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MSc Programme in Urban Management and Development

Rotterdam, The Netherlands

September 2018

Thesis

Title: A study of neighborhood satisfaction in pre-war and post war neighborhoods in Rotterdam, The Netherlands.

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Specialization: Urban Competitiveness and Resilience

UMD 14

MASTER'S PROGRAMME IN URBAN MANAGEMENT AND DEVELOPMENT

(October 2017 – September 2018)

A study of neighbourhood satisfaction in pre-war and post war neighbourhoods in Rotterdam, The Netherlands.

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UMD 14 Report number: 1132

Rotterdam, September 2018

Summary

Nowadays, quality of urban life is an important concept to urban living environments. Satisfaction with the live in the neighborhood is seen to be a meaningful subset of this concept.

This research approaches the theme of neighborhood satisfaction in pre-war and post-war neighborhoods in the city of Rotterdam, the Netherlands. The typology of pre-war and post-war urban areas are assumed to provoke differences in satisfaction. Therefore, this research aims to explain the extent to which neighborhood factors (physical, social and safety) and selected spatial features of the urban environment can influence the level of neighborhood satisfaction in these two types of neighborhood.

For that matters, data from the Wijkprofiel Rotterdam (2018) was used to get information regarding neighbourhood satisfaction as well as physical, social and safety measures. The data from spatial features, which include micro and macro scale measures were taken from the database of Google maps and Akkelies Van Nes (2003), respectively. Micro scale included the degree of inter-visibility of windows and entrances while macro scale referred to measures of metrical and angular analysis through the use of Space Syntax. Together with neighbourhood factors and selected spatial features (independent variables) a beta regression was performed, with dependent variable being neighbourhood satisfaction. The result of the statistical analysis reflects distinctive relationships between these variables in pre-war and post war neighbourhoods, as analysed separately.

The results indicated that there is a significant relationship and a difference to the extent in which both neighborhood factors and spatial features influence neighborhood satisfaction in pre-war and post war neighborhoods. In addition, a few spatial features were also seen to differently influence neighborhood factors in these two types of neighborhoods studied. The research further observed significant effects from the control variable of average income.

Keywords

Quality of Urban life, Neighbourhood satisfaction, Neighbourhood factors, Spatial features of the urban built environment, Pre-war neighbourhoods, Post war neighbourhoods.

Acknowledgements

I would like to thank everyone who supported me during this journey. Firstly, to my loving parents, who has always supported me to achieve my dreams and invested in my academic formation no matter how they could. I am forever thankful, and I love you very much.

To my supervisor, Akkelies van Nes, for believing in my potential and encourage me to going forward. You are a great supervisor and an amazing human being. Thanks for having the opportunity to learn from you.

To Wijkprofiel Rotterdam, who provided me with the data which made this research possible.

To my second reader Jaap Rozema, which feedback were valuable to the construction of this thesis.

To all UMD14 friends, for creating this amazing learning and sociable environment. I am forever grateful to have made friends in every part of the world and learn something new from each of you.

Finally, I am thankful to all members of UCR and RMT teams for teaching us all tools needed to elaborate the thesis from the beginning of this intense process. Special thanks to Paula Nagler, who always made herself available to help me with the statistical part. To Sharon, who were always willing to help.

Abbreviations

IHS	Institute for Housing and Urban Development
UN	United Nations
QoL	Quality of Life
QoUL	Quality of Urban Life
VROM	Ministry of Housing, Planning and Environment
QGIS	Quantum Geographic Information System
OBI	Business and Intelligence Research
II WW	Second World War
PCA	Principal Component Analysis
VIF	Variance Inflation Factors

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Chapter 1: Introduction

"The city definitely has assumed a central place in producing and dynamizing symbolic goods as well as in guaranteeing the general welfare of its population." (Castell and Borjas, 1996, p.1)

1.1 Background

This research examines the influence of neighbourhood factors (physical, social and safety) and spatial features on neighbourhood satisfaction in selected areas in the city of Rotterdam, the Netherlands. In particular, it identifies which indicators of those factors significantly influence neighbourhood satisfaction

Currently, more than 50% of the world's population resides in urban areas, and with the current urbanization trends this number is expected to increase in the upcoming years (UN, 2014). The process of urbanization and urban growth has both its positive and negative side. This process can significantly contribute to the social-economic development of the place, generating agglomeration economies and boosting opportunities for employment, education and health services (Arouri et al, 2014). However, it may also bring many potential problems to people and the environment. Many challenges cities face in this century within the process of urbanization and urban growth are the social inequality, lack of safety, housing shortages and inadequate housing, pollution, flood, traffic jam, lack of resources, shrink of green areas, destruction of habitats and the environment among others. In this context, concerns related to Quality of Life and Life Satisfaction of people are subjects which are gaining more relevance, and how to improve it has been an important issue for urban planners and policy makers worldwide.

Quality of Life (Qol) is characterized as a multidisciplinary term including all beliefs of a good and satisfying life. In this context, it is often related with terms of life satisfaction and individual wellbeing, furthers reflecting on distinctive characteristics which are believed to determine life satisfaction. In addition, the term happiness is an important word when discussing about the general welfare of a population. In order to discover whether people are happy or not, it is needed to look the level of overall satisfaction with their lives (Veenhoven, 2013). According to the literature, life satisfaction can be influenced by many aspects such as income, social connectivity, relationships and health among others (Leyden, Goldberg, et al., 2011).

Life satisfaction is also significant when approaching scales, such as cities and neighbourhoods. This thesis will approach specially the neighbourhood scale. In this sense, neighbourhoods that are doing well in matters of development can influence life satisfaction in a positive way. Conversely, neighbourhoods with high level of life satisfaction can be considered as good or strong areas (Shields and Wooden, 2003). The strong neighbourhoods provide more positive outcomes to the city, and those outcomes consist of better employment opportunities, education, safety, physical and mental health, and actively participation in society, enhancing the notion of citizenship (Ibid, 2003). Consequently, strong neighbourhoods improve the quality of life of the citizens (Ibid, 2003). When enhancing the quality of life of citizens, concurrently the level of life satisfaction of its citizens is improved as well.

Considering the context of study, Rotterdam is a port city located in the province of South Holland in the Netherlands. It is the second largest city in the country and the largest port in Europe, with a total population of 638,181 habitants (Geemente Rotterdam, 2018). The port of the city provides a strategic location not only within the Netherlands, but within all Europe.

Rotterdam is a multicultural and dynamic city, composed of over 9 ethnicities and various nationalities, with most of the population composed by the age group of 15 to 65 years (Geemente Rotterdam, 2018). The city is divided into two parts by the Nieuwe Maas river, the north and the south. The North is known to be more prosperous while the South is recognized as a more disadvantaged area as it is socio-economically poorer as well as presents a job shortfall and a large immigrant population. As compared to other Dutch cities (e.g. Amsterdam Utrecht, Groningen and The Hague), Rotterdam presents lower results in relation to some quality of life index such as safety, pollution and health. (Numbeo, 2015).

After the Second World War (1939-1945), the city experienced a significant housing shortage and a growing number of households. The housing production was hence necessary and took place in a short period of time to accommodate the residents (Posthumus et al, 2013). In this context, the city of Rotterdam can be divided in neighbourhoods which were constructed before (pre-war) and after (post-war) to the Second World War. Both pre-war and post war neighbourhoods are focus to strategies for improvement nowadays, as originated from the list of the "40 most deprived" neighbourhoods. This list was created by the Ministry of Housing, Planning and Environment (VROM) in 2007 to state the most deprived neighbourhoods in the Netherlands. The criteria of selection were based on aspects such as crime rates, resident's income and economic problems (Van Nes and Lopez, 2014). The aim of the list was to prioritize the improvement in these problematic areas, by doing strategic planning and reports for each neighbourhood. Although it has been modified with the past of the years because some refused to be on it due to the danger of bad reputation, Rotterdam presents the highest number of neighbourhoods in the list (Van Nes and Lopez, 2014). According to Van Nes and Lopez (2014) the strategies implemented in those areas were more focused on social issues rather than spatial aspects. In general, spatial improvements has been implemented without a solid study base, as only few areas present a correlation between social issues and spatial solutions. Therefore, the study of quality of life is valid and important to manage these areas properly and further improve life satisfaction

1.2 Problem Statement

Taking in consideration the Quality of Urban Life, most researches have studied aspects such income, housing, education, health, safety, personal relationships. However, not enough attention has been given to the built environment and spatial related factors, such as spatial features. In addition, satisfaction with urban living is predicted to happen at various geographic scales, such as home, neighbourhood, community, city and regions (Marans and Stimsom, 2011). Therefore, comprehend each of these scales and how it can possibly interact with their surrounding environment is also important to determine how is perceived by the inhabitants.

The socio-spatial dynamics organization and structure of a city/neighbourhood may potentially influence the daily lives of residents and how they perceive the place. Leyden et al (2011) state that places can facilitate human social connections and relationships. In this context, the level of the neighbourhood, as a scale, is important when considering the interactions between people on a daily basis. The neighbourhood has the power to enable "social connections and connection with the place itself" (Ibid, 2011, p.869). Hence, understanding how people's behaviour in space is based on its spatial attributes and how this relationship can influence their life satisfaction is key to academic debates surrounding urban policies and the environment itself. Yet, there is limited research in the literature regarding those subjects.

In 2012, the research regarding quality of life conducted in European cities reported that habitants of Dutch cities (Amsterdam, Rotterdam and Groningen) present a high life satisfaction with their overall life and the city which they are living in. However, in comparison to the other Dutch cities, the city of Rotterdam shows a lower level of life satisfaction in relation to their city, places where they live and the life they are heading. This can be explained through the perception of safety and the environment (e.g. cleanliness, air quality and noise) as well as the presence and integration of foreigners, along with some spatial characteristics of the city (e.g. green spaces, public spaces, streets and buildings). Rotterdam reports a lower level of satisfaction in relation to these aspects if compared to Amsterdam and Groningen (European Comission, 2012).

According to De Rooij and Van Nes (2015), the unemployment rate in Rotterdam is twice as the national average (8.5%). Rotterdam South, for example, even presents higher numbers than the average for unemployment, with some neighbourhoods consisting of 95% low skilled immigrants coming from non-western countries. Considering this context, the study of Quality of Life to Rotterdam should be disaggregated to the neighbourhood scale in order to understand better how both physical, social and safety factors affect life satisfaction, which are the factors researched in this master thesis. According to the information contained in the Wijkprofile Rotterdam (2018), it is clear the difference between neighbourhoods such as Kralingen or Hillegersberg compared to neighbourhoods such as Hillesluis or Overschie in relation to the factors mentioned above.

Finally, pre-war and post war neighbourhoods present differences in its typology which might influence quality of life, and hence satisfaction at the neighbourhood scale. Investigate these differences might give a new insight on the way of producing urban policies and managing neighbourhoods.

1.3 Research Objectives

The objective of this research is to explain the extent to which some neighbourhood factors (physical, social and safety) can influence the level of neighbourhood satisfaction by studying separately pre-war and post-war neighbourhoods in the city of Rotterdam, the Netherlands. In addition, it also aims to relate to selected spatial features of the urban built environment with neighbourhood satisfaction. As a result, the study hopes to contribute to urban planning and policy recommendations for cities that aim to improve neighbourhood development and consequently a better life satisfaction for people.

1.4 Provisional Research Question(s)

To what extent does neighbourhood factors (physical, social and safety) and spatial features' impact on neighbourhood satisfaction in pre-war and post war neighbourhoods in Rotterdam, The Netherlands?

Sub Questions:

1. What are the indicators of physical, social and safety factors that significantly influence satisfaction?
2. What are the spatial features of the least and most satisfied pre-war and post war neighborhoods?

3. How does selected spatial features of the urban built environment influence neighborhood factors?

1.5 Significance of the Study

The relationship between neighbourhood characteristics and how they might impact on life satisfaction remains an area that still need to be further explored. In this context, understanding the differences between a pre-war and a post war neighbourhood, and how this difference can possibly impact on life satisfaction of its residents is significant for policy makers and urban planners. The comprehension of each situation can determine the elaboration and application of appropriate urban policies and a coherent urban planning for the neighbourhoods.

After the Second World War, the city adopted new planning strategies on how to build an urban area. The concept of neighbourhood was adopted, generating a new way of seeing and living in the city. Years have passed but the principles of the urban planning remain, making important to investigate the differences in life satisfaction in different contexts.

Furthermore, in this field of study, the study adds knowledge on less researched determinants of life satisfaction and quality of life research by identifying physical, social and safety characteristics of the urban built environment in cities which may significantly influence their level of satisfaction. It mainly hopes to identify that spatial related characteristics of the environment have a significant impact on well-being of residents. This might be as important as individual and well researched characteristics such as income, work and health.

1.6 Scope and Limitations

The scope of the analysis will be in the city of Rotterdam, in The Netherlands. This research uses secondary data available to conduct the analysis of life satisfaction in pre-war and post-war neighbourhoods. The results obtained are related with the context, hence a generalization may be valid for cities in European countries which were affected by the war and faced with the same issues. Moreover, the use of secondary data has limitations as it was not gathered for the specific purpose of the research as well as some validity issues. Those validity issues will be further explored in chapter 3.

In addition, in such a research, it is difficult to obtain a global and detailed approach of all the aspects currently involved in determining the quality of urban life and life satisfaction, even if considering as main approach the neighbourhood level. Thus, this study opts to focus mainly on the influence of the urban environment and in determined spatial elements, by selecting physical, social and safety aspects as factors for its analysis as well as considering selected spatial features of the urban environment as proposed by the author Akkelies Van Nes.

Chapter 2: Literature Review / Theory

This chapter explains some of the concepts used in this research. It makes a literature review about the following topics: Pre-War and Post War Neighbourhoods; Quality of Life and Quality of Urban Life; Neighbourhood Satisfaction and Spatial Features of the Urban Environment. Mainly it is concerned on how quality of life and life satisfaction is attached to neighbourhood characteristics. In the end, a conceptual framework shows how these concepts are connected to each other.

2.1 Pre-War and Post-War Neighbourhoods

From 1939 to 1945 the Second World War involved many of the world's nations, including the Netherlands. The city of Rotterdam, a strategic point due to its river port, was one of the most affected cities in the country. A great part of the city, mainly the center, was heavily bombed and destructed by the war. After the end of the war, the city began its reconstruction process and became worldwide recognized for its modern architecture. The period before and after the war regarding urban areas will be briefly discussed in this section.

Urban areas before the Second World War in The Netherlands were considered problematic. When mentioning Rotterdam, Bos et al (1946) stated that the city was too large and chaotic, being an obstacle to community development. In addition, the pre-war city presented issues for individual and healthy development for its citizens. As a response to these issues, post-war developments followed the idea of the “neighbourhood concept”. This concept arose as a solution for the lasting housing shortages, and the social and psychological problems that came with the uncontrolled growth and sprawl of cities (Netherlands ICOMO, 2003). “In large cities the individual vanished in the masses and the amorphous agglomeration of districts defied the development of any sense of Community” (Ibid, 2003, p. 147). The fundamental belief was that by structuring the city into neighbourhoods, a better sense of society would be stimulated, hence achieving an improved subjective well-being (Wassenberg, 2006). The neighbourhoods were mostly constructed during the 1950s and 1960s and were supplied by the government on a large scale. The design of these units aimed to achieve an explicit focus in the community development as well as to attain a dimension of space and function for the residents (Wassenberg, 2006). Thus, the neighbourhoods were intentioned to reproduce the structure of society and create a genuine community. (Netherlands ICOMO, 2003).

