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Title: **Connectivity and Happiness:**
Assessing the Impact of Accessibility on Well-being

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Connectivity and Happiness:

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Summary

Rapid urbanization has led to an increase in the over dependence on cars as people endeavour to enhance their mobility and meet their travel needs. Strategies have been developed to avert the negative impacts of this phenomenon that focus behavioural changes such as reducing travel by combining trips and changing travel destinations and also modal shift which involves shifting to less polluting modes like cycling, walking and mass transit or public transportation.

Literature has shown that as an incentive to public transportation use it is important that infrastructure that enables people to access the system with ease is in place for instance having the platforms within easy reach, having sufficient parking facilities at the stops and having real-time information displays that would give users the accurate time on what time to expect the next mode.

This thesis aims at explaining how improved connectivity as a result of better accessibility would enhance the wellbeing of people. Wellbeing or happiness is a focal point in this study because recent literature on happiness economics has revealed that it would be important to evaluate the impact of projects not only basing on the economic benefits but also on the impact they have on people given the fact that they are the eventual users. Innovations in transportation could affect the wellbeing of people positively by enabling them to meet the travel needs and negatively by exposing them pollution and traffic safety concerns.

The study use data from the Municipality on the quality of life spatial indicators from the Rotterdam gebeidprofiel (Rotterdam Area Profile (2008-2012)) and the information on happiness from the Rotterdam Leisure Survey (2009). Demographic information was accessed from the website of Statistics Netherlands which is the Dutch central bureau of statistics while time schedules and travel patterns of modes was accessed from the Rotterdamse Elektrische Tram (RET) website. Interviews were also conducted and these targeted the Municipality and RET personnel especially those involved in the transport and planning sector.

The analysis is performed using the ordered probit model and it focuses on the causal relationship between accessibility and happiness, accessibility is measure in terms of distance from public transportation stops to determine the ease of accessing transportation, frequency to determine efficiency and this is analysed by considering the number of mode visits, the waiting time at the stations and the time spent in the modes The number and type of nodes is used to determine the choice available for users. The study also includes an analysis on the impact of income on travel behaviour and mode choice.

The study reveals that proximity to nodes despite the accessibility benefits would reduce the happiness of neighbourhoods as it heightens concerns on noise pollution and traffic safety. Increased number of nodes also negatively affects happiness as does the increased number of directions that the modes go through. Increased number of mode visits reduces happiness as it would lead to congestion, increased waiting time also negatively affects happiness as people attach value on travel time which incorporates both waiting time and in-vehicle time.

Overall it is recommended that measures be developed to be mitigate the negative impacts of overall accessibility such as having buffers at the stops to shield people from excessive noise levels and ensure effective use of public transportation. It is also important especially for the neighbourhoods categorised as very unhappy that access to public transportation is improved in terms of reducing the distance from the homes to the nodes, increasing frequency modes and also increasing the number of directions accessible to them as all these indicators are positive for the happiness of this category.

Keywords

Connectivity. Public Transport. Happiness. Travel Behaviour. Income

Dedication

I dedicate this work to my son Darryl Mark Arinaitwe, may it inspire you to always aim for the best in your studies and life.

To my mother, thank you for always standing by me, for believing in me and for being my greatest inspiration.

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Abbreviations

CBS	Centraal Bureau voor de Statistiek/ Central Bureau of Statistics
RET	Rotterdamse Elektrische Tram
VIF	Variance Inflation Factor
QoL	Quality of Life

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Chapter 1: Introduction

This chapter introduces the study outlining the background to the study, the problem statement and the objectives of the study. The main research question and the sub-questions that are to guide the study are also stated. Justification for the research is explained in the section on significance and the chapter concludes with the scope and limitations of the research.

1.1 Background of the Study

"Transport infrastructure plays an important role in shaping the configuration of spatial socio-economic structure and influences regional accessibility."

(Fengjun, Chengujin, et al., 2010)

Rapid urbanization has led to an increase in the over dependence on cars as people endeavour to enhance their accessibility. This high mobility has in turn led to increased congestion, air and noise pollution and traffic safety concerns in the urban setting and therefore in a bid to avert these effects and in line with ensuring sustainable development, policies under sustainable transportation have been developed with the goal of ensuring basic access needs of individuals are met while limiting emissions within the planets ability to absorb them.

Accessibility refers to people's overall ability to reach services and activities, it is among the fundamental goals of urban planning and one of the most probable reasons as to why cities tend to attract and have high populations is because they enable people to have access to services, information, goods, jobs and recreation, it is the growing awareness of the need for these factors that has contributed to rapid urbanisation. The quality of accessibility has tremendous direct and indirect impacts ranging from social cohesion, environmental impacts and economic development.

The main goal of transport planning is facilitating connectivity and thus enabling individuals to satisfy their needs by easing access to important destinations and activities. There are many ways in which transportation contributes to favourable life outcomes, such as time savings or local economic development. Transport infrastructure is therefore unquestionably a very important aspect of government investment and expenditure. It is also of great importance in neighbourhoods as it increases interactions within and across the neighbourhood. Goldman and Gorham (2006) citing Centre for Sustainable Transport in Toronto states that one of the components that best defines sustainable transport is a system that allows the basic access and development needs of individuals, companies and societies to be met safely and in a manner consistent with human and ecosystem health, and promises equity within and between successive generations.

Among the strategies developed to minimise the negative effects of mobility is modal shift which involves shifting to less polluting modes like cycling, walking and mass transit or public transportation would be a much better option as it would to some extent allow individuals to maintain their travel demands and patterns. Public transportation would to greater extent contribute to reducing the negative impacts of car dependency as it would ensure connectivity without drastically affecting the travel needs of individuals and since it involves transportation of large number of people at a go, there would be less emissions as a result of less vehicles in the network.

Connectivity is a measure of the degree to which one location is connected to all other locations and it is an important phenomenon because it influences the settlement patterns in a neighbourhood as people would prefer to settle in places that are easily accessible. Bertolini, Clercq, et al. (2005) state that it can be expected that less accessible residential areas are not

desirable and that people who chose to stay in them would have to travel longer. This statement points to the importance of residential areas being easily accessible and the fact that quality transportation has an impact on settlement patterns.

As an incentive to public transportation use it is important that infrastructure that enables people to access the system with ease is in place for instance having the public transportation nodes within easy reach, having sufficient parking facilities at the stops and having real-time information displays that would give users the accurate time on what time to expect the next mode. Transportation nodes are points within a transportation route or network where travellers can access the network or points through which it is possible to change a transport mode. Allsop (2008) states that travellers are typically represented as having points of entry to and exit from the network, each represented by a node and that in many scenarios, where most or all of the transport system concerned is being modelled, these points represent the origins and destinations of the travellers' journeys. In other words the nodes to an individual traveller refer to the start, intermediate or end points on a route.

As earlier mentioned transportation through promoting connectivity enables people to satisfy their needs and travel demands. People travel for different reasons that could range from travel to work, for leisure or any other activity but for whatever reason they decide to travel it is always important and in people being able to satisfy their needs they are able to achieve happiness. Optimization of this happiness can be achieved through ensuring easy access to different modes and this can be done through provision of transport nodes as close as possible to the people who need them.

Happiness is a focal point in this study because recent literature on happiness economics has revealed that it would be important to evaluate the impact of projects not only basing on the economic benefits but also on the impact they have on people given the fact that they are the eventual users. Happiness and wellbeing are usually taken to mean the same thing for instance according to Veenhoven (2009) happiness refers to the degree to which an individual evaluates his life as a whole positively, in other words how much one likes the life he lives and Duarte, Garcia, et al. (2010) define well-being as the perceived evaluation of the overall life environment or system. In both definitions talking what is key is the individual evaluation of overall life

It is imperative to include happiness studies in transport geography because innovations in transportation can affect the wellbeing of people positively by enabling them to meet the travel needs and negatively by exposing them pollution and traffic safety concerns. Happiness can be looked at as a personal positive reaction to a certain environment or system in a certain time frame and this perceived happiness depends on both the environment considered and the different personal points of view among individuals (Dijk and Beek, 2009). The fact that transportation both impacts on the personal views of individuals through how they perceive its importance to their surroundings and environment, it becomes important therefore that it be evaluated basing on its impact on happiness of these individuals

Veenhoven (2009) further exploring the concept of happiness introduces under two categories of satisfaction, the first one being passing satisfaction and the other enduring satisfaction. He further sub-categorises these and the categories under passing satisfaction are pleasure referred which he refers to as passing satisfaction with a part of life and then peak satisfaction which he describes as passing satisfaction with life as a whole. Under enduring satisfaction he talks about part satisfaction which according to him is enduring satisfaction with a part or domain of life like work or family life and the second one is life satisfaction which he defines as enduring satisfaction with life as a whole which he also terms as subjective well-being.

Subjective well-being refers to a person's own assessment of their happiness and satisfaction with life through an evaluation of her past experiences; it is an evaluation of how people experience the quality of their lives and includes both emotional reactions and cognitive judgements. Frey and Stutzer (2002) define subjective well-being as a scientific term in psychology for an individual's evaluation of her experienced positive and negative affect, happiness or satisfaction with life. As stated in the definition it involves both emotional reactions and cognitive judgements, emotional reactions can be referred to as affect and this reflects the immediate evaluation that people attach to circumstances that take place in their lives and it is indicated by the overall satisfaction with life,

Objective well-being is another concept in the happiness studies and it is a conscious evaluation that individuals make about the quality of their surroundings and life situation. This involves a critical evaluation of the built environment they are in for instance the presence of public spaces, access to health services, education, amenities and commerce. The indicator for this assessment is known as quality of life and it is not only the presence of these amenities that is important but how accessible they are in terms of affordability.

Quality of life is a subjective, multidimensional and dynamic condition that responds to life events, incorporating both positive and negative features of life. It is multidimensional in the sense that it encompasses factors such as physical health, psychological state, level of independence, family, education, wealth, religious beliefs, a sense of optimism, local services and transport, employment, social relationships, housing and the environment (Veenhoven, 2009). It is subjective in the sense that different individuals evaluate different factors differently, one individual might regard health as an important indicator for his quality of life and therefore rate his quality of life on how accessible it is for him to access health services.

1.2 Problem Statement

Over the years as a result of rapid urbanization, there has been an increase in over dependence on car use and the problems associated with it such as congestion, air and noise pollution. Strategies that have been proposed to deal with these challenges are geared towards behavioural changes such as shifting to less polluting modes, reducing travel and changing travel destinations which might not be practical as they inconvenience the users. Technological solutions such as improving the energy efficiency of cars and developing new forms of road surface have also been recommended.

Promotion of public transport as an alternative to individual car use would be influential in addressing these issues without necessarily disrupting the travel demands of individuals. Travel being a derived demand and not an activity that people do for the sake of it, it is important that it is facilitated in a way that ensures that people are able to minimize costs both in terms of time taken to travel and cost of travel. This calls for a highly efficient and effective public transportation network that is equally distributed and people should be able to easily access or change to other modes within the network. Transport nodes which as earlier defined are the points through which travellers can access the modes, play a very important role in promoting the use of public transport and the proximity to the nodes is therefore a crucial factor to consider in urban planning.

Some research has been carried out on the impact of proximity to transport modes on social well-being, for example (Brereton, Clinch, et al., 2008) find that proximity to major roads is a detractor for well-being and marginal significance. This they attribute to the fact that the inconveniences of being near a road somewhat outweigh its access benefits for instance environmental negatives such as noise and air pollution. They also find that congestion is a drain on well-being, but that this effect is not statistically significant.

(Morris, 2011)found the ability to walk, vehicle ownership, and location near a rail transit station to be positively, though modestly, linked to social well-being.

However little research has been done on the importance of proximity to transport nodes and their impact on the well-being of people. (Brereton, Clinch, et al., 2008) attempt to find the relationship between proximity to airports and social well-being and their findings are mixed, again probably because of tension between the environmental costs of being near a major transportation facility and its access benefits.

This study attempts to find the relationship between accessibility and happiness and the assumption is that people with better accessibility are happier than those who do not, happiness is the dependent variable and accessibility the independent variable. The indicators for accessibility are distance from the different transport nodes, frequency of modes, number and type of nodes in a neighbourhood and how these influence the happiness of people. The research also looks at which of the different nodes has the highest influence on happiness by considering the nodes that people prefer to stay closest to.

1.3 Research Objectives

The objective of the research is to examine if accessibility has an impact on the well-being of the different income groups in Rotterdam and sought to explain which of the different transport modes has the highest influence on well-being.

1.4 Research Question

To what extent does accessibility have an impact on the wellbeing of the different income groups in Rotterdam?

1.4.1 Sub questions

- How does proximity to transport nodes affect the well-being of people in Rotterdam?
- To what extent does the frequency of a transport mode impact the quality of life of people in Rotterdam?
- What is the impact of number and variety of transport nodes on the happiness of neighbourhoods in Rotterdam?
- How does income influence node proximity preference?

1.5 Significance of the Study

As shown in the background and mentioned in the problem statement, not much research has been done on the causal relationship between proximity to transport nodes and happiness. Some research has been done on the relationship between proximity to transport modes like the roads and happiness, relationship between modes like walkability and social well-being but not much concrete research has been carried out on the importance of transport nodes to the well-being of individuals. This study intends to build on the current limited data available and hopefully trigger interest into further study on the phenomenon.

The study aimed at examining the relationship between location of residences in relation to transport nodes and the impact this has on their well-being. Transportation as earlier mentioned is of great importance and therefore the ease by which individuals can access the transportation network has a great influence on where they decide to settle. This therefore means that if people are indeed happier staying close to transport nodes then land use plans would have to ensure proper distribution of these nodes so as to enhance the quality of life of people in neighbourhoods.

1.6 Scope and Limitations

The research is carried out in Rotterdam in all the neighbourhoods basing on their happiness levels, so as to make a comparison on how different the allocation of transport nodes is in these neighbourhoods and determine if indeed this allocation contributes the difference in the happiness levels of the neighbourhoods.

The study focuses on the main passenger transport nodes which are the bus stops, tram stops, metro stations, and train stations as the independent variables. The sea port and airport were left out because these usually handle freight transportation and even where passengers are accommodated the time taken between the different nodes is longer and not easy to analyse. They are also not used on daily basis therefore their impact could not be analysed easily

The happiness data from the Rotterdam Leisure survey is used and information on distance from nodes is extracted from the quality of life spatial indicators from the Rotterdam area profile, information on population and neighbourhood size are from the Statistics Netherlands website, whereas time schedules and travel patterns of modes are from the RET website.

The indicators for measurement of independent variable are distance of residences from the nearest transport node frequency of modes and number of transport nodes within a neighbourhood. The controls will include, employment status, nationality, size of the neighbourhood, city size and population of the district.

Chapter 2: Literature review

2.1 State of the art theories

This chapter reviews literature on key concepts relevant to the study which include connectivity, accessibility, transportation network, transport modes, transport nodes, proximity to nodes, happiness, travel behaviour and impact of income on travel behaviour

2.1.1 Connectivity

Connectivity refers to the density of connections within a transport network and increased connectivity tends to increase accessibility (Litman, 2015). A dense path or road network with shorter blocks and more connections tends to provide good accessibility due to multiple routes, more direct connections between destinations, and narrower streets with lower traffic speeds that are better suited to walking and cycling, and therefore to public transit travel since most transit trips involve walking links.

The quality of system integration, such as the quality of stations and terminals and the ease of transferring between modes affect accessibility, this implies that the linkage between paths, modes and nodes is crucial for accessibility. Connectivity in transportation network is the measure of the degree to which the modes are connected to one another and the ease and speed with which they can interact. A good transport system should be able to promote connectivity and the more connected the system is the more reliable it is. The location and quality of transportation terminals like bus stops, train stations, ferry terminals, parking spaces and other transfer facilities affects the relative accessibility of the modes they serve.

According to Bell, G., H., Michael, (2000) network reliability has two dimensions the first relating to the connectivity of a network and the other being performance reliability. With regard to connectivity reliability he says that when links fail in unfavourable configurations it may no longer be possible to reach a given destination from a given origin, in which case the network becomes disconnected. This implies that in order for the network to be more reliable the nodes should have the capability of being accessed through more than one link such that in the event that one of the links is disrupted by any occurrence, the flow of traffic is still enabled through the other links.

Connectivity reliability is concerned with the probability that the network nodes remain connected, for each node pair, the network is considered successful if at least one path is operational the paths here consisting of components such as roadways and arcs (Chen, Yang, et al., 2002)). The connectivity between two points that is the origin and the destination is a very important component for the success of a network. In the road network for example during peak hours there could be congestion on a particular route thus affecting the effective flow of traffic, having alternative routes of getting to a destination that may not necessarily be a road would make the transport network more responsive and reliable. Improving connectivity not only decreases the distance between places but also increases traffic capacity.

Usually within the transportation network the automobile transportation is generally well integrated with destinations having affordable parking and most transfer stations being located and designed for easy highway access. The integration of other modes is however significantly inadequate and this sometimes is a major barrier to non-automobile accessibility, for instance it is sometimes difficult to access airports and ferry terminals using public transit. This inadequate integration could prevent use of alternative public transit and instead influence travellers to opt for use of automobiles because they are convenient and this trend would eventually affect accessibility.

2.1.2 Accessibility

Accessibility can be used in reference to the ability of something or a place to be reached, for instance access to information, access to food, and access to education. In this case accessibility would be used as a measure for proximity between two points or aspects for instance proximity to an education facility would facilitate access to education, proximity to a market would facilitate access to food, proximity to a library would facilitate access to information. The term accessibility can also be used in reference to the ability of a transport system to provide a quick and efficient method of people getting to different locations.

Bertolini, Clercq, et al. (2005) find accessibility to be related to both the qualities of the transport system which include travel speed and also the qualities of the land use system such as functional densities and mixes. They also add that there is need for a shift of focus in urban transport planning from catering for mobility to catering for accessibility as this would help to see how more sustainable transport options can, under certain land use conditions, provide a competitive degree of accessibility that matches less sustainable options.

The concept of accessibility is framed by three broadly supported assumptions about human beings which are one that people travel not just for the sake of it, but in order to participate in spatially disjointed activities, secondly that people would want to have a choice among as large a number and as diverse a range of activities as possible and thirdly that travel costs and most importantly travel time, rather than travel distance, determine which of these activities can be engaged in especially in the developed world ((Hagerstrand, 1970),(Downes and Emmerson, 1985)).

Based on these assumptions therefore accessibility can be defined as the number and diversity of activities and places that can be reached within the shortest time and cost possible. Accessibility between points is affected by the distance between them and the effect may be felt in travel time and cost. Affordability, efficiency and diversity of places reached are key when looking at accessibility and therefore the transportation system that can enable people to achieve this would be considered reliable.

Accessibility is considered as the inherent characteristic or advantage of a place with respect to overcoming some form of spatially operating source of friction like time and distance (Ingram, 1971). It has two subsidiary forms which are relative accessibility defined as the degree to which two places or points on the same surface are connected and integral accessibility which is the degree of inter-connexion with all other points on the same surface.

Since accessibility is the ultimate goal of most transportation activity transport planning should be based on accessibility. However, conventional planning tends to evaluate transport system performance based primarily on motor vehicle travel conditions using indicators such as roadway level-of-service, traffic speeds and vehicle operating costs (Litman, 2015). This leaves out the important aspect of promoting public transport and instead favours mobility and the challenges associated with it.

2.1.3 Transportation

Transportation is the movement of people, animals and goods from one location to another and it is important because it enables interaction both at a social and economic level between persons, which is essential for development. The economy of nations is profoundly influenced by efficient and reliable transport systems that promote accessibility and support safe and efficient movement of people and freight.

The transport system is divided into infrastructure, vehicles and operations with infrastructure consisting of the fixed installations which are further divided into routes or paths and knots or

nodes which can be used for interchanges of the passengers and cargo between modes The paths include roads, railways, airways, waterways, canals and pipelines and the nodes consist of terminals such as seaports, airports, railway stations, bus stations, warehouses, trucking terminals, and refuelling depots including fuelling docks and fuel stations. Modes of transport include air, rail, road, water, cable and pipeline.

The vehicles in the system are the means by which the people and cargo are transported and they include among others cars, bicycles, buses, trains, trucks, trams, watercraft and aircraft. Operations refer to the procedures set for managing and programming how the vehicles are operated, and they include financing, legalities and policies. The operations and ownership of infrastructure can be either public or private, and also in the case of passenger transportation there is both public and private transportation. Public transportation involves provision of services by operators for instance the trains, buses and trams, while private involves individuals providing the services for themselves and includes for instance car ownership, or having a bicycle.

Transport is not an end in itself but it is the means by which people are able to engage in activities that require people themselves and material goods to be in different places at different times (Allsop, 2008). It is a means of overcoming physical separation for the purpose of economic, social cultural and personal activity, it is important therefore to consider the transport system in relation to the activities it serves with regard to their nature, timing and location.

Transport plays an important part in economic growth and globalization, good planning of transport is essential to make traffic flow and restrain urban sprawl. However transportation is not only important for economic growth but also for wellbeing of people as it is explained by Duarte, Garcia, et al. (2010) that transport is not only a key factor in modern economies, but it also plays an important role for the individual happiness and that optimisation of transport systems is crucial to meet increasing demands and sustainable development. They add that a transport system will have more chances to be successful as much as it meets the economic, social and environmental demands of the area it serves.

2.1.3.1 Transportation Network

A transportation network refers to the structure which enables vehicular movement and flow of commodities, it serves and connects multiple nodes, people, flows and functions to achieve the goal of moving people, goods and services as efficiently and cost-effectively as possible to increase prosperity and opportunity. The structure includes routes such as rails, roads and streets and also nodes such as sea ports, airports, train stations and bus stops. The main function of network is to find the most efficient way to connect origins and destinations in the shortest time possible

Connectivity can only be achieved through a good and well linked transport network that promotes multimodal transport which means having infrastructure supporting all the modes and also conditions that make all the modes attractive for instance within a roadway there can be rails for trams and then both bicycle lanes and walk ways for the non-motorised modes. This would enable use of different modes of transport on the same route, thereby enhancing reliability of the network. These other modes however should have infrastructure like the tram stops and parking space for bicycles so as to attract travellers to use them.

According to Allsop (2008) even in prehistoric times, transport by land tended to be concentrated on well-defined tracks, and that in earliest history this tendency was reinforced by the construction of roads and bridges. He further adds that the building of ports led to a similar tendency, as far as navigational capability and weather allowed, in maritime transport.

The formalisation of land ownership and rights of way, and the development of inland waterways, railways and modern road transport, he says have defined land transport networks ever more precisely.

Intersections are another important component in the network especially when focusing on the road network. This is essential because congestion usually occurs on the road network since the highest volume of traffic is concentrated on this network, having a sufficient number of intersections in the network would enable automobiles and other transportation modes to have multiple path choices and thus enabling traffic to spread out uniformly in the network. Having multiple intersections in the network usually limits the need to have traffic signals thereby reducing delays.

As earlier mentioned, the network comprises routes that as mentioned above can have intersections for better flow of traffic but then it also consist of the nodes that enable entry, exchange or exit from the network. Allsop (2008) states that it is natural for transport systems to be represented by networks of links along which traffic in the form of people, animals, vehicles is modelled as flowing and nodes at which modelled traffic merge or diverge or may enter or leave the model network.

