesses located within the catchment area of the upgrade, divided by size
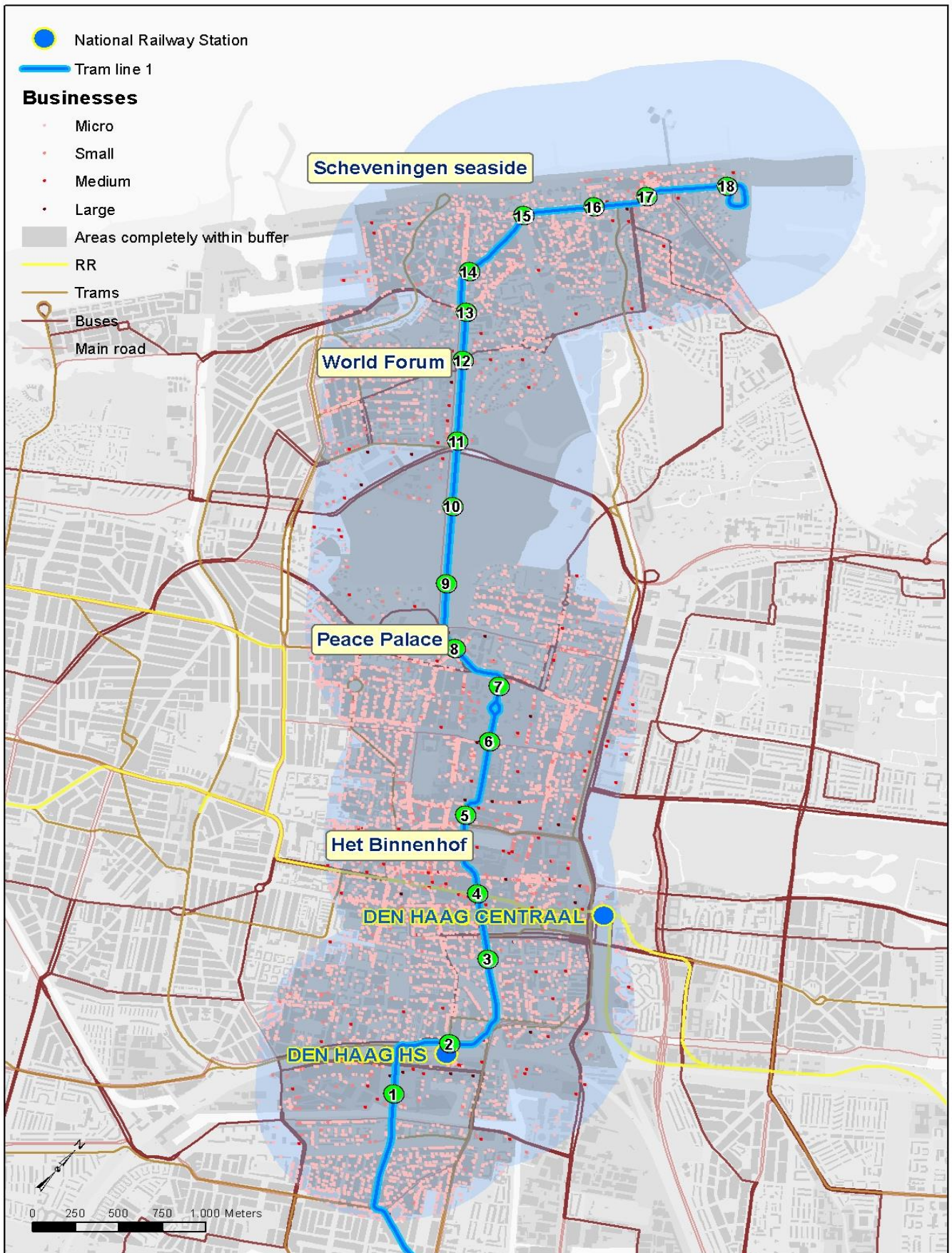
Figure D 4 Overview of the