The planning and design of a great part of the post-war areas was enormously influenced by the Congrès Internationaux d’Architecture Modern (CIAM). According to Turkington et al (2004) the modern architect intended to support the creation of a new, modern, and egalitarian civilization. As a result, identical housing types and planning layouts prevailed in the new neighbourhoods as modernism preached the standardization, repetition and functionality for architecture (Wassenberg, 2006). The author further affirms that “most residential schemes were mono-functional and widely seen as monotonous, due to the large numbers that were built of a given dwelling type and to the big areas and repeated geometric patterns” (Ibid, 2006, p. 5). Furthermore, the post-war districts were usually consisted of various neighbourhoods, each with its own social and cultural approach. Social and community services within walking/cycling distance, such as schools, health centres, community centres and churches. Those facilities were usually found clustered around public green areas, squares and main streets (Netherlands ICOMO). The principle of light and air were articulated through long repetitive residential blocks interspersed with those public green areas. Finally, a

neighbourhood both brought the idea of an area where all daily facilities could be supplied as well as a safe and familiar environment for its residents.

Decades later after the construction period, these post-war urban areas experienced functional problems due to "developments in society, and changes in population, in neighbourhood centres and within the facility structure itself" (Wassenberg, 2006, p.1). The population decline, which happened because of the migration to newly suburban neighbourhoods and the increase of car possession, was reversed due to the arrival of immigrants from sub developed countries in the late 1980's. These migrants, which were considered "working-class", filled the available empty houses of post war construction, transforming a mostly white neighbourhood into a multicultural environment (Beckers and Kloosterman, 2014). This process also happened in pre-war urban areas, which can explain the significant current occupation of immigrants in these neighbourhoods. Reinforcing what has been said, Aghabeik and Van Nes (2015) states that the composition of residents in less favoured neighbourhoods has significantly changed over the past four decades. "From being a home for low-income people from only one culture, various low skilled non-western immigrants with various cultural backgrounds are now living in these areas" (Ibid, 2015, p. 2).

It was later found in 1997 through the revision of a policy document called "Policy Document on Urban Reconstruction in the Future" that the overall quality of life in these post war neighbourhoods was poor. Some of the facts that contributed to this poor quality of life were public spaces in decay, a significant number of low-income households, a lack of safety sense and a lot of maintenance backlogs (Netherlands ICOMO, 2003). Consequently, these areas which lack quality of life appeared on the agenda with the purpose of refurbishment, resulting in a great part of it being destroyed and rebuilt. This approach is still being used and was considered a successful, as the "effect was an increase of the living conditions and caused a reduction of social problems and criminal incidents" (Aghabeik and Van Nes, 2015).

Currently, post war neighbourhoods are often considered as tedious and uniform, with archaic layouts and finishing. Finally, a great part of them are considered as 'problem neighbourhoods' nowadays, as they are characterized by "relatively high levels of deprivation and singled out by the Dutch government for integral neighbourhood improvement schemes" (Beckers and Kloosterman, 2014, p.159). Moreover, many post war neighbourhoods experience high levels of unemployment rates. Many newcomers did not have a job when moving there and a good part of the residents who had it, lost their jobs due to the economic and financial crisis in the last few years (Posthumus et al, 2013).

In contrast to most cities, Rotterdam centre consist of several post-war neighbourhoods. This is due to the bombing in the WW2 as well as the modernist rebuilding plan for the city. Normally, the neighbourhoods built after the war are located on the edges/fringes of the cities.

In summary, a Dutch pre-war urban area is formed by "small streets and row houses shaping enclosed blocks", while a Dutch post war urban area is formed by "freestanding flats or row houses with many open spaces between the buildings" (Van Nes and Rueb, 2009, p.2). Consequently, in a pre-war neighbourhood most people know each other as the streets and houses can be easily visible, whereas in a post war neighbourhood the streets are too wide so the degree of visibility and sociability of people in the streets are much less. Moreover, it is usually seen a large variation of distinctive kinds of commercial activities in pre-war neighbourhoods than in post war neighbourhoods (Van Nes and De Rooij, 2015).

2.2 Quality of Life (QoL) and Quality of Urban Life (QoUL)

Quality of Life (QoL) is a broad and multidimensional concept which include the notion of a good, happy and satisfactory life and can be described as "the satisfaction that a person receives from surrounding human and physical conditions". (Mulligan et al. 2004 in Marans and Stimson 2011, p.1). These conditions are dependent on relations of scale and can potentially influence the behaviour of people and groups, varying from households until economic units such as firms. (Marans and Stimson, 2011). Therefore, the investigation of quality of life is an important process because it has a significative effect on the behaviour of people as well as their life satisfaction. Furthermore, QoL also refers to the expectations of how people think their life in relation to the place where they live (Morais et al., 2013). Other terms can relate to this concept, such as wellbeing, happiness and life satisfaction. The former - subjective wellbeing – is about the QOL experience, while satisfaction is more viewed as a personal judgment or mental experience, and happiness as a short-term mood of joy. (Marans and Stimson, 2011)

According to Marans and Stimson (2011) there are two approaches which can be considered when studying Quality of Life, the objective and subjective, which can study overall life satisfaction or satisfaction over different life domains, including urban. In relation to the objective approach, the analysis and report is supported using secondary data, in which data collected through government are the main source of collection. In addition, the data is usually clustered at different spatial scales. On the other hand, the subjective approach collects primary data at the individual or disaggregate level. The data is usually collected through surveys focusing on people's behaviours and how quality of urban life aspects is evaluated (Ibid, 2011). Furthermore, it is important to highlight that there is a supposed dichotomy between subjective and objective ways to study quality of life, regarding the inclusion of both kind of indicators. There is a gap in the literature in relation to this link, but a few studies have managed to find a weak connection between objective and subjective indicators. However, McCrea et al (2011) states that it is meaningful to continue developing research that "explicitly seek to investigate the links between the objective characteristics of the urban environment and the subjective evaluations of the urban environment". (p.85).

Table 1: Example of objective and subjective QoL indicators used to investigate QoUL in cities and neighbourhoods. Source: Marans and Stimson (2011).

Objective Indicators	Subjective Indicators
Employment Rates	Housing and neighbourhood satisfaction
Income	Perceptions of crime
Crime Statistics	Perceptions of school quality
Air Quality	Perception of health care services
Residential Density	Feelings about neighbours
Amount of parkland	Feelings about congestion and crowding
Distance to transit stop	Satisfaction with family, friends, job etc
Availability of grocery/food stores	Life Satisfaction, overall happiness

The approach of a Quality of Urban Life (QoUL) comes from the realistic situation that great part of the population is currently living in urban environments, both in development and developed countries. Hence, the term QoUL relates quality of life to specifics aspects of urban life, which means, the access to urban provisions and the evaluation of the degree to which its obtainable, also considering typically urban needs. In this context, better facilities and amenities can enhance the level of life satisfaction of people living cities (Ballas, 2013). Therefore, the city which presents a good quality of life is the city that will enable it citizens access to a higher ways of alternative life styles (Silveira et al, 2015). It is undeniable that citizens display higher life satisfaction when they reside in a city which offer great public transport, facilities and amenities among others.

Quality of Urban Life can be distinguished from QOL which derives from the urban environment (e.g. housing, neighbourhood, community) and QOL experienced in it (e.g. work, family, health) (Marans and Stimson, 2011). The first one is "related to links between the objective dimensions of the urban environment and people's subjective evaluation of the urban environment, which is attracting attention in some of the more recent research into QoUL." (McCrea et al, 2011, p. 59).

Currently, a few studies have been looking the influence of objective attributes and/or subjective perceptions of the built environment on subjective wellbeing of people residing in urban areas. Leyden (2011) states that the design and condition of places do matter and were found to be associated with happiness pursuit in 10 cities, taking also into consideration the common predictors of happiness (e.g. health, income, social relationships among others). This convey that there is a relationship between people and places, where they live, and the degree of maintenance are extremely important to reach happiness. Moreover, "happiness is linked to whether people feel their cities successfully provide amenities that improve their quality of life" (Leyden et al, 2011, p.862). The cities which provides great accessibility to cultural facilities, mixed-use facilities and public transport system as well as perception of safety, cleanliness and beauty are more likely to report happiness. Furthermore, Leyden believed that happiness is closely related to social capital. People feel happier when they can trust their community and friends, strengthening social capital, which can be described as "the degree to which people feel connected to others in their community and actively participate in formal or informal community activities" (Leyden et al, 2011, p.866).

As matter of fact, many studies have been linking the formation of social capital to the built environment. An emblematic example is Jacobs (2011), which discussed that a mixed land use, which are areas that combine home, work, recreation and commercial activity among others, and a pedestrian oriented neighbourhood has a powerful positive influence on resident's well-being as it promotes social connections. These two aspects – mixed use and pedestrian priority - are important to ensure that people use the street at all time. This scenario enhances the perception of safety as well as contributes to create liveable spaces. Furthermore, other city characteristics such as population size, density and heterogeneity were also important to develop vitality, social capital and improve safety in the neighbourhood. (Jacobs, 2011). On top of that, Jacobs claimed that a great diversity of uses which can provides both social and economic support are the guideline that cities should stand for to become successful, and consequently promotes quality of life for its citizens.

Finally, Santos and Martins (2002) affirm that the multiplicity of components that integrate the concept of quality of life has led to the emergence of more focused studies in this area, with

various spatial breakdowns and applied to the most diverse themes and specific groups of the society.

Thus, it is found on literature studies on the quality of life at the urban, regional, national and international levels. In perspective to this idea, Marans and Stimson (2011) highlights that people lives in places, in which the urban environment characteristics can significantly influence life satisfaction. Places also have different scales; hence, satisfaction with life might be observed at multiple levels or different urban domains, such as:

"Satisfaction with Housing
Satisfaction with Neighbourhood,
Satisfaction with the wider community or broader region".

(Marans and Stimson, 2011, p.7)

Marans and Stimson (2011) further highlights that satisfaction with each domain is perceived to predispose general satisfaction with QoL (Marans and Stimson 2011). Each urban domain is associated with specific urban attributes, hence satisfaction in an urban domain is best presumed by the assessments of these attributes. For example, neighbourhood attributes explain neighbourhood satisfaction. (McCrea et al., 2011). Those domains are also found to be interrelated among each other, therefore urban attributes of a different urban domain are also possible to predict satisfaction of another domain. For instance, housing satisfaction is predicted by housing attributes as well as neighbourhood and community attributes. Although all three domains are associated, in a few cases some relationships are stronger than others. For example, community satisfaction is seen to be more closely related to neighbourhood than housing satisfaction (McCrea et al., 2011). The following model shows that the relationship (one predicting the other) between objective characteristics, subjective perceptions and subjective evaluations determines urban domain satisfaction, and therefore overall life satisfaction.

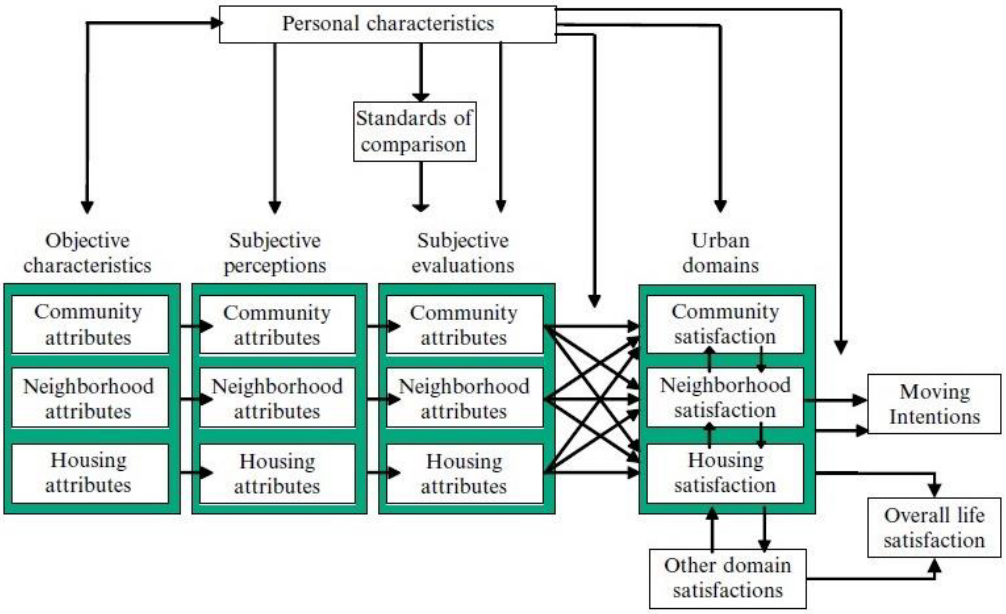


Figure 1 Broad conceptual framework of determinants of satisfaction with the residential environment. Source: McCrea et al., 2011, adapted from Campbell et al., 1976).

An analysis in the link between objective and subjective indicators concluded that subjective evaluations has equal importance to assess and represent urban conditions.

The same author further developed a research about QoL in the Brisbane-Southeast Queensland region in Australia using a simplified structural equation model to investigate possible links among objective and subjective indicators of the urban environment in influencing subjective quality of urban life (McCrea et al, 2006). The research found that there was not a significant link between subjective and objective measures as there was not a significant relationship between the indicators used (e.g objective access and subjective access). Moreover, it was revealed that the objective variables were not necessarily significant to QoUL while all the subjective variables were able to directly predict it. These results are believed to support previous findings which indicate that objective attributes are not as strongly associated with satisfaction in life domains as subjective evaluations of the urban environment. Nonetheless, it is also implied that satisfaction in life domains might arbitrate the connection among objective variables and overall life satisfaction, since these variables are the basis of satisfaction with specific life domains (figure 1). Therefore, it is believed that both objective and subjective evaluations impact on overall QoUL or life satisfaction through the mediation of specific urban domains.

The following diagram (figure 2) shows the full structural model equation, which differs from the model in figure 1 because it directly predicts subjective evaluations from objective characteristics, skipping subjective perception. Moreover, it combines the various geographic scales of subjective QoUL into a general measure of subjective urban quality of life.

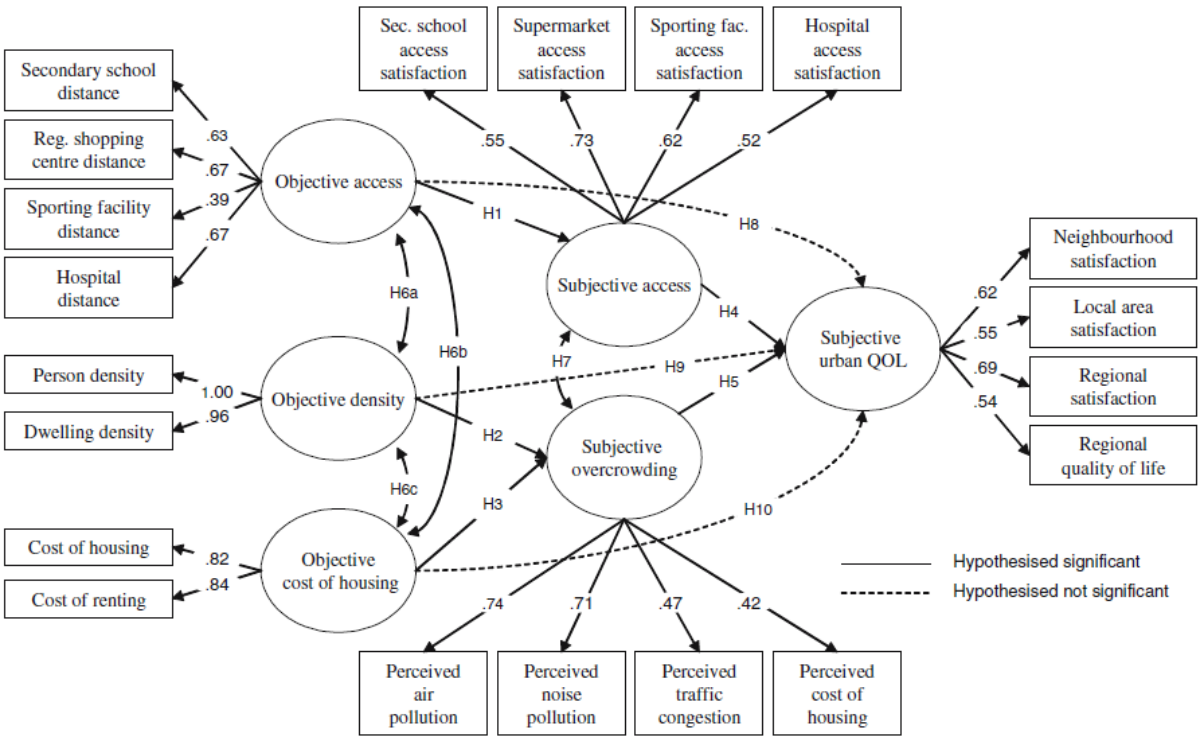


Figure 2 Testing the relationship between objective and subjective QoUL through the structural equation model. Source: McCrea et al., 2006.