2.1.3.2 Transport Modes

Transport modes refer to ways or means by which people and merchandize attain mobility and they are an essential component of transport systems since they are the means by which mobility is achieved. There are three basic types of modes depending on over what surface they travel which are land water and air. The modes that travel over land are further grouped into two categories which are the motorised such cars, trains and trams and the non-motorised modes such as walking and biking. The modes are deployed and utilized in different parts of the world depending on the specific freight and passenger traffic demands of the area and each mode has specific requirements and features.

Non-motorised transport modes such as walking and biking according to Rietveld (2000) do not receive much attention in transportation research because these transport services are predominantly produced by households themselves implying that they are not of any interest when one wants to study interactions between supply and demand. He also attributes this to their modest share in total traffic and the low externality problems associated with them. This implies that because these modes have less likelihood in affecting the environment, less attention is paid to them and focus is mainly on the motorised modes which are the main pollutants both in noise and air pollution.

The non-motorised modes of transport despite the little attention given to them in transportation research are very important because even where travellers intend to use motorised modes the non-motorised modes always come into play for instance walking to the bus stop or biking to a train station. These modes are especially favourable for short distance trips and also where competing modes are slow. They also influence the use of amenities as noted by Grow, Saelens, et al. (2008) who find that children and adolescents tend to use multiple recreation sites at least once every other week for physical activity and that their frequent active use of several recreation sites is associated with closer proximity to home and even more so, whether they can walk or bike to sites. Their findings suggest that walking or biking to sites remains significantly associated with more frequent active use of the site and that non-motorised modes are equally important in the transportation studies.

The role non-motorised modes plays in promoting access to the other modes cannot be ignored and for that reason they should be considered as complements to the other modes especially for public transportation and should be given the due attention they deserve if the other modes

are to be successful. A good transport system should therefore not only consider the frequency and efficiency of the motorised modes but also the accessibility of the non-motorised which includes having infrastructure such as walking and cycling lanes and also adequate bicycle parking facilities. This is affirmed by Rietveld (2000) who suggests that for public transport chains where some segments have low frequencies the non-motorised access modes of walking and biking may greatly improve the overall quality of the chain.

As mentioned above transport research concentrates more on motorised transport modes because of the negative externalities associated with them especially those on the environment. In the Netherlands, the contribution of transport to total carbon dioxide (CO2) emissions in the is 19%, as reported in The Rijksinstituut voor Volksgezondheid en Milieu, while nitrous oxide (NOx) emissions are at 66% and volatile organic compound emissions at 42%. In addition, noise pollution has a significant impact on the people with about 27% of the population being seriously affected by noise from road traffic. The report further states that the shares of transport in CO2 emissions are even higher in several other Western European countries, whereas the share in NOx emissions is of the same order in at over 50% in almost all European countries, both Western and Eastern (Wee, Janse, et al., 2005).

With these staggering statistics and given the fact that Europeans countries are among those with advanced technology and would therefore be expected to better be able to avoid such negative impacts, it is no wonder that much attention is being given to the motorised transport modes. Efforts and strategies are being developed to avert these trends so as to have a healthier environment

Transport related strategies such as reducing total transport volume as expressed in passenger trips or in tonnes of goods to be transported, reducing transport distances by combining distance with a given number of trips or tonnes, use of more fuel efficient vehicles and changing the way in which vehicles are driven by for instance maintaining lower speeds have been proposed in order to reduce the negative environmental impacts of transport. These however especially those related to travellers changing their travel patterns might not be supported because they could be perceived as limiting the freedom of the travellers. It would instead be better to develop approaches that would both meet the need for overcoming distance but minimise dependence on car use and this would call for paradigm shift from private car use to public transit.

The paradigm shift would involve modal split, a shift to public transport instead of car use and from lorry to train use for freight, this is mainly because public transport means such as buses and metros have a bigger capacity than the individual cars and also the trains are able to carry heavier load of cargo than the Lorries. If for instance more people use public transportation then there will be less cars on the roads and therefore less emissions into the environment not to mention less congestion.

However much as modal split could be a good strategy, travellers might not be willing to shift from car use because of its convenience and the high mobility associated with individual car use. In order to facilitate this shift therefore, there has to be incentives to attract car users to the use of public transportation and one of these is making sure that they are accessible or that the nodes are within close proximity to where the travellers live and work. Time taken to access public transportation is one of the detractors to its use, which implies that a reliable transport system should critically analyse the walking time from residences to transportation nodes in relation to the total travel time of the travellers depending on the distance and purpose of travel.

Wardman (2004) mentions that public transport use involves walking to and from services or transfer between vehicles or modes. Walk time can be expected to have a premium value since

it incurs greater effort than in vehicle time and that in order to tempt car users to bus use it is essential to provide faster, more frequent and accessible services with measures taken to reduce or compensate the high value attached to bus time.

2.1.3.3 Transport Nodes

Enough nodes and links must be defined to enable all movements that are both physically possible and permitted by regulations in the real system to take place in the model, prevent any movement that is physically impossible or prohibited by regulations in the system from taking place and enable all costs of any kind experienced by each user of the system to be reflected correctly in the costs of traversing the links that make up their modelled route (Allsop, 2008). This points to the importance of nodes in a transport network both for the service operators and also for the users, for users they act as areas to for joining, changing or exiting a mode while for operators they act as places for maintenance of the vehicles.

Modal shift as mentioned earlier is one of the ways in which overdependence on car use can be decreased, other approaches being reduction of distance through mixing land use, reduction of the need to travel through combining trips and also technological invention such use of more renewable resource in vehicles. Modal shift would involve promotion of walking, cycling and public transit instead of a personal car. Transport nodes are especially important for promotion of the modal shift and more so in promoting public transport.

Banister (2008) suggests that transport policy measures can reduce levels of car use through the promotion of walk and cycle and the development of a new transport hierarchy which can be achieved through slowing down urban traffic and reallocating space to public transport, through parking controls and road pricing, and through making it easier to use public transport. The reallocated space can be used to provide much needed infrastructure for promotion of public transport like parking for bicycles and shelters at tram and bus stops. This would enhance accessibility to the entry points to the public transport and with this, travellers would find it more convenient to use public transportation.

Litman (2015) mentions that airports and ferry terminals are sometimes difficult to access by public transit, and bus stops and train stations are sometimes uncomfortable and difficult to access, particularly by people with disabilities, children, and people carrying heavy loads. He further asserts that some destinations lack suitable bicycle parking and changing facilities and it is often difficult to obtain accurate information on alternative modes. All these aspects can be deterrents to effective use of public transportation as individuals would want to start and finish their journeys with as little inconveniences as possible.

2.1.3.4 Proximity to Transport Nodes

The extent to which stations or interchange nodes are integrated with their surrounding urban environment is a major determinant of the success of public transport initiatives (Dobrovolsky and Marsay, 2007). This integration requires the creative blending of transport functionality with property development opportunities at public transport nodes. This statement alludes to the significance of location of property in relation to transport nodes. Public transportation is heavily dependent on the effectiveness of nodes in relation to how accessible they are to the users and therefore the distance between transport nodes and the other land uses will determine how successful public transportation is.

As mentioned before, travel is an activity that cannot be avoided because of the need to meet different goals and participate in activities. Banister (2008) maintains that travel is a derived demand not an activity that people wish to undertake for its own sake and that it is only the value of the activity at the destination that results in travel. It is therefore a given that people will always have the need to travel for diverse reasons and as such behavioural approaches that

are aimed at reducing the travel behaviours of people might not be practical. It is also a known fact that people would want to minimise travel cost both in terms of time and actual cost of the journey. Private cars are preferred because of their flexibility, high mobility and the time saving factor. In order for modal shift to be successful, public transportation has to be able to fulfil these conditions and thus attract users.

Behavioural changes that have been proposed to check the high mobility rate may be perceived as restrictive to the quality of life of life of people as they reduce the comfort of travellers and are likely to be resisted. Optimisation of transport systems is crucial in order to enhance sustainable development but then alternatives that promote this without necessarily restricting the travel behaviours of people should be developed. It is in line with this that the study of transportation happiness becomes important because it helps understand the decision making process of users.

Time taken to get to the transport nodes, waiting time and also the sometimes unreliable time between transfers are probably the main detractors to the use of public transport. Sometimes due to inadequate information on the arrival and departure times of some modes, travellers are forced to get to the access points much earlier or even miss them because they underestimated the time it would take to get to the nodes.

Abou-Zeid, Witter, et al. (2012) assert this view claiming that one of the undesirable features of public transport is the fact that the extent to which a journey can be made at the desired time depends on the frequency of service requiring users to either plan their activities around scheduled departure times, which involves inconvenience and transaction costs along with some amount of wait time, or else turn up at the departure point at random, which avoids the scheduling costs but incurs additional waiting which on average equals half the headway.

Travel costs, and especially in the developed world most importantly travel time, rather than travel distance, are major determinants of the possible places and different activities that people would be willing to engage in. It is for this reason that travellers have total daily travel time budgets and travel-to-work time budgets so that they can devise ways of decreasing the time taken to travel and the cost of travel (Bertolini, Clercq, et al., 2005).

These factors emphasise the importance of proximity to transport nodes as being close to them would eliminate the problem of time taken to get to the nodes and therefore travellers would not have to make extensive time schedules before travel. Proximity to transport nodes would also eliminate the extra costs involved in moving from the residences for instance to the public transportation access points.

Proximity to transport nodes has been found by previous research to be both an amenity and a disamenity. Brereton, Clinch, et al. (2008) find that life satisfaction is highest for those living between thirty and sixty kilometres from an international airport while Wu (2013) finds that homeowners' happiness about commuting convenience rises significantly in places affected by the building of new train stations, relative to places that were unaffected and that homeowners' residences receiving increased station proximities experience improvements in happiness about traffic pollution and living convenience.

The findings of these researchers indicate that much as people would like to have easy access to the transport network, the negative impacts of being close to them might be detractors for living close to transport nodes. An international airport would ideally have a significantly high volume of traffic leading to and from it, and people would therefore not want to be affected by the congestion, noise and air pollution associated with such high traffic. A train station would on the other hand have less traffic and therefore less negative impacts associated with it which would explain the findings of Wu (2013) with regard to train use and happiness. The type of

transport node and most importantly how much its benefits balance against its negative attributes would determine peoples decision to stay near it or not.

The above literature introduces a new method of analysing the success of projects, cost benefit analyses using economic indicators are the main evaluation methods adopted for projects in the transport sector, however given the fact that these projects are meant to be used by people and that they therefore impact on the well-being of and communities it is important that happiness studies be integrated in the transportation field. The study of happiness in transport geography becomes empirical therefore not only because of the opportunities that a good transport system offers such as access to life domains but also because of the negative aspects associated with transport that could negatively impact on the well-being of individuals.

2.1.3 Happiness

"Measuring the extent to which where we live affects how we feel and our overall QoL has long been the subject matter of theoretical and empirical work in the fields of human geography, urban and regional studies, regional science and regional Economics. Most of the efforts to date involve the use of objective approaches to researching QoL and well-being, whereby factors pertaining to the social and physical environment, that are relatively easy to quantify and which are assumed to determine human well-being (e.g. income, consumption, residential land, wages and rents, local amenities, natural environment, environmental pollution) are observed, measured and modelled."

(Ballas, 2013)

According to Veenhoven (2009), there are four different classifications of quality of life that fall either under external qualities or internal qualities that present themselves in the form of either life chances or life outcomes. Liveability of the environment is an external quality under the life chances category which refers to the environment an individual lives in and the opportunities it offers, life-ability of a person which is also under the category of life chances refers to internal categories of an individual such as their health and their disposition. The life outcomes category consists of the utility of life and satisfaction with life. Utility of life according to the author denotes the meaning of life, life should be good for something, implying that it should have a purpose. Satisfaction with life, the subjective appreciation of life is also commonly referred to as subjective well-being. He asserts that this is the best criterion for assigning priorities as it reflects the degree to which external living conditions fit with inner abilities.

McFadden in (Duarte, Garcia, et al., 2010) states that transportation is affected by human behaviour through its consumers who are the drivers, riders, vehicle buyers, and shippers, through its managers and workers and through the policy-makers and voters who determine transportation infrastructure and policy. This indicates that much as transport infrastructure impacts the well-being of people, it is also affected by the perceptions and needs of its eventual users and operators. A transport system will be more effective if it meets the social, economic and environmental demands of the area it is located and as such the priorities and perceptions of the population it is to serve or is serving have to be put into consideration to facilitate its success.

Characteristics of people's immediate surroundings have been found to have an impact on their well-being (Brereton, Clinch, et al., 2008). Aspects like presence of and access to amenities like public open spaces, quality of the built and natural environment and the opportunities these offer to the community would influence their evaluation of their well-being. Smith, Nelischer, et al. (1997) state that community quality is a tremendously complex concept which involves the physical environment providing opportunities for humans to meet their needs and desires.

They further mention six categories of the community quality which are liveability, character, connection, mobility, personal freedom, mobility and diversity.

Liveability, connection, mobility and diversity are importance to transport geography and this research, liveability as earlier mentioned refers to the quality of the external environment and it embodies the basic qualities that are required for the success of a community. Connection refers to provision of opportunities for social interaction both within and outside the community and mobility is the ease and convenience with which people in a community can move while diversity denotes the presence of a variety of choices for individuals and the freedom that they have to choose. Transportation and in this public transit should be able to enhance these aspects by providing convenient and affordable access to as diverse a range of activities and opportunities without adversely affecting quality of environment.

The concept of utilitarianism which advocates for actions aimed at greatest happiness for the greatest number advanced by Bentham has been the focus of many planning interventions and project initiatives, transport planning being one of them. He proposed a new moral principle that the goodness of an action should not be judged by the decency of its intentions, but by the utility of its consequences thereby conceiving final utility as human happiness (Veenhoven, 2004). This principal suggests that for every intervention taken that would have an impact on people, decision makers should critically think about the impacts on the happiness of the people and in this case a good decision would be one that would make the majority of people happy.

As earlier mentioned, travel time is the most important determinant of travel mode choice followed by aspects like affordability and convenience. People are more likely to choose private cars over public transit because the private cars present flexibility and ability to schedule trips in a way that would ensure they arrive within the shortest time possible. The convenience of knowing that at the end of the trip, the individual will be able to park their vehicle in their backyard or street parking lot and not have to walk long distances back to their homes is another factor. This is not usually the case with public transportation where people have to walk or ride to stations in order to access different modes, sometimes even missing them probably because they did not check the schedule or because they got delayed on the way as result of traffic congestion or as result of for instance in cases where transfers are required one train taking long to get them to the transfer station. Such inconveniences are some of the detractors to use of public transport.

This line of thought points to the significance of proximity of living areas to transport nodes, in transport dominance, proximity to transport nodes or hubs and trunk roads is one of the three components along with transport network density and accessibility. Transport dominance is an integrated indicator used to evaluate and measure the development level of transport infrastructure network in a region to reflect its supportive capacity for its socio-economic activities (Fengjun, Chengujin, et al., 2010). Under this indicator, airports and seaports are considered as transport hubs while railways and highways are trunk roads. Proximity according to Fengjun, Chengujin, et al. (2010) is designed to evaluate how close a place is to these important transport facilities and the greater the proximity, the better the transport condition.

Consequently from the above people would ideally be happier living and working near transport nodes because they would provide the ease of accessing public transportation modes without spending more than necessary and wasting time. This would imply that proper transport should ensure that these nodes are as close as possible to the living and working areas. Although this is true, it is not always practical because as earlier mentioned the nodes are associated with a number of disamenities of which noise pollution is the highest followed by air pollution and traffic related insecurity. Wu (2013) in his study on the impact of proximity

to rail transport found that the traffic safety happiness decreased with reduction of distance to the train station.

Such insecurities and concerns related to health and safety are the biggest detractors of locating nodes within close proximity to dwelling areas and therein lies the dilemma on whether to forego safety and health concerns and maximise accessibility or optimise connectivity at the expense of health. Happiness literature has shown that people evaluate their happiness by evaluating their life satisfaction as a whole so they would not be willing to trade off on aspect for another, that is why for instance in Wu, (2013) findings home owners would be happy with the commuting convenience but then have their happiness decreased by safety concerns.

These issues raise important questions like how far or near does one have to be from a transport node to be happy, bearing in mind the travel conveniences associated with being near them and the negative impacts that come with that proximity. It also calls for more innovative planning on ways in which technology can be used to mitigate these negative impacts but ensure accessibility for the people. In the Netherland for instance having underground train and metro stations has helped to address the issue of noise pollution. Other innovations that can be looked into are having green walls to address air pollution and also having street lights at these nodes to maximise safety.

It is however important to emphasise that not all the transport nodes have the same level of disamenities. The noise from a bus leaving a bus station is not the same as that of a plane taking off, nor is the noise level at a tram stops the same as that at a train station. This implies that as one plans for the ideal distances from the nodes, it is crucial to consider the type of node being planned for and what levels of noise it generates as well as levels of air pollution and the safety concerns of the neighbourhood.

The ideal walking distance from a dwelling unit to the nearest bus station is given as 500 meters which would be an acceptable distance for the tram stops as well whereas the ideal distance for the metro is 800m. A train station is given a distance of between 800-1000 metres.

Wu (2013) in his study uses a distance band of 2 km and finds people living within 2km from the rail station to be happier while happiness decreases as the distance from the station increases. He further uses a 1km distance band and finds the results to have little changes but with stronger evidence of positive happiness effects associated with commuting convenience. The distances from airports as established by Brereton, Clinch, et al. (2008) depends on the type whereby people are happier living between 30km and 60km from an international airport while the amenity value for regional airports is at less than 30km.

2.1.5 Travel Behaviour

Travel behaviour is a broad concept that encompasses analyses of how people plan and use transport, it involves a study of issues like travel purpose, number of trips, destinations, route choices, sequence and pattern of trips. According to literature travel behaviour seems to be influenced by two broad factors, namely urban form and socio-demographic and lifestyle factors. The urban form refers to the evolution of metropolitan areas from monocentric to polycentric structures and how this impacts on commute distances and the time taken to travel.

Schwanen, Dieleman, et al. (2001) in their study on how monocentric and polycentric urban structures affect modal choice found that people living in the core of the cities travel relatively long distances by public transport whereas those living in suburbs drive long distances and that in decentralized urban regions distance by car is relatively long while the distance travelled by public transport is relatively short. In cross-commuting urban systems where many suburban commuters work in other suburbs the distance travelled by car is relatively short and by public transport fairly long.

The socio-demographic and lifestyle factors include aspects like income level, age, sex, employment status, level of education, ethnicity, marital status and household composition and these are sometimes referred to as individual attributes. The lifestyle factors include travel distance, travel purpose and car ownership

The influence of difference in sex on travel behaviour as stated by Best and Lanzendorf (2005) in their study on impact of sex on travel is that women are considered to be more likely to adopt sustainable travel behaviours compared with men. They also find that much as there is no significant differences in the total number of trips or distances travelled between men and women, there are some gender differences in the type or destination of trips and that women make fewer journeys to work by car and more journeys for maintenance activities such as shopping and child-care.

Newbold, Scott, et al. (2005) studies the travel behaviours of Canadians aged 65 years or more to determine if their travel patterns are different from younger Canadians and finds that older Canadians do make fewer daily trips than younger Canadians which they attribute to the fact that they are no longer employed and therefore no longer making travel-to-work journeys. They further find that the older Canadians rely more on the car than on public transport compared with younger Canadians.

On household composition Ryley (2006) finds that households with children are highly dependent on cars as the primary source of travel mode and favour cycle trips mostly for leisure rather than work journeys. Schwanen, Dieleman, et al. (2001) find that adults with children make the most trips as they tend to take their children to school and take them for leisure activities like visits to parks.

Giuliano (2003), Giuliano and Narayan (2003) and Giuliano and Dargay (2006) find significant differences in travel behaviour between different demographic groups in the USA and the UK. Their data shows that American participants make 4.4 trips per day travelling approximately 31 miles whereas the British participants travel only 16 miles in 3 trips per day. The difference in the results they say could however be attributable to the fact that the data collection methods they used for both countries was different.

2.1.5.1 Income and Travel Behaviour

Nielsen in (Chen, Gan, et al., 2015) points out that travel mode choice relates not only to the level of service but also the individual attributes and travel characteristics. The individual attributes as mentioned earlier would include the gender, age and income level among others.

Commuters as mentioned in the earlier chapters endeavour to choose transport modes that enable them to minimize travel costs and opportunity costs of travel and for this reason the mode choice is made with regard to trip speed and time taken. Income affects travel behaviour in several ways which include the choice of mode used to travel, travel purpose, distance travelled, the destination and the number of trips made.

DeSalvo and Huq (1996) through an observation of the commuting patterns in U.S. cities in his paper on the relationship between income, residential location and mode choice states that lower income individuals commute predominantly by bus while higher income individuals commute predominantly by car and that therefore both mode choice and the money cost of travel seem to be influenced by income.

Dieleman, Dijst, et al. (2002) use the Netherlands National Travel Survey from 1996 to study the travel behaviours of participants aged 12 years or more. Their research studies the micro-factors of urban form, household attributes and the residential context and their major findings are that households with higher incomes are more likely to own and use a car than the low

income households. This implies that with more income the demand for public transport is lowered given the comfort and convenience that comes with using a personal car.

Some studies have however argued against the influence of income on transport choice mode instead attributing the choice to the taste of the commuters but Jara-Diaz and Farah (1987) emphasise it's importance most especially with regard to the developing low income countries were the wages of the workers are low and add that what makes the income effect relevant is the relative importance of disposable income with respect to an expenditure level which can be regarded as the minimum necessary for survival.

Income also plays a role across the different age groups as established by Chen, Gan, et al. (2015) in their study on travel mode choice among migrant workers in China which reveals that the older migrant workers would prefer walking as a travel mode compared to the younger ones and they attribute this to the fact that the older migrants have families to care for and therefore cherish their hard earned money more than the younger workers. The fact that using another mode would decrease the money they need to address other crucial issues in their families pushes them to use a mode that would not further decrease their monthly income.

According to DeSalvo and Huq (1996) when considering the various modes typically used for commuting, it seems reasonable to array them in terms of their average speeds and in their analysis they conclude that it costs more to go faster. They however elaborate that to travel a greater distance, commuters would not choose to change speed by changing the mode unless the total commuting cost rises at a slower rate with the new mode than with the old one. This shows the influence of income in determining the transport mode to use in covering long distances and it seems to suggest that high income earners are more willing to travel longer distances as they can easily afford the modes that would enable them cover the longer distances faster. In more results DeSalvo and Huq (1996) affirm this assumption stating that as the wage rate rises, commuters choose a faster mode so as to spend less time commuting, this again reflecting on the importance of income.

2.1.6 Summary and Lessons Learnt from Literature

Travel is demand driven and therefore people are bound to travel for whatever reason and at any given time and they will chose the mode of transport that will enable them meet their needs at the lowest cost possible, the reason as to why most chose use of private cars because of their high mobility and flexibility rates.

Time travel that involves an evaluation of both in-vehicle time and time taken to and at transfer stations is of considerable importance in determining the travel mode especially in the developed countries. Equally important is the cost of travel while length of travel is not of so much importance given the availability of high speed modes of transit.

From the literature it is also evident that it is not just the presence of a transport network that is important but the number and diversity of opportunities and activities that it enables people to access that has a higher impact on the happiness of people. Furthermore the accessibility of this transportation and affordability are also of importance to well-being.