international organizations within the catchment area of the upgrade, divided by size
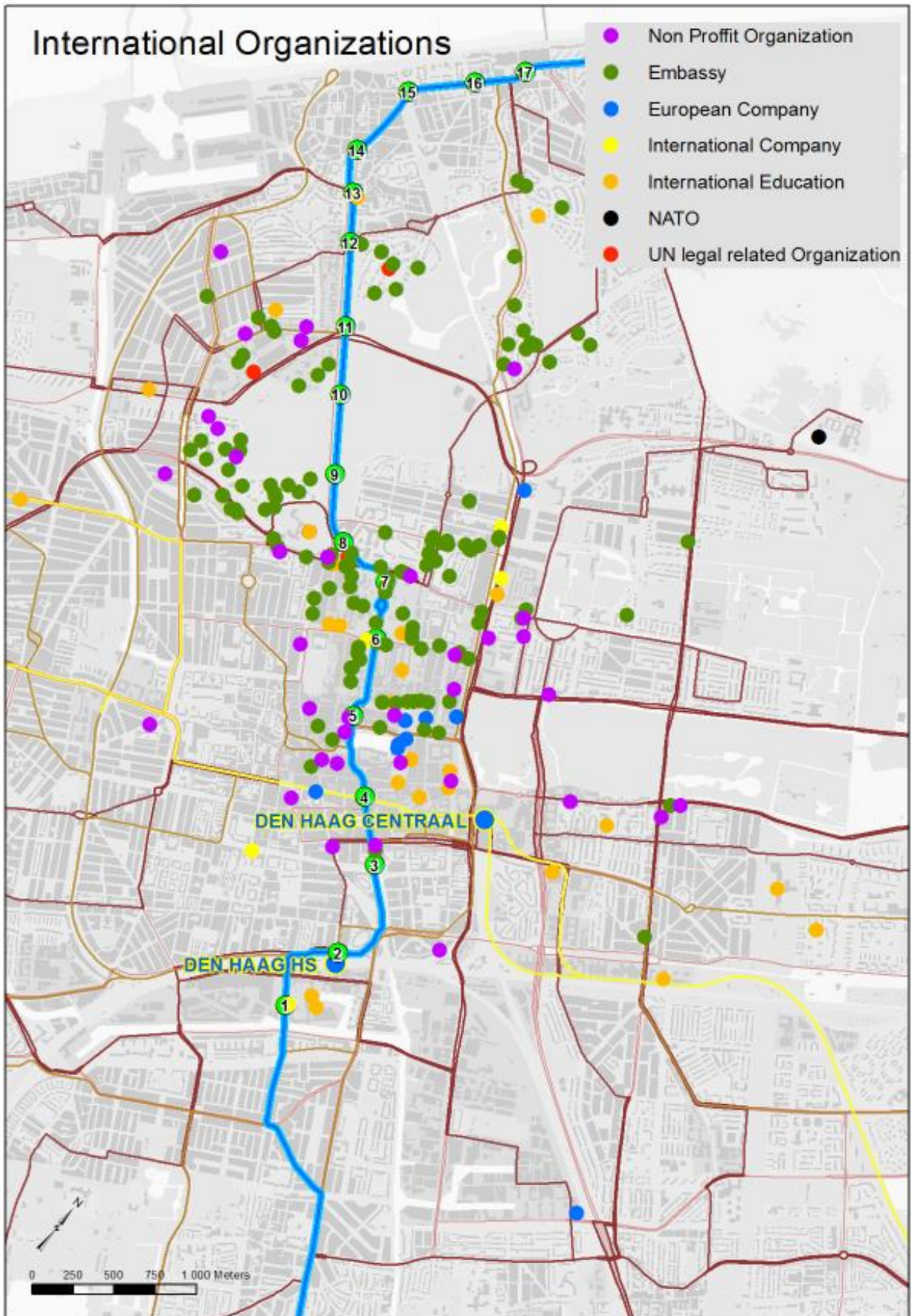
9.5. Appendix E