The study done by McCrea et al (2006) allows the conclusion that subjective evaluations of the urban environment is both seen to predict better satisfaction in urban domains and general life satisfaction (McCrea et al., 2006) as well as presents an equal importance to assess and represent urban conditions. However, both objective and subjective measures can still be considered together, "when objective measures are weighted by the subjective importance of various aspects of the urban environment in contributing to urban QOL" (McCrea et al, 2006, p.80). Finally, "even though QoUL can be measured either objectively or subjectively, it may well be that QoUL is ultimately more subjective" (McCrea et al, 2011, p. 99).

Finally, in relation to the scale of the neighbourhood, Lu (1999) highlights that studies on satisfaction have pointed out significant importance to the perception of neighbourhood conditions. Moreover, Parkes et al. (2002) states that perception is a significant measure and may better explain satisfaction with neighbourhood aspects. As a conclusion, "the neighbourhood remains the most basic environmental unit in which our social lives occur, and it necessarily affects the quality of life of residents". (Hur and Morrow-Jones, 2008, p.620). In this context, the neighbourhoods are an important scale in the city and in order to comprehend the effect of place and spatial features, this thesis chooses to study the neighbourhood domain.

2.3 Neighbourhood Satisfaction

Neighbourhood satisfaction consists in an evaluation of different aspects related to life in the neighbourhood, and it concept, and measurement has been included in a diverse body of studies. It is a subjective perception as well as an objective evaluation of the conditions of the local urban environment. Marans and Stimson (2011) explains this kind of satisfaction as a prediction of different neighbourhood features.

Although there is a good body of research regarding neighbourhood satisfaction, the findings are sometimes ambiguous because of the complex nature that satisfaction represents. The importance of satisfaction in shaping characteristics of the built environment is supported by a good amount of empirical research relating a diverse number of topics to neighbourhood satisfaction, such as health, social capital, safety among others. Mesch and Manor (1998) defends that the most important factors which predicts satisfaction are the physical and social ones. Hur and Morrow Jones (2008) highlights that aspects which influences neighbourhood satisfaction diverge among neighbourhood groups which presents a satisfactory or unsatisfactory condition, which means that different features matter for residents in distinctive kinds of neighbourhoods to determine satisfaction. For example, a bigger importance to social problems is given by residents living in unsatisfactory neighbourhoods. However, it was also found that for both kind of neighbourhoods, satisfaction with physical appearance is one of the most important factors to predict neighbourhood satisfaction.

Moreover, Marans and Rodgers (1975) mentions that there is a strong consecutive relationship between neighbourhood satisfaction, decisions to move, and quality of life. People's intentions to move from a place can be determined by the level of satisfaction and perception they have from the place they live. A high level of satisfaction stimulates residents to stay in the neighbourhood and boost new people to move in while a low level of satisfaction influences residents to move out (Hur and Morrow Jones, 2008). Satisfaction with the neighbourhood is believed to predict mobility, consequently affecting quality of life" (Marans and Rodgers, 1975). Moreover, "there may be some very direct relationships between satisfaction, on the one hand, e (or residential environment) characteristics on the other hand" (Dekker et al, 2011, p.482)

Consecutively, some empirical research acknowledges levels of crime, perception of safety and physical condition as important features to predict neighbourhood satisfaction for residents as well as community amelioration (Grogran-Kaylor et al, 2008; Woolley & Grogan-Kaylor, 2006; Coulton et al., 1995) Decades ago, Jacobs (2011) highlighted aspects of safety for the urban environment. She stated that safer streets and sidewalks contribute to create better spaces, and consequently cities. The streets have an important function to maintain urban safety, therefore, prosperous neighbourhoods will be the ones who are able to succeed in maintaining safety. When people fear the street, they use it less, consequently making it less safe and affecting wellbeing of people (Jacobs, 2011). Improving safety in the neighbourhood contributes may increase the sense of wellbeing between residents (Grogran-Kaylor et al, 2008). Furthermore, the scale of neighbourhood and its spatial features are important to determine quality of life, especially concerning social safety and accessibility (Ettema and Schekkerman 2015).

Given the diverse relationships that can occur inside the neighbourhood, it is important to comprehend how can neighbourhood satisfaction be measured. Neighbourhood satisfaction is commonly measured in a subjective way, through the application of questionnaires. The main question is usually as follow: *"Taking all things together, how satisfied are you with the neighbourhood you live in?"*. The options of possible answers follow the standard of Likert scale (1-5), where 1 is "extremely dissatisfied" and 5 "extremely satisfied" (Sirgy and Cornwall 2002; Leyden et al. 2011). Simultaneously, satisfaction in the neighbourhood level can also be measured by different features that builds up the neighbourhood environment. Fundamentally, these so called "neighbourhood features" are a diverse set of quantifiable living conditions associated to the neighbourhood scale, and frequently measured by different indicators.

Sirgy and Cornwall (2002) studied the relationship between different neighbourhood features and quality of life. The author stated that the neighbourhood features which has received empirical evidence regarding neighbourhood satisfaction can be divided in three categories: physical, social and economic (table 2).

Physical Features – Refers to the aspects of the built environment, aiming attention at conservation and quality of spaces.

Social Features – Refers to the aspects that motivates and enable social interactions in the neighborhood environment.

Economic Features – Refers to the aspects of different economic conditions in the neighborhood.

(Sirgy And Cornwall, 2002)

Table 2: Neighbourhood Features according to Sirgy and Cornwall, 2002.

Neighbourhood Features	**Indicators**
Physical Features	"- Satisfaction with upkeep of homes and yards; - Satisfaction with landscape in the neighborhood; - Satisfaction with the street lighting in the neighborhood; - Satisfaction with crowding and noise level;

	- Satisfaction with nearness of neighborhood to facilities needed; - Satisfaction with quality of the environment in the community." (Sirgy And Cornwall, 2002, p.81)
Social Features	"- Satisfaction with social interactions with neighbors; - Satisfaction with the outdoor play space; - Satisfaction with people living in the neighborhood; - Satisfaction with ties with people in the community; - Satisfaction with crime in the community; - Satisfaction with race relations in the community; - Satisfaction with sense of privacy at home." (Sirgy And Cornwall, 2002, p.81/82)
Economic Features	"- Satisfaction with home value in the neighborhood; - Satisfaction with cost of living in the community; - Satisfaction with socio-economic status of neighborhood; -Satisfaction with neighborhood improvement." (Sirgy And Cornwall, 2002, p.82)

In his research, it was proven that those features influence life satisfaction through the effects of different domain satisfactions (e.g. neighbourhood, housing, home and community). In detail, the model (figure 3) points out that satisfaction with physical features impacts neighbourhood as well as housing satisfaction. Additionally, satisfaction with the social features affect neighbourhood and community satisfaction - the latter having a significant influence on life satisfaction. Concurrently, satisfaction with neighbourhood economic features contributes to house and home satisfaction – the latter significantly affecting life satisfaction. Satisfaction with the neighbourhood influences community satisfaction, while satisfaction with housing influences home satisfaction. Finally, it is both satisfaction with home and community that will significantly contribute to life satisfaction, with neighbourhood satisfaction impacting overall life satisfaction indirectly through mediating effects. (Sirgy and Cornwall,2002; McCrea et al, 2011). This model characterize wells the cross over scale effects and relationships between domains and illustrates the complex relations which falls the urban studies.

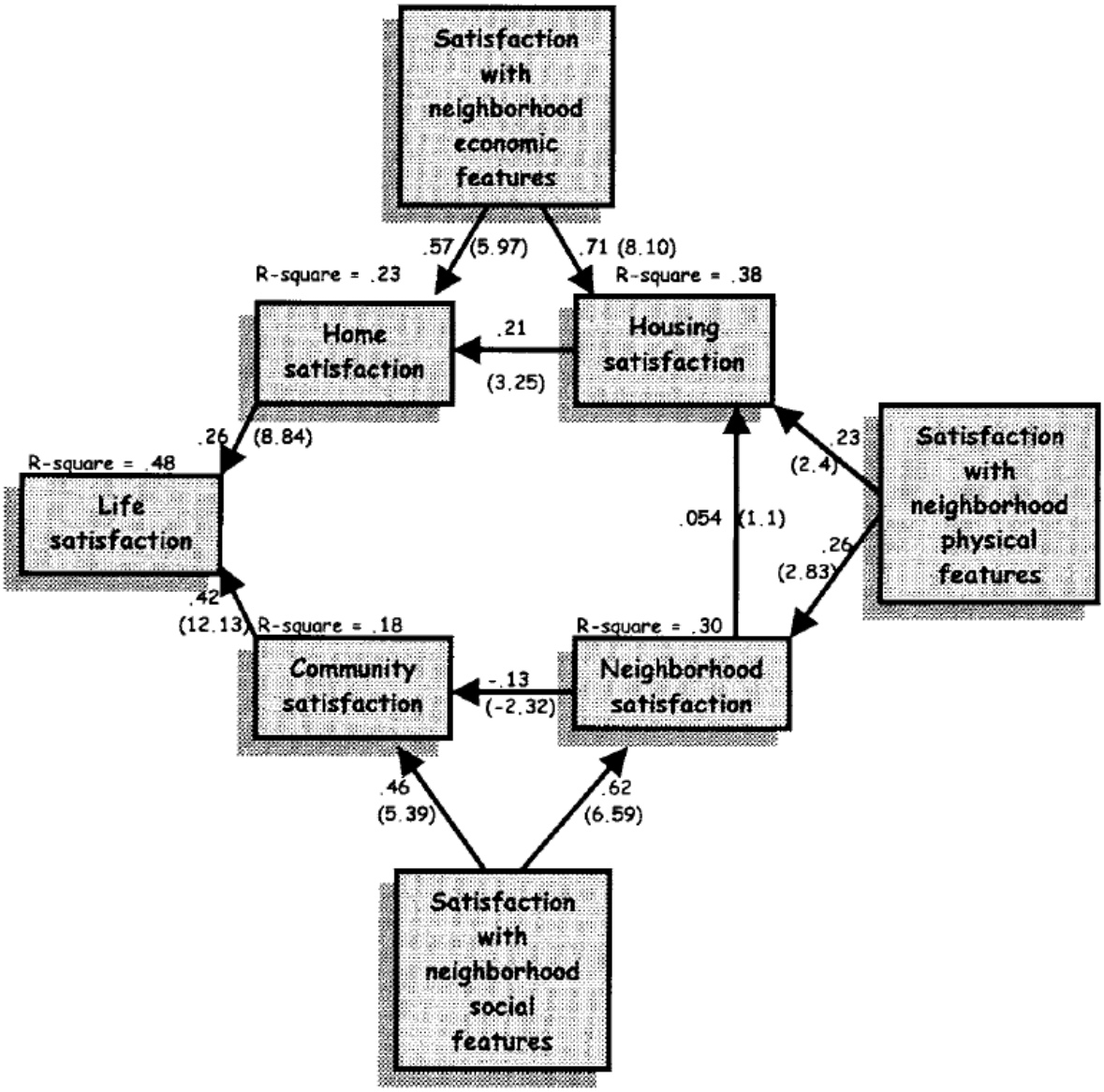


Figure 3 Conceptual framework illustrating how neighborhood features influence life satisfaction through a hierarchy. Source: Sirgy and Cornwall, 2002.

Likewise, additional empirical researches have associated other features to neighborhood satisfaction, for example safety features. Fundamentally, neighborhood safety features refer to the aspects of the built environment that relates to levels of crime and safety as well as the report of theft and violence. The research conducted by McCrea et al. (2005) about Quality of Life in Brisbane, Australia, illustrates the importance of perception of safety and crime for assessing neighborhood satisfaction. The author states that there is a strong negative relation between reported crimes and lower life satisfaction. From all features studied by the author (neighborhood interaction, neighborhood transport, neighborhood crime, neighborhood access and neighborhood services, table 2) , it was concluded that neighborhood interaction and neighborhood crime were best predictors of neighborhood satisfaction. Mc Crea et al. (2005) further highlights that neighborhood interaction was considered more important to elderly people while neighborhood crime was more significant to younger and single people. This entails that satisfaction with the neighborhood will largely rely upon the degree of safety and sense of belonging with the place. Finally, this allows to conclude that interactions with neighbors and an active street life are important aspects to ensure a lively neighborhood.

Table 2 Measures of Neighbourhood Attributes according to McCrea, 2005.

Neighborhood Attributes				
Neighborhood Interaction	Neighborhood Transport	Neighborhood Crime	Neighborhood Access	Neighborhood Services
"I have little to do with people in this neighborhood People in this neighborhood are willing to help each other".	"Living in this area would be difficult without a car Public transport in this area is adequate for my needs".	"Vandalism is a problem in this neighborhood Breaking and entering is a problem in this neighborhood".	"How satisfied or dissatisfied are you with your access to the following facilities (shops, post offices, bank, hospitals, school, sporting facilities)".	"How satisfied are you with the following services provided by your local council (public parks, street cleaning, street lightening, road maintenance, bus services etc)"

2.4 Spatial Features of the Urban Built Environment

To define spatial features of the urban built environment, first it is necessary to establish the concept of built environment. Leyden (2003, p.1546) defines this concept as "the way we design and build our communities and neighbourhoods". Another definition is given by Handy et al (2002, p.65) in which the author states that "the built environment comprises urban design, land use, and the transportation system, and encompasses patterns of human activity within the physical environment". Land use, for example, concerns the distinctive types of use distributed in the space, being divided in a variety of categories (e.g. residential, commercial, industrial, institutional among others). According to what has been said, spatial features of the urban built environment can thus be referred as the relationship between the space and buildings, including its location and relations to the street.

According to Van Nes (2007), cities are shaped by people as well as cities shapes behaviour of people. Human behaviour is a complex subject, influenced by different aspects. Multiples areas of knowledge are required to have a great comprehension of this subject. One to be highlighted is the urban physical configuration, which is significant to identify physical manifestations of people in space and why they behave distinctively in different places.

In order to comprehend both the urban built environment fully, urban managers need a tool which enables the measurement of the characteristics of the space, both in a city and neighborhood scale. Moreover, it facilitates the comparison of streets objective values in relation to socioeconomic data (e.g. crime and flows of pedestrians among others). In this context, space syntax is a useful tool to measure spatial characteristics and analyzing urban networks. It can be used into the research field to generate insights about segregation, crime, accessibility and commercial areas. In addition, it is a significant tool because "the robustness of this method lies on its independency of context, since it does not depend on culture, society or political structures" (Miranda and Van Nes, 2017, p.13). Finally, it consists in three sets of distances: metric, geometric and topological, with two specific measures: integration and choice.

As Jacobs (2011) mentions, the presence of people in streets and the "street eyes" are able to make a city lively and safe. Reinforcing that, Hillier and Shu (2000) proved that integrated and

connected street networks contributes to attract people to the streets, further supporting the economic activity. This is closely related to the "theory of the natural movement", which affirms that the presence of commercial activity in a street is mutually related with the presence of pedestrians, but both do not have an impact in the street grid. However, as shown in figure 4, the street grid does impact on the movement of people as well as the location of the shops.