Behavioural changes aimed at reducing travel frequency and travel distances may not be practical since as noted people travel with an aim and so usually it is impossible for them combine trips, or completely cut out trips as this would deprive them of much needed access to opportunities. A modal shift would instead be more effective in both checking the rising challenges of high mobility while still enabling travellers to maintain their travel demands.

As an incentive to more use of public transportation, it is important to ensure that proximity of dwelling places, work area, public open spaces to transport nodes is considered so as to

eliminate the inconveniences usually associated with public transportation. It is however of equally great importance that the negative impacts of the nodes being too close are factored in so as to strike a balance between accessibility and environmental quality.

The aspect of the distances to consider in the location of these nodes is highly dependent on the type of mode for which the node is being constructed and the degree of disamenities associated with that particular node, this too is an important criterion that should be considered.

2.2 Conceptual Framework

Among the key components that a transport system should have in order to be regarded as effective are its ability to operate fairly and efficiently, offer choice of transport mode, and support a competitive economy as well as balanced regional development and is affordable, (Goldman and Gorham, 2006).

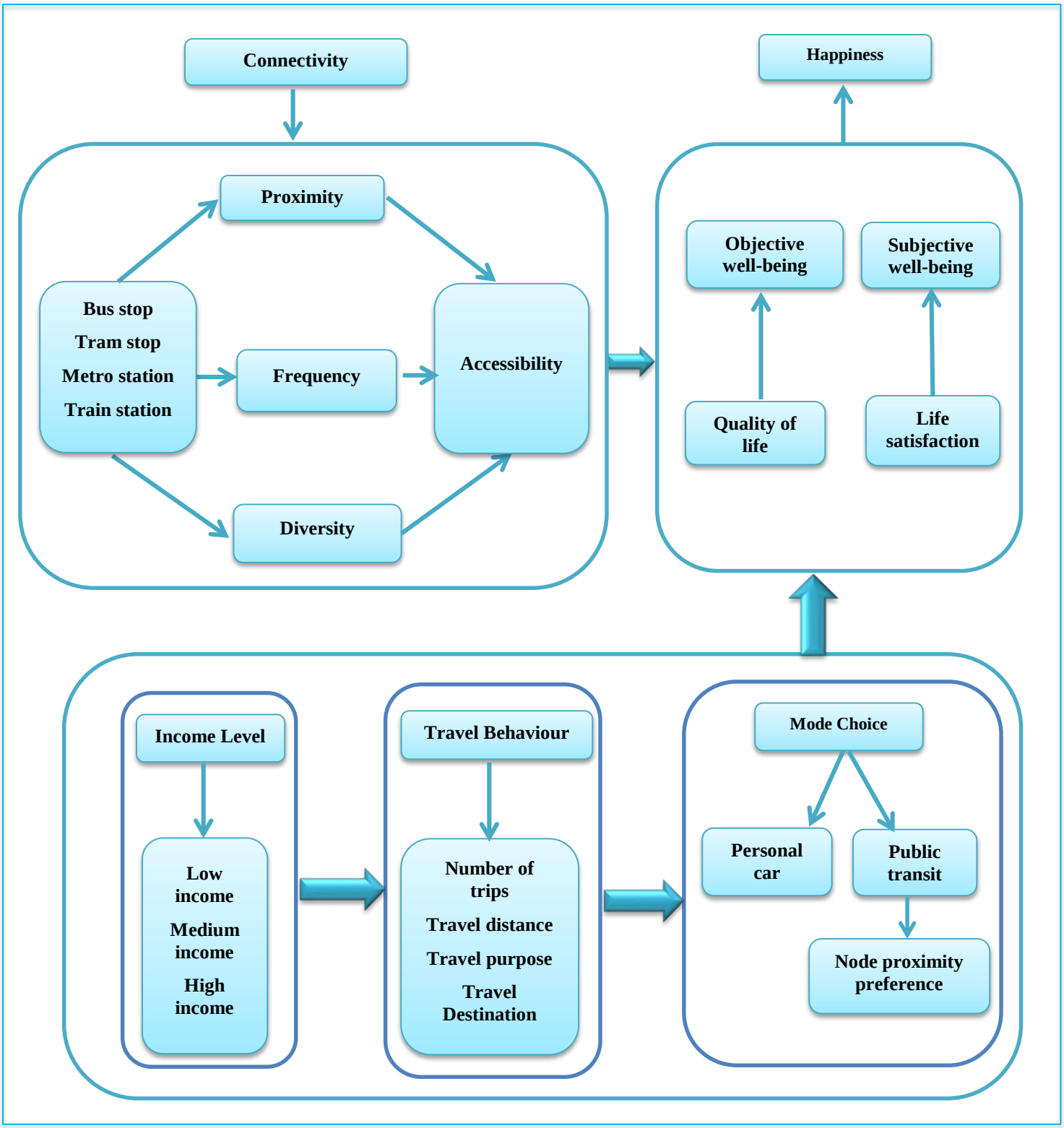
It is from these key components that the conceptual framework has been developed basing on the concepts identified from literature. The conceptual framework depicts the relationship between connectivity and happiness and also considers the linkage between income, travel behaviour, accessibility and happiness.

Connectivity as identified in the literature is determined by the accessibility of the transport nodes and this accessibility is measured by the distance of the node from houses, denoted in the framework as proximity, the flexibility of the transport system measured by the number and variety of nodes that would provide the users with choice and efficiency of the system measured by the frequency of modes and how they are responsive to the travel needs of the patrons in relation to travel time.

Frequency of transport nodes in terms of number of trips that the modes make and therefore the number of times they go by a transport node also emerges as an important measure for accessibility as it complements the flexibility of the system allowing users to better schedule their travel. Allsop (2008) emphasises this stating that the one feature of public transport systems that has to be kept in mind is that response of service providers to increased demand on a route by increasing the frequency of the services can lead to decreasing link cost functions.

The literature also showed that the accessibility of a residential area is an important determinant of attracting people to it. The link between connectivity and happiness is in the fact that it enables people to access important functions of life like work, commerce and business, education, health and leisure. This happiness would be measured two fold the first one being an evaluation of the transport system in terms of availability of infrastructure at the nodes like parking spaces. This evaluation is an assessment of their quality of life which is the degree of contentment that the people have in their ability to meet and participate in the different domains of their lives. The other is life satisfaction which is an indicator of subjective well-being and transportation affects this through the experiences that the travellers go through as they travel for instance the sense of security they feel while at the nodes, the ease by which the travellers access it, the flexibility and smoothness of transferring from one mode to another and this experience could be summed as good or bad depending on the individual. The conceptual framework is presented here below.

Figure 1: Conceptual Frame work



Source: Author, (2015)

The lower section of the conceptual framework shows the relationship between income, travel behaviour and happiness. In the literature income comes out as one of the determinants of transport mode choice as it is seen to influence the number of trips made by travellers, the distance travelled and the travel purpose. People with low income tend to travel less and tend to combine trips so that they do not have to spend more. Wardman (2004) finds that although income has little influence on the distance travelled, people with high income tend to travel longer distances.

These influences of income ultimately impact the choice of mode used, with high income earners preferring to use personal vehicles while those who use public transportation tend to use trains and metros because of their ability to cover longer distances faster.

Chapter Three: Research Design and Methods

3.0 Introduction

This chapter focuses on the approaches that were undertaken towards the research design, the data collection methods, the research instruments, the sample size of the study and the criterion used in selecting the sample. It also includes operationalization of the variables and how they were measured.

3.1 Revised Research Questions

The research objective was to explain the influence of connectivity on happiness of people by which would be measured by its accessibility in terms of the number of people who were within close proximity to transport nodes and the impact of this on their well- being. However from the literature it was evident that accessibility could not be measured by proximity alone but also efficiency of the service in terms of frequency and flexibility in terms diversity of the transport system and the choices it offers the users.

Affordability of the transport mode is another factor that came out as important in the transport mode choice as it affected the preference for the mode used depending on the income of the user ultimately having an impact on the node that the users prefer to be close to

The main research question for the study is;

To what extent does accessibility have an impact on the wellbeing of the different income groups in Rotterdam?

The revised Sub research questions are;

- How does proximity to transport nodes affect the well-being of people Rotterdam?
- To what extent does the frequency of a transport mode impact the quality of life of people in Rotterdam?
- What is the impact of number and variety of transport nodes on the happiness of neighbourhoods in Rotterdam?
- How does income influence node proximity preference?

3.2 Operationalization: Variables, Indicators

The indicators selected were developed from the variables defined in the conceptual framework, below the definitions of some of the main concepts are given and the variable have been categorised into the dependent variable which is happiness as the Y-variable and accessibility the independent variable as the X-variable. The variables are further unbundled into indicators and measurements that are also shown in the tables.

Table 1: Definition of Main Concepts in Literature

Concept	Definition	Author
Connectivity	Connectivity is the density of connections within a transport network	(Litman, 2015)
	Connectivity refers to the probability that the network nodes remain connected	(Chen, Yang, et al., 2002)
Accessibility	Accessibility is related to the ability of a transport system to provide low cost and or quick method of overcoming the distance between different locations	(Ingram, 1971)
	Accessibility mainly denotes how easily a place can reach key spatial nodes	(Fengjun, Chengujin, et al., 2010)

Happiness	Happiness is a personal positive reaction to a certain environment or system in a certain time frame	(Duarte, Garcia, et al., 2010)
	Happiness is the overall enjoyment of life as a whole	(Veenhoven, 2004)
	Happiness is the degree to which an individual judges the quality of his life as a whole	(Veenhoven, 2009)
	Happiness is conceived as the degree of how one views one's life as a whole or some particular domain of one's life as favourable	(Powdthavee, 2007)

Source: Author, (2015)

Table 2: Operationalisation of Concepts

Analysis	**Research**	**Concept**	**Variable**	**Indicators**
Explanatory	How does proximity to nodes affect the well-being of people	Connectivity	Accessibility	Distance of Nodes from dwelling units
		Happiness	Objective well-being	Quality of Life
			Subjective well-being	Life Satisfaction
	To what extent does the frequency of a transport impact the quality of life of people?	Frequency	Efficiency	Number of trips made by mode
	What is the impact of number and variety of transport nodes on the happiness of neighbourhoods in Rotterdam?	Diversity	Flexibility	Number of nodes Type of node
	How does income influence node proximity preference?	Affordability	Income level	Percentage of income spent on public transport
		Acceptability	Node proximity preference	Perception of necessity of node and mode

Source: Author, (2015)

Table 3: Variables and Indicators

Variable	Description of indicators	Source of information	Unit	Data type
Y-Variable: Happiness				
Subjective well-being	Perceived life satisfaction as a result of accessibility	Rotterdam Leisure Survey	-	Ordinal
X-Variable: Accessibility				
Bus stop	Distance of nearest bus stop from dwelling unit	Rotterdam Municipality	Km	Interval
Tram stop	Distance of nearest tram stop from dwelling unit	Rotterdam Area Profile	Km	Interval
Metro station	Distance of nearest metro station from dwelling unit	Rotterdam Area Profile	Km	Interval
Train station	Distance of nearest train station to dwelling unit	Rotterdam Area Profile	Km	Interval
Diversity	Number of and variety of nodes	Rotterdam Area Profile	No.	Interval
Frequency	Number of trips made by the different modes	Transport service providers	No.	Interval
Intervening Variable				
Income	Percentage of income spent on public transportation		%	Ratio
Controls				
Employment Status			-	Nominal
Nationality			-	Nominal
Population			-	Continuous
Neighbourhood size			No.	Continuous

Source: Author, (2015)

3.3 Research strategy

The objective of the research is to assess the impact of connectivity on the happiness of people. Accessibility which is the independent variable is measured by distance from public transportation node which include bus stops, tram stops, metro and train stations in Rotterdam. The study analyses the impact that each of these nodes has on the happiness of the respondents and which of the nodes has the highest influence and which therefore people would prefer to stay close to the most. As the research focuses on the relationship between several independent variables and one dependent variable, the case study research strategy is used because it allows for this.

The phenomenon of impact of accessibility on happiness is also studied along with other variables that could influence happiness such as the city and neighbourhood population, demographic characteristics such as nationality, income levels and employment status. The case study strategy is ideal when the phenomenon to be analysed cannot be isolated from its context and where influences from other factors on the dependent variable cannot be controlled. Happiness cannot be attributed to proximity to transport nodes nor is proximity to transport nodes the only aspect that would have an impact on happiness in neighbourhood as other

aspects like reliability of the particular mode served by the node, its affordability could also have an impact.

3.4 Data Collection Methods

The study uses both primary and secondary data and for the primary data the qualitative method is used. Interviews were conducted and these targeted the Municipality and RET personnel especially those involved in the transport and planning sector. The information obtained from these interviews includes the criteria used in allocation and distribution of transport nodes in Rotterdam, the impact of accessibility on the happiness of people in Rotterdam, the challenges that are faced in the management of public transportation in the Municipality and suggestions towards addressing these challenges.

The secondary data is on the happiness levels of the Municipality is extracted from the Rotterdam Leisure survey (2009) whereas the distance indicators are got from the quality of life spatial indicators from the Rotterdam Area Profile (2008-2012). The Netherlands Statistics or CBS website provides the information on the demographic of the neighbourhoods. This a government institution charged with gathering and publishing information on while time schedules and travel patterns of modes were accessed from the RET website. The table 4 below summarises the sources

Table 4: Data Collection Methods and Sources

Method	Source	Type of data
Qualitative	Respondents from the municipality and the transport company	Connectivity impact on happiness
Secondary	Rotterdam Municipality	Happiness database
		Quality of Life indicators
	Websites	Number of Nodes Frequency of modes

Source: Author, (2015)

3.5 Sample Size and Selection

The single embedded, case study approach was used as the research focuses on neighbourhoods in Rotterdam. It focuses on the number of transport nodes and types of nodes in all the neighbourhoods to determine if difference in the number and type of nodes in a neighbourhood has an impact on the well-being of its people. The frequency of the modes that go through these neighbourhoods is also analysed to determine how it affects their happiness.

The target group for the interviews was personnel from the Municipality and the Public Transportation service providers, specifically those who are involved in the planning and management of transportation and could therefore provide information on the public transportation in Rotterdam

Table 5 : Sample Size and Selection

Type of sample	Geographic scope	Selection criteria	Sample size	Target Sample
Purposive Sampling	Rotterdam Municipality	Departments involved with the design and management of the transport infrastructure	6	Personnel in these departments that have knowledge on the transport infrastructure

Source: Author, (2015)

3.6 Data Analysis Methods

The data obtained from the interviews was transcribed as the original format was in an audio format it was then prepared using Alas Ti and the responses organized according to the research questions they were answering.

The secondary data is used to prepare maps using ArcGIS showing the different happiness levels of neighbourhoods, percentage of residents with access to public transport and all the other indicators used in the study. Charts prepared in Excel are also used in the presentation of data.

The data is analysed using the ordered probit regression model in STATA to determine the influences of the independent variable on the dependent variable. The formula for the analysis is given by;

$$\gamma_i^* = \beta_0 + \beta_1 x_1 + \beta_2 x_2 \ldots\ldots \beta_n x_n + \varepsilon_i$$

Where:

γ_i^*: Dependent variable

x_1 : Independent Variable

β_0 : Constant/ Intercept

β_n : Coefficient of variable *n*

x_n : Number of independent variables

ε_i : Error term

The ordered probit regression analysis is used because happiness the dependent variable is categorical data and in this case ordinal because it is ranked on a scale of 1-4 with 1 denoting Very unhappy, 2 representing Unhappy, 3 being Happy and 4 denoting Very happy.

3.7 Validity and Reliability

To ensure external validity the study targets all the neighbourhoods in Rotterdam to establish if there is a trend in the results on the relationship between accessibility and happiness, analysing data from different neighbourhoods while internal validity is ensured by including demographic and socio economic characteristics that could have an impact on happiness in the model as controls and analysing the relationship between all of them to determine the ones with the highest significance.

The Rotterdam Area profile and the Rotterdam Leisure survey as a result of intensive surveys conducted by the Municipality and are therefore reliable. The information on demography is obtained from the Netherlands CBS website which also conducts intensive surveys for the data

and conducts quality checks to ensure the data is accurate. The time schedules and travel patterns of modes was accessed RET website and these too have to accurate because they are accessed by the whole public and have to be accurate.

Chapter Four: Research Findings

4.0 Introduction

This chapter focuses on the findings of the study includes a description of the study area, description of the respondents, the sources of data and presentation of the results of the analysis of data.

4.1. Study Area

Rotterdam city is the second largest municipality in The Netherlands and it is situated west of the country within the Rhine-Meuse-Scheldt river delta at the North Sea. The population of the Municipality is approximately 618,355 as per the Central Bureau of Statistics report of 2015. It is divided into 14 districts which include Charlois, Delfshaven, Feijenoord, Hillegersberg-Schiebroek, Hoek van Holland, Hoogvliet, IJsselmonde, Kralingen-Crooswijk, Noord, Overschie, Pernis, Prins Alexander, Rotterdam Centrum and Rozenburg.

The districts are sub-divided into 92 neighbourhoods and the study was initially intended to focus on all of them but some of the neighbourhoods were taken out because they either do not have any transport nodes in them or they share the nodes with other neighbourhoods, for instance neighbourhoods like Tussendijken that shares all its nodes with Bospolder only one could be used and in this Tussendijken was taken out. The total number of neighbourhoods analysed at this level is seventy six out of the ninety two.

4.2 Data collection process

The research process involved a combination of Primary data collection and secondary data collection, the primary data was obtained through interviews that targeted respondents from the Gemente (Municipality) which is the planning authority of the city and also the transportation company. The issues discussed in the interviews range from challenges that Rotterdam faces in the transport sector, constraints to the use of public transportation, suggestions on strategies to address the challenges in transportation and the impact of proximity to transportation nodes on the happiness of people.

Six interviews were conducted and among the respondents from the municipality included the Urban Planner for Sustainable Urban Development and Geographic Information, the Strategic Advisor for Urban Planning, the Traffic Engineer from the Department of transportation, a Researcher from the Department of Research and Business Intelligence and the chairman for one of the area committees. The respondent from the RET the transportation company was the company's strategic advisor who also doubles as the accounts manager for the company's contacts with city of Rotterdam and the region (Rotterdam-The Hague region) as shown in the summary table on respondents *(Annex:1).*

The secondary data used includes the results extracted from the Rotterdam Leisure survey conducted in 2009 that provided information on the different happiness levels of all the neighbourhoods. The survey required respondents in each neighbourhood to rate their happiness levels on a scale of 1 to 4 and the averages of their responses was calculated and happiness of each neighbourhood graded according to how majority of its residents perceive their happiness.

The data base on the quality of life spatial indicators also prepared by the Municipality provides information on household income, income per capita for each neighbourhood, nationality, number of people with access to public transport stops, employment and information on

percentage labour share per neighbourhood. Information on the population for each neighbourhood was got from the Netherlands Central Bureau of Statics website.

Data on the public transportation obtained from RET website provides information on the modes, the line, the directions they take and the stops they go through. When considering the tram for example, the information includes the line for instance line 4, the direction it takes, in this case from Marconiplein to Molenlaan, the stops it goes through and the schedule for all the trams of the same line that will be operating on that day. Table 6 below shows an extract of part of the schedule for a tram. Tram line 4 operates in two directions, one from Marconiplein to Molenlaan and then from Molenlaan to Marconiplein and on these routes the tram makes stops at tram stops Delfshaven, Van Dulystraat and Zeilmakersstraat as indicated in the table.

When heading towards Marconiplein for example the first tram arrives at the Delfshaven stop, at 5:51AM and then the next one would be there 21 minutes later. This information was collected for all the modes except for the trains because the train schedules where not as streamlined as for the other modes

Table 6: Public Transportation Schedule for Modes

Mode	**Line**	**Direction**	**Stops**	**Departure Times**				
Tram	4	Marconiplein	Delfshaven	5:51	6:13	6:31	6:51	7:05
			Van Dulystraat	5:52	6:14	6:32	6:52	7:06
			Zeilmakersstraat	5:53	6:15	6:33	6:53	7:07
Tram	4	Molenlaan	Zeilmakersstraat	6:38	6:58	7:13	7:28	7:43
			Van Dulystraat	6:39	6:59	7:14	7:29	7:44
			Delfshaven	6:40	7:00	7:15	7:30	7:45

Source: Author, (2015)

With the information on the modes collected, they were then organized per neighbourhood because the website only indicates the stops that each mode goes through but does not show in which neighbourhood the stops are located. The Municipality provided information on the distribution of stops per neighborhood and then the information on the time schedules and routes was organized per neighbourhood so that it would show the modes that go through each neighbourhood, the time they go through it and the stops they go to.