Appendix E 1

Descriptive statistics of the survey results for Businesses and (International Organizations)
The statistics are presented for each question from the questionnaire distributed to the participants in the survey

```
. des

Contains data from G:\Stata\New data set Companies.dta
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years_operation str3   %9s
prop_status     str4   %9s
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pt_use          str3   %9s
car_use         str3   %9s
bicycle_use     str3   %9s
other_use       str3   %9s
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access_impr     byte   %8.0g
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reduc_psp       byte   %8.0g
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reduc_caruse    byte   %8.0g
incr_lbp        byte   %8.0g
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access_bic~pl_1 byte   %8.0g
access_bic~cl_1 byte   %8.0g
access_bicy~t_1 byte   %8.0g
htm_contr       byte   %8.0g
_____
Sorted by:

.
```

Category 1 – General information about the interviewed business/ (international) organization

Q3 Years of operation
```
. tab years_operation
```

years_operation	Freq.	Percent	Cum.
10	1	9.09	9.09
15	1	9.09	18.18
3	1	9.09	27.27
32	1	9.09	36.36
4	1	9.09	45.45
42	1	9.09	54.55
5	1	9.09	63.64
60	2	18.18	81.82
8	2	18.18	100.00
Total	11	100.00	

Q4 – Property status of employers 'location within the catchment area
```
. tab prop_status
```

prop_status	Freq.	Percent	Cum.
Own	6	54.55	54.55
Rent	5	45.45	100.00
Total	11	100.00	

Category 2- Employees and travel behavior

Q1 Number of employees and working patterns
```
. sum empl_total
```

Variable	Obs	Mean	Std. Dev.	Min	Max
empl_total	11	166.7273	268.8305	5	850

Q2 Working patterns of employees (fulltime/partime)
```
. sum empl_ft
```

Variable	Obs	Mean	Std. Dev.	Min	Max
empl_ft	11	129.2727	217.8362	1	680
```
. sum empl_pt
```

Variable	Obs	Mean	Std. Dev.	Min	Max
empl_pt	11	39.27273	51.62381	4	170

Q3 Lease car use
```
. sum car_lease
```

Variable	Obs	Mean	Std. Dev.	Min	Max
car_lease	11	21.36364	58.13308	0	196

```
. tab car_lease
```

car_lease	Freq.	Percent	Cum.
0	3	27.27	27.27
1	2	18.18	45.45
2	1	9.09	54.55
3	1	9.09	63.64
8	2	18.18	81.82
16	1	9.09	90.91
196	1	9.09	100.00
Total	11	100.00	

Q4 Private cars used for business trips
```
. sum prcar_bt
```

Variable	Obs	Mean	Std. Dev.	Min	Max
prcar_bt	11	2.454545	5.502066	0	15

```
. tab prcar_bt

    prcar_bt |      Freq.     Percent        Cum.
-------------+-----------------------------------
           0 |          9       81.82       81.82
          12 |          1        9.09       90.91
          15 |          1        9.09      100.00
-------------+-----------------------------------
       Total |         11      100.00
```

Q5 Number of parking places available to employers
```
. tab parking_pl

  parking_pl |      Freq.     Percent        Cum.
-------------+-----------------------------------
           1 |          1        9.09        9.09
          10 |          1        9.09       18.18
          11 |          1        9.09       27.27
          12 |          2       18.18       45.45
          17 |          1        9.09       54.55
          20 |          1        9.09       63.64
         222 |          1        9.09       72.73
         305 |          1        9.09       81.82
         378 |          1        9.09       90.91
         445 |          1        9.09      100.00
-------------+-----------------------------------
       Total |         11      100.00
```

```
. sum parking_pl

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
  parking_pl |         11    130.2727    172.5503          1        445
```

Q6 Business trips per month made by employees
```
. tab trips_bs

    trips_bs |      Freq.     Percent        Cum.
-------------+-----------------------------------
           1 |          1        9.09        9.09
          10 |          1        9.09       18.18
         100 |          2       18.18       36.36
          15 |          2       18.18       54.55
         150 |          1        9.09       63.64
           2 |          1        9.09       72.73
          30 |          1        9.09       81.82
          45 |          1        9.09       90.91
         600 |          1        9.09      100.00
-------------+-----------------------------------
       Total |         11      100.00
```

Category 3- Mobility

Q1 Mobility policy – presence of mobility policy
```
. sum   mob_pol_mp

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
  mob_pol_mp |         11    .6363636     .504525          0          1
```
```
. tab   mob_pol_nomp

 mob_pol_nom |
           p |      Freq.     Percent        Cum.
-------------+-----------------------------------
           0 |          7       63.64       63.64
           1 |          4       36.36      100.00
-------------+-----------------------------------
       Total |         11      100.00
```
```
. tab mob_pol_mp

  mob_pol_mp |      Freq.     Percent        Cum.
-------------+-----------------------------------
           0 |          4       36.36       36.36
           1 |          7       63.64      100.00
-------------+-----------------------------------
       Total |         11      100.00
```