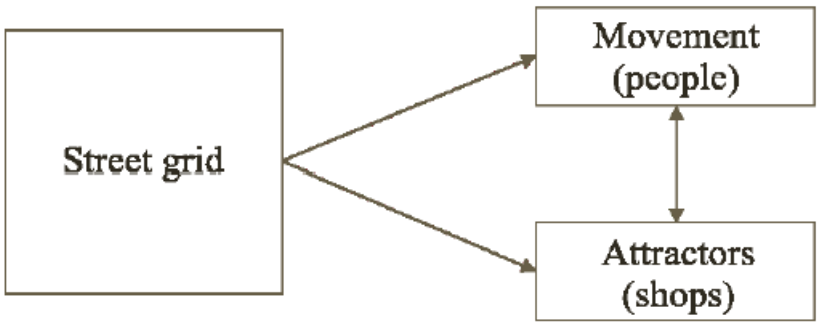


Figure 4 Theory of the Natural Movement. Source: Miranda and Van Nes (2017).

In summary, the theory validates that streets with good integration increase movements flows, which in turn, influences land use and its value. Moreover, movement of people and an active street life enhances local centres, attracting social, economic and commercial development for the area.

One of the most explored line of research in the space syntax context are the urban macro scale, which measures local and global integration through metrical and angular analysis. In a general way, a high local segment integration refers the accessibility of a street in a local scale, in relation to its surroundings. On the other hand, a high global segment integration means that the street is integrated to the whole city scale. "Integration values in line maps are of great importance in understanding how urban systems function because it turns out that how much movement passes down each line is very strongly influenced by its integration value." (Hillier, 1996, page 160). On the other hand, *choice* (betweenness) indicates the potential of through movement and flows, measuring the amount of times a segment is likely to be passed. In addition, choice can also be analyzed locally and globally. While passing through many different paths indicates lower levels of connectivity, the less the number of paths means more connected the network will be.

The local angular analysis, for example, provide information in a local scale about the most vibrant and active streets, when combined with metrical distances. Theoretically, neighbourhoods that are well integrated to such networks have better favourable circumstances to be closer to amenities and services, and hence the levels of satisfaction might be higher.

Another line of study in the Space Syntax field explore the investigation in the urban micro scale, which is believed to affect street life and safety in the urban environment. According to Van Nes (2008) "micro scale spatial variables in urban studies aims at defining the inter-relationship of buildings or private spaces and adjacent street segments" (p.2). The relationship in the micro scale can be analysed through the following indicators:

- "the density of entrances;
- Constitutedness of the street: the degree to which buildings have their entrance located in the street (being part the street) or on the side back façade (not being part of the street);

- Inter-visibility of windows and entrances: whether house entrances can be seen by the neighbor naturally;
- Topology of deep entrances: whether the house door is in the street or not. The degree to which entrances are topological shallow or topical depth. For example, the bigger the amount of 'steps' among the public and private space, the bigger the topological depth will be."

Van Nes (2008)

In addition, De Rooij and Van Nes (2015) conceived a methodology of urban analysis for built up areas, based on the study of layered models of Heeling (2002) (figure 5). It is constituted of many spatial and functional elements of a place categorized in five layers of urban analysis explained as follow:

1. Spatial structure: connection of streets;
2. Public space versus private space: relationship between streets and buildings, measured through the density of entrances and the inter-visibility on the ground floor;
3. Land use: functionality of each building (e.g. residential, commercial, among others);
4. Behavior: how human behave in these spaces.
5. Perception: how human perceive the environment

De Rooij and Van Nes (2015)

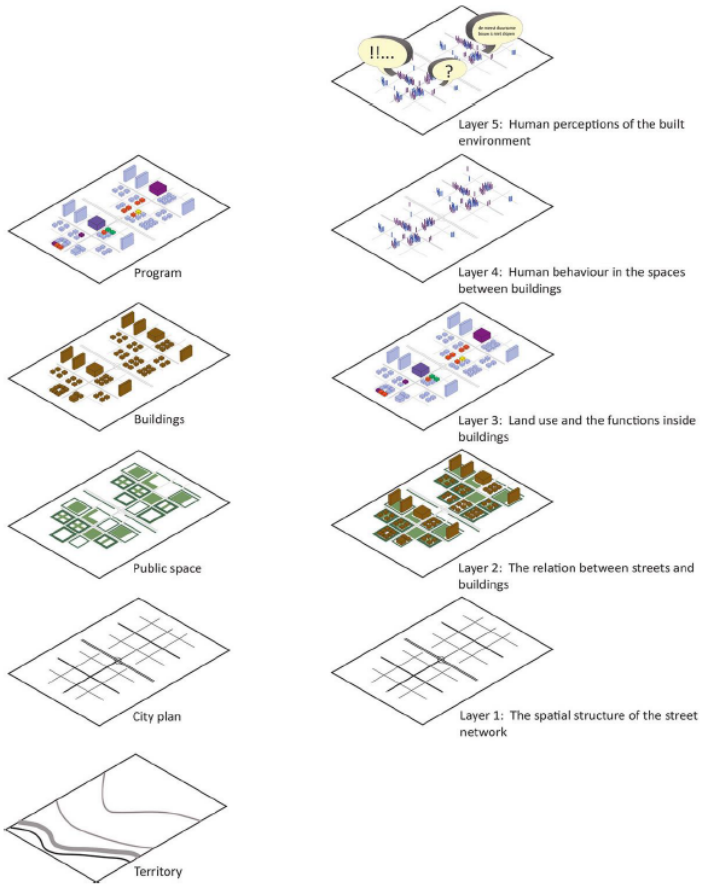


Figure 5: In the left, model proposed by Heeling (2002). In the right, model proposed by De Rooij and Van Nes (2015)

2.5 Lessons learned from the Literature

In general, Quality of Urban Life is an important concept nowadays as a great part of the world's population live in urban areas. In this context, the result of living in an urban environment is a considerable amount of place-based dynamics which are to affect quality of life.

From the literature review, it was learned that there is the quality of life which is the product from the urban environment (e.g. different geographic scales) and the quality of life experienced in the urban environment, (related to individual aspects such as work, family, health) (Marans and Stimson, 2011). The perspective that satisfaction with urban living happens at distinctive geographic levels (e.g., housing, neighbourhood, community and even region) was further proved to predict overall life satisfaction, even if some of these geographic scales influence the general satisfaction through mediate effects (e.g. the neighbourhood) (Syrgy and Cornwall, 2002, McCrea et al., 2011). Out of those domains, neighbourhood satisfaction was the scope of measure selected for this research, as the neighbourhood is a local scale present in everyday life of people.

The assessment of satisfaction at the neighbourhood scale consists in an evaluation of distinctive neighbourhood attributes, becoming a complex and diverse theme of study. The literature review showed that the most significant features that influence satisfaction at the neighbourhood scale are physical and social (Sirgy and Cornwall, 2003), as well as interactions and crime (McCrea et al, 2005). Although it was found that satisfaction in urban domains and overall life satisfaction are best measured by subjective evaluations of the built environment, objective attributes are also important measures and can still be used to assess satisfaction. Therefore, this thesis made the choice of use both measures.

In relation to the influence of the built environment, a large body of literature makes a reflection upon urban networks. The morphology of streets and roads as well as the presence of buildings is partly responsible to shape life in cities, which influence might extend even farther their physical characteristics. In this context, space syntax provides a large scope of analysis, which many frequently relates socio economic performances to the urban network. Space syntax has been used, for example, to investigate the influence of connectivity and integration with occurrences of crimes and feelings of safety in different urban typologies as well as location of commercial activities and flows in the city. In addition, micro scale measures such as inter-visibility, is closely related with social aspects and safety issues of the neighbourhood. In this context, it can be said that those aspects might significantly impact on diverse aspects of urban living.

2.6 Conceptual Framework

Neighbourhood satisfaction can be assessed by the overall level of satisfaction with the quality of urban life in the neighbourhood. To measure this satisfaction, it is necessary to comprise different characteristics of life in the neighbourhood. Therefore, it can be said that quality of life in the neighbourhood scale is reliant on neighbourhood factors (physical, social and safety factors) and might as well be conditioned by spatial features of the urban built environment. By taking into consideration the effects of place into this relationship, it can be assumed that these effects will impact both on neighbourhood satisfaction and neighbourhood factors. This denotes that certain measures of micro and macro scale could contribute to how the neighbourhood features develop and are further assessed. This is done in the context of pre-

war and post war neighbourhoods, and their differences which might influences the satisfaction with the neighbourhood.

The relation among the concepts explained through the literature review can be featured in the proposed conceptual framework (figure 6).

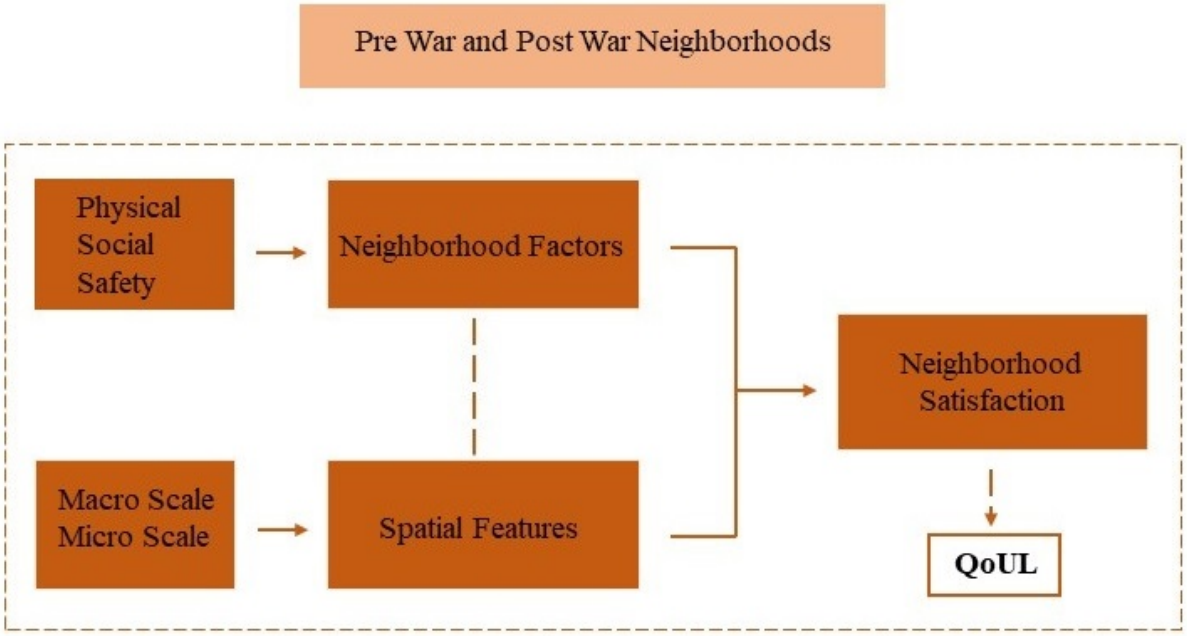


Figure 6 Conceptual framework. Source: Author, 2018.

Chapter 3: Research Design and Methods

This chapter provides in detail the research methods. It approaches the operationalization, research strategy, data collection and data analysis methods required in order to achieve the research objective and answer the research questions. Additionally, it mentions the validity and reliability of the research.

3.1 Revised Research Questions

To what extent does neighbourhood factors (physical, social and safety) and spatial features' impact on neighbourhood satisfaction in pre-war and post war neighbourhoods in Rotterdam, The Netherlands?

Sub Questions:

1. What are the indicators of physical, social and safety factors that significantly influence satisfaction?
2. What are the spatial features of the least and most satisfied pre-war and post war neighborhoods?
3. How does selected spatial features of the urban built environment influence neighborhood factors?

3.2 Operationalization

In this research, the operationalization of the dependent and independent variables gathers the knowledge acquired in the literature review together with the availability of data in the database of Wijkprofiel Rotterdam, following the objective research specified previously.

The following tables shows the operationalization of the concepts included in the research questions and literature review. It includes information about the variables, indicators, measurement and source for each one.

3.2.1 Dependent Variable

In summary, neighborhood satisfaction is the sum of different factors that might influence resident's overall life satisfaction with their own neighborhood's quality of life. It is naturally a subjective perception of the neighborhood, capturing an individual evaluation of the urban environment. Due to availability of data and the sample size, the measurement of this variable only includes the sum of the percentage of people that are satisfied and very satisfied.

Table 3 Operationalization of the Dependent Variable.

Concepts	Variable	Indicators	Measurement	Source
Quality of Life	Neighbourhood Satisfaction	"Percentage of households indicating that they are "very satisfied" and "satisfied" with the neighbourhood, people, house and facilities."	Ratio	Wijkrofile Rotterdam 2018

3.2.2 Independent Variable

Neighborhood factors are the sum of conditions of the urban environment responsible for how the neighborhood functions and are perceived by the residents. As the focus of this research is on influence of the urban environment, it narrows down to neighborhood factors that might be influenced by it: physical, social and safety. The economic feature, mentioned by Sirgy and Cornwall (2002), will not be considered here as an independent variable due to the scope of the research. However, the economic concept can be found forming a few indicators from the social and physical factors. Finally, satisfaction in urban domains and overall life satisfaction can be measured by both subjective and objective evaluations, hence the three factors will be assessed by it.

The following lists represent the subjective and objective indicators which were included in this research as adapted from the Wijkprofiel database.

Table 4 Subjective and objective indicators of Physical Factors.

Physical Factors (Source: Wijkprofiel Rotterdam, 2018)	
Subjective Indicators	**Objective Indicators**
"% of households satisfied with the range of facilities together (schools, healthcare, commercial activities etc) % of households indicating that public transport is sufficiently present % of households indicating that green spaces are sufficiently available % of households satisfied with quality street lighting % of households satisfied with maintenance of cycle paths % of households satisfied with maintenance of pavements % of households satisfied with safety of pavements % of households satisfied with safety of sidewalks % of households find buildings in the neighborhood attractive % of households satisfied with the current home"	"% of houses with baker within standard distance % of houses with butcher within standard distance % of houses with greengrocer within standard distance % of houses with sports hall within standard distance % of houses with pharmacy within standard distance % of houses with general practice within standard distance % of houses with playground within standard distance % of houses with schools within standard distance % of houses with underground station within standard distance % of houses with tram stops within standard distance % of households that finds the state of maintenance of buildings in the neighborhood good. % of housing with overcrowding."

Table 5 Subjective and objective indicators of Social Factors.

Social Factors (Source: Wijkprofiel Rotterdam, 2018)	
Subjective Indicators	**Objective Indicators**
"% of residents who feels connected to neighborhood.	"% of residents with weekly contact with other neighborhoods
% of residents who likes their own neighborhood	% of residents who live in the neighborhood for long time
% of residents who says that locals know each other	% of residents that participate in cultural activities in the neighborhood monthly
% of residents who says that locals help each other	% of residents who are considered as non-natives
% of residents that have no problems with local residents.	% of households with low income."
% of residents who says the relationship between ethnic groups in the neighborhood is good	
% of residents who says that are enough places for joint activities in the neighborhood"	

Table 6 Subjective and objective indicators of Social Factors.

Safety Factors (Source: Wijkprofiel Rotterdam, 2018)	
Subjective Indicators	**Objective Indicators**
"Bicycle theft often occurs as a neighborhood problem	"Number of thefts on vehicles (per thousand habitants)
Thefts from cars often occurs as a neighborhood problem	Number of thefts on bicycles (per thousand habitants)
Threatening often occurs as a neighborhood problem	Number of reports of pickpocketing (per thousand habitants)
Violent offenses often occur as a neighborhood problem	Number of crimes of threats (per thousand habitants)
Robbery with violence often occurs as a neighborhood problem	Number of crimes of abuse (per thousand habitants)
Burglary in homes often occurs as a neighborhood problem	Number of crimes of threats (per thousand habitants)
Haze wall or buildings often occurs as a neighborhood problem	Number of crimes of robbery with violence (per thousand habitants)
Destruction of telephone, tram or bus booths often occurs as a neighborhood problem	Number of crimes of burglaries (per thousand habitants)
Destruction of street furniture often occurs as a neighborhood problem	Number of crimes of vandalism (per thousand habitants)
Drug nuisance is often perceived as neighborhood problem."	Number of reports on drug cases (per thousand habitants)."