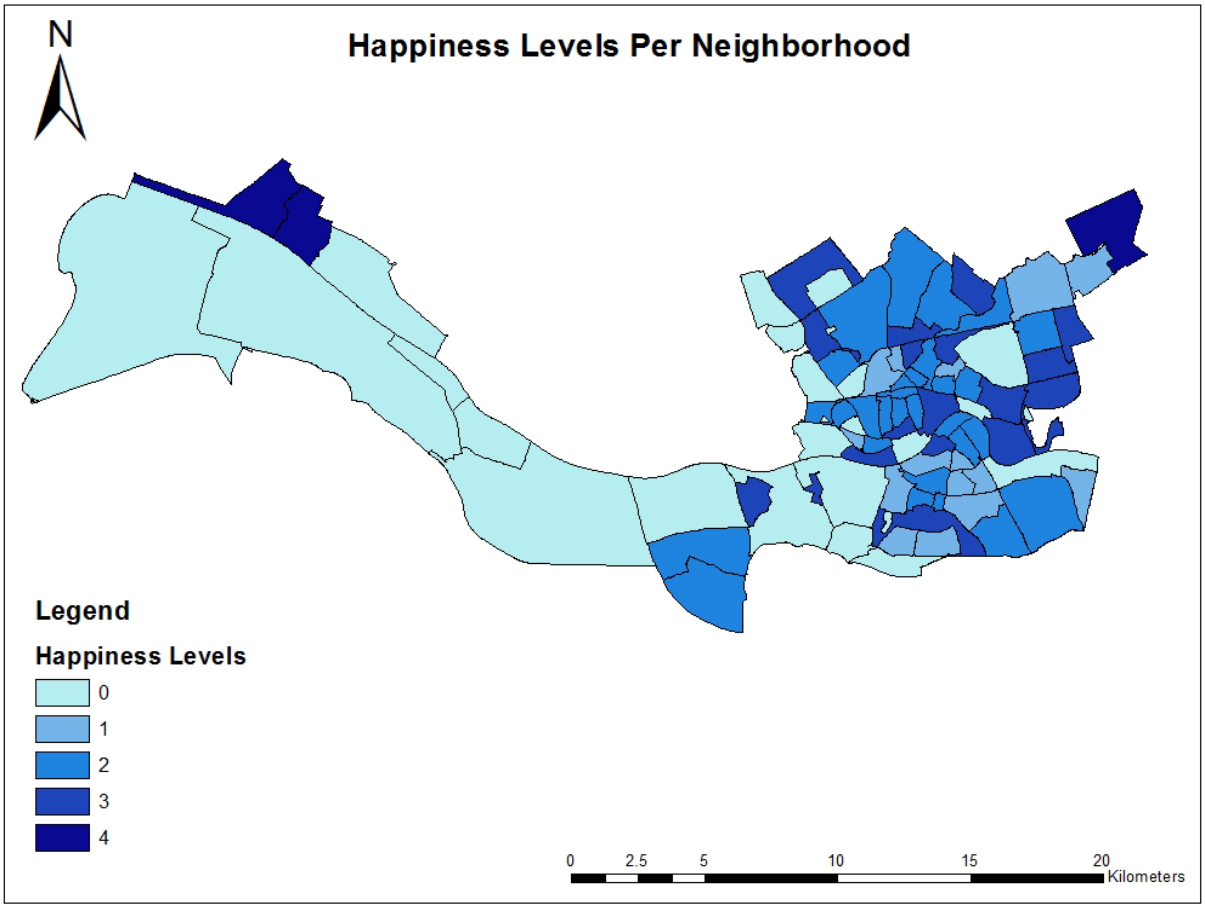
This information was then developed into variable for overall accessibility which included the total number of directions accessible, total number of platforms, average number of combine visits and average combined waiting time. Indicators were also developed for each of the modes, and these include the total number of directions, number of platforms, number of visits and average waiting time for the metro, tram and bus as indicated in the summary statistics table for all the variables used in the study *(Annex 2).*

4.3 Research Findings

4.3.1 Happiness levels in the Neighbourhoods

The results from the happiness survey show that 3 neighbourhoods are in the very happy category, 18 are in the happy category, 30 in the unhappy category and 15 of the neighbourhoods are very unhappy. Residents from 25 of the neighbourhoods did not respond to the survey and the neighbourhoods therefore do not have data on happiness. Map 1 below shows the results from this survey

Map 1: Map of Rotterdam Showing the Happiness Levels



Source: Author, (2015) ArcGIS map based on Leisure Survey (2009)

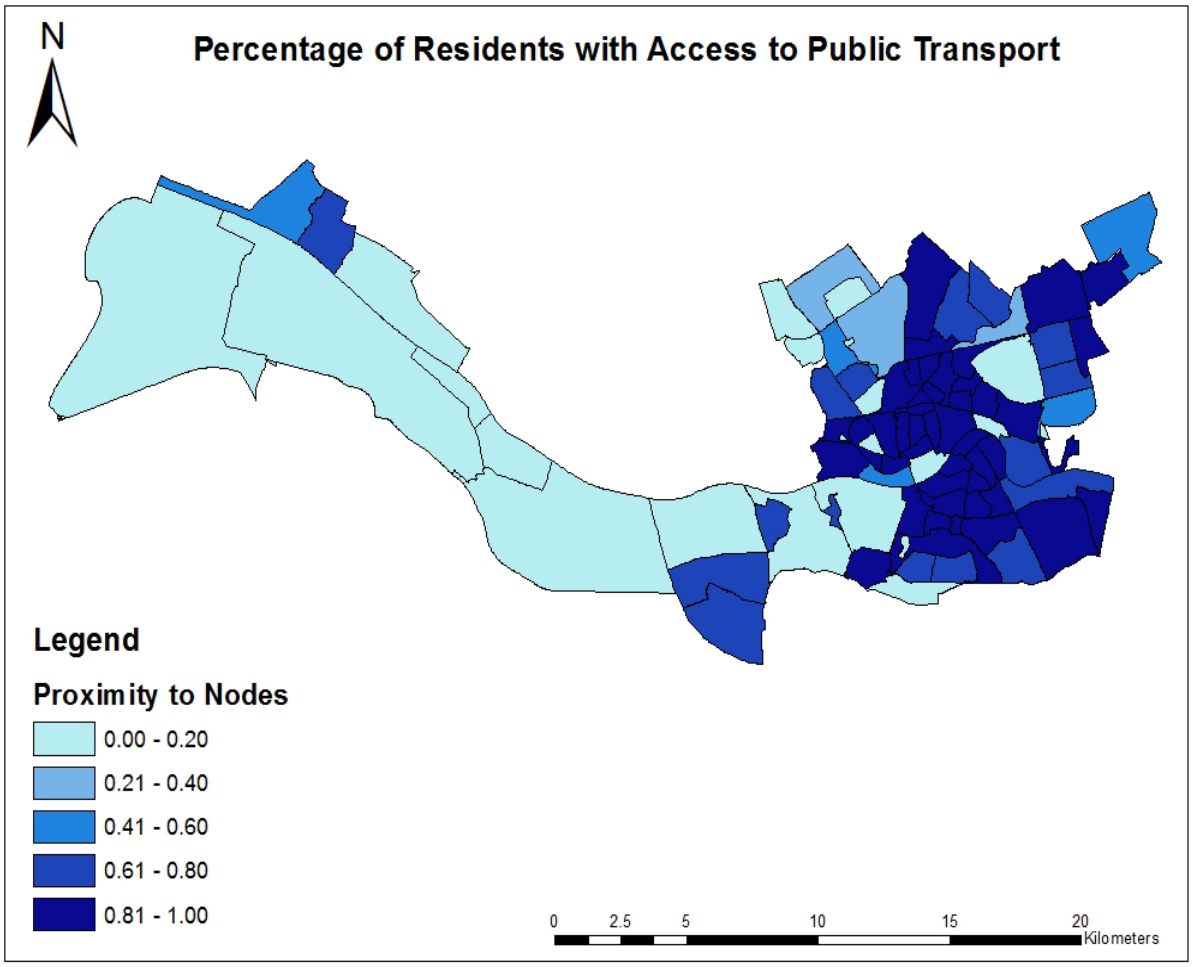
The Very happy neighbourhoods as shown in the map are three and they include Strand en Duin, Dorp, and Nesselande. The different shades of colour represent the different levels with the darkest colour representing the Very happy neighbourhoods and the lighter shades showing the lower levels. The lightest shade of blue is for the neighbourhoods without data on happiness and in the legend they are represented as 0.

4.3.2 Proximity to Nodes and Happiness

Among the spatial indicators used in rating the quality of life of neighbourhoods in Rotterdam is the aspect of proximity to transport and in this the survey considers the percentage of residents in each neighbourhood with access to Public Transport stops within a reasonable distance. The stops that are considered in the survey are tram stops, metro stations and the train stations. In this particular survey information on distance from bus stops is not captured. The buffers that are considered for the stops are 1500 meters for the train station, 800 meters for

the metro station and 500 meters for the tram stops. Map 2 below shows the percentage of residents within reasonable distance from the public transport nodes. The darker shades represent neighbourhoods with a higher percentage of their residents close to the nodes while the neighbourhoods with lighter shades have less.

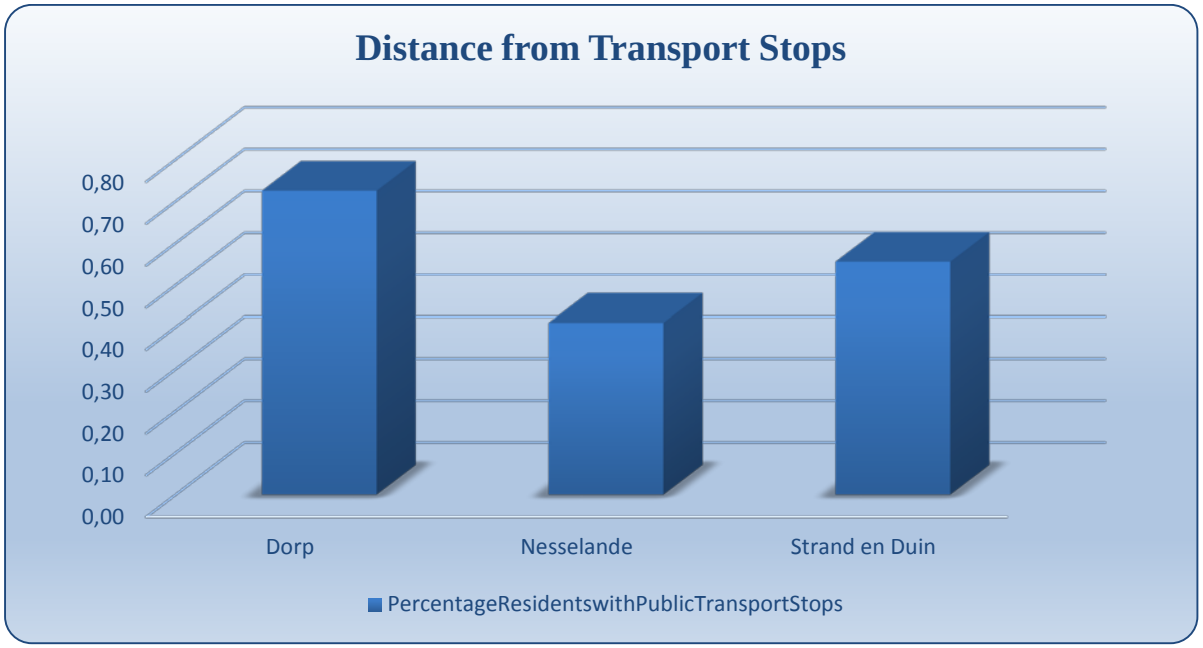
Map 2: Residents with Access to Public Transport Nodes



Source: Author, (2015) ArcGIS map based on Rotterdam Area Profile (2008-2012)

Data from quality of life spatial indicators show that among the Very happy neighbourhoods Dorp has 73% of its residents living within close proximity to the nodes, Strand en Duin 56% and Nesselande has 41%. Chart 1 below summarises these findings.

Chart 1: Proximity to Nodes in Very happy Neighbourhoods

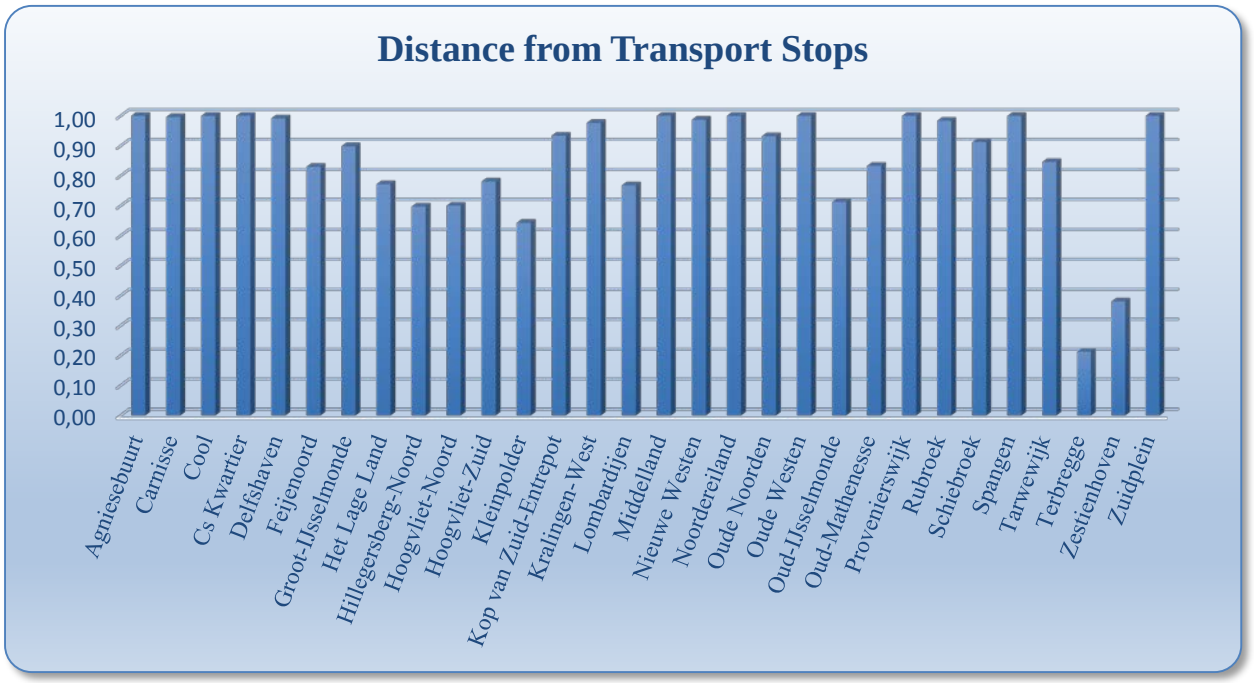


Source: Author, (2015) Excel Chart Based on Rotterdam Area Profile (2008-2012)

In the happy neighbourhoods Stadsdriehoek and Dijkzigt have 100% of their residents within lose proximity to nodes, Kralingen-Oost has 97%, Nieuw-Crooswijk 95% and Hillegersberg-Zuid 92% while the rest in this category have between 41% to 80% of their residents with access to public transport.

It is the unhappy neighbourhoods with the highest percentages of residents within close proximity to the transport nodes with almost half of the neighbourhoods having above 90% of their residents living within close proximity to the stops as shown in chart 2 below. In the very happy neighbourhoods eight of the fifteen neighbourhoods, percentage residents within reasonable distance from the transport nodes is above 90%. Overall a good number of neighbourhoods in Rotterdam have sufficient access to public transport in terms of distance from the stops.

Chart 2: Proximity to Nodes in Unhappy Neighbourhoods



Source: Author, (2015) Excel Chart Based on Rotterdam Area Profile (2008-2012)

4.3.2.1 Impact of Proximity of Transport Nodes on Happiness

This indicator was used in the regression having looked at the happiness levels of each neighbourhood and the percentage of residents with access to public transport nodes to find out how being close to transport nodes would influence the happiness of the residents and the results are shown in table 7 below. The regressions were run first with the independent variable and dependent alone and the results as shown in the table above under the column 1 indicate that overall as the percentage of residents with public transport stops within reasonable distance increases happiness reduces, implying that being close to a transport node reduces happiness of residents. The controls were then added into the regression one at a time to find out how each control influenced the significance of distance from nodes on happiness.

Under Column 2 are results for when population is added as a control and they show that population has a negative influence on happiness meaning that as population increases happiness reduces. Proximity to transport nodes still leads to reduction in happiness when controlled for population but it is less significant than when regressed alone. Under column 3 percentage of residents within reasonable distance are still less happy even when controlled for both population and employment. Percentage employment on the other hand does not have an impact on happiness although it is positive and population is not significant either.

When income per capita is included in the regression, the results which are under column 4 still show that as the percentage of people within close proximity to transport increases, the happiness in the neighbourhood reduces, the influence is however less significant than in the previous regression. Income has a positive relationship with happiness, therefore as the income average income per capita of the neighbourhood increases, the happiness of the neighbourhood increases. Increase in population reduces happiness and percentage employment although positive still has no impact on happiness.

Table 7: Impact of Proximity on Happiness

Happiness	**1**	**2**	**3**	**4**
Percentage Residents with Public Transport Stops Within Reasonable Distance	-2.16**	-1.90*	-2.27*	-1.98*
	(0.71)	(0.80)	(0.90)	(0.90)
Population		-0.68**	-0.47	-0.51*
		(0.22)	(0.25)	(0.25)
Percentage Employment			1.28	1.31
			(0.71)	(0.72)
Income				0.43*
				(0.21)
cut1				
Constant	-2.61***	-3.06***	-2.88***	-1.83*
	(0.65)	(0.73)	(0.78)	(0.92)
cut2				
Constant	-1.31*	-1.65*	-1.39	-0.27
	(0.62)	(0.70)	(0.75)	(0.90)
cut3				
Constant	-0.07	-0.35	-0.10	1.05
	(0.62)	(0.69)	(0.75)	(0.91)
Observations	67	67	67	67
R^2				
Adjusted R^2				

Source: Author, (2015) STATA ordered probit regression analysis

In all the four analyses, results show that as the percentage of residents with public transport increases, the happiness of the neighbourhood reduces, this can be attributed to the fact that being close to transport nodes would expose these residents to noise pollution both from the modes that use the stops and also personal cars transporting people to the stops. These disturbances from the increased noise levels could eventually outweigh the benefits of being close to the nodes thereby affecting the happiness of the residents.

There is also a possibility of these residents being concerned about their safety, the nature of the public transport is in such a way that everyone has access to it and can go wherever they want to go and access it from anywhere as long as they can pay for it. The stops are also quite open for the public and therefore residents who are close to stops would be concerned about the security of these areas. The other concern could also be on traffic safety, as the distance from the nodes and the dwelling areas reduces, there is a likelihood of them being more vulnerable to traffic accidents like vehicles crashing into the buildings or even the buildings being affected by tremors from the modes,

4.3.2.2 Impact of Proximity to Nodes on Happiness of Neighbourhoods

The marginal effects of each outcome were predicted as the first regression was considering all the neighbourhoods as a whole, the marginal effects would show the influence proximity to the transport nodes on the happiness levels of the four different categories of neighbourhoods. They were predicted using the model that has all the controls, the results are presented in the table 8 below.

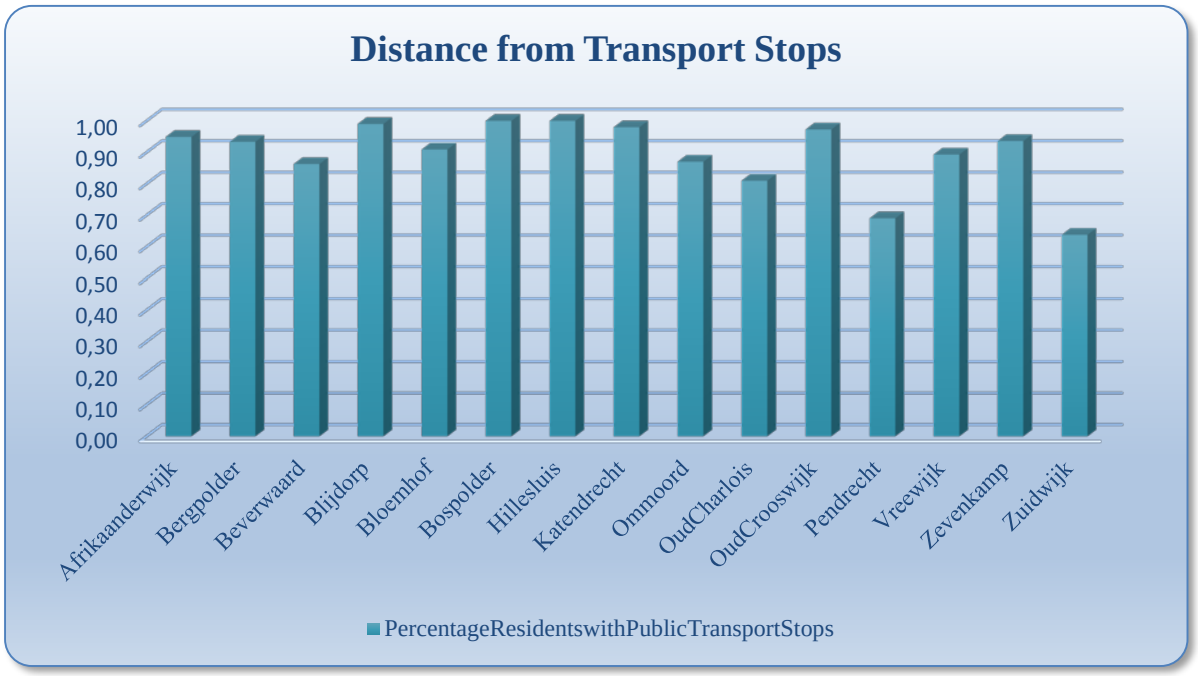
Table 8: Impact of Proximity to Nodes on Neighbourhood Happiness

	Very Unhappy Neighbourhoods	Unhappy Neighbourhoods	Happy Neighbourhoods	Very Happy Neighbourhoods
Percentage of Residents with Public Transport Stops	0.49*	0.07	-0.36*	-0.19
	(0.22)	(0.08)	(0.15)	(0.11)
Population	0.13*	0.02	-0.09	-0.05
	(0.06)	(0.02)	(0.05)	(0.03)
Percentage Employment	-0.32	-0.04	0.24	0.13
	(0.18)	(0.05)	(0.14)	(0.07)
Income	-0.11*	-0.01	0.08*	0.04
	(0.05)	(0.02)	(0.04)	(0.03)
Observations	67	67	67	67
R^2				
Adjusted R^2				

Source: Author, (2015) STATA ordered probit regression analysis

The results show that proximity to transport nodes is significant and positive to the happiness of the very unhappy neighbourhoods. As the percentage of residents with public stops increases in the very unhappy neighbourhoods, their happiness also increases. The results mean that for the residents in the very unhappy neighbourhoods improved accessibility as a result of being close to the nodes is more important to them than the likelihood of being exposed to excessive noise. Under this category most of the neighbourhoods have over 80% of their residents within close proximity to the transport nodes as shown in chart 3 below. The results imply that in these neighbourhood having access to public transportation is of great importance to their well-being and for them to be happier they would need to be even closer to the nodes. Accessibility therefore is more important to them than the negative impacts of being close to the nodes like the increased noise levels or even insecurity.

Chart 3: Proximity to Nodes in the Very unhappy Neighbourhoods



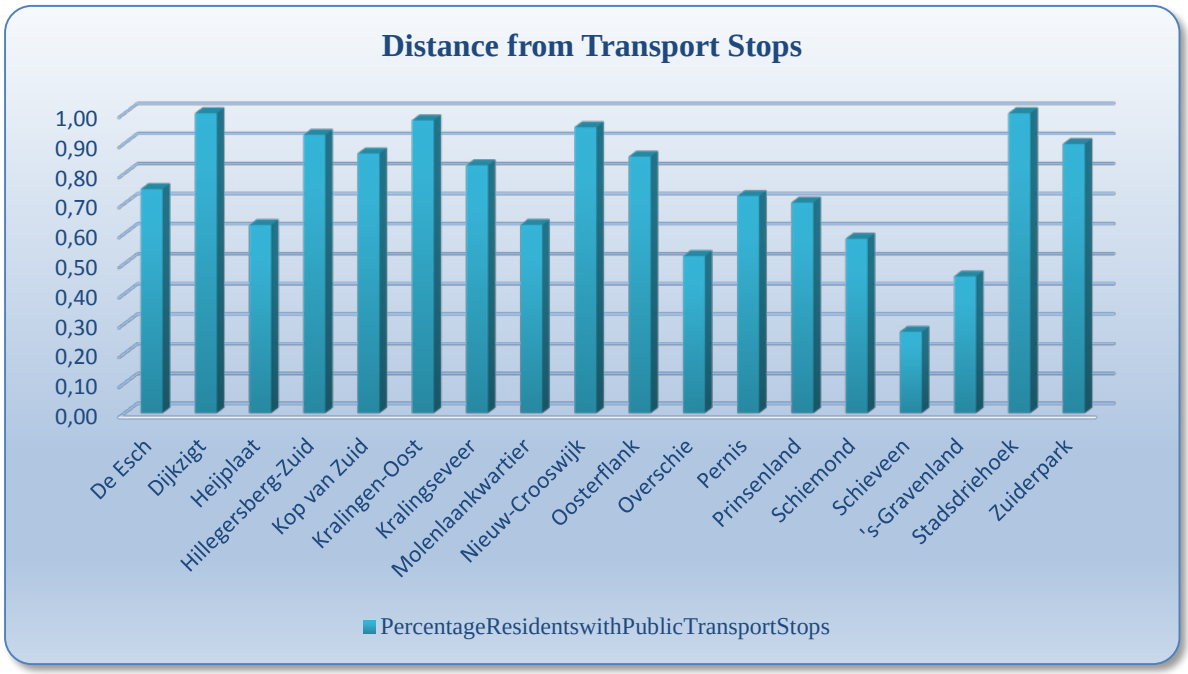
Source: Author, (2015) Excel Chart Based on Rotterdam Area Profile (2008-2012)

The marginal effects on the unhappy neighbourhoods which have the highest percentage of residents with access to Public Transport stops is positive but not significant for the happiness of these neighbourhoods, in other words it neither increases nor reduces happiness levels of these residents. The fact that it is positive though means that the residents in these neighbourhoods appreciate the distance they have to the nodes and they are not bothered much by the disamenities of being close to them.