Q2 Travel expenses coverage (fully/ partially coverage of commuting expenses)
```
. sum exp_commute_fully

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
  exp_com~ully |       11    .5454545     .522233          0          1
```

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```
. sum exp_commute_partially

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
 exp_com~ally |        11    .1818182    .4045199         0          1

. sum exp_commute_no

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
 exp_commut~o |        11    .2727273    .4670994         0          1

. tab exp_commute_fully

 exp_commute |
      _fully |      Freq.     Percent        Cum.
-------------+-----------------------------------
           0 |          5       45.45       45.45
           1 |          6       54.55      100.00
-------------+-----------------------------------
       Total |         11      100.00

. tab exp_commute_partially

 exp_commute |
  _partially |      Freq.     Percent        Cum.
-------------+-----------------------------------
           0 |          9       81.82       81.82
           1 |          2       18.18      100.00
-------------+-----------------------------------
       Total |         11      100.00

. tab exp_commute_no

 exp_commute |
         _no |      Freq.     Percent        Cum.
-------------+-----------------------------------
           0 |          8       72.73       72.73
           1 |          3       27.27      100.00
-------------+-----------------------------------
       Total |         11      100.00
```

Category 3- Accessibility

Question 1 Accessibility to employers' office location before/ after the upgrade by employees, clients and visitors by:

- *Public transport – before the upgrade*

```
. sum access_pt_empl access_pt_cl access_pt_visit

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
access_pt~pl |        11    3.363636    .9244163         2          5
access_pt_cl |        11    3.363636    1.206045         2          5
access_pt_~t |        11    3.545455    1.128152         2          5

. sum access_pt_empl_1 access_pt_cl_1 access_pt_visit_1

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
acc~t_empl_1 |        11    4.090909    .8312094         3          5
acces~t_cl_1 |        11    4.181818    .8738629         3          5
access_p~t_1 |        11    4.181818    .8738629         3          5

. tab access_pt_empl

  access_pt_e |
         mpl |      Freq.     Percent        Cum.
-------------+-----------------------------------
           2 |          2       18.18       18.18
           3 |          4       36.36       54.55
           4 |          4       36.36       90.91
           5 |          1        9.09      100.00
-------------+-----------------------------------
       Total |         11      100.00

. tab  access_pt_cl

  access_pt_c |
           l |      Freq.     Percent        Cum.
-------------+-----------------------------------
           2 |          4       36.36       36.36
           3 |          1        9.09       45.45
           4 |          4       36.36       81.82
           5 |          2       18.18      100.00
-------------+-----------------------------------
       Total |         11      100.00
```

```
. tab access_pt_visit

access_pt_v │
       isit │      Freq.      Percent        Cum.
────────────┼───────────────────────────────────────
          2 │          3        27.27       27.27
          3 │          1         9.09       36.36
          4 │          5        45.45       81.82
          5 │          2        18.18      100.00
────────────┼───────────────────────────────────────
      Total │         11       100.00
```

- *Public transport – after the upgrade*

```
. tab access_pt_empl_1

access_pt_e │
      mpl_1 │      Freq.      Percent        Cum.
────────────┼───────────────────────────────────────
          3 │          3        27.27       27.27
          4 │          4        36.36       63.64
          5 │          4        36.36      100.00
────────────┼───────────────────────────────────────
      Total │         11       100.00
```

```
. tab access_pt_cl_1

access_pt_c │
       l_1 │      Freq.      Percent        Cum.
────────────┼───────────────────────────────────────
          3 │          3        27.27       27.27
          4 │          3        27.27       54.55
          5 │          5        45.45      100.00
────────────┼───────────────────────────────────────
      Total │         11       100.00
```