Nuisance is often perceived as a neighborhood problem. ”	Number of reports on environmental inconvenience (per thousand habitants).”

Some of these indicators are going to be further aggregated in similar categories through a reliability analysis (Cronbach’s Alpha). This strategy will be explained on the section 3.6 concerning data analysis method.

The following tables present the final operationalization for the independent variables.

Table 7 Operationalization of Physical, Social and Safety factors.

Concept	Variable	Indicator	Scale of Measurement	Source
Neighborhood Factors	Physical	Subjective Indicators Objective Indicators	Ratio	Wijkprofiel Rotterdam, 2018
	Social	Subjective Indicators Objective Indicators	Ratio	
	Safety	Subjective Indicators	Ratio	
		Objective Indicators	Ordinal	

Upon done the correlation of neighbourhood factors with satisfaction, spatial features of the urban environment will be approached to give an insight about the structure of the space, following the methodology of Van Nes (2008)

Table 8 Operationalization of Spatial Features

Concept	Variable	Indicator	Scale of Measurement	Source
Spatial Features of the urban built environment	Micro Scale	Inter-visibility of entrances and windows in the ground floor in the main street(s)	Likert Scale (1-5, where 1 is very high and 5 very low)	Own analysis
	Macro Scale	Segment analysis	Local and global segment integration	
		Angular analysis	Local and global angular choice analysis	

Inter-visibility of windows and entrances was the only micro scale feature selected due to time constraints. However, it is a powerful micro scale characteristic which can provide valuable information about the relationship between streets and buildings.

3.2.3 Control Variable

As previously mentioned, there are other factors that are predicted to influence satisfaction at an individual level, such as employment, income, household composition etc. As this research deals with the neighbourhood level, it will consider factors that can influence similarly this scale. Therefore, average income will be controlled for, as it is not the focus of this thesis research.

Table 9 Operationalization of the Control Variable.

Concepts	Variable	Indicators	Measurement	Source
Economic Characteristics	Economic Situation	Average Income	Ordinal	Wijkrofile Rotterdam 2018

3.3 Research strategy

The research is considered a deductive research, as the main focus is to analyse and explain the extent to which neighbourhood's factors (physical, social and safety) and spatial features influences on neighbourhood satisfaction. Taking this into consideration, the research hopes to achieve the objective by referencing the use of existing theories. In addition, the research strategy is based on the use of secondary quantitative data (desk research), which is currently gaining even more popularity with the increase access to quality open source data. In this sense, the availability of data about the neighbourhood profile generated by the municipality of Rotterdam, under the supervision of the Research and Business Intelligence (OBI), asserts the use of secondary quantitative analysis as an adequate research strategy.

The research covers an overall view of neighbourhood satisfaction for 65 neighbourhoods in Rotterdam, divided in two categories: pre-war and post war neighbourhoods. Therefore, the general scale of study is the city and the variables addressed can be analysed as a generalization. Finally, the study does not intend to generate qualitative data and intend to make use of existing indicators.

3.4 Sample Size and Selection

Rotterdam is divided in 71 neighborhoods composed in 14 districts. This thesis is bound to study the neighborhoods which are clustered north and south of the Rotterdam Nieuwe Maas river. The other districts, Hoek van Holland, Rozenburg, Hoogvliet and Pernis, were not considered because they are either coastal towns, satellite cities or recently annexed to the municipality of Rotterdam.

As this thesis aims to study the influence of different factors in neighborhood satisfaction in pre-war and post war neighborhoods, a division between the neighborhoods in these two kinds of category was, consequently, necessary. The division was assessed by following two main guidelines:

1. Wijkprofiel Rotterdam

The Wijkprofiel Rotterdam has context indicators, in which divide neighborhoods according to their type, with each of its own having specific characteristics. (see annex 2)

- Type 1 - Functionally mixed districts.
- Type 2 - Compact city districts
- Type 3- Greener city districts
- Type 4- Green Suburbs
- Type 5- Old villages and golden edges

Each type contains information related to their density, percentages of houses built in the period up to 1945, and if it is post war expansion districts or a mix of new expansion districts. That information was taken into consideration in the assessment of the neighborhoods.

2. Google Maps

The Google Maps visualization was an important tool to categorize between pre-war and post war neighborhoods. Through it, it was possible to visualize the spatial characteristics of each neighborhood and assess according to the attributes previously defined in the literature review.

Although the city center existed before the Second World War, it was considered as a post war neighborhood as it was almost fully bombed and reconstructed after.

In total, the thesis considered 65 neighborhoods for its analysis divided according to the following table:

Table 10 Division between pre-war and post war neighbourhoods. Source: Author, 2018.

Pre-War Neighbourhoods	Post War Neighbourhoods
Afrikaanderwijk (Feijenoord)	Overschie (Overschie)
Hillesluis (Feijenoord)	Kleinpolder (Overschie)
Vreewijk (Feijenoord)	NoordKethel/Schieveen/Zestienhoven (Overschie)
Bloemhof (Feijenoord)	Kop van Zuid-Entrepot (Feijenoord)
Noordereiland (Feijenoord)	Kop van Zuid (Feijenoord
Katendrecht (Feijenoord)	Pendrecht (Charlois)
Feijernoord (Feijenoord)	Heijplaat (Charlois)
Carnisse (Charlois)	Wielewaal (Charlois
Oud-Charlois (Charlois)	Zuiderpark and Zuidrand (Charlois)
Tarwewijk (Charlois)	Zuidplein (Charlois)
New West (Delfshaven)	Zuidwijk (Charlois)
Bospolder (Delfshaven)	Beverwaard (Ijsselmonde)
Delfshaven (Delfshaven)	Groot IJsselmonde-Noord (Ijsselmonde)
Mild County (Delfshaven)	Groot IJsselmonde-Zuid (Ijsselmonde)
OudMathenesse/Witte Dorp (Delfshaven)	Lombardijen (Ijsselmonde)

Spangen (Delfshaven	Schiemond (Delfshaven)
Tussendijken (Delfshaven)	De Esch (Kralingen)
Provenierswijk (Noord)	New Crooswijk (Kralingen)
Old North (Noord)	Terbregge (Hillegersberg-Schiebroek)
Liskwartier (Noord)	Schiebroek (Hillegersberg-Schiebroek)
Blijdorp (Noord)	Molenlaankwartier (Hillegersberg-Schiebroek
Bergpolder (Noord)	Hillegersberg-north (Hillegersberg-Schiebroek)
Agnieeseburt (Noord)	Ommord (Prince Alexander)
Kralingen Oost/ Bos (Kralingen/Crooswijk)	Zevenkamp (Prince Alexander)
Kralingen West (Kralingen/Crooswijk)	S_Graveland (Prince Alexander)
Old Crooswijk (Kralingen)	Prinsenland (Prince Alexander)
Rubroek (Kralingen)	Oosterflank (Prince Alexander)
Struisenburg (Kralingen)	Kralingseveer (Prince Alexander)
Hillegersberg-south (Hillegersberg-Schiebroek)	Nesselande (Prince Alexander)
Old West (Centrum)	The low country (Prince Alexander)
Oud IJsselmonde (Ijsselmonde)	Cool (Centrum)
	CS quarter (Centrum
	New Work (Centrum
	Stadsdriehoek (Centrum)

The thesis further selected four neighborhoods to describes their detailed spatial features. The selection included the least and the most satisfied for pre-war and post war neighborhoods.

3.5 Data Collection Methods

This research makes use of secondary data which comes from the Wijkprofile Rotterdam (2018), Google Street Maps and the author Van Nes. The last one made the space syntax map of Rotterdam available for analysis.

Secondary Quantitative Data Collection

1) Rotterdam Wijkprofiel (Neighborhood Profile)

Data Source: Rotterdam Gemeente, 2018

The Wijkprofiel is an online platform created and managed by the municipality of Rotterdam. Since 2014, it monitors and provides data about all neighborhoods in Rotterdam, aiming to help different stakeholders involved in maintaining the city as well as to track the developments

made over time. This platform can be considered a reliable tool and a coherent picture of the reality as it is done in a systematic manner by professionals in the field of research and urban management. Furthermore, it is updated once every two years, extracting information from two distinctive surveys, the “Vragenlijst Wijkonderzoek Rotterdam” and the “Vragenlijst Wijkonderzoek Veilig”. The first one enquires about the social and physical aspects of the city while the second one considers the safety aspects.

The most recent surveys were conducted in 2018, gathering residents from 15 years to 75 years old. A total of 16.063 residents participated in the survey, with an average of 175 to 300 respondents per neighborhood representing the sample size. In small neighborhoods, the number of respondents is no more than 100. The sample selection “was stratified according to neighborhood, age and ethnicity in order to obtain optimal representativeness" (Wijkprofiel, 2018, p.7). The residents could fill the surveys through an online or written questionnaire as well as interviews.

The neighborhood profile works as a thermometer for the city as it shows information for three factors: physical, social and safety for all neighborhoods and districts (table 11). These three factors comprise of a set of themes divided between subjective and objective indicators. The subjective evaluations are measured through two different surveys, capturing the perception of the respondents and behavioral information. The “Vragenlijst Wijkonderzoek Rotterdam” asks questions about resident’s opinion related to physical and social aspects, such as “satisfaction with the supply of services together” and "experiencing discrimination in the neighborhood”. In turn, the “Vragenlijst Wijkonderzoek Veilig Rotterdam” ask questions about resident’s opinions on “perception of being a victim in their own neighborhood”. A great part of the questions related to subjective assessment is measured with the use of a Likert Scale. Finally, the objective measures come from various records of different registration systems (e.g. police records), measuring crime rate, level of education among many others.

Table 11 Wijkprofiel index division

Physical	**Social**	**Safety**
Real Sate	Capacities	Theft
Public Space	Living Environment	Violence
Provisions	Participation	Intrusion
Environment	Binding	Vandalism
Living Experience	Quality of life experience	Nuisance
		Security experience

The database from the Wijkprofiel Rotterdam counts with a total of 86 observations, for 71 neighborhoods, 14 districts and one for the entire city of Rotterdam, divided in subjective and objective assessments. This database contributed to constitute the measures of the dependent variable of neighborhood satisfaction and independent variables of physical, social and safety.

2) Google Street Maps

Source: Online Open Source

Google street map is an online platform for geographic information, which mainly presents maps of cities, being also possible to visualize neighborhoods. The tool is open source and counts with a 3d view of the street which contributed to analyze and classify the inter-visibility of entrances and windows on the ground floor (plinth). Besides that, the 3D views were also useful to determine whether the neighborhood was pre-war or post war as mentioned above.

The inter-visibility was assessed based on the methodology of Lopez and Van Nes (2007) as followed in figure 7. This analysis takes into consideration the degree of visibility of windows and entrances on the ground floor through aspects that might hinder the view, such as buildings facing different directions and its distance, blockages between the buildings and the street, and the presence of basements.

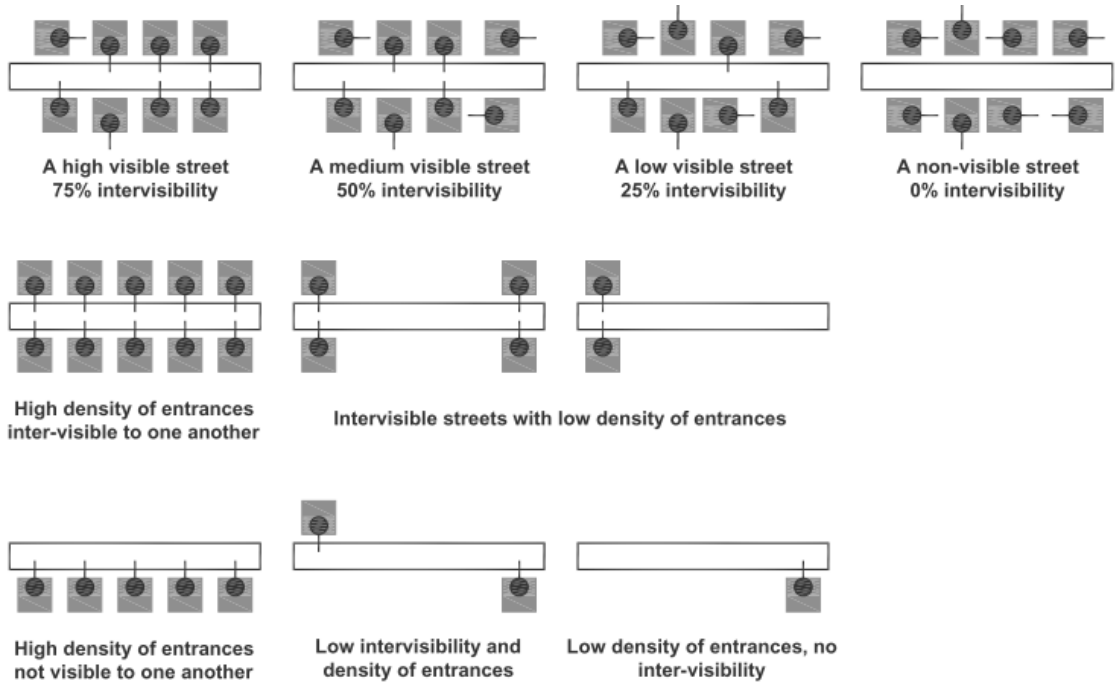


Figure 7: Inter-visibility assessment measure. Source: López and Van Nes, 2007.

3.6 Data Analysis Methods

- Data preparation and data generation

As this research makes use of secondary data, in which much is elaborated for other research purposes, the data needs to be proper prepared. This preparation includes renaming and organizing the data, as well as excluding duplicates to minimize errors. In addition, relevant information was selected from the data base to simplify and make the analysis more consistent.

The second part consisted in generating data through the aggregation of indicators with the same category and scale of measurement considering a reliability test analysis (Cronbach's Alpha). The Cronbach's Alpha method indicates the consistency of the group of indicators which will be used for aggregation. The coefficients range from 0 to 1, where 0 displays no consistency and 1 a perfect consistency in the measurement of the variable. The coefficients should be higher than 0.60 to be considered consistent and acceptable for the analysis. Through the software Stata, it was possible to perform this analysis and combine various indicators into a single measure. This strategy is believed to make the analysis more comprehensible and reliable, helping to answer the research question precisely.

- Space Syntax

The axial map of Rotterdam used in this research was drawn by Akkelies Van Nes in 2003 in the DepthmapX software was used for the macro spatial analysis: segment integration analyses with metrical radius and angular choice analysis with metrical radius. This enabled the investigation of the streets in the context of both local and global street network, therefore the results from the space syntax analyses represent this thesis macro scale spatial analyses. The following special measurements were used for the macro spatial analysis: angular choice analyses with two different metrical radii; one radius for pedestrian accessibility (R02) and one radius for bicycle and car accessibility (R20). According to the body of literature, vital local centres are found in neighbourhoods where these two spatial measurements overlap with high integration values (coloured in yellow and red).

- Statistical Analysis using STATA

After data preparation, a Pearson's bivariate correlation test was performed, aiming to identify which indicators were correlated with the dependent variable. The indicators which showed correlation were then selected for the statistical analysis, narrowing down on indicators that would best predict satisfaction. Afterwards, the statistical analysis was conducted using the Beta Regression (betareg) model in order to answer the main question and sub questions 1 and 3. This model is believed to best fit the situation as the dependent variable is measured in a ratio scale and assume values in the "standard unit interval" (0,1), which means is greater than 0 and less than 1. Furthermore, it is a model known by its flexibility where its response is assumed to be beta distributed, being "naturally heteroskedastic and easily accommodates asymmetries" (Cribari-Neto and Zeileis, 2009, p. 2). As the model does not allow interpret the magnitudes of effects from the coefficients of the results by itself, the average marginal effect was used to obtain interpretable results for the covariates.