In the happy neighbourhoods proximity is significant but it reduces the happiness of the residents. This is understandable because the happy neighbourhoods which include among others Stadsdriehoek, Dijkzigt, Oosterflank, Kralingen-Oost, Nieuw-Crooswijk and Hillegersberg-Zuid are within the centre and for those that are not so much into the city like Oosterflank, they are still busy neighbourhoods with a lot of traffic on the roads and relatively high noise levels. The added noise from the stops would worsen the situation thereby reducing the happiness of these residents. Therefore much as they have better accessibility their happiness is reduced by the increased noise. The chart 4 below shows the percentage of residents within reasonable distance from the stops in the happy neighbourhoods and as can be seen, majority of the neighbourhoods have more than 60% of their residents within close proximity to the nodes.

Proximity to transport nodes has a negative relationship with happiness for the neighbourhoods in the very happy category although it is not significant and this could be so because these three neighbourhoods currently have few stops and therefore less people within close proximity to nodes. The results negative relationship implies if these stops were to increase and therefore more people got reduced distances to nodes, the happiness levels would reduce.

Chart 4: Proximity to Nodes in the happy Neighbourhoods



Source: Author, (2015) Excel Chart Based on Rotterdam Area Profile (2008-2012)

4.3.3 Overall Accessibility and Happiness

The overall accessibility variable was developed by combining the total number of directions that the modes take for both the trip to and from a place including the number of stops it has to make per trip, the total number of platforms in a neighbourhood, average number of combined visits that the modes make to a neighbourhoods and the average combined waiting time which was measured in terms of the minutes the residents have to wait at any of the stations before a mode arrives. The variable was developed to determine how all the accessibility indicators taken together would influence happiness.

The results are presented below as indicated in table 9 show that when the analysis is run for overall accessibility alone, the results which are under column 1 show that with increased overall accessibility there would be reduced happiness and then when controlled for population as shown under column 2 overall accessibility would still lead to a reduction in the happiness of the neighbourhoods as would an increase in the population.

Under column 3 percentage employment is included in the model and the results still show a negative relationship between overall accessibility and happiness, population is negative as well but not significant anymore for happiness while an increase in percentage employment would lead to an increase in happiness. Column 4 shows the results of the regression with income per capita included and here overall accessibility still negatively affects happiness while an increase in income per capita and employment would lead to an increase in happiness

This is understandable considering the fact that increasing overall accessibility would mean increasing the number of platforms in an area and increasing the number of times the modes come into the neighbourhood and also increasing the number of stops that the modes make. Increasing the number of platforms in the neighbourhood would give it a feeling of congestion and reduce on the aesthetics of the area. The stops no matter how well they are designed still

increase the level of the built environment and it would be tolerable if they are few but then if they are numerous then they are bound to make the neighbourhood less visually appealing and lead to reduction in the happiness levels of the neighbourhood.

Table 9: Impact of Overall Accessibility

Happiness	**1**	**2**	**3**	**4**
Overall Accessibility	-0.15**	-0.11*	-0.18**	-0.21***
	(0.05)	(0.06)	(0.06)	(0.06)
Population		-0.54*	-0.14	-0.09
		(0.24)	(0.30)	(0.32)
Percentage Employment			1.81*	2.12**
			(0.74)	(0.78)
Income				0.66**
				(0.20)
cut1				
Constant	-2.34***	-2.44***	-2.34***	-1.25*
	(0.56)	(0.57)	(0.57)	(0.60)
cut2				
Constant	-1.07*	-1.09*	-0.90	0.32
	(0.52)	(0.53)	(0.53)	(0.57)
cut3				
Constant	0.25	0.22	0.47	1.79**
	(0.52)	(0.55)	(0.58)	(0.62)
Observations	67	67	67	67
R^2				
Adjusted R^2				

Source: Author, (2015) STATA ordered probit regression analysis

An increase in the number of times that the modes go into the neighbourhood would increase the traffic volume in the neighbourhood and the problems associated with this such as increased noise levels, traffic accidents and air pollution, these concerns would lower the happiness levels of the neighbourhood and affect the benefits of having improved accessibility.

The other indicator which is the average number of directions would also affect the happiness of neighbourhoods because if a mode makes a lot of stops or goes through many areas then the in-vehicle time of the travellers in increased thereby making their travel time even longer and this would make that public mode less desirable for the residents.

Average waiting time is the other indicator under this variable and indeed increasing the waiting time for modes would reduce the happiness of residents because it would increase the total travel time just like the time spent in the mode. People would want to be able to have access to means that get them to their final destination as soon as possible and without them having to make complicated trip schedules or carefully planning the time to start their journey which would in most cases involve them having to start earlier then desirable if the waiting time for the modes is long. If the waiting time increases therefore their happiness would be reduced.

The marginal effects of each outcome were predicted to determine the impact overall accessibility would have on the happiness of the neighbourhoods. The results of the predicted marginal effects are shown in table 10 below.

Table 10: Impact of Overall Accessibility on Neighbourhoods

	Very Unhappy Neighbourhoods	**Unhappy Neighbourhoods**	**Happy Neighbourhoods**	**Very Happy Neighbourhoods**
Overall Accessibility	0.05***	0.01	-0.04***	-0.02*
	(0.01)	(0.01)	(0.01)	(0.01)
Population	0.02	0.00	-0.02	-0.01
	(0.08)	(0.01)	(0.06)	(0.03)
Percentage Employment	-0.51**	-0.07	0.39**	0.19*
	(0.19)	(0.07)	(0.15)	(0.08)
Income	-0.16**	-0.02	0.12**	0.06*
	(0.05)	(0.02)	(0.04)	(0.03)
Observations	67	67	67	67
R^2				
Adjusted R^2				

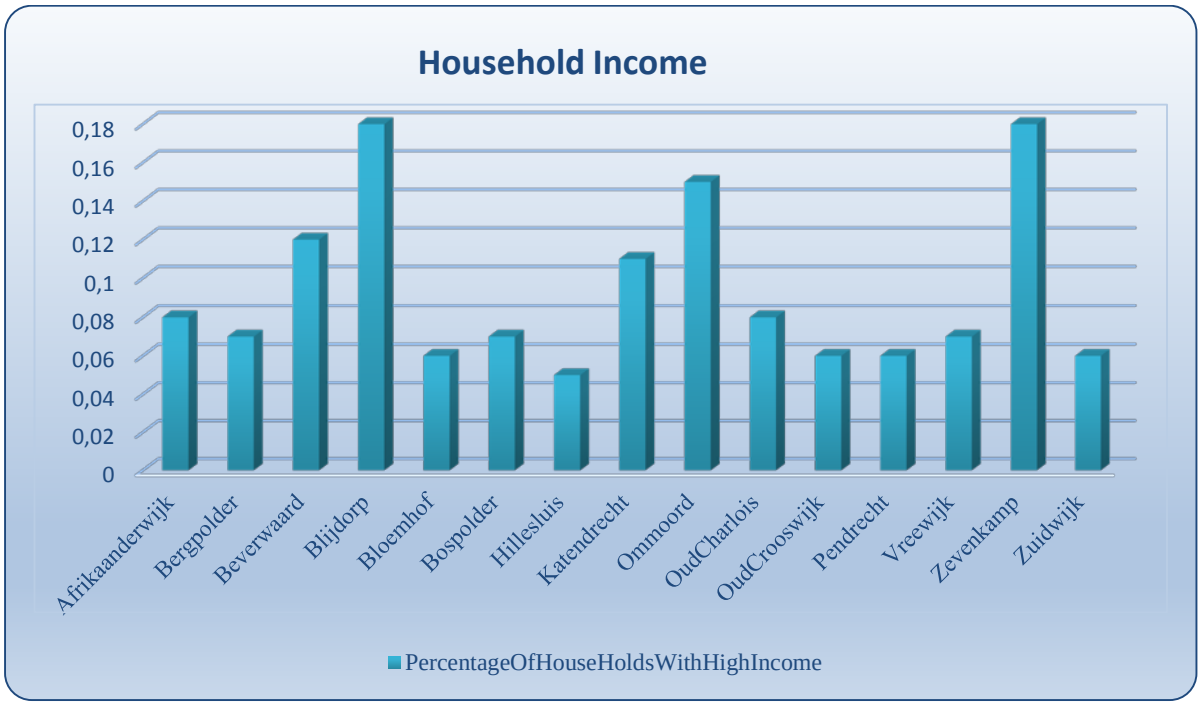
Source: Author, (2015) STATA ordered probit regression analysis

The table shows that for the very unhappy neighbourhoods overall accessibility is very significant and would lead to an increase in their level of happiness. This implies that for these neighbourhoods despite the fact increasing overall accessibility would lead to an increase in negative impacts as explained earlier, being able to access public transportation is more important to them. This could be because in these neighbourhoods the residents are less dependent on the private cars or even if they do have cars they are less willing to spend on them as this would be costly. Data from Quality of life indicators show that these neighbourhoods have the lowest level of percentage of households with high income, with the highest percentage being 50% and the lowest being 4%.

In chart 5 below the neighbourhoods in this category with the highest percentage of households with high income are Blijdorp and Zevenkamp with 18%, majority of the neighbourhoods however have less than 8% of their residents having a high income. This could explain why for these neighbourhoods having better accessibility would be more important than concerns over increased noise levels, congestion and having to wait longer for the modes to arrive. For them it is more important that they can be able to get to the places that they need to.

In the unhappy neighbourhoods overall accessibility is not significant and would therefore have no impact on either and increase or reduction in the happiness of the neighbourhoods in this category. It is however again positive which implies that although it would not affect the levels happiness of the neighbourhoods, the residents would still appreciate having improved accessibility.

Chart 5: Percentage of Households with High Income in Very Unhappy Neighbourhoods



Source: Author, (2015) Excel Chart Based on Rotterdam Area Profile (2008-2012)

Increasing overall accessibility in the happy neighbourhoods would significantly reduce the happiness levels of these neighbourhoods and this is so because as explained before, these areas have the highest levels of traffic volume because most of them are located in the core of the Municipality which is a very busy area. Increasing the level of any of the indicators of overall accessibility would increase congestion and the traffic volume which would then reduce the level of happiness.

In the very happy neighbourhoods overall accessibility would reduce happiness but not as much as in the happy neighbourhoods, these neighbourhoods are located out of the city the centre and they would therefore not be adversely affected as the ones in the happy category but overall accessibility would reduce their happiness all the same because they would also be exposed to increased noise levels.

4.3.4 Frequency and Happiness

The indicators were further analysed each on its own and frequency being one of the indicators identified in the literature review was considered. Frequency was analysed in two ways, first in the number of times that modes go through an area and also by looking at the average waiting time in minutes that people have to wait for the modes to arrive. In the interviews conducted frequency came up as an important determinant of public transport use as an efficient transport system would have to address the travel needs of the residents using it.

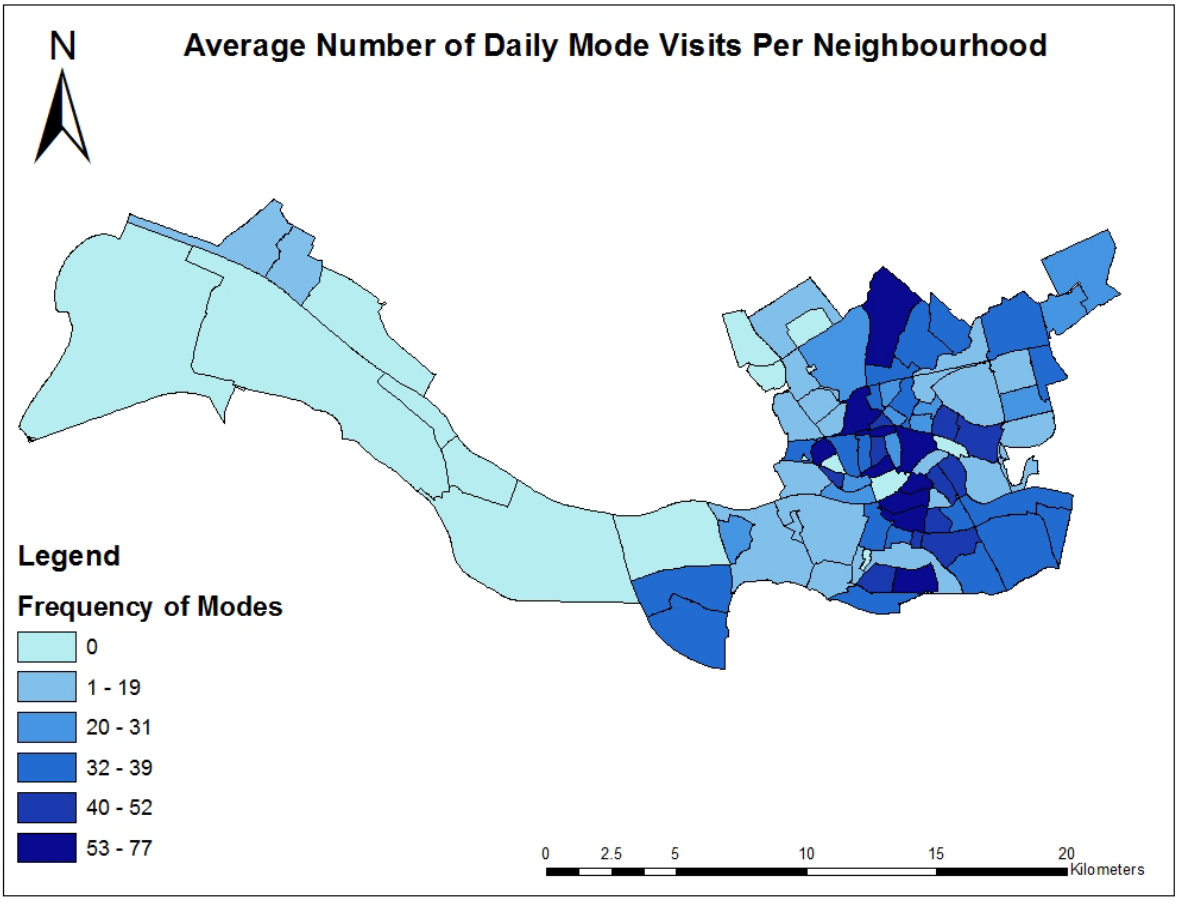
4.3.4.1 Impact of Average Number of Visits on Happiness

The average number of visits was got by combining the average number of times the bus, tram and metro go through an area. In each neighbourhood there are particular modes that serve it while there are those where all the modes go through, in Strand en Duin for instance only the

train and bus serve while in Kralingen-Oost the tram, metro and operate on a daily basis. This indicator involved combining all the trips made by each of the modes and then that would be the average number of trips per day. The map 3 below shows the number of visits that each neighbourhood receives per day. The lowest is 1 which is shown with a lighter shade of blue and the neighbourhoods with the highest volume of trips are the ones with the darkest shade. The lightest blue which in the legend is given the value 0 is for the neighbourhoods with missing information on the number of trips of modes. Zuidwijk has the highest number of visits at 77 visits per day followed by Schiebroek with 76 visits per day. Stadsdriehoek and Groot Ijjsselmonde which have the highest number of platforms at 105 and 151 respectively, do not necessarily have the highest number of visits although Stadsdriehoek is still among those with high frequency at 56 visits per day while Groot Ijjsselmonde gets on average 39 visits in a day.

Among the neighbourhoods with the lowest average combined number of visits are Dorp with average of 1 visit per day, Strand en Duin also with 1 and Schieveen with 6 visits per day. The low rate for Dorp and Strand en Duin can be attributed to the fact in these two neighbourhoods during the day the most used public transportation mode used is the train and in the indicators information on the train was not included because the train routes and schedules could not be easily be accessed. In the night people access this areas using the night buses.

Map 3: Average Number of Combined Visits



Source: Author, (2015) ArcGIS map based on RET public transport schedule (2015)

In the interview held with the Urban Planner for Sustainable Urban Development, he talks about the importance of the number of visits of the modes saying that what makes the metro very popular for instance is the fact that travelers do not have to look at the time schedule a lot but that they can just go to the metro station and know that within five minutes there will be a metro and that this makes its use much higher. He adds that frequency is an important factor to consider when planning for an efficient public transport system because it impacts on the success of the system.

The indicator was analysed and the results as presented in table 11 below show that an increase in the average number of visits would decrease the happiness of neighbourhoods. The results remain the same even when the controls are added. In the controls both income and employment are significant and lead to an increase in the levels of happiness. Population on the other hand reduces happiness as it increases as shown under column 2 while under columns 3 and 4 it is not significant but still has a negative relationship with happiness

As explained in the previous section increasing the number of times modes go into an area will lead to increased volumes of traffic and thus contribute to increase congestion in the neighbourhoods thereby contributing to an issue they are meant to address. If the modes come too often they could also increase the noise levels in the neighbourhoods making them less appealing to the residents and thus reducing their happiness levels. The metro and to some extent the tram produce noise and if they make trips too often then they would affect the happiness of the neighbourhoods.

Table 11: Impact of Average Number of Visits on Happiness

Happiness	**1**	**2**	**3**	**4**
Average Number of Combined Visits	-0.03***	-0.02**	-0.03***	-0.03***
	(0.01)	(0.01)	(0.01)	(0.01)
Population		-0.59**	-0.30	-0.32
		(0.23)	(0.25)	(0.26)
Percentage Employment			1.61*	1.77*
			(0.69)	(0.75)
Income				0.57**
				(0.22)
cut1				
Constant	-1.81***	-2.23***	-1.86***	-0.80
	(0.36)	(0.37)	(0.43)	(0.57)
cut2				
Constant	-0.50	-0.82*	-0.34	0.86
	(0.31)	(0.32)	(0.41)	(0.57)
cut3				
Constant	0.79*	0.50	0.98*	2.24***
	(0.35)	(0.35)	(0.48)	(0.62)
Observations	67	67	67	67
R^2				
Adjusted R^2				

Source: Author, (2015) STATA ordered probit regression analysis

The marginal effects for the average number of visits were predicted and the results are shown in the table 12 below. The results were run using all the controls to determine how the average number of visits would influence the happiness levels of the neighbourhoods in each category

Table 12: Impact of Average Number of Visits on Happiness of Neighbourhoods

	Very Unhappy Neighbourhoods	Unhappy Neighbourhoods	Happy Neighbourhoods	Very Happy Neighbourhoods
Average Number of Combined Visits	0.01***	0.00	-0.01***	-0.00*
	(0.00)	(0.00)	(0.00)	(0.00)
Population	0.07	0.02	-0.06	-0.03
	(0.06)	(0.02)	(0.05)	(0.03)
Percentage Employment	-0.40*	-0.08	0.31*	0.17*
	(0.17)	(0.07)	(0.14)	(0.09)
Income	-0.13**	-0.03	0.10**	0.06*
	(0.05)	(0.02)	(0.04)	(0.03)
Observations	67	67	67	67
R^2				
Adjusted R^2				

Source: Author, (2015) STATA ordered probit regression analysis

The results in the table above show that for the very unhappy neighbourhoods the number of visits made by the modes is very important for their happiness as it is very significant and positive. This means for these neighbourhoods if the number of times the modes go into them is increased then they will be happier. This again could be because the residents in these neighbourhoods are more dependent on public transportation use and so for them regardless of the disamenities of increased number of visits, having a mode available when they need to travel is more important to them.

In the unhappy neighbourhoods, although number of visits has a positive relationship with happiness, it would not lead to a change in their happiness levels. In the Happy neighbourhoods an increase in the number of visits would reduce their happiness and as shown in the earlier sections, majority of these neighbourhoods are the ones with highest volume of traffic and therefore increasing the number of visits of the public transportation modes although it would lead to better accessibility, would worsen issues like traffic congestion, noise pollution and traffic accidents.

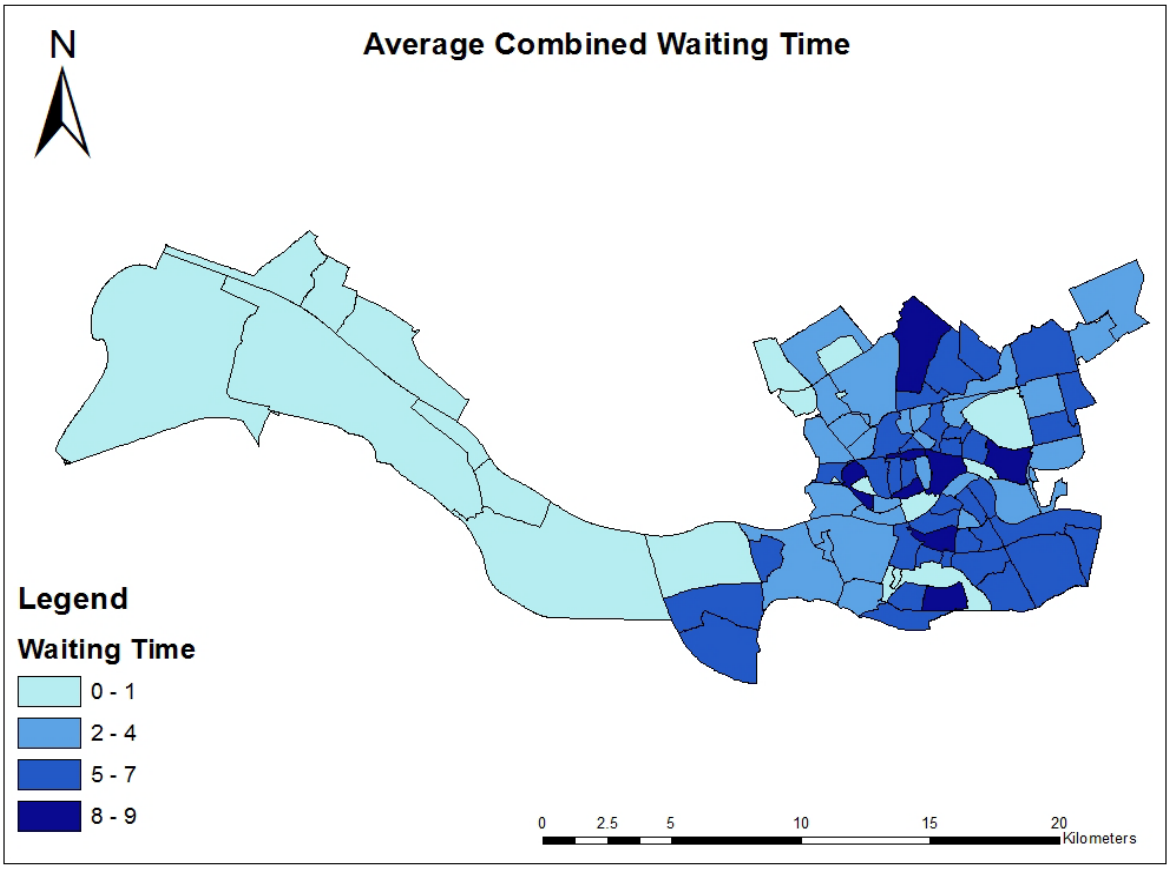
Number of mode visits has a negative relationship with the happiness in the very happy neighbourhoods as well, the main modes of public transport in these neighbourhoods are train for both Strand en Duin and Dorp, and metro for Nesselande. All of them use the bus as well but it is not popular in these neighbourhoods because especially in Dorp and Strand en Duin the buses operate mostly in the night. The noise levels from the stops would be relatively high given the type of modes in these areas and yet since they are located out of the main city centre these neighbourhoods have low traffic flow from their cars because they are not so busy. It is possible that people who choose to stay in such neighbourhoods do so because they want to live in quiet environments, with a slower pace and not the busy city centres, having frequent visits from the modes would therefore affect this and thus reduce their happiness as well.