```
. tab  access_pt_visit_1

access_pt_v │
    isit_1 │      Freq.      Percent        Cum.
────────────┼───────────────────────────────────────
          3 │          3        27.27       27.27
          4 │          3        27.27       54.55
          5 │          5        45.45      100.00
────────────┼───────────────────────────────────────
      Total │         11       100.00
```

- *Car– before the upgrade*

```
. tab access_car_empl

access_car_ │
      empl │      Freq.      Percent        Cum.
────────────┼───────────────────────────────────────
          2 │          2        18.18       18.18
          3 │          5        45.45       63.64
          4 │          2        18.18       81.82
          5 │          2        18.18      100.00
────────────┼───────────────────────────────────────
      Total │         11       100.00
```

```
. tab access_car_cl

access_car_ │
        cl │      Freq.      Percent        Cum.
────────────┼───────────────────────────────────────
          2 │          2        18.18       18.18
          3 │          5        45.45       63.64
          4 │          4        36.36      100.00
────────────┼───────────────────────────────────────
      Total │         11       100.00
```

```
. tab access_car_visit

access_car_ │
     visit │      Freq.      Percent        Cum.
────────────┼───────────────────────────────────────
          2 │          2        18.18       18.18
          3 │          5        45.45       63.64
          4 │          4        36.36      100.00
────────────┼───────────────────────────────────────
      Total │         11       100.00
```

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- *Car– after the upgrade*

```
. tab access_car_empl_1
```

access_car_ empl_1	Freq.	Percent	Cum.
2	2	18.18	18.18
3	3	27.27	45.45
4	2	18.18	63.64
5	4	36.36	100.00
Total	11	100.00	

```
. tab access_car_cl_1
```

access_car_ cl_1	Freq.	Percent	Cum.
2	2	18.18	18.18
3	2	18.18	36.36
4	6	54.55	90.91
5	1	9.09	100.00
Total	11	100.00	

```
. tab access_car_visit_1
```

access_car_ visit_1	Freq.	Percent	Cum.
2	2	18.18	18.18
3	2	18.18	36.36
4	6	54.55	90.91
5	1	9.09	100.00
Total	11	100.00	

- *Bicycle– before the upgrade*

```
. tab access_bicyc_empl
```

access_bicy c_empl	Freq.	Percent	Cum.
3	2	18.18	18.18
4	2	18.18	36.36
5	7	63.64	100.00
Total	11	100.00	

```
. tab access_bicyc_cl
```

access_bicy c_cl	Freq.	Percent	Cum.
3	2	18.18	18.18
4	3	27.27	45.45
5	6	54.55	100.00
Total	11	100.00	

```
. tab access_bicyc_visit
```

access_bicy c_visit	Freq.	Percent	Cum.
3	2	18.18	18.18
4	3	27.27	45.45
5	6	54.55	100.00
Total	11	100.00	

- *Bicycle– after the upgrade*

```
. tab  access_bicyc_empl_1
```

access_bicy c_empl_1	Freq.	Percent	Cum.
3	2	18.18	18.18
4	2	18.18	36.36
5	7	63.64	100.00
Total	11	100.00	

```
. tab access_bicyc_cl_1
```

access_bicy c_cl_1	Freq.	Percent	Cum.
3	2	18.18	18.18
4	2	18.18	36.36
5	7	63.64	100.00
Total	11	100.00	

```
. tab access_bicyc_visit_1
```

access_bicy c_visit_1	Freq.	Percent	Cum.
3	2	18.18	18.18
4	2	18.18	36.36
5	7	63.64	100.00
Total	11	100.00	

Benefits of the upgrade for employers' performance

Question 1 Indicators benefiting the performance of employers

```
. sum access_impr reduc_bstr_cost reduc_psp reduc_trtime_cost cap_increase reduc_caruse incr_lbp rel_traf_cong imp
> r_ctimg
```

Variable	Obs	Mean	Std. Dev.	Min	Max
access_impr	11	4.272727	.7862454	3	5
reduc_bstr~t	11	3.818182	.8738629	3	5
reduc_psp	11	3.181818	.6030227	2	4
reduc_trti~t	11	4	.8944272	3	5
cap_increase	11	3.909091	.700649	3	5
reduc_caruse	11	3.636364	.8090398	3	5
incr_lbp	11	3.454545	.6875517	3	5
rel_traf_c~g	11	4	.8944272	3	5
impr_ctimg	11	4.272727	.6466698	3	5

Question 4 Likelihood of entering into an agreement with HTM after upgrading tramline 1
```
. tab htm_contr
```

htm_contr	Freq.	Percent	Cum.
1	1	9.09	9.09
2	2	18.18	27.27
3	2	18.18	45.45
4	4	36.36	81.82
5	2	18.18	100.00
Total	11	100.00	