Taking this into consideration, the statistical analysis was divided between the subjective and objective indicators for each neighbourhood factor. The significant relations in this research refer to the statistical significance where the achieved p-value falls in a 90% confidence interval, which mean is less than 0.1.

After conducting the statistical analysis and extract the indicators which are significant for pre-war and post war neighbourhoods, a Principal Component Analysis (PCA) was conducted in order to determine the extent to which physical, social and safety influence on neighbourhood satisfaction, hence answering the main research question. The PCA method allows the estimation of principal component models parameters by identifying patterns and highlighting data similarities and differences (Smith, 2002). In addition, it compresses the data without much loss of information, generating a sort of index.

3.7 Validity and Reliability

Validity and reliability are important concerns when doing a research. According to Van Thiel (2014) there are two types of validity, internal and external. The first one refers to whether the research measures or not what was previously established, whereas the second one refers to the extent the research can be generalizable (Ibid 2014). In this research, internal validity refers to whether the research measures properly neighbourhood satisfaction according to the factors mentioned. As it was seen, the literature review makes use of neighbourhood factors to measure

satisfaction. This research mainly selected factors which were previously chosen and proved in other research to measure neighbourhood satisfaction, except for the inclusion of spatial features of the urban environment. Therefore, the internal validity is secured in this research. However, it is important to highlight that this thesis makes use of secondary data derived from surveys as its data collection instruments. According to Van Thiel (2014), the lack of control over responses is one of the main limitations to surveys. In this case, two surveys were applied, in which both had responses differing from the sample. This resulted in neighbourhoods being under represented or overrepresented. To solve this problem, (non-response bias) different strategies were applied, such as sample balancing, the use of weights and ranking process (Wijkprofiel Rotterdam, 2018). This constraint with survey data collection can be considered a limitation in the results obtained in this research. In relation to external validity, the context of the research is significant, which makes the results specific to the context of study. Consequently, there is an extent to whether results can be generalizable, reducing external validity.

Finally, the reliability refers to the accuracy and consistence in which the variables are measured (Van Thiel, 2014). In this research, it refers to the accuracy of secondary data. Despite the limitations mentioned in the paragraph above, the use of secondary data enables significant and representative results that fit into the constraints of the research. In addition, the Geemente Rotterdam is considered a reliable source of data, with well recognized research departments.

Chapter 4: Research Findings

This chapter is divided in two parts categorized into four sections. The first part elaborates on data preparation and description of the dependent and independent variables, while the last one approaches the empirical results.

A great emphasis was given to the first part, mainly what refers to data description, being important to understand the data as it has an influence on how the research was conducted. For example, preparing data for the independent variables (neighborhood factors and spatial features), followed multiple steps of data generation and correlation analysis, in order to narrow down from the large list of indicators. Following the selection of significant indicators to the creation of indexes. Moreover, neighborhood satisfaction was well explored aiming at the comprehension of the distribution of satisfaction within the neighborhoods.

4.1 Neighbourhood data and division

The data gathered from the Wijkprofiel Rotterdam represents observations for the neighborhood, district and city scale. As this thesis deals specifically with the neighborhood scale, information on districts and city were excluded to avoid duplication. Furthermore, some neighborhoods located west of Rotterdam were not considered as they didn't fit the scope of the study. The final list of neighborhoods analyzed consisted in 65 observations, with 58 independent neighborhoods and 7 combined neighborhoods. According to Wijkprofiel Rotterdam (2018), those combined neighborhoods were aggregated to represent a single measure because either it lacked enough information regarding its data collection or represented a large open space (e.g Kralingen Bos).

From the final 65 observations, the neighborhoods were further divided between "pre-war neighborhood's" and "post war neighborhoods", the first one with 31 observations while the latter with 34 as illustrated in figure 8.

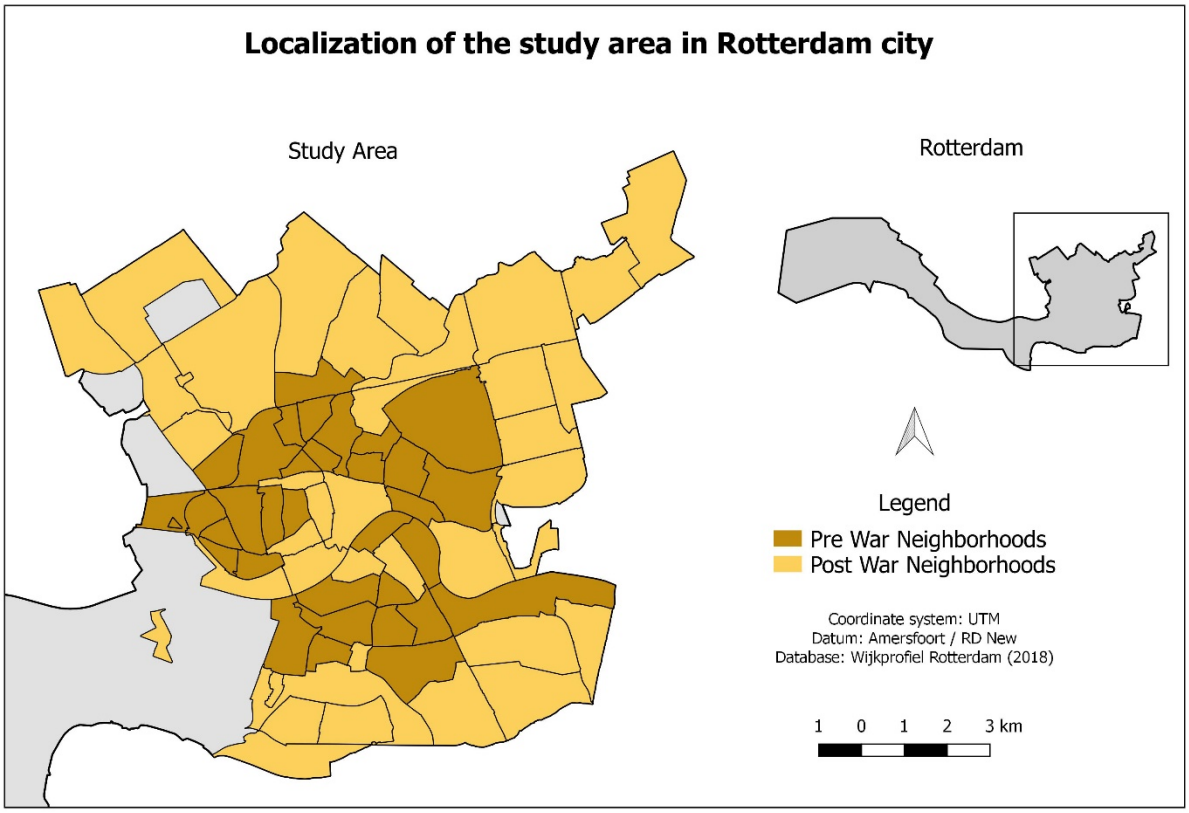


Figure 8 Demarcation of study area and division of the city between pre and post war neighbourhoods. Source: Wijkprofiel Rotterdam, 2018, own map.

4.2 Neighbourhood Satisfaction

This section will present the descriptive analyses for neighborhood satisfaction of the study area. Neighborhood satisfaction is a measure of "Percentage of people that say they are very satisfied and satisfied with their neighborhood, people, house and facilities."

Before approaching the description of neighborhood satisfaction, it is necessary to understand the meaning of skewness and kurtosis. The first one measures the degree and direction of asymmetry while the second one refers to the heaviness of the tails of a distribution. Additionally, a symmetric distribution presents a value of 0, while left skewed distributions (when the mean is less than the median), are negative. In turn, a normal distribution has a kurtosis of 3. If the distributions have a heavy tail, the kurtosis is greater than 3, whereas light tailed distributions are less than 3.

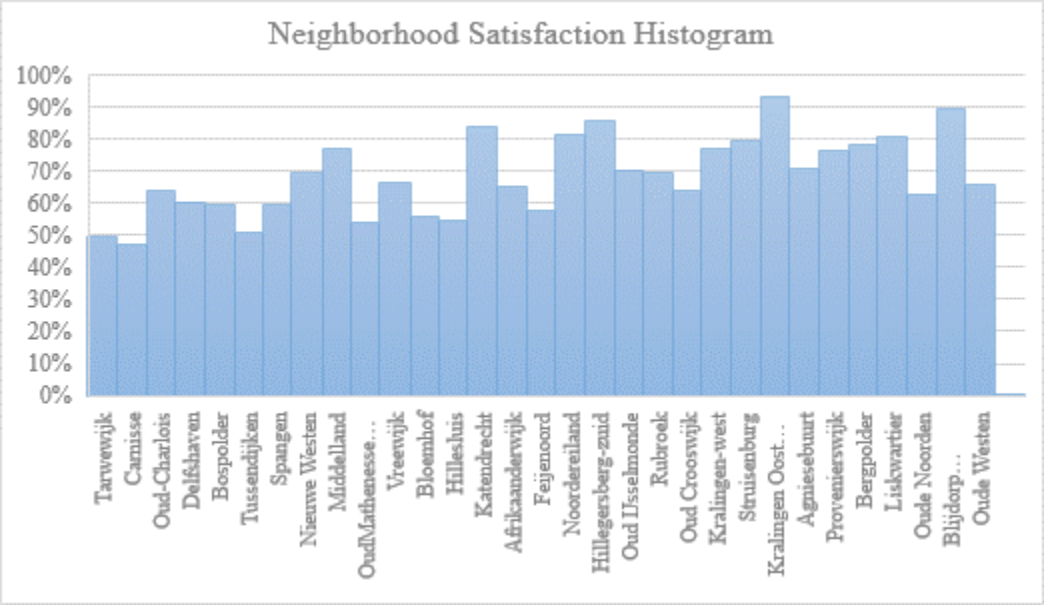
4.2.1 Pre-War Neighborhoods

Through descriptive statistics, it can be drawn that being (very) satisfied with the neighborhood, among the 31 pre-war urban areas in Rotterdam, varies from approximately a minimum of 47% to a maximum of 93%, with a mean of 68% (table 12). The low standard deviation points out that most numbers are close to the average. Moreover, the data has a slightly skewness distribution to the right, indicating that the mean is more than the median. Similarly, it also has a light tail distribution in relation to it kurtosis measure.

Table 12 Descriptive statistics for neighbourhood satisfaction in pre-war neighbourhoods. Source: Author, 2018.

Variable	Obs	Mean	Std. Deviation	Minimum	Maximum	Skewness	Kurtosis
Neighbourhood Satisfaction	31	0.683834	0.1222921	0.4696517	0.9305263	0.1572388	2.114725

The histogram below allows a better visualization of the descriptive statistics and the distribution of life satisfaction across the pre-war neighborhoods.



Graph 1 Histogram of neighbourhood satisfaction in pre-war neighbourhoods. Source: Wijkprofiel, 2018, own graph.

When analyzing the spatial distribution of neighborhood satisfaction in pre-war neighborhoods (figure 9), it is clear the difference between the north and south part of the city. In general, the north part concentrates the neighborhoods most satisfied while the south part gathers the least ones.

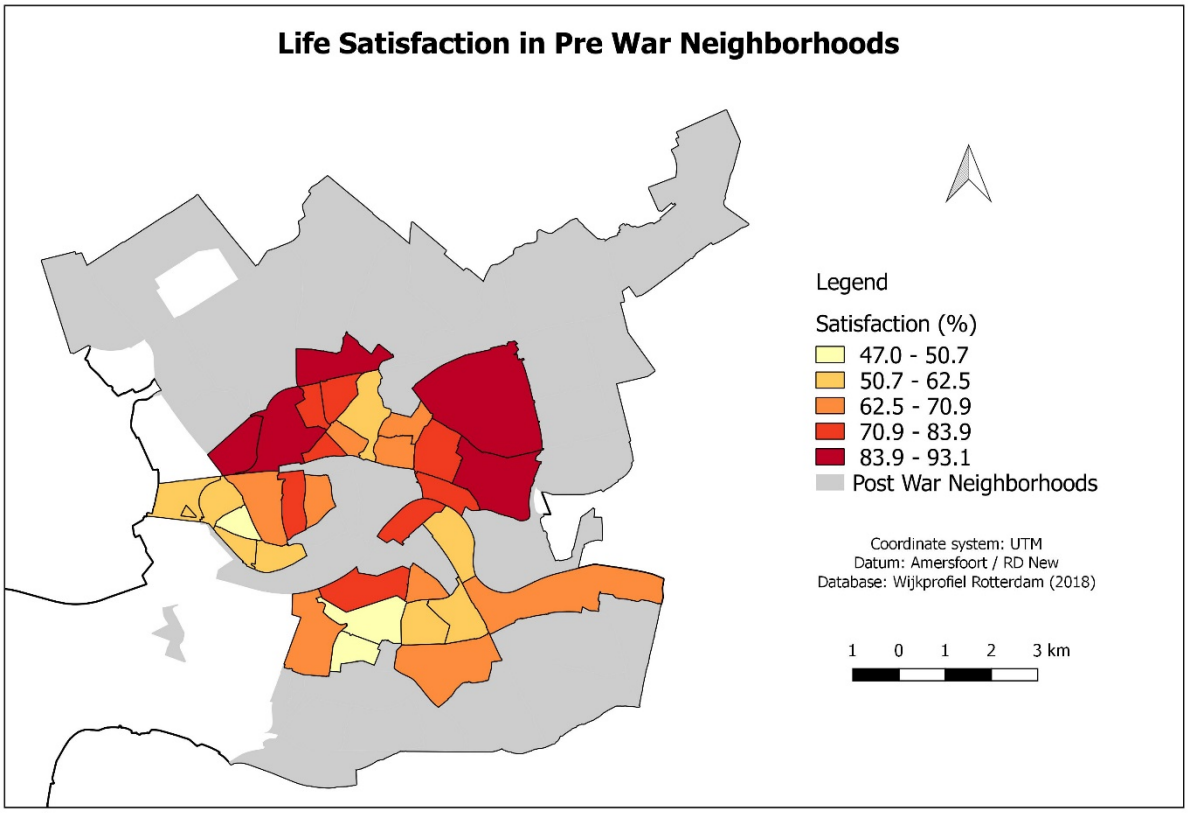


Figure 9 Map indicating the levels of satisfaction in pre-war neighbourhoods. Source: Wijkprofiel, 2018, own map.

In a deeper investigation into which neighbourhoods are the least satisfied, it is no surprise that areas such as Tarwewijk (Charlois), Carnisse (Charlois), Tussendijken (Delfshaven), Hillesluis (Feijenoord) and Bloemhof (Feijenoord) turns up (table 13). These neighbourhoods appear in the list of the 40 "problematic" or "power" neighbourhoods by the VROM, and hence presents a range of economic, social and safety issues which may compromise their life satisfaction. The neighbourhoods which are the most satisfied, such as Kralingen Oost/Bos (Kralingen-Crooswijk), Blijdorp/Blijdorpsepolder (Noord), Noordereiland (Feijenoord) and Katendrecht (Feijenoord) (table 13) correspond to areas with the presence of park. In fact, Kralingen Oost/Bos correspond to a quiet and green urban environment, due to its largely disposition of green areas such as the Kralingen Bos, whereas Blijdorp/Blijdorpsepolder counts with the service of the famous Blijdorp Zoo and Vroesenpark. In addition, it is important to highlight that Noordereiland and Katendrecht are both located in Feijenoord, the same district where Hillesluis and Bloemhof are. These results show that life satisfaction is not necessarily connected to the district where the neighbourhoods are located, but to the neighbourhood itself.

Table 13 Top 5 least and most satisfied pre-war neighbourhoods. Source: Author, 2018.