4.3.4.2 Impact of Average Combined Waiting Time on Happiness

This is also a measure for frequency and it reflects how long a person has to wait for a mode at a public transport stop. It is an even more important determinant for public transport use because it affects the total travel time of people and this is something that the transportation company puts into consideration as explained by the Strategic Advisor for the transport company who says that as a principle, for the railway lines which are the Tram and Metro and also the basic Bus lines there should be a mode every ten minutes especially for the very crowded routes and that routes especially the bus routes which are less crowded have less frequency. He further adds that the ten minutes are very important because it is at about that point that people accept waiting time without noticing exactly the time that has gone by.

An important fact to note from this is that the system should be responsive towards the needs of the users, it not a matter of having modes visit the neighbourhoods many times, but they should be as frequent as possible depending on the volume of possible travellers because it would be meaningless for the modes to make trips into neighbourhoods that have very few users or for a particular mode to go into an area where it is not popular for one reason or the other. The map below shows the average waiting time for each neighbourhood

Map 4: Average Combined Waiting Time



Source: Author, (2015) ArcGIS map based on RET public transport schedule (2015)

The minimum average combined waiting time is 1 minute while the maximum is 9 minutes, it is important to note that this indicator considers the waiting time for all the modes in a neighbourhood, the average waiting time for each mode would be different. The minimum average waiting time for the bus is approximately 1 minute while the maximum is 11 minutes, average minimum waiting time for the tram is 7 minutes and the maximum is 11 minutes

while the minimum for the metro is 9 minutes and maximum is 11 minutes. Again this is combined average waiting time and it can be less or even much higher depending on the neighbourhood and how often the modes go through the stops. When this indicator is analysed, results are as indicated in the table below;

Table 13: Impact of Average Combined Waiting Time on Happiness

Happiness	**1**	**2**	**3**	**4**
Average Combined Waiting Time(minutes)	-0.23**	-0.18*	-0.23**	-0.26***
	(0.07)	(0.08)	(0.08)	(0.08)
Population		-0.56*	-0.27	-0.26
		(0.23)	(0.26)	(0.28)
Percentage Employment			1.50*	1.72*
			(0.71)	(0.78)
Income				0.62**
				(0.22)
cut1				
Constant	-2.00***	-2.29***	-1.98***	-0.87
	(0.44)	(0.42)	(0.47)	(0.57)
cut2				
Constant	-0.71	-0.91*	-0.51	0.74
	(0.39)	(0.38)	(0.45)	(0.57)
cut3				
Constant	0.59	0.40	0.80	2.13***
	(0.42)	(0.42)	(0.51)	(0.63)
Observations	67	67	67	67
R^2				
Adjusted R^2				

Source: Author, (2015) STATA ordered probit regression analysis

Table 13 above shows that waiting time is significant and has a negative relationship with happiness when regressed without the controls as shown in the results under column 1 and also as the controls are included one at a time as shown in the next three columns. This analysis implies that as the average waiting time increases, happiness reduces meaning that people do not want to wait for long periods as this would negatively impact on the travel time.

These results when compared to the analysis on the numbers of visits would appear to be contradictory but they show that the frequency of the modes should be as a result of the demand for it, the modes should be responsive enough to meet the travel demands of the residents without making too many unnecessary trips to the neighbourhoods. What is important is that for the travellers there is a mode within the shortest time possible to get them to their travel destinations.

In order to find out the impact average waiting time on the happiness of the four categories of neighbourhoods, the marginal effects were predicted and the results are in shown in table below and they indicate that in the very unhappy neighbourhoods an increase in the waiting time would not reduce their happiness, this could probably be because the maximum waiting time is still within or close to the accepted waiting time of 10 minutes. It could also mean that

for these neighbourhoods importance is placed mainly on the availability of a transport mode and less value attached to the time the modes take to arrive. The results are shown in table 14 below.

Table 14: Impact of Average Combined Waiting time on Happiness of Neighbourhoods

	Very Unhappy Neighbourhoods	Unhappy Neighbourhoods	Happy Neighbourhoods	Very Happy Neighbourhoods
Average Combined Waiting Time (minutes)	0.06***	0.01	-0.05***	-0.02*
	(0.02)	(0.01)	(0.01)	(0.01)
Population	0.06	0.01	-0.05	-0.03
	(0.06)	(0.01)	(0.05)	(0.03)
Percentage Employment	-0.40*	-0.07	0.31*	0.16
	(0.18)	(0.06)	(0.14)	(0.09)
Income	-0.14**	-0.03	0.11**	0.06*
	(0.05)	(0.02)	(0.04)	(0.03)
Observations	67	67	67	67
R^2				
Adjusted R^2				

Source: Author, (2015) STATA ordered probit regression analysis

In the unhappy neighbourhoods the waiting time has no significance on the happiness of the residents while in the happy and the very happy neighbourhoods increase in the waiting time would reduce their level of happiness. The difference in the results could be as result on the demand for transportation whereby in the happy and very happy neighbourhoods value is attached to time because of the purpose of the travel such as employment for example. Chart 6 below shows eight neighbourhoods representing the four different categories of neighbourhood happiness level. Strand en Duin and Nesselande are the very happy neighbourhoods, Stadsdriehoek and Kralingen-Oost the happy neighbourhoods, Zuidplein and Kop van Zuid-Entrepot the unhappy neighbourhoods and Afrikaanderwijk and Bospolder, the very unhappy neighbourhoods.

Chart 6: Labour Share and Unemployment per Neighbourhood

Source: Author, (2015) Excel based on Rotterdam Area Profile (2008-2012)

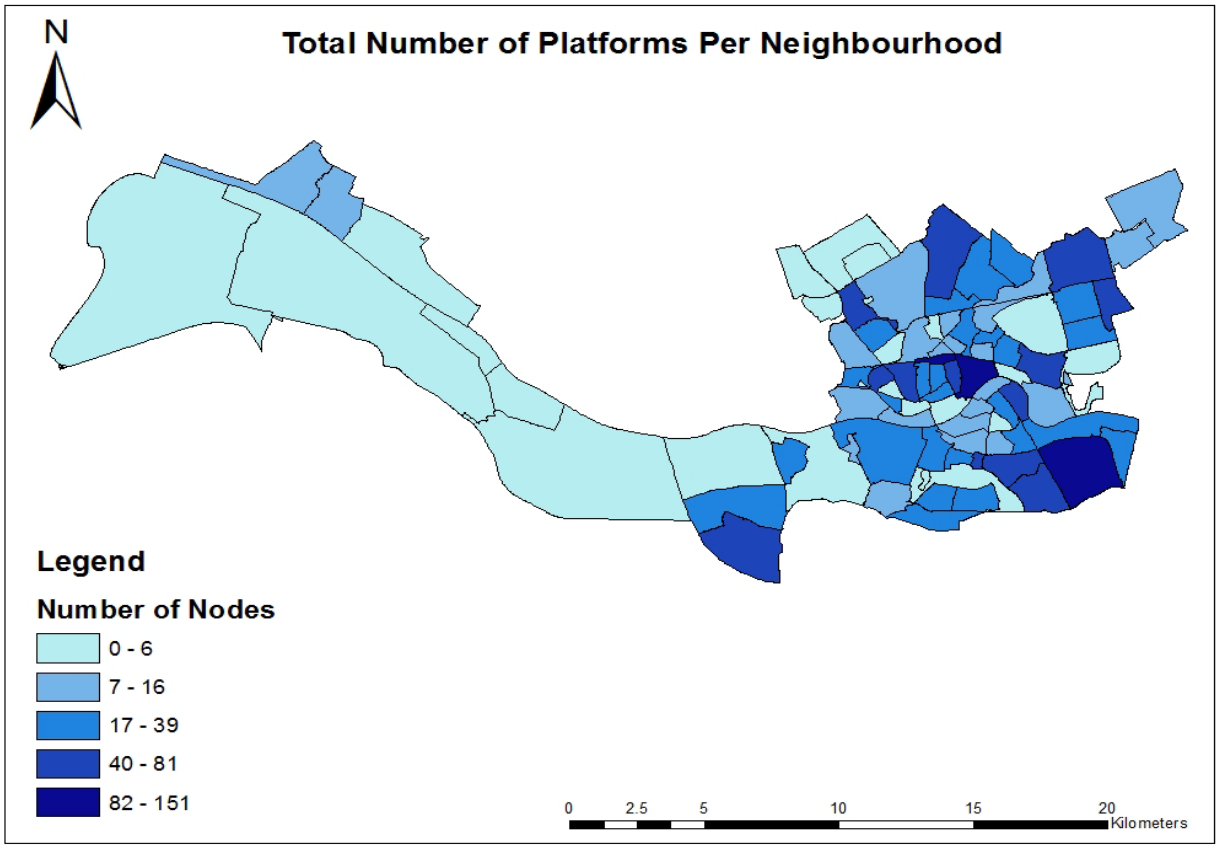
In the chart the very happy neighbourhoods and the happy neighbourhoods have a much lower percentage of labour share per total population except for Stadsdriehoek that has the highest at 80% which can be attributed to the fact that it has a higher population. The unhappy and very unhappy neighbourhoods generally have a higher percentage of labour share but then they also have higher levels of unemployed labour force with Afrikaanderwijk and Bospolder having a percentage of 13%. Strand en Duin has only 1%, Kralingen-Oost 2% and Kop van Zuid-Entrepot has 7%. These higher levels of unemployment could affect the significance of waiting time for the very unhappy and unhappy neighbourhoods.

The strategic advisor for planning supports this theory saying that for neighbourhoods like Bospolder for instance that has many residents without jobs and are too old for education or think of themselves too old, their demand for transportation is low. This he adds does not mean that they don't travel at all but they are likely to attach less value to public transportation and aspects such as waiting time or even being close to the nodes because their travel purpose leans more towards leisure activities and shopping which can be done within the neighbourhood and using other alternatives like the bicycle. This means that people who have demanding travel purposes will attach vale to what the transportation has to offer including the efficiency in terms of being on schedule.

4.3.5 Number of Nodes and Happiness

This section analyses the influence of the number and type of nodes on the happiness of neighbourhood and for this indicator all the stops in the neighbourhood were combined to arrive at the total number of stops. The map below shows the distribution of public transport stops per neighbourhood

Map 5: Number of Public Transport Stops



Source: Author, (2015) ArcGIS map based on RET public transport schedule (2015)

The neighbourhoods with the highest number of nodes are Groot-Ijjsselmonde which has 151 stops, Stadsdriehoek with 105 stops and C.S. Kwartier with 91 while among those with the least number are Kralingse Bos with 1 stop, Kralingseveer with 1 and Schieveen with only 4 stops. The very happy neighbourhoods have few stops with Strand en Duin having 8 stops, Dorp with 10 and Nesselande only 8 as well. Two of the neighbourhoods with the most number of nodes, Stadsdriehoek and C.S. Kwartier have all the four public transport stops and receive high average number of visits as they are located in the city center and act as connecting points for most travelers. The indicator was regressed and the results from the analysis are presented below in table 15.

When analyzed without controls as indicated under column 1 results show that the number of platforms is not significant for the happiness but has a negative relationship with happiness implying that people would not want to have many platforms in the area, when the controls are added platforms still do not contribute to a change in the happiness levels of the neighbourhood but then the relationship becomes positive. The number of nodes appears not to affect the happiness and this could be because the service of the system is more important than just having the infrastructure. It is possible to have a platform for instance and still people do not use it because of dissatisfaction with the frequency of the mode or because they cannot afford it. The location of platforms is only relevant if it meets the access needs of its users.

Table 15: Impact of Total Number of Platforms on Happiness

Happiness	1	2	3	4
Total Number of Platforms	-0.00	0.01	0.01	0.00
	(0.00)	(0.01)	(0.01)	(0.01)
Population		-0.93***	-0.83*	-0.69
		(0.27)	(0.34)	(0.36)
Percentage Employment			0.35	0.78
			(0.63)	(0.75)
Income				0.54*
				(0.22)
cut1				
Constant	-0.80***	-1.46***	-1.34***	-0.20
	(0.23)	(0.26)	(0.40)	(0.61)
cut2				
Constant	0.40	-0.09	0.04	1.25*
	(0.22)	(0.24)	(0.39)	(0.60)
cut3				
Constant	1.52***	1.08***	1.21**	2.49***
	(0.30)	(0.30)	(0.45)	(0.62)
Observations	67	67	67	67
R^2				
Adjusted R^2				

Source: Author, (2015) STATA ordered probit regression analysis

Even when the marginal effects are predicted for the different categories of neighbourhoods as shown in table 16 below, it still remains insignificant for any change in the happiness of the neighbourhoods. This implies that for the neighbourhoods the number of platforms is not a determining factor for their happiness or their use, what appears to be important is the fact that there is a stop in the neighbourhood so that they can access public transport

Table 16: Impact of Total Number of Platforms on Happiness of Neighbourhoods

Happiness	Very Unhappy Neighbourhoods	Unhappy Neighbourhoods	Happy Neighbourhoods	Very Happy Neighbourhoods
Total Number of Platforms	-0.00	-0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Population	0.18*	0.03	-0.14	-0.07
	(0.09)	(0.04)	(0.07)	(0.04)
Percentage Employment	-0.20	-0.04	0.16	0.08
	(0.20)	(0.05)	(0.15)	(0.08)
Income	-0.14*	-0.03	0.11**	0.06
	(0.06)	(0.03)	(0.04)	(0.03)
Observations	67	67	67	67
R^2				
Adjusted R^2				

Source: Author, (2015) STATA ordered probit regression analysis

When an analysis was made of a comparison between the neighbourhoods with most number of nodes and those with the least number and specifically looking at the platforms of the different modes the bus platforms are significant and would lead to an increase in the levels of happiness of both the most connected neighbourhoods and the least connected neighbourhoods as shown in the table *(Annex: 3).*

The tram and metro platforms are not significant but the number of metro platforms have a positive relationship with happiness implying that they would be appreciated in the neighbourhoods but would not impact on happiness, the tram stops on the other hand have a positive relationship with happiness for the first three neighbourhoods and are negative for Zuiderpark. This means that in the three neighborhoods the residents would appreciate having more tram stops but they would not increase their happiness while in Zuiderpark the stops would have no impact and would probably not be used.

The positive influence of the bus platforms can be attributed to the fact the buses produce less noise when compared to the other three modes of transport and residents would prefer having them within their neighbourhoods and they are also relatively fast although not as much the metro and the train.

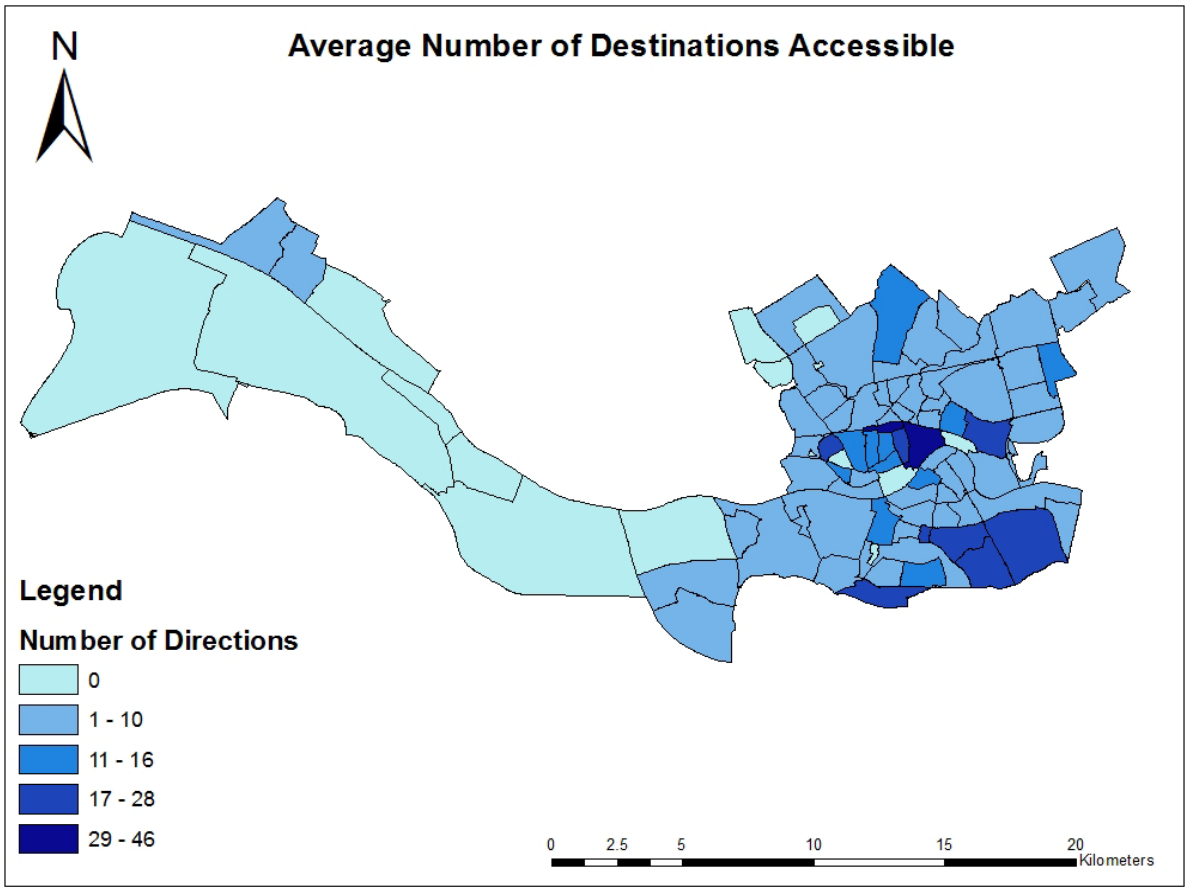
Another analysis was made comparing the very happy neighborhoods and the very unhappy neighbourhoods to find out if the impact of number of platforms would be different considering the difference in their happiness levels. This analysis was also made by considering the specific components for each mode which are number of platforms, number of visits, number of directions and waiting time. The analysis again shows that for all neighbourhoods, regardless of the happiness levels, the bus platforms are significant for an increase in happiness while both the tram and metro platforms do not contribute to a change in the happiness of the neighbourhoods *(Annex: 4)*

4.3.6 Number of Directions and Happiness

Total number of directions as an indicator considers the number of places that the modes connect and it includes the general route the modes take which would be the final destination and also the number of stops it makes within this route. When considering the number of directions for Metro Line B for instance the indicator considers the trip from Schiedam Centrum to Nesselande and also the stops within that route that the metro connects to. This reflects on the number of places that a particular neighbourhood would be able to access as a result of having that particular stop.

A map was prepared showing the total number of directions that were accessible by the neighbourhood and the map shows that C.S. Kwartier and Stadsdriehoek have the highest number of directions which can be attributed to the fact that they have the highest number platforms and also have all the nodes. C.S. Kwartier for instance has the Central Station that is the main transport hub for the municipality connecting people to places within the Netherlands and Europe including access to Schiphol international Airport in Amsterdam. Furthermore all the modes go through this area and therefore residents living in this neighbourhood can access their residencies from any direction. Stadsdriehoek also has almost the same level of directions and it also has a train station. Map 6 below summarises the information on number of directions.

Map 6: Total Number of Directions



Source: Author, (2015) ArcGIS map based on RET public transport schedule (2015)

When the indicator was analyzed the results as presented in table 17 below show that the number of directions that the neighbourhood is connected to is not significant to its happiness when the indicator is regressed without the indicators. When controlled for population number of directions remain insignificant and negative towards happiness and the results are the same when controlled for percentage employment as shown by the results under column 3.

When income is added as control however the total number of directions become significant but still leading to reduced levels of happiness. This implies that when travelers have to go through many stops before they can get to their final destinations they are less happy and this mainly because having too many stops or to many detours would mean having longer travel time. People would instead prefer to start a trip and get to their destination in the shortest time possible although being able to access more places would improve the connectedness of the neighbourhood

Table 17: Impact of Total Number of Directions on Happiness

Happiness	**1**	**2**	**3**	**4**
Total Number of Directions	-0.01	-0.01	-0.03	-0.04*
	(0.01)	(0.02)	(0.02)	(0.02)
Population		-0.74***	-0.45	-0.36
		(0.22)	(0.29)	(0.31)
Percentage Employment			1.45*	2.03*
			(0.73)	(0.89)
Income				0.66**
				(0.21)
cut1				
Constant	-0.91***	-1.54***	-1.16**	0.15
	(0.25)	(0.31)	(0.41)	(0.59)
cut2				
Constant	0.30	-0.21	0.22	1.67**
	(0.23)	(0.28)	(0.40)	(0.59)
cut3				
Constant	1.43***	0.99**	1.44**	2.98***
	(0.30)	(0.32)	(0.48)	(0.65)
Observations	67	67	67	67
R^2				
Adjusted R^2				

Source: Author, (2015) STATA ordered probit regression analysis

The marginal effects were predicted for the outcomes in the different categories of neighbourhoods and the results presented in table 18 below;

Table 18: Impact of Total Number of Directions on Happiness of Neighbourhoods

	Very Unhappy Neighbourhoods	**Unhappy Neighbourhoods**	**Happy Neighbourhoods**	**Very Unhappy Neighbourhoods**
Total Number of Directions	0.01*	0.00	-0.01*	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Population	0.09	0.02	-0.07	-0.04
	(0.08)	(0.02)	(0.06)	(0.03)
Percentage Employment	-0.49*	-0.11	0.40*	0.20
	(0.22)	(0.09)	(0.19)	(0.10)
Income	-0.16**	-0.03	0.13***	0.07*
	(0.05)	(0.03)	(0.04)	(0.03)
Observations	67	67	67	67
R^2				
Adjusted R^2				

Source: Author, (2015) STATA ordered probit regression analysis

The results show that for the very unhappy neighbourhoods the total number of directions would increase their happiness levels, which implies that for them it is more important that they access as many areas as possible and the time they spend on the journey is not as important.

In the unhappy neighbourhoods the directions are not significant but have a positive relationship meaning that in these neighbourhoods access to as many areas as possible is more important

In the happy neighbourhoods total number of directions would reduce their levels of happiness as it would increase their travel time and as seen in the analysis for average waiting time the fact that in the happy neighbourhoods there are more people with employment, they attach value on the time taken to travel which would include both the waiting time and the in-vehicle time. The residents in these neighbourhoods therefore because they need to get to their work places in time for instance would not want the inconvenience of stopping in many places

Total number of directions has negative relationship with happiness for the very happy neighbourhoods although it is not significant. This means that the people in this neighbourhood would also not like to have to go through many stops before they can get to their final destinations, it might not affect their happiness but would have an impact on their use of public transportation. The over dependence on car use in the very happy neighbourhoods like Nesselande could attributed to this fact

In the interview held with the traffic engineer he explains that the low use of public transportation in Nesselande can be attributed to the fact that the neighbourhood is a phoenix city as majority of the people leaving in it are not so oriented on the city of Rotterdam especially with regard to their employment. He adds that most of the residents work in other regional parts of the Netherlands like Amsterdam and Utrecht and that for them it is not easy to use public transportation because they would have to first move back to Alexander for instance in order to get a train to Utrecht which takes a lot of time. The neighbourhood is therefore very car oriented because their travel destination and purpose affect their demand for public transport and having too many transfers would be inconveniencing for them.