```
. sum  htm_contr
```

Variable	Obs	Mean	Std. Dev.	Min	Max
htm_contr	11	3.363636	1.286291	1	5

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Appendix E 1

*Paired t-tests run for comparison of the means for the perceived level of accessibility to employers'
locations by employees, clients and visitors (comparison of "before and after"effect)*

T-test results for the level of accessibility by public transport by employees

```
. ttest access_pt_empl== access_pt_empl_1
```

Paired t test

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
a~t_empl	11	3.363636	.278722	.9244163	2.742605	3.984668
access..	11	4.090909	.2506191	.8312094	3.532495	4.649323
diff	11	-.7272727	.2727273	.904534	-1.334947	-.1195985

```
      mean(diff) = mean(access_pt_empl - access_pt_empl_1)         t = -2.6667
Ho: mean(diff) = 0                                degrees of freedom =       10

Ha: mean(diff) < 0            Ha: mean(diff) != 0            Ha: mean(diff) > 0
Pr(T < t) = 0.0118        Pr(|T| > |t|) = 0.0236        Pr(T > t) = 0.9882
```

T-test results for the level of accessibility by public transport by clients
```
. ttest access_pt_cl== access_pt_cl_1
```

Paired t test

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
acc~t_cl	11	3.363636	.3636364	1.206045	2.553404	4.173869
a~t_cl_1	11	4.181818	.2634796	.8738629	3.594749	4.768887
diff	11	-.8181818	.2959786	.9816498	-1.477663	-.1587005

```
      mean(diff) = mean(access_pt_cl - access_pt_cl_1)         t = -2.7643
Ho: mean(diff) = 0                             degrees of freedom =       10

Ha: mean(diff) < 0            Ha: mean(diff) != 0            Ha: mean(diff) > 0
Pr(T < t) = 0.0100        Pr(|T| > |t|) = 0.0200        Pr(T > t) = 0.9900
```

T-test results for the level of accessibility by public transport by clients
```
. ttest access_pt_visit== access_pt_visit_1
```

Paired t test

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
~t_visit	11	3.545455	.3401507	1.128152	2.787552	4.303357
access..	11	4.181818	.2634796	.8738629	3.594749	4.768887
diff	11	-.6363636	.2032789	.6741999	-1.089297	-.18343

```
      mean(diff) = mean(access_pt_visit - access_pt_visi~1)         t = -3.1305
Ho: mean(diff) = 0                                  degrees of freedom =       10

Ha: mean(diff) < 0            Ha: mean(diff) != 0            Ha: mean(diff) > 0
Pr(T < t) = 0.0053        Pr(|T| > |t|) = 0.0107        Pr(T > t) = 0.9947
```

T-test results for the level of accessibility by car by employees
```
. ttest access_car_empl== access_car_empl_1
```

Paired t test

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
a~r_empl	11	3.363636	.3096252	1.026911	2.673748	4.053524
access..	11	3.727273	.3590621	1.190874	2.927232	4.527313
diff	11	-.3636364	.2439347	.8090398	-.9071567	.179884

```
      mean(diff) = mean(access_car_empl - access_car_emp~1)         t = -1.4907
Ho: mean(diff) = 0                                  degrees of freedom =       10

Ha: mean(diff) < 0            Ha: mean(diff) != 0            Ha: mean(diff) > 0
Pr(T < t) = 0.0834        Pr(|T| > |t|) = 0.1669        Pr(T > t) = 0.9166
```

T-test results for the level of accessibility by car by clients