Least Satisfied	Most Satisfied
1. Tarwewijk (Charlois)	1. Kralingen Oost/Bos (Kralingen-Crooswijk)
2. Carnisse (Charlois)	2. Blijdorp/Blijdorpsepolder (Noord)
3. Tussendijken (Delfshaven)	3. Hillegersberg-zuid (Hillegersberg)
4. Hillesluis (Feijenoord)	4. Noordereiland (Feijenoord)

5. Bloemhof (Feijenoord)	5. Katendrecht (Feijenoord)

As speculated, the categorization between least and most satisfied neighbourhoods are also closely related with their average income (figure 10). The scatter plot (graph 2) shows an exponential increase of neighbourhood satisfaction in relation to average income. The least satisfied neighbourhoods are commonly the neighbourhoods with lower average income, while the most satisfied neighbourhoods are commonly the neighbourhoods with higher average income. Therefore, this confirms the use of income as a control variable.

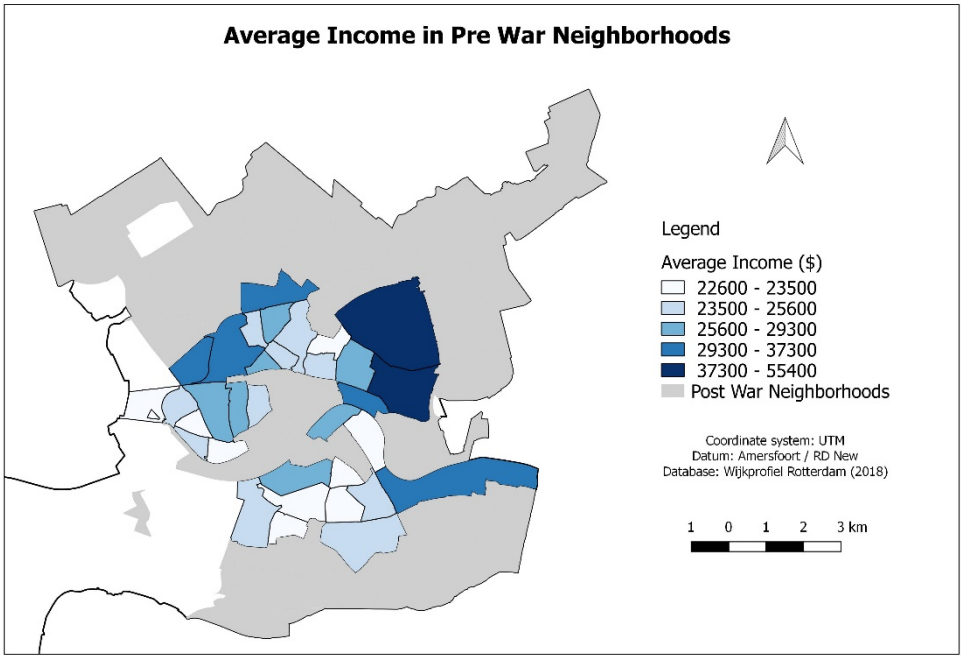
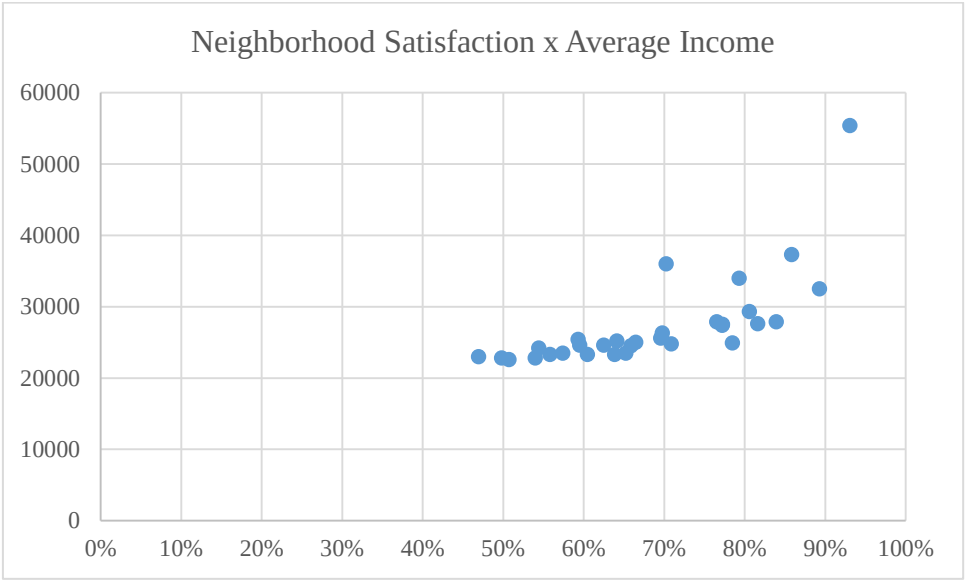


Figure 10 Average income in pre-war neighbourhoods



Graph 2 Scatter plot of neighbourhood satisfaction versus average income in pre-war neighbourhoods. Source: Wijkprofiel, 2018, own graph.

The table below shows the top 5 lowest and highest income pre-war neighbourhoods.

Table 14 Top 5 lowest and highest income pre-war neighbourhoods. Source: Author, 2018.

Lowest income neighbourhoods	Highest income neighbourhoods
1. Tussendijken (Delfshaven)	1. Kralingen Oost/Bos (Kralingen-Crooswijk)
2. Tarwewijk (Charlois)	2. Hillegersberg-zuid (Hillegersberg-Schiebrok)
3. Oud Mathenesse (Delfshaven)	3. Oud Ijsselmonde (Ijsselmonde)
4. Carnisse (Charlois)	4. Struisenburg (Kralingen-Crooswijk)
5. Delfshaven (Delfshaven)	5. Blijdorp/Blijdorpsepolder (Noord)

The descriptive statistics of average income shows that income in pre-war neighbourhood's ranges from a minimum of 22.600 to a maximum of 55.400 euros annually (table 15). However, it is important to state that the mean falls around 27.290, with a relatively higher standard deviation. Therefore, some values are spread out and not necessarily close to the average. This is further confirmed by the skewness and kurtosis measure. The first indicates an asymmetric distribution to the right, implying that the mean is higher than the median, while the latter displays a high tailed distribution in the data.

Table 15 Descriptive statistics for average income in pre-war neighbourhoods. Source: Author, 2018.

Variable	Obs	Mean	Std. Deviation	Minimum	Maximum	Skewness	Kurtosis
Average Income	31	27290.32	6484.05	22600	55400	2.922332	12.59066

Taking this into consideration, a log value was generated for the indicator of average income (figure 11). The log transformation was necessary in order to minimise errors due to its uneven distribution and facilitate the statistical analysis.

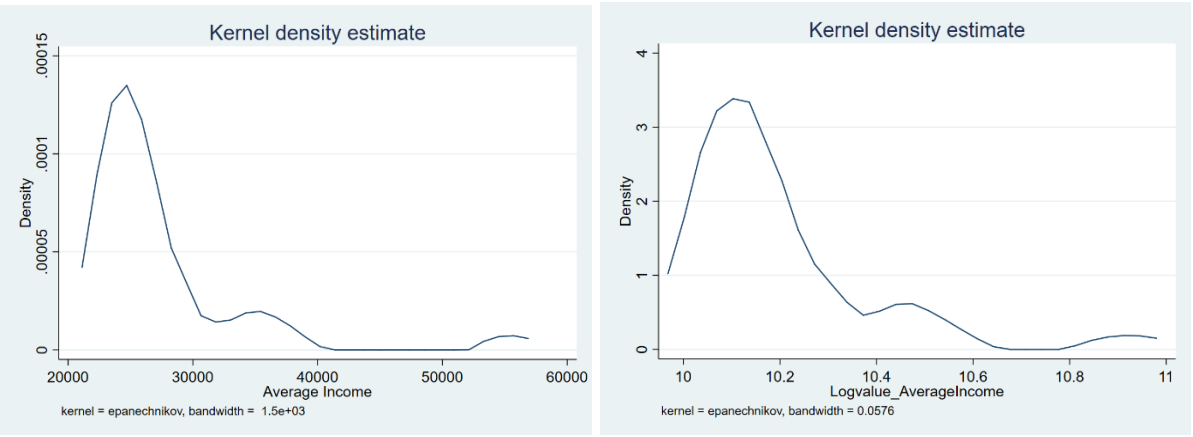


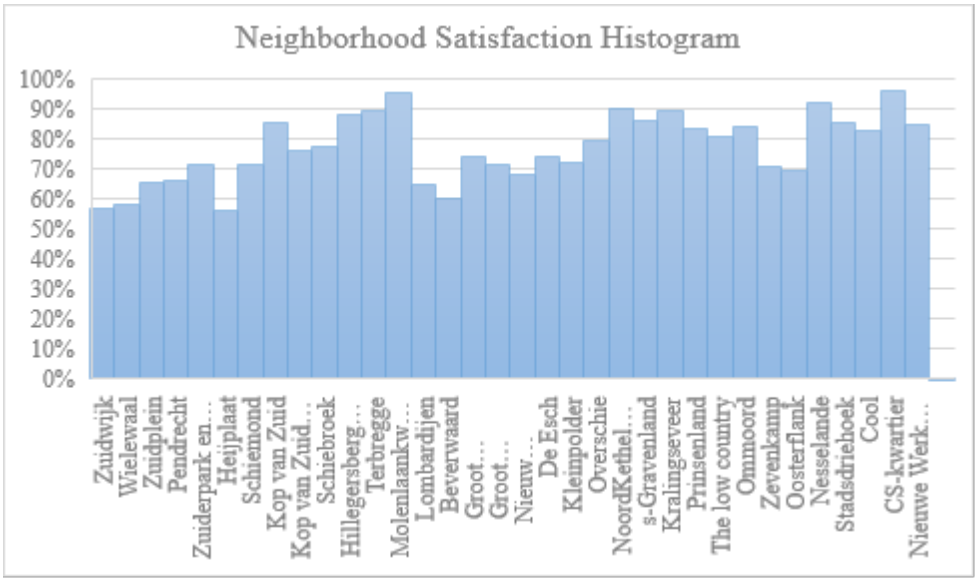
Figure 11 Kernel density estimate of average income and log average income of pre-war neighbourhoods. Source: Wijkprofiel, 2018, own graph.

4.2.2 Post War Neighborhoods

In relation to the thirty-four post war neighbourhoods considered, the descriptive statistics displays that being (very) satisfied with the neighbourhood varies from a minimum of 56% to a maximum of 96%, presenting a mean of almost 77% (table 16). The low standard deviation indicates that most numbers are close to the average. In addition, the data is marginally skewed to the left, indicating that the mean is less than the median, while lightly tailed distributed regarding it kurtosis. Through the table and histogram (graph 3), it is possible to have a better visualization of the distribution of life satisfaction across the post war neighborhoods.

Table 16 Descriptive statistics for neighbourhood satisfaction in post war neighbourhoods. Source: Author, 2018.

Variable	Obs	Mean	Std. Deviation	Minimum	Maximum	Skewness	Kurtosis
Neighbourhood Satisfaction	34	0.7694224	0.1115148	0.5639081	0.9623533	-.1659287	2.069804



Graph 3 Histogram of neighbourhood satisfaction in post war neighbourhoods. Source: Wijkprofiel, 2018, own graph.

Similarly with the spatial distribution of neighborhood satisfaction of pre-war neighborhoods, the difference between the north and south part of the city is highlighted in the map below (figure 12).

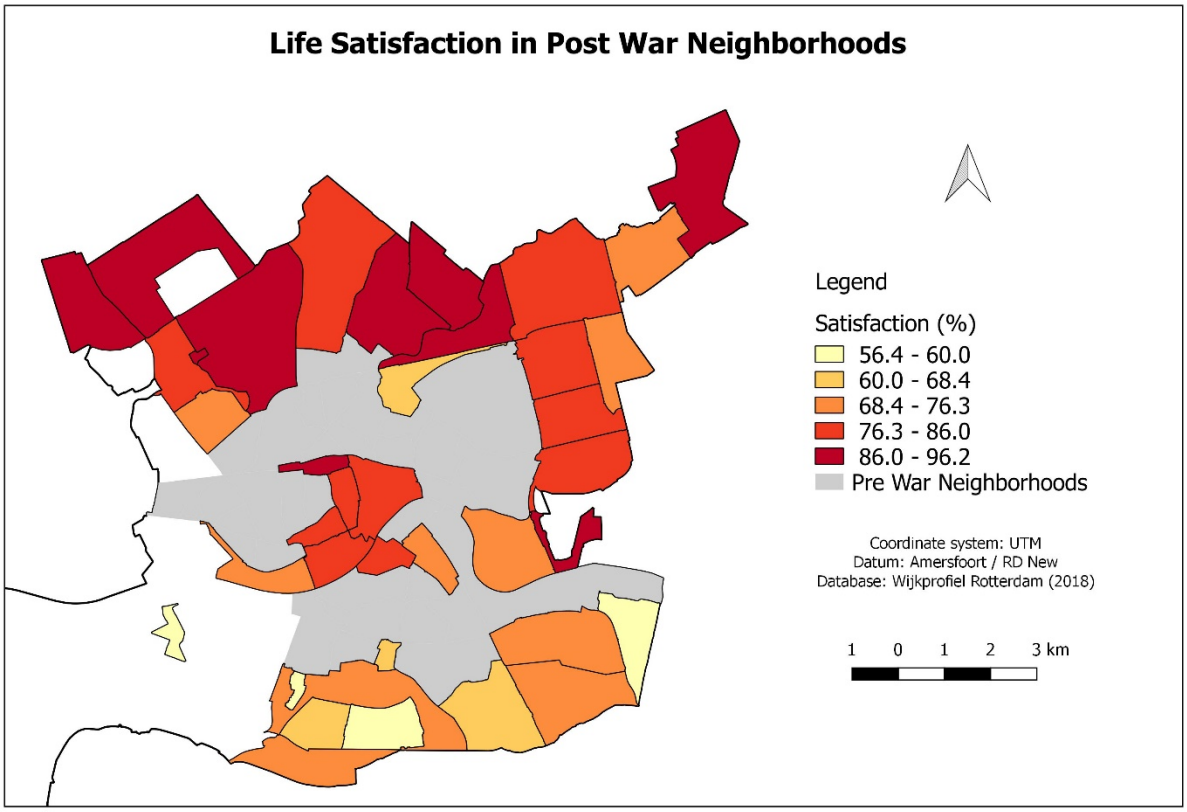


Figure 12 Map indicating the levels of satisfaction in Post War neighbourhoods. Source: Wijkprofiel, 2018, own map.

In relation to the neighborhoods which are the least satisfied, the district of Charlois gathers the first three in the list: Heijplat, Zuidwijk and Wielawaal, followed by Beverwaard and Lombardijen located both in Ijsselmonde. These are usually residential layout neighborhoods where most facilities are located outside the neighborhood. Heijplat, for example, is an area more isolated from the city as it shapes like a peninsula among harbor and industry. In relation to the neighborhood which is the most satisfied, CS- Kwartier (Rotterdam Centrum), it corresponds to a central area of Rotterdam, where all daily needs, such as facilities, commercial activities, public transportation and spaces to socialize among many others are within easy reach. Followed by CS- Kwartier, the most satisfied neighborhoods are Molenlaankwartier (Hillegersberg-Schiebrok), Nesselande (Prins Alexander), NoordKethel/Schieven/Zestienhoven (Overschie) and Terbregge (Hillegersberg-Schiebrok) (table 17). Those neighborhoods are all located around the north periphery of Rotterdam, far from the commercial and economic core of the city, and closer to the nature, surrounded by large green spaces and lakes.

Table 17 Top 5 least and most satisfied post war neighbourhoods. Source: Author, 2018.