4.3.7 Impact of Modes on Happiness

An analysis was made of all the modes and the indicators to determine which aspect of the modes had the greatest impact on the happiness of the neighbourhoods. Some of the indicators like the number of metro directions, average metro waiting time, number of tram platforms and average tram waiting time were excluded from the model because when checks for VIF were run they were found to have a high multi-collinearity and therefore would affect the validity of the results. This check shows those independent variables or indicators that have a very strong relationship with other independent variables in the model and could therefore be measuring the same thing. In this analysis all the variables that had a VIF value of more than 10 were excluded.

In the table 19 below under column 1 which was regressed without the control variables, the number of metro platforms, number of metro visits and the number of tram visits are significant. The number of metro visits and the tram visits would however lead to a decrease in happiness while the number of metro platforms would lead to increased happiness levels.

When controlled for population as shown under the column 2 the number of bus directions are significant but an increase in the number of bus directions would lead to a decrease in happiness, the number of bus platforms would lead to an increase in happiness while the number of bus visits would decrease the happiness levels. The metro platforms and visits are also significant but the metro visits would still lead to decrease in happiness while the platforms increase happiness.

Table 19: Impact of Modes on Happiness

Happiness	**1**	**2**	**3**	**4**
Number of Bus Directions	-0.04	-0.13**	-0.13**	-0.17***
	(0.04)	(0.04)	(0.04)	(0.05)
Number of Bus Platforms	0.02	0.05***	0.05***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)
Average Number of Bus Visits	-0.02	-0.03*	-0.03*	-0.02
	(0.01)	(0.01)	(0.01)	(0.01)
Average Bus Waiting Time(minutes)	-0.11	-0.04	-0.03	-0.08
	(0.10)	(0.10)	(0.11)	(0.12)
Number of Metro Platforms	0.08*	0.09**	0.09*	0.05
	(0.04)	(0.03)	(0.04)	(0.04)
Average Number of Metro Visits	-0.01**	-0.01*	-0.01*	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Number of Tram Directions	0.03	0.06	0.05	0.06
	(0.05)	(0.05)	(0.05)	(0.06)
Average Number of Tram Visits	-0.01*	-0.01	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Population		-1.24***	-1.18*	-1.05*
		(0.37)	(0.46)	(0.49)
Percentage Employment			0.29	1.06
			(0.85)	(1.04)
Income				0.67**
				(0.25)
cut1				
Constant	-2.76***	-3.52***	-3.42***	-2.10*
	(0.61)	(0.63)	(0.80)	(0.89)
cut2				
Constant	-1.26*	-1.69**	-1.58*	-0.11
	(0.52)	(0.52)	(0.71)	(0.80)
cut3				
Constant	0.26	-0.10	0.00	1.56*
	(0.50)	(0.53)	(0.71)	(0.79)
Observations	67	67	67	67
R^2				
Adjusted R^2				

Source: Author, (2015) STATA ordered probit regression analysis

Column 3 three shows the regression with percentage employment included as a control and the results are the same as with those in column 2. When income is included in the model, the bus directions are still significant but leading to lower levels of happiness. The bus platforms would lead to an increase in happiness levels while the rest of the indicators are not significant. The results imply that increasing the number of bus platforms would increase happiness and this can be attributed to the fact that the bus produces relatively low noises and residents would therefore not be adversely affected by the noise from them

The marginal effects of the impact of the modes on the neighbourhoods were predicted to determine how they would affect the happiness of each of the four categories of neighbourhoods and the results are summarised in table 20 below;

Table 20: Impact of Modes on Happiness of Neighbourhoods

	Very Unhappy Neighbourhoods	Unhappy Neighbourhoods	Happy Neighbourhoods	Very Happy Neighbourhoods
Number of Bus Directions	0.03***	0.01	-0.03**	-0.01*
	(0.01)	(0.01)	(0.01)	(0.01)
Number of Bus Platforms	-0.01***	-0.00	0.01**	0.00**
	(0.00)	(0.00)	(0.00)	(0.00)
Average Number of Bus Visits	0.00	0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Average Bus Waiting Time(minutes)	0.01	0.00	-0.01	-0.01
	(0.02)	(0.01)	(0.02)	(0.01)
Number of Metro Platforms	-0.01	-0.00	0.01	0.00
	(0.01)	(0.00)	(0.01)	(0.00)
Average Number of Metro Visits	0.00	0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Number of Tram Directions	-0.01	-0.00	0.01	0.00
	(0.02)	(0.01)	(0.02)	(0.01)
Number of Tram Platforms	-0.00	-0.00	0.00	0.00
	(0.01)	(0.00)	(0.01)	(0.00)
Average Number of Tram Visits	0.00	0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Population	0.19*	0.06	-0.16*	-0.08*
	(0.09)	(0.03)	(0.08)	(0.04)
Percentage Employment	-0.19	-0.06	0.17	0.09
	(0.19)	(0.06)	(0.16)	(0.09)
Income	-0.12**	-0.04*	0.10**	0.05*
	(0.04)	(0.02)	(0.03)	(0.03)
Observations	67	67	67	67
R^2				
Adjusted R^2				

Source: Author, (2015) STATA ordered probit regression analysis

The results show that in the very unhappy neighbourhoods the bus directions would lead to an increase in their happiness levels while the bus platforms would lead to a decrease in their happiness. In other words if the people in the very unhappy neighbourhoods were to choose between having many transport nodes and being connected to many neighbourhoods, they

would opt for more connections. None of the indicators are significant in the unhappy neighbourhoods while in the happy and very happy neighbourhoods increased bus directions would lower their happiness levels and the number of bus platforms would contribute to an increase in happiness.

4.3.8 Accessibility and Happiness of Ethnic groups

The regressions where run but this time controlling for the nationality of residents in these neighbourhoods to find out if the ethnicity of the residents had a bearing on how they perceived the importance of accessibility on their happiness. The categories for this are the Dutch who are the natives of the Netherlands and then the Non-Dutch who include all the other nationals both within Europe and the other continents.

The regressions were run first for the indicators alone to determine which of the modes influenced happiness more for that particular indicator and then for the modes to determine what aspect of the mode was significant for happiness.

4.3.8.1 Impact of Indicators on Happiness of Ethnic groups

The table 21 below for direction only the direction of the bus is significant but it would lead to a decrease in the happiness of the Dutch. The metro and tram directions are not significant but have a negative relationship to happiness. Number of directions overall would therefore lower the happiness of the Dutch

Table 21: Impact of Public Transport Indicators on Happiness of the Dutch

Happiness	Directions	Platforms	Visits	Waiting Time
Bus	-0.09**	-0.01	-0.03***	-0.18**
	(0.03)	(0.01)	(0.01)	(0.06)
Metro	-0.06	-0.01	-0.01*	-0.07
	(0.07)	(0.03)	(0.00)	(0.04)
Tram	-0.03	-0.02	-0.01*	-0.10**
	(0.04)	(0.01)	(0.00)	(0.04)
Dutch	0.00	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)
Percentage Employment	2.89**	1.92*	1.85*	1.56*
	(1.01)	(0.81)	(0.75)	(0.77)
Income	0.78**	0.64*	0.50*	0.52*
	(0.28)	(0.29)	(0.24)	(0.26)
cut1				
Constant	0.96	0.71	-0.95	-1.29
	(0.61)	(0.66)	(0.70)	(0.81)
cut2				
Constant	2.30***	1.95**	0.54	0.14
	(0.63)	(0.65)	(0.66)	(0.77)
cut3				
Constant	3.72***	3.26***	2.11**	1.73*
	(0.69)	(0.65)	(0.68)	(0.76)
Observations	53	53	53	53
R^2				
Adjusted R^2				

Source: Author, (2015) STATA ordered probit regression analysis

The number of platforms are not significant in any of the modes but in all of them they have a negative relationship with happiness, therefore among the Dutch having too many nodes would decrease their happiness. The number of trips made by all the modes are significant but would lead to lower levels of happiness as they would increase the noise levels and congestion as seen in the first regressions.

The waiting time for the Bus and Tram are significant and an increase in the waiting time of these modes would decrease the happiness levels of the Dutch in the neighbourhoods, this implies that for the Dutch modes have to frequent enough to meet their travel demands.

The proximity indicator was not included in the regression because as earlier explained the quality of life spatial indicators in the neighbourhood profiles did not incorporate distance from the bus stops.

The same regression was run for the Non-Dutch and the results are the same as those for the Dutch with the bus directions being significant but leading to less happiness levels, while the tram and metro directions are not significant. The platforms are still not significant while all the visits would lead to less happiness levels. The waiting time has the same impact as was with the Dutch *(Annex: 5)*

4.3.8.2 Impacts of Modes on Happiness of Ethnic groups

When the regression was run for the modes the results presented in table 22 below show that the direction of the bus and the number of bus platforms are significant for happiness, the number of directions however would lead to a decrease in happiness, again this can be attributed to the fact that increased number of directions would make trips longer and thus affect the happiness of people. The platforms on the other hand have a positive impact on happiness and this is because the bus stops are less noisy as the buses do not produce high noise levels when compared to the other modes.

The metro and the tram do not have any significant indicators but for both of them the number of directions and visits would not contribute to the happiness of the Dutch. Overall therefore the bus has the highest impact on the happiness of the Dutch and with regard to improving their happiness levels then it would be important to provide more bus stops. When the regression was run for the Non-Dutch, the results are the same as those of the Dutch *(Annex: 6)*

Table 22: Impact of Modes on the happiness of the Dutch

Happiness	Bus	Metro	Tram
Directions	-0.16**	-0.16	-0.04
	(0.05)	(0.32)	(0.08)
Platforms	0.03*	0.02	0.00
	(0.02)	(0.08)	(0.03)
Visits	-0.02	-0.07	-0.02
	(0.01)	(0.04)	(0.01)
Waiting Time(minutes)	-0.01	0.53	0.08
	(0.11)	(0.39)	(0.08)
Dutch	0.00	-0.00	-0.00
	(0.01)	(0.01)	(0.01)
Percentage Employment	2.50**	1.69*	1.49*

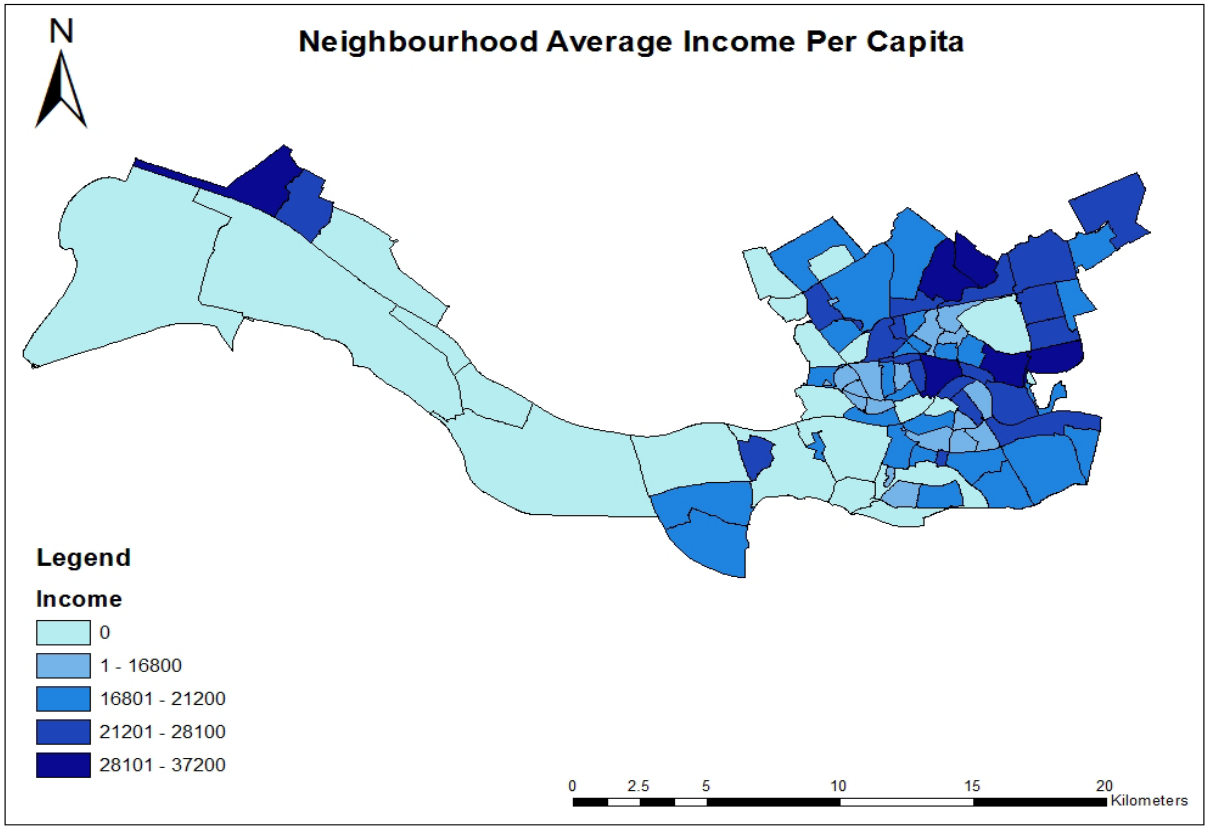
	(0.80)	(0.79)	(0.70)
Income	0.70**	0.54	0.45
	(0.24)	(0.31)	(0.28)
cut1			
Constant	0.18	0.53	0.19
	(0.71)	(0.73)	(0.65)
cut2			
Constant	1.65*	1.83*	1.46*
	(0.68)	(0.72)	(0.63)
cut3			
Constant	3.24***	3.14***	2.77***
	(0.74)	(0.70)	(0.65)
Observations	53	53	53
R^2			
Adjusted R^2			

Source: Author, (2015) STATA ordered probit regression analysis

4.3.9 Income and Travel Behaviour

Data from the quality of life spatial indicators state the highest average income per capita for the period between 2008-2012 as 37,200€ and the lowest at 13,000€. The top three neighbourhoods with the highest average income per capita are Kralingen-Oost with 37,200€, Molenlaankwartier with 36,200€ and Strand en Duin with 32,600€ while the ones with the lowest are Hillesluis with 13,300€, Feijenoord with 13,000€ and Afrikaanderwijk with 13,000€ as well. The map below represents the different levels of average income per capita per neighbourhood

Map 7: Average Income per Capita



Source: Author, (2015) ArcGIS map based on Rotterdam Area Profile (2008-2012)

As in the maps before, the darker shade represents the neighbourhoods with the highest income per capita while the lighter shade represents the ones with the lowest. The very light blue which in the legend is represented by 0 is for the neighbourhoods that do not have information on average income per capita.

Of particular interest here is the fact the happiest neighbourhoods are not necessarily the ones with the highest income as in the map Strand en Duin is the only very happy neighbourhood that is in the very high average income per capita category. Nesselande and Dorp are in the second which is also high but then neighbourhoods like Stadsdriehoek which is among the happy neighbourhoods has a higher average income per capita than the two very happy neighbourhoods

In order to find out the impact of income on the use of public transportation, the indicators where regressed with dummy variables for particular neighbourhoods included based on their average income per capita. In 23 table below the first two are the high income areas and the last two are the low income areas. The results in all the four neighbourhoods are the same with number of bus stops being the only indicator that leads to an increase in the happiness levels of the neighborhoods, while the bus directions and number of visits would lower happiness levels.

Table 23: Impact of Income on Travel Behaviour

Happiness	Kralingen-Oost	Strand en Duin	Hillesluis	Afrikaanderwijk
Number of Bus Directions	-0.13**	-0.13**	-0.13**	-0.13**
	(0.04)	(0.04)	(0.04)	(0.04)
Number of Bus Platforms	0.04**	0.04**	0.04**	0.04**
	(0.01)	(0.01)	(0.01)	(0.01)
Average Number of Bus Visits	-0.03*	-0.03**	-0.03**	-0.03**
	(0.01)	(0.01)	(0.01)	(0.01)
Average Bus Waiting Time(minutes)	-0.02	0.02	0.01	0.02
	(0.10)	(0.11)	(0.10)	(0.10)
Number of Metro Platforms	0.08	0.08	0.08	0.08
	(0.05)	(0.04)	(0.05)	(0.05)
Average Number of Metro Visits	-0.01	-0.01	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Number of Tram Directions	0.03	0.02	0.03	0.02
	(0.10)	(0.10)	(0.10)	(0.11)
Number of Tram Platforms	0.01	0.01	0.01	0.01
	(0.04)	(0.04)	(0.04)	(0.04)
Average Number of	-0.01	-0.01	-0.01	-0.01*

Tram Visits				
	(0.01)	(0.01)	(0.01)	(0.01)
Population	-1.18*	-1.12*	-1.22*	-1.21*
	(0.48)	(0.47)	(0.48)	(0.49)
Percentage Employment	0.47	0.70	0.44	0.49
	(0.86)	(0.86)	(0.84)	(0.87)
_Idistrict3_1	1.16***			
	(0.28)			
_Idistrict6_1		5.59***		
		(0.70)		
_Idistrict2_1			-5.68***	
			(0.41)	
district1==1				-6.03***
				(0.39)
cut1				
Constant	-3.44***	-3.10***	-3.37***	-3.50***
	(0.79)	(0.80)	(0.79)	(0.79)
cut2				
Constant	-1.56*	-1.25	-1.47*	-1.56*
	(0.69)	(0.72)	(0.68)	(0.68)
cut3				
Constant	0.23	0.59	0.29	0.23
	(0.71)	(0.80)	(0.71)	(0.71)
Observations	67	67	67	67
R^2				
Adjusted R^2				

Source: Author, (2015) STATA ordered probit regression analysis

From the above analysis it can be inferred that the difference in income levels does not play a big role in the decision to use public transportation and on node proximity preference as in both the low income and high income neighbourhoods the bus platforms are the preferred stops.

4.4.4 Conclusion

The results show that overall proximity to transport nodes would reduce happiness of the neighbourhoods and this can be attributed to the fact that closeness to the stops would expose the residents to increased noise levels and concerns of traffic safety as they would be more vulnerable to accidents. In the very unhappy neighbourhoods however, being close to the transport nodes would increase their happiness levels and this implies that for these neighbourhoods the ability to easily access transportation is more important than negative impacts involved.

Overall accessibility also has a negative influence on the overall happiness of the neighbourhoods and given the indicators within this variable this is expected as increasing the number of visits of modes could lead to congestion and increased noise levels, increasing number of platforms would increase level of built environment thereby affecting the aesthetics of the neighbourhood and since they are meant to be accessed by the modes, having more platforms would mean having more modes in the area which would again lead to congestion. Increased waiting time would affect happiness as people do not want to have to wait long for modes to arrive as this would affect their travel schedule as would the increased number of

directions because the more directions a mode has to go through the longer the journey is and all this would lower happiness. The indicators are however positive in the very unhappy neighbourhoods except for number of platforms which is not significant

The mode indicators that would lead to increase in happiness are the bus platforms which could be as a result of the low levels of noise generated by the buses as compared to the other modes. In the very unhappy neighbourhoods however the bus directions would increase their levels of happiness more implying that in these neighbourhoods the residents would like to be connected to as many places as possible

Ethnicity has no impact on the decision to use public transportation or on the type of mode as the results for both the Dutch and the Non-Dutch came out the same with the number of bus directions, number of visits of all the modes and increase in waiting time of the bus and tram leading to lower levels of happiness. The results also showed that for both the Dutch and Non-Dutch the number of platforms would lead to an increase in happiness.

The difference in income also does not play a big role in public transportation use as the results from a comparison between the high income and low income neighbourhoods showed that in all the neighbourhoods only the bus indicators have an impact on happiness and again only the bus platforms would lead to an increase in happiness.

Chapter Five: Conclusion and Recommendations.

5.0 Introduction

This chapter presents a summary of the research and provides answers for the research questions. The interpretation of the results is also presented and the relevance of the study is given. The chapter concludes with recommendation on areas for further research.

5.1 Research Purpose

The purpose of the study was to examine the impact of connectivity on the wellbeing of individuals and the connectivity would be determined by the distance of dwelling units from transport nodes, the number of nodes in the neighbourhood and the frequency of the modes in each neighbourhood. The study also aimed at finding out which of the nodes has the highest impact on the wellbeing of people and this would be determined by the mode that they used the most.

The main hypothesis was that the closer individuals are to a transport node the happier they are and that the more connected a neighbourhood is with regard to the total number of its residents living within close proximity to nodes, the happier the neighbourhood is. The assumption was taking into consideration the type of node, number of nodes and the frequency of modes

The study further set out to determine the influence income has on the mode choice and ultimately on the type of platform that the different income groups would prefer to live closer to. The assumption with theories built from literature was that the high income earners would prefer to stay closer to modes that are faster although they cost more while the low income earners would prefer to be nearer to the more affordable nodes at the expense of speed.

5.1.1 Impact of Proximity to transport nodes on Happiness

How does proximity to transport nodes affect the well-being of people in Rotterdam?

The first assumption was that proximity to transport nodes would have a significant positive impact on the wellbeing of the people in Rotterdam as it would enable them have better access to the transportation network. The findings however show that proximity to the nodes would lead to less levels of happiness especially in the happy and the very happy neighbourhoods. Given the nature of these neighbourhoods it is understandable why proximity to nodes would affect their happiness.

Majority of the happy neighbourhoods have the highest amount of traffic both from private and public transport and since the stops are located along roadways, it would mean that people close to the nodes are exposed to increased noise pollution from the traffic. The very happy neighbourhoods like a Nesselande are strategically located in the outskirts of the Municipality to cater for the housing needs of those who do not want to be in very noisy places, residents in such neighbourhoods and are close to the nodes would therefore be less happy because they are still affected by the noise they were trying to avoid in the first place. In the very unhappy neighbourhoods, proximity to nodes would lead to increased happiness.

Whereas the analysis for this indicator came out negative for happiness, this does not mean that distance to transport nodes with relation to dwelling units is not important, on the contrary it is so important that the Municipality has a principle for allocation of the nodes that ensures coverage but also considers the actual walking distance of the residents to the nodes.

The Strategic advisor for Urban planning emphasizes this importance citing the not happy, not connected area as the south end where according to him people are living in a place where it is hard for their children to get to the schools they want because there is no sufficient public

transportation and yet it is too far for them to bike. He adds that this affects their happiness because then the children are forced to either bike tiring distances to get to better education or opt for the schools within their neighbourhoods.

He further hints on this aspect affecting housing development, attributing the change or mind shift in real estate development from the South of Rotterdam to the fact that there is no access to good public transportation in the area. Real estate developers are reluctant to put up housing in the South because the high income earners whom they usually target will not settle there since they do not have enough possibilities and yet since they have jobs in the region, the time taken to travel would be too long for them. He further adds that there is more development on the Northside because real estate developers are aware that people target areas with more accessibility.

Linkage to literature

Banister (2008) suggests that among the ways that could reduce levels of car use is by adopting transport policy measures that would make it easier to use public transport. Having transport nodes close to people would make it easier for people to use public transport and ultimately reduce dependency of transport on car use.