```
. ttest access_car_cl== access_car_cl_1

Paired t test
─────────────────────────────────────────────────────────────────────────
Variable │    Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
─────────┼───────────────────────────────────────────────────────────────
acc~r_cl │     11    3.181818    .2263618    .7507572    2.677453    3.686184
a~r_cl_1 │     11    3.545455    .2816715    .9341987    2.917851    4.173058
─────────┼───────────────────────────────────────────────────────────────
    diff │     11   -.3636364      .15212     .504525   -.7025809   -.0246919
─────────────────────────────────────────────────────────────────────────
     mean(diff) = mean(access_car_cl - access_car_cl_1)      t =  -2.3905
 Ho: mean(diff) = 0                              degrees of freedom =      10

 Ha: mean(diff) < 0          Ha: mean(diff) != 0          Ha: mean(diff) > 0
 Pr(T < t) = 0.0190       Pr(|T| > |t|) = 0.0379       Pr(T > t) = 0.9810
```

T-test results for the level of accessibility by car by visitors

```
. ttest access_car_visit== access_car_visit_1

Paired t test
─────────────────────────────────────────────────────────────────────────
Variable │    Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
─────────┼───────────────────────────────────────────────────────────────
~r_visit │     11    3.181818    .2263618    .7507572    2.677453    3.686184
access.. │     11    3.545455    .2816715    .9341987    2.917851    4.173058
─────────┼───────────────────────────────────────────────────────────────
    diff │     11   -.3636364      .15212     .504525   -.7025809   -.0246919
─────────────────────────────────────────────────────────────────────────
     mean(diff) = mean(access_car_visit - access_car_vis~1)   t =  -2.3905
 Ho: mean(diff) = 0                              degrees of freedom =      10

 Ha: mean(diff) < 0          Ha: mean(diff) != 0          Ha: mean(diff) > 0
 Pr(T < t) = 0.0190       Pr(|T| > |t|) = 0.0379       Pr(T > t) = 0.9810
```

T-test results for the level of accessibility by bicycle by employees

```
. ttest  access_bicyc_empl== access_bicyc_empl_1

Paired t test
─────────────────────────────────────────────────────────────────────────
Variable │    Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
─────────┼───────────────────────────────────────────────────────────────
a~c_empl │     11    4.454545    .2472995    .8201995    3.903528    5.005563
access.. │     11    4.454545    .2472995    .8201995    3.903528    5.005563
─────────┼───────────────────────────────────────────────────────────────
    diff │     11           0    .2696799    .8944272   -.6008844     .6008844
─────────────────────────────────────────────────────────────────────────
     mean(diff) = mean(access_bicyc_e~1 - access_bicyc_e~1)   t =   0.0000
 Ho: mean(diff) = 0                              degrees of freedom =      10

 Ha: mean(diff) < 0          Ha: mean(diff) != 0          Ha: mean(diff) > 0
 Pr(T < t) = 0.5000       Pr(|T| > |t|) = 1.0000       Pr(T > t) = 0.5000
```

T-test results for the level of accessibility by bicycle by clients

```
. ttest access_bicyc_cl== access_bicyc_cl_1

Paired t test
─────────────────────────────────────────────────────────────────────────
Variable │    Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
─────────┼───────────────────────────────────────────────────────────────
acc~c_cl │     11    4.363636    .2439347    .8090398    3.820116    4.907157
a~c_cl_1 │     11    4.454545    .2472995    .8201995    3.903528    5.005563
─────────┼───────────────────────────────────────────────────────────────
    diff │     11   -.0909091    .2112536     .700649   -.5616115    .3797933
─────────────────────────────────────────────────────────────────────────
     mean(diff) = mean(access_bicyc_cl - access_bicyc_c~1)    t =  -0.4303
 Ho: mean(diff) = 0                              degrees of freedom =      10

 Ha: mean(diff) < 0          Ha: mean(diff) != 0          Ha: mean(diff) > 0
 Pr(T < t) = 0.3380       Pr(|T| > |t|) = 0.6761       Pr(T > t) = 0.6620
```

T-test results for the level of accessibility by bicycle by visitors

```
. ttest access_bicyc_visit== access_bicyc_visit_1

Paired t test
─────────────────────────────────────────────────────────────────────────
Variable │    Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
─────────┼───────────────────────────────────────────────────────────────
~c_visit │     11    4.363636    .2439347    .8090398    3.820116    4.907157
access.. │     11    4.454545    .2472995    .8201995    3.903528    5.005563
─────────┼───────────────────────────────────────────────────────────────
    diff │     11   -.0909091    .2112536     .700649   -.5616115    .3797933
─────────────────────────────────────────────────────────────────────────
     mean(diff) = mean(access_bicyc_v~t - access_bicyc_v~1)   t =  -0.4303
 Ho: mean(diff) = 0                              degrees of freedom =      10

 Ha: mean(diff) < 0          Ha: mean(diff) != 0          Ha: mean(diff) > 0
 Pr(T < t) = 0.3380       Pr(|T| > |t|) = 0.6761       Pr(T > t) = 0.6620
```

Additional t-tests run at 10% significance level

T-test comparison the accessibility level perceived by PT, perceived by employees (before and after the upgrade)

```
. ttest access_car_empl== access_car_empl_1, level(90)

Paired t test
```

Variable	Obs	Mean	Std. Err.	Std. Dev.	[90% Conf. Interval]	
a~r_empl	11	3.363636	.3096252	1.026911	2.802453	3.92482
access..	11	3.727273	.3590621	1.190874	3.076487	4.378059
diff	11	-.3636364	.2439347	.8090398	-.8057585	.0784858

```
        mean(diff) = mean(access_car_empl - access_car_emp~1)          t =   -1.4907
Ho: mean(diff) = 0                                degrees of freedom =        10

Ha: mean(diff) < 0            Ha: mean(diff) != 0            Ha: mean(diff) > 0
Pr(T < t) = 0.0834        Pr(|T| > |t|) = 0.1669        Pr(T > t) = 0.9166
```

T-test comparison the accessibility level perceived by bicycle, perceived by employees, clients and visitors (before and after the upgrade)

```
. ttest access_bicyc_empl== access_bicyc_empl_1, level(90)

Paired t test
```

Variable	Obs	Mean	Std. Err.	Std. Dev.	[90% Conf. Interval]	
a~c_empl	11	4.454545	.2472995	.8201995	4.006325	4.902766
access..	11	4.454545	.2472995	.8201995	4.006325	4.902766
diff	11	0	.2696799	.8944272	-.4887844	.4887844

```
        mean(diff) = mean(access_bicyc_e~1 - access_bicyc_e~1)          t =    0.0000
Ho: mean(diff) = 0                                degrees of freedom =        10

Ha: mean(diff) < 0            Ha: mean(diff) != 0            Ha: mean(diff) > 0
Pr(T < t) = 0.5000        Pr(|T| > |t|) = 1.0000        Pr(T > t) = 0.5000

. ttest access_bicyc_cl== access_bicyc_cl_1, level (90)

Paired t test
```

Variable	Obs	Mean	Std. Err.	Std. Dev.	[90% Conf. Interval]	
acc~c_cl	11	4.363636	.2439347	.8090398	3.921514	4.805759
a~c_cl_1	11	4.454545	.2472995	.8201995	4.006325	4.902766
diff	11	-.0909091	.2112536	.700649	-.4737981	.2919799

```
        mean(diff) = mean(access_bicyc_cl - access_bicyc_c~1)          t =   -0.4303
Ho: mean(diff) = 0                                degrees of freedom =        10

Ha: mean(diff) < 0            Ha: mean(diff) != 0            Ha: mean(diff) > 0
Pr(T < t) = 0.3380        Pr(|T| > |t|) = 0.6761        Pr(T > t) = 0.6620

. ttest  access_bicyc_visit== access_bicyc_visit_1, level(90)

Paired t test
```

Variable	Obs	Mean	Std. Err.	Std. Dev.	[90% Conf. Interval]	
~c_visit	11	4.363636	.2439347	.8090398	3.921514	4.805759
access..	11	4.454545	.2472995	.8201995	4.006325	4.902766
diff	11	-.0909091	.2112536	.700649	-.4737981	.2919799

```
        mean(diff) = mean(access_bicyc_v~t - access_bicyc_v~1)          t =   -0.4303
Ho: mean(diff) = 0                                degrees of freedom =        10

Ha: mean(diff) < 0            Ha: mean(diff) != 0            Ha: mean(diff) > 0
Pr(T < t) = 0.3380        Pr(|T| > |t|) = 0.6761        Pr(T > t) = 0.6620

.
```