This aspect is further supported by Goldman and Gorham (2006) who state that the ability to offer choice of transport mode is a key component that a transportation system should have in order to be regarded as effective. Having access to public transportation through the nodes offers the residents more choice. As mentioned by the Strategic Advisor for Urban Planning the fact that the South of Rotterdam is not well connected contributes to the area being unhappy because then the choices of the residents are limited.

It was therefore expected that by being close to transport nodes, people would be happier as this would enable them to have better access, however the study reveals that proximity to transport nodes reduces happiness and this can be attributed to the negative aspects associated with being close to them. Wu (2013) in his study on influence of rail access on home happiness finds that station-distance reductions are found to decrease the homeowners' happiness towards traffic safety and social environment nearby station areas. Such concerns could be the reason as to why the public transportation nodes would have a negative impact on happiness.

5.1.2 Impact of frequency of transport modes happiness

To what extent does the frequency of a transport mode impact the well-being of people in Rotterdam?

In the analysis, frequency was analysed from two perspectives, the first one based on the number of visits made by the modes and the other on the waiting time at the stops, the results from the number of visits show that an increase in visits would reduce the happiness of neighbourhoods. This is so because more visits would imply more noise levels, more congestion and more concern over traffic safety. This is especially true for the very happy and happy neighbourhoods but more so for the happy neighbourhoods that would be the most affected by increased visits. The very unhappy neighbourhoods would however be happier if the number of visits increases.

Waiting time on the other hand emerges as the better indicator for happiness as an increase in waiting time for all the modes would lead to reduced happiness levels. This implies that much as the people in the neighbourhoods do not want to have too many modes in their areas, they would still want them to be efficient enough to keep to their schedules and get to them to their destinations in the shortest time possible.

The efficiency of the transport system is therefore not in having as many modes as possible plying the same route but in responding to the travel needs of its patrons, the number of visits should be based on the different needs of each neighbourhood, the volume of users per route and the time of day, for instance since early mornings and late evenings are usually the busiest times of day, it would be justifiable if the number of visits are more in order to cater for the users. Frequency is therefore important for well-being because it reflects on the average waiting time which if it is too high would reduce happiness of people

Equally important to consider with regard to travel time is the in-vehicle time which came out in the analysis for total number of directions. Being able to access many places would be of importance to the neighbourhood as it would enhance connectivity, however having to go through many stops and neighbourhoods would affect the commute happiness of an individual as it would mean that they spend more time in the vehicle. If the individual for instance has to make a transfer to another mode at another stop there would be a possibility of the traveller missing the connection which would be of great inconvenience.

It is most likely for this reason that the regression for average number of directions turns out negative because more directions would mean more stops and therefore more time in the vehicle, longer travel time and therefore less commute happiness.

Linkage to Literature

Hagerstrand, (1970) and Downes and Emmerson, (1985) assert that in the developed world travel costs and most importantly travel time, rather than travel distance, determine which activities individuals can engage in. This reflects importance of the mode frequency is responding to demand especially basing on the waiting time at the platforms. The number of visits of the modes have a negative impact on happiness but then they should be frequent enough to meet the travel demands of the users. It is important for individuals that they are able to engage in as many activities as possible, if the public transportation system cannot ensure that, then its impact will be low.

Allsop, (2008) mentions that service providers of public transport should respond to the increase of demand on a route by increasing the frequency of modes as this would reduce link cost functions. This has been adopted in Rotterdam as indicated by the Strategic Advisor for RET, who says that the frequency of the modes is determined by the demand for it whereby, neighbourhoods that have more people will have more frequency than those with less.

Abou-Zeid, Witter, et al. (2012) also emphasize the importance of frequency claiming that one of the undesirable features of public transport is the fact that the extent to which a journey can be made at the desired time depends on the frequency of service requiring users to either plan their activities around scheduled departure times, which involves inconvenience and transaction costs along with some amount of wait time, or else turn up at the departure point at random, which avoids the scheduling costs but incurs additional waiting which on average equals half the headway. To prevent this therefore and make public transportation more effective the waiting time has to be factored into the scheduling of transport modes

5.1.3 Number of Nodes and Happiness

What is the impact of number and variety of transport nodes on the happiness of neighbourhoods in Rotterdam?

The total number of platforms is not significant for happiness meaning it would neither increase nor decrease the levels of happiness of neighbourhoods. When comparison is made between the neighbourhoods with most number of nodes and those with the least number, bus platforms

emerge significant and contributing to an increase in the levels of happiness. Comparison between the very happy and very unhappy neighbourhoods yields the same results when all the mode indicators are included in the model with the bus platforms being significant.

Overall, with all the control variable included only the bus platforms would lead to an increase in happiness levels. The metro platforms are only positive and significant when the analysis is not controlled for income *(Table: 19).* Making income constant therefore reduces the significance of the metro platforms which seems to indicate that with difference in income levels there is a likelihood of some neighbourhoods preferring to have metro platforms. This could be the high income neighbourhoods because that would enable them move to faster and as literature has shown, as income increases people prefer to use modes that are quicker to get to their destinations

The variety of the nodes also does not seem to have an impact because again as shown in the comparison between the neighbourhoods with a lot of stops and those with few stops, in all the neighbourhoods only the bus platforms have a significant positive impact on the happiness of people. This however also points to the importance of having a node in relation to travel destination, in Nesselande for instance where there is both a metro stop and bus platforms, there is low use of public transportation because the metro and the bus in the area do not go to the areas that are of importance to the residents. Public transportation use would probably be higher if the neighbourhood had a train station or if the metro had a connection to Amsterdam or Utrecht.

An important factor to consider with regard to number and type of platforms to be located in an area is analyzing the composition of the neighbourhood that is to benefit from the platform as asserted by the Traffic Engineer who points out that in the South of Rotterdam after engaging in discussions with people from the south bank the Municipality had the intention of constructing a new Metro line that would enable the residents to access the center but then the residents indicated that for them access to the center was not important because they do not have jobs there and socially most of the people they know are within the same neighbourhood. He adds that it can happen that a new line and stop is constructed and people don't use it because their neighborhood is their world and they have amenities within. This means that it is not just a matter of increasing the number of nodes but they should be able to meet the needs of the people in the area.

Linkage to Literature

DeSalvo and Huq, (1996) argue that it costs more to travel faster and that as the wage rate rises commuters choose faster modes so as to cover longer distances while spending less time travelling. It is for this reason therefore that for a neighbourhood like Nesselande it would be convenient to have a metro line given the fact most of the residents travel longer distances and need a faster mode while for neighbourhoods in the South for instance cheaper modes would have more significance. As earlier explained the decision to construct a stop in an area is to some extent influenced by the composition of the neighbourhood in that relatively affordable modes are placed in areas that have low income while for the high income focus is more on the mode that can get them faster to their destinations instead of on the cost.

It is therefore not just about having many platforms in an area but on the impact that the particular stop would have on the happiness of the neighbourhood determined by how affordable it is to them and the extent to which it meets their travel needs, for instance if the people in the neighbourhood need to travel longer distances then they should be able to have access to a faster means of public transport system.

5.1.4 Influence of income on node proximity preference

How does income influence node proximity preference?

Income does not have an impact on the type of public transport node that residents would prefer to live close to as seen from the analysis on mode indicators in the neighbourhoods with high income per capita and those with low income per capita where for all the neighbourhoods only the bus platforms are significant for an increase in happiness. The other more obvious comparison can be on Stadsdriehoek and Nesselande both of which have a high average income per capita with Stadsdriehoek at 29,700€ and Nesselande at 26,800€ and both having different patterns of settlement. Literature seems to suggest that high income earners would prefer to stay in the outskirts of cities because they tend to go for quiet neighbourhoods and they would not be affected by having to travel longer distances because they can afford faster modes of transportation.

Based on this theory therefore it would be expected that the city centre would have only low and middle income earners but as it can be seen from these two neighbourhoods, high income earners also want to live in places where they can easily access public transportation. This view is supported by the Strategic Advisor who states that the reason as to why high income earners would want to live in the city centre is because they would then be able to access better public transportation and access to jobs and education.

With regard to planning however it is important to consider the type of mode in relation to the neighbourhood in which it is to be located as this could affect its use. The Strategic Advisor for Urban Planning for instance points out that as the Municipality considers improving access to the South, it cannot start by extending a metro line because it is slightly relatively more expensive than the bus and tram.

The Traffic Engineer supports this saying considering the fact that it expensive to extend transportation especially for the tram and metro then it is important to ensure that the type of mode being extended is suitable for the income group that is to benefit from. He adds that starting with a metro line for instance in the South would have little impact on improving the residents' access when compared to the bus which most of them consider to be more affordable. He further says that it was because Nesselande was expected to have high income earners that the metro line was extended to the neighbourhood even before the housing started because the Municipality predicted that this would be more suitable for them.

Linkage to Literature

According to Murray, Davis, et al. (1998) it makes sense to adjust the notion of service coverage to reflect the spatial, socioeconomic and demographic characteristics of potential patronage rather than attempting to set public transport goals for the entire region and that the extent to which cost recovery by public transport services is expected needs to be assessed when setting performance goals.

This implies that although income might not have an impact on the node proximity preference, it has an influence on the impact on the performance of modes, for instance if the income of the people in a neighbourhood is not put into consideration and a train line is extended into the area, the train would be used less if the neighbourhood turns out to be a low income area and service providers might not be able to recover the operational costs for that route because of the poor performance of the train.

5.2 Interpretation of findings

Proximity to transport nodes it enhances accessibility does not lead to increase in the level of happiness of people in the neighbourhoods overall because of the negative impacts associated with it. It however increases happiness in the very unhappy neighbourhoods

The number of trips made by the modes is more relevant if they factor in the travel demands of the users so that they are more frequent in the areas with a lot of people who require public transportation and this way waiting time which has been found to reduce happiness as it increases would be maintained at within the acceptable range that would not affect the overall travel time of the users. The total directions of the modes would improve connectivity of the neighbourhood but would reduce that happiness levels of the neighbourhoods because they would make the in-vehicle time of travellers longer as the modes they go through all the stops

The difference in the levels of employment play a more important role in travel behaviour than just the income levels as it affects both the disposable income and therefore the residents willingness to pay for public transportation and also determines the demand for transportation, people who are employed would appreciate an efficient transport system. It can therefore be inferred that the travel purpose and ultimately the travel destination play a more central role in the decision mode choice.

Bus platforms because of the low levels of noise from the buses are the more preferred nodes in most of the neighbourhoods. The bus's low negative impacts being the most apparent reason for its being popular implies that for the other modes to be as effect, measure have to be put in place to mitigate the negative environmental and social aspect associated with them

5.3 Recommendations

The study reveals that the negative impact of proximity to nodes on happiness could be as a result of concerns on congestion, pollution and traffic safety, in order to enhance the impact of public transportation in terms of access therefore it is important that buffers to protect residents from pollution and traffic accidents be included in the designs for the platforms. Having the platforms located underground as it is in some areas within Rotterdam helps reduce the noise levels but for the areas where underground stations are not possible, buffers would be important.

In order to enhance connectivity without necessarily increasing the in-vehicle time, there could be classification of these modes as it is with the trains whereby there are trains that make stops at particular stations while others make stops at every train station. This can be adopted for all the modes and this way those who are greatly inconvenienced by the detours made by the modes can opt for the one that has a more direct route. Transport network connectivity in terms of ease of connections between the different modes and therefore the directness of travel between destinations is very influential (Litman, 2015).

Frequency of the modes in the area should be determined by the demand for that mode reflected by the volume of users and the time of day, they should be more frequent at the times when the demand is highest and where people are more. This way unnecessary trips to neighbourhoods would be avoided and thus the negative impacts limited.

The research shows that in the very unhappy neighbourhoods access to public transport is important and would lead to increase in happiness, it would therefore be important for the Municipality to prioritise it's public transportation innovations in these neighbourhoods while at the same time putting measures to avert the would be negative impacts of improved accessibility as suggested above. Depending upon policy objectives, priority would be given to improving access to areas that contain a high proportion of transport disadvantaged groups

such as the elderly, invalid pensioners, low income earners or areas which contain a high probability of increasing public transport patronage (Murray, Davis, et al., 1998).

5.4 Contribution of the research

The previous research reviewed for this study in relation to proximity to public transportation nodes was mainly on the big infrastructure like the airports and the train stations. This research contributes to the field of transportation by focusing on the nodes that are most frequently used for daily travel and examining their impacts on the wellbeing of the people.

For scientific relevance the research has shown from statics that in overall accessibility the number of Bus platforms and to some extent Metro platforms are significant for an increase in happiness of the people. The research has also shown that the waiting time and in-vehicle time are important determinants of public transport use and should be put into consideration when planning for an efficient transport system.

The research is also relevant for policy, having shown that for the very unhappy neighbourhoods in Rotterdam an increase in accessibility in terms of decreasing distance of dwelling units from the nodes, increasing number of mode visits and also an increase in the number of areas accessible would improve their happiness. It would therefore be important for the Municipality to focus on improving accessibility in these neighbourhoods. According to Murray, Davis, et al. (1998) focusing attention on providing service access to those that would most likely use it is a much better approach rather than seeking to improve service to the entire population and that this way the standards of coverage would then be somewhat modified and perhaps much more realistic.

5.5 Recommendations for Further Research

Further research can be done on the impact of proximity to transport nodes on housing satisfaction. This would be significant as it would give insight on how distance from nodes would affect the housing prices and also impact on the settlement pattern. It would also guide policy makers on the transport modes that would have more impact on the different income groups' decision to settle in an area based on their willingness to pay for houses close to different types of nodes. This way they would be able to prioritise and focus on those transport nodes that have more impact on the different income groups.

In line with enhancing public transportation further research could also focus on the impact of accessibility on commute happiness, this would be more focused on the transportation geography and would guide policy makers on which aspects of transportation need to be prioritised in order to make the systems more responsive to travel needs.

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Annex 1: Primary Survey Respondents

Organisation	Name	Role
Rotterdam Municipality	Martin Aarts	Strategic Advisor for Urban Planning
	Martin Guit	Traffic Engineer
	Roland van der Heijden	Urban Planner-Sustainable Urban Development and Geographic Information Systems
	Chris de Vries	Researcher-Research and Business Intelligence
	Rens van Overdam	Chairman Kralingen-Crooswijk
RET	Eddie Pelle	Strategic Advisor/Accounts Manager

Source: Author, (2015)

Annex 2: Summary Statistics Table

	Mean	Standard Deviation	Minimum	Maximum
Happiness	2.15	0.82	1	4
Overall Accessibility	9.42	3.03	0	14
Total Number of Directions	9.49	8.29	1	46
Total Number of Platforms	26.80	25.45	1	151
Average Number of Combined Visits	31.25	17.45	1	77
Average Combined Waiting Time(minutes)	4.89	2.13	0	9
Number of Bus Directions	5.50	5.41	0	29
Number of Bus Platforms	17.50	18.75	0	109
Average Number of Bus Visits	30.79	20.20	0	88
Average Bus Waiting Time(minutes)	6.44	2.98	0	11
Number of Metro Directions	1.29	2.21	0	10
Number of Metro Platforms	2.12	4.66	0	30
Average Number of Metro Visits	23.97	37.12	0	101
Average Metro Waiting Time(minutes)	3.01	4.61	0	10
Number of Tram Directions	2.70	3.55	0	16
Number of Tram Platforms	7.18	10.31	0	53
Average Number of Tram Visits	38.99	36.40	0	101
Average Tram Waiting Time(minutes)	5.21	4.77	0	11
Percentage Residents with Public Transport Stops Within Reasonable Distance	0.76	0.28	0	1
Percentage Residents With Metro 800m	0.47	0.41	0	1
Percentage Residents With Tram 500m	0.51	0.44	0	1
Percentage Residents WithTrain1500m	0.44	0.44	0	1
Population	0.78	0.60	0	3
Percentage Employment per Total Jobs and Residents	0.35	0.31	0	1
Income	1.78	0.89	0	4
Percentage of Households with High Income	0.13	0.11	0	1
Total Surface Area	207.55	228.32	12	1571
Total Land Area	166.99	140.51	10	576
Dutch	35.33	33.55	1	138
Non-Dutch	59.70	52.25	2	203
Observations	76			

Source: Author, (2015) STATA

Annex 3: Comparison between Most Connected and Least Connected Neighbourhoods

Happiness	Groot Ijjsselmonde	Stadsdriehoek	Liskwartier	Zuiderpark
Number of Bus Directions	-0.16**	-0.17**	-0.16**	-0.17**
	(0.05)	(0.05)	(0.05)	(0.05)
Number of Bus Platforms	0.05**	0.05**	0.05**	0.05**
	(0.01)	(0.02)	(0.02)	(0.02)
Average Number of Bus Visits	-0.02	-0.02	-0.02	-0.02
	(0.01)	(0.01)	(0.01)	(0.01)
Average Bus Waiting Time(minutes)	-0.08	-0.08	-0.04	-0.08
	(0.11)	(0.12)	(0.12)	(0.12)
Number of Metro Platforms	0.05	0.05	0.05	0.05
	(0.06)	(0.07)	(0.05)	(0.05)
Average Number of Metro Visits	-0.01	-0.01	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Number of Tram Directions	0.05	0.05	0.03	0.07
	(0.14)	(0.12)	(0.12)	(0.12)
Number of Tram Platforms	0.00	0.00	0.01	-0.00
	(0.05)	(0.04)	(0.04)	(0.04)
Average Number of Tram Visits	-0.01	-0.01	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Population	-1.06*	-1.05*	-1.08*	-1.06*
	(0.52)	(0.50)	(0.51)	(0.50)
Percentage Employment	1.06	1.11	1.31	0.93
	(1.08)	(1.07)	(1.04)	(1.06)
Income	0.67**	0.67**	0.66**	0.76*
	(0.25)	(0.25)	(0.25)	(0.30)
_Idistrict1_1	0.18			
	(1.37)			
_Idistrict6_1		0.28		
		(1.68)		
_Idistrict3_1			6.42***	
			(0.68)	
district74==1				1.02
				(0.77)
cut1				
Constant	-2.11*	-2.10*	-1.98*	-1.87*
	(0.89)	(0.91)	(0.90)	(0.93)

cut2				
Constant	-0.12	-0.10	0.07	0.13
	(0.80)	(0.82)	(0.81)	(0.86)
cut3				
Constant	1.55	1.57	1.88*	1.82*
	(0.80)	(0.81)	(0.81)	(0.87)
Observations	67	67	67	67
R^2				
Adjusted R^2				

Source: Author, (2015) STATA ordered probit regression analysis

Annex 4: Comparison between Very Happy and Very Unhappy Neighbourhoods

Happiness	Very Happy Nesselande	Very Happy Strand en Duin	Very Unhappy Afrikaanderwijk	Very Unhappy Bospolder
Number of Bus Directions	-0.17**	-0.16**	-0.16**	-0.17**
	(0.05)	(0.05)	(0.05)	(0.05)
Number of Bus Platforms	0.05***	0.05**	0.05**	0.05**
	(0.02)	(0.02)	(0.02)	(0.02)
Average Number of Bus Visits	-0.03*	-0.02	-0.02	-0.02
	(0.01)	(0.01)	(0.01)	(0.01)
Average Bus Waiting Time(minutes)	-0.04	-0.07	-0.06	-0.09
	(0.12)	(0.12)	(0.12)	(0.12)
Number of Metro Platforms	0.08	0.05	0.06	0.06
	(0.04)	(0.05)	(0.05)	(0.05)
Average Number of Metro Visits	-0.01*	-0.01	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Number of Tram Directions	0.06	0.05	0.05	0.01
	(0.12)	(0.11)	(0.12)	(0.11)
Number of Tram Platforms	-0.00	0.00	0.01	0.02
	(0.04)	(0.04)	(0.04)	(0.04)
Average Number of Tram Visits	-0.01	-0.01	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Population2	-1.27*	-1.02*	-1.08*	-1.31**
	(0.50)	(0.49)	(0.50)	(0.50)
Percentage Employment	1.09	1.14	1.03	0.57
	(1.05)	(1.02)	(1.03)	(0.95)
Income	0.56*	0.62*	0.61*	0.59*
	(0.25)	(0.26)	(0.25)	(0.24)
_Idistrict3_1	7.40***			
	(0.69)			
_Idistrict6_1		4.61***		

		(0.82)		
_Idistrict1_1			-5.44***	
			(0.49)	
district8==1				-6.61***
				(0.64)
cut1				
Constant	-2.37**	-2.05*	-2.31**	-2.74**
	(0.92)	(0.89)	(0.88)	(0.87)
cut2				
Constant	-0.25	-0.07	-0.26	-0.64
	(0.83)	(0.80)	(0.79)	(0.75)
cut3				
Constant	1.62	1.62*	1.41	1.10
	(0.86)	(0.81)	(0.78)	(0.74)
Observations	67	67	67	67
R^2				
Adjusted R^2				

Source: Author, (2015) STATA ordered probit regression analysis

Annex 5: Impact of Public Transport Indicators on Happiness of the Non-Dutch

Happiness	Directions	Platforms	Visits	Waiting Time
Bus	-0.08**	-0.01	-0.03**	-0.18**
	(0.03)	(0.01)	(0.01)	(0.06)
Metro	-0.06	-0.01	-0.01*	-0.07
	(0.07)	(0.03)	(0.00)	(0.04)
Tram	-0.03	-0.01	-0.01*	-0.09*
	(0.04)	(0.02)	(0.01)	(0.04)
Non-Dutch	-0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Percentage Employment	2.50*	1.35	1.69*	1.44
	(1.13)	(0.89)	(0.79)	(0.82)
Income	0.75*	0.54	0.49*	0.51*
	(0.30)	(0.31)	(0.24)	(0.26)
cut1				
Constant	0.70	0.24	-1.07	-1.36
	(0.77)	(0.81)	(0.73)	(0.84)
cut2				
Constant	2.04**	1.50	0.43	0.07
	(0.77)	(0.78)	(0.69)	(0.79)
cut3				
Constant	3.42***	2.78***	1.98**	1.64*
	(0.79)	(0.73)	(0.69)	(0.77)
Observations	53	53	53	53
R^2				
Adjusted R^2				

Source: Author, (2015) STATA ordered probit regression analysis

Annex 6: Impact Modes on the happiness of the Non-Dutch

Happiness	Bus	Metro	Tram
Directions	-0.15**	-0.13	-0.04
	(0.05)	(0.32)	(0.09)
Platforms	0.03*	0.03	0.01
	(0.02)	(0.08)	(0.03)
Visits	-0.02	-0.06	-0.02
	(0.01)	(0.04)	(0.01)
Waiting Time(minutes)	-0.02	0.45	0.10
	(0.11)	(0.40)	(0.08)
Non-Dutch	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)
Percentage Employment	2.20**	1.20	1.02
	(0.83)	(0.78)	(0.72)
Income	0.67**	0.47	0.39
	(0.25)	(0.31)	(0.28)
cut1			
Constant	-0.07	-0.03	-0.24
	(0.81)	(0.81)	(0.71)
cut2			
Constant	1.40	1.31	1.05
	(0.77)	(0.77)	(0.68)
cut3			
Constant	2.97***	2.61***	2.36***
	(0.79)	(0.72)	(0.67)
Observations	53	53	53
R^2			
Adjusted R^2			

Source: Author, (2015) STATA ordered probit regression analysis

Annex 7: Secondary Data Source for Transport Modes

http://www.ret.nl/nc/reizen-met-ret/dienstregeling.html

Annex 8: Secondary Data Source for Demographics

http://www.cbs.nl/nl-NL/menu/home/default.htm