Least Satisfied	Most Satisfied
1. Heijplaat (Charlois)	1. CS- Kwartier (Rotterdam Centrum)
2. Zuidwjik (Charlois)	2. Molenlaankwartier (Hillegersberg-Schiebrok)
3. Wielawaal (Charlois)	3. Nesselande (Prins Alexander)
4. Beverwaard (Ijsselmonde)	4. NoordKethel/Schieven/Zestienhoven (Overschie)

5. Lombardijen (Ijsselmonde)	5. Terbregge (Hillegersberg-Schiebrok)

As it happens with pre-war neighbourhoods, average income can be associated with neighbourhood satisfaction in post war neighbourhoods (figure 13). Although not as strong as it happens in pre-war urban areas, the least satisfied neighbourhoods are generally the neighbourhoods with lower average income, whereas the most satisfied neighbourhoods are generally the neighbourhoods with higher average income. The district of Charlois holds here four neighbourhoods with the lowest income while the highest income neighbourhoods concentrates in Hillegersberg-Schiebrok and Prins Alexander. The scatter plot (graph 4) illustrates that neighbourhood satisfaction rises proportionally to average income, reassuring it use as a control variable.

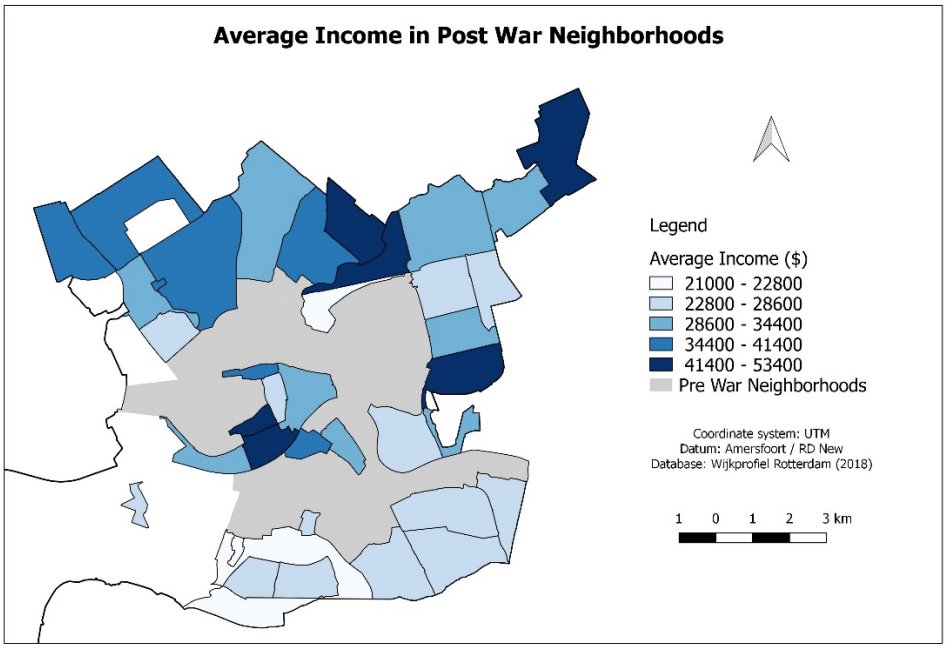
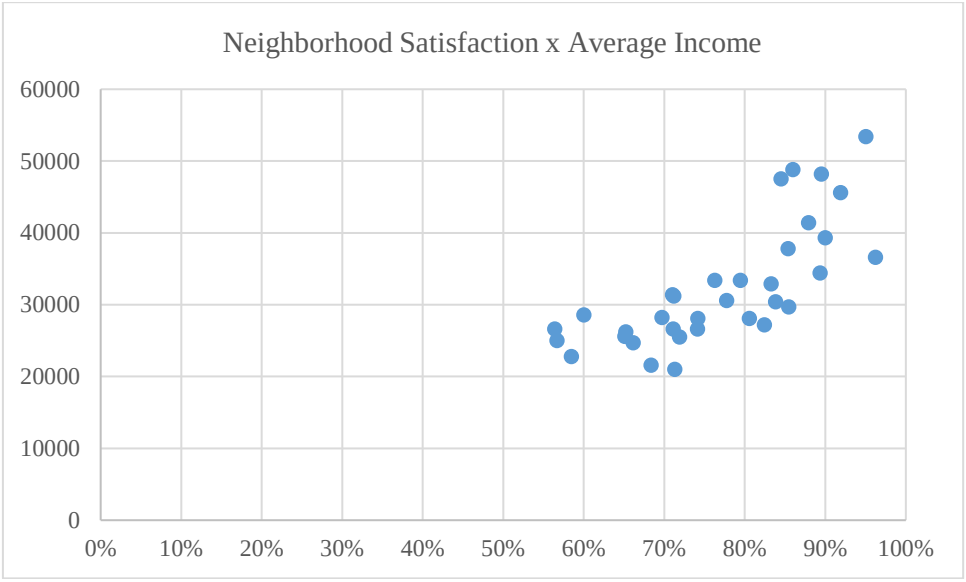


Figure 13 Average income in post war neighbourhoods.



Graph 4 Scatter plot of neighbourhood satisfaction versus average income in post war neighbourhoods. Source: Wijkprofiel, 2018, own graph.

The table below shows the top 5 lowest and highest income post war neighbourhoods.

Table 18 10 Top 5 lowest and highest income post-war neighbourhoods. Source: Author, 2018.

Lowest income neighbourhoods	Highest income neighbourhoods
1. Zuiderpark en Zuidrand (Charlois)	1. Molenlaankwartier (Hillegersberg-Schiebrok)
2. Nieuw Crooswijk (Kralingen-Crooswijk)	2. S- Gravenland (Prins Alexander)
3. Wielawaal (Charlois)	3. Terbregge (Hillegersberg-Schiebrok)
4. Pendrecht (Charlois)	4. Nieuwe Werk/Dijkzigt (Rotterdam Centrum)
5. Zuidwijk (Charlois)	5. Nesselande (Prins Alexander)

In post war neighbourhoods, average income varies from 21.000 to 53.400 euros annually, slightly less than in pre-war urban areas. The mean falls around 32.305 euros, with a standard deviation that shows the values are relatively close to the average (table 19). Furthermore, the data is marginally asymmetrically distributed to the right, which implies that the mean is slightly higher than the median. However, a kurtosis of 3 suggests a normal distribution of the tails. A log value of average income was also generated as in pre-war neighbourhoods in order to facilitate the statistical analysis (figure 14).

Table 19 Descriptive statistics for average income in post war neighbourhoods. Source: Author, 2018.

Variable	Obs	Mean	Std. Deviation	Minimum	Maximum	Skewness	Kurtosis
Average Income	34	32305.88	8424.889	21000	53400	0.9721892	3.007392

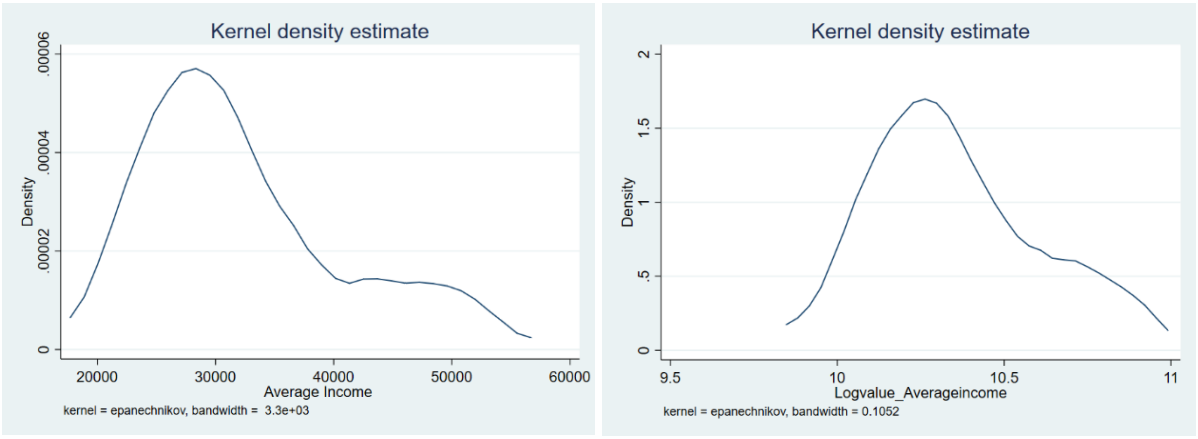


Figure 14 Kernel density estimate of average income and log average income of post war neighbourhoods. Source: Wijkprofiel, 2018, own graph.

4.3 Independent Variables

According to literature, a list of indicators from subjective and objective measures were selected that best represented the neighbourhood scale related to physical, social and safety factors. Descriptive and inferential analysis were applied to further understand the indicators and find out the significance of the relationship with the dependent variable. The inferential

analysis was run separately for subjective and objective indicators, and marginal effects were generated in order to interpret the coefficient of the indicators. Furthermore, tests to check the variance inflation factor were perfomed to control for possible multicollinearity.

Before running the statistical analysis, the Cronbach's Alpha test was performed aiming at the aggregation of indicators in a reliable way.

Indicators selected:

- "% of households satisfied with quality street lighting
- % of households satisfied with maintenance of cycle paths
- % of households satisfied with maintenance of pavements
- % of households satisfied with safety of pavements
- % of households satisfied with safety of sidewalks."

Scale reliability coefficient: 0.8059

As the value achieved was higher than 0.60, these indicators are consistent to be aggregated. Therefore, this aggregate indicator was named as: "% of households satisfied with the range of services". The rest of the list can be found in the Annex 1.

Having performed the generation of new indicators and the Pearson's bivariate correlation to narrow down on significant indicators, the descriptive analysis and inferential analysis were conducted separately in pre-war and post war neighbourhoods. Because of the differences in correlation with the two kinds of neighbourhood studied, sometimes they don't present the same indicators for the statistical analysis. The list of indicators used for each case can be spotted with the descriptive analysis. In addition, the list of correlations can be found in annex 1. Furthermore, Variance Inflation Factors (VIF) were also run to ensure that collinearity would not be a problem in the regression.

4.3.1 Physical Factors

The selection of physical subjective measures focuses on the perception of facilities, green spaces, services, public transport and attractiveness from surrounding buildings while the objective focuses on the standard distance from facilities, transport stops and housing condition.

1) Pre-War Neighbourhoods

From the descriptive analysis (table 20), it is drawn that pre-war neighbourhoods presents a high mean of dwellings with facilities and tram stops within standard distance. Concurrently, there is a discrepancy within the neighbourhoods regarding those facilities in a standard distance, with a minimum value of 15% while others may reach up to 97%. Moreover, when it comes to buildings, the assessment of the state of maintenance and finding them attractive in the neighbourhood have a lower mean.

Table 20 Descriptive analysis of physical factors in pre-war neighbourhoods

Variable	Obs	Mean	Std. Dev.	Minimum	Maximum
% satisfied with the range of facilities	31	0.51	0.11	0.30	0.76
% green spaces are sufficiently available	31	0.74	0.13	0.51	0.97
% satisfied with the range of services	31	0.57	0.06	0.45	0.68
% find buildings in the neighbourhood attractive	31	0.51	0.15	0.23	0.84
% of households satisfied with the current home	31	0.73	0.08	0.54	0.90
% dwellings with facilities within standard distance	31	0.78	0.18	0.15	0.97
% dwellings with tram stops within standard distance	31	0.99	0	0.99	1
% of households that finds the state of maintenance of buildings in the neighborhood good.	31	0.43	0.14	0.18	0.83
% of housing with overcrowding.	31	0.08	0.03	0.02	0.15

The inferential analysis (table 21 and 22) was run and from the list of subjective indicators % of households satisfied with facilities, % of households find buildings attractive and % of households satisfied with current home were found to significantly influence satisfaction. They all seem to positively influence satisfaction in the neighbourhood by an increase of 40%, 27,4% and 57% respectively. As from the list of objective measures, % dwellings with facilities within standard distance and % of households that finds the maintenance state of buildings good are seen to influence positively with an increase of 25,6% and 74,2% in satisfaction whereas % of housing with overcrowding is seen to negatively impact on satisfaction with a decrease of 143%.

Table 21 Regression with physical subjective indicators in pre-war neighbourhoods.

	Neighbourhood Satisfaction
VARIABLES	Marginal effects
% of households satisfied with the range of facilities together	0.400***
	(0.0657)
% of households indicating that green spaces are sufficiently available	-0.0208
	(0.0543)
% of household satisfied with the range of services	0.202
	(0.146)
% of household find buildings in the neighbourhood attractive	0.274***
	(0.0760)
% of households satisfied with the current home	0.570***
	(0.139)
% of households indicating public transport is sufficiently available	-0.0577
	(0.114)
Observations	31

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 22 Regression with physical objective indicators in pre-war neighbourhoods

	Neighbourhood Satisfaction
VARIABLES	Marginal effects
% dwellings with facilities within standard distance	0.256***
	(0.0701)
% dwellings with tram stops within standard distance	-5.735
	(17.19)
% of households that finds the state of maintenance of buildings in the neighbourhood good.	0.742***
	(0.0977)
% of housing with overcrowding.	-1.431***
	(0.301)
Observations	31

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

2) Post War Neighbourhoods

In Post War neighbourhoods, it is visible that most neighbourhoods experience high levels of satisfaction with the availability of green spaces and satisfaction with current home. However, it is not all neighbourhoods who find green spaces available, with a few reaching 16%. It can further be observed that the mean of households satisfied with the range of facilities in the neighbourhoods coincides with its respective mean objective measure of having facilities within a standard distance. In relation to pre-war neighbourhoods, the availability of tram stops within standard distance is much lower, reaching a discrepancy of a minimum of 0% for a few neighbourhoods to a maximum or 100% for a few others. Similarly, underground stops also present this huge discrepancy varying from 0% to 100% (table 23).

Table 23 Descriptive analysis of physical factors in post-war neighbourhoods

Variable	Obs	Mean	Std. Dev.	Minimum	Maximum
% satisfied with the range of facilities	34	0.54	0.11	0.26	0.81
% green spaces are sufficiently available	34	0.85	0.16	0.38	0.99
% satisfied with the range of services	34	0.62	0.07	0.46	0.83
% find buildings in the neighbourhood attractive	34	0.62	0.17	0.33	0.97
% of households satisfied with the current home	34	0.81	0.08	0.60	0.98
% dwellings with facilities within standard distance	34	0.49	0.17	0.13	0.85
% dwellings with tram stops within standard distance	34	0.66	0.43	0	1

% dwellings with underground stops within standard distance	34	0.58	0.45	0	1
% of households that finds the state of maintenance of buildings in the neighbourhood good.	34	0.56	0.16	0.25	0.90
% of housing with overcrowding.	34	0.05	0.02	0.02	0.10

From the list of subjective indicators, the statistical analysis (table 24 and 25) found % of households satisfied with facilities, % of households indicating green spaces are enough, % of households find buildings attractive and % of households satisfied with current home to positively influence satisfaction in the neighbourhood with an increase of 28%, 11%, 14% and 86%, respectively. It can be drawn how much satisfaction with house increases satisfaction with the neighbourhood. From the objective measures, % dwellings with underground stops within standard distance and % of households that finds the maintenance state of buildings good are significant and increases neighbourhood satisfaction by 5% and 51%, whereas having dwellings with facilities within standard distance and houses with overcrowding significantly decreases neighbourhood satisfaction by 14% and 100%, respectively.

Table 24 Regression with physical subjective indicators in post war neighbourhoods.

	Neighbourhood Satisfaction
VARIABLES	Marginal effects
% of households satisfied with the range of facilities together	0.276***
	(0.0911)
% of households indicating that green spaces are sufficiently available	0.113*
	(0.0685)
% of household satisfied with the range of services	-0.193
	(0.143)
% of household find buildings in the neighbourhood attractive	0.144**
	(0.0711)
% of households satisfied with the current home	0.856***
	(0.131)
Observations	34

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 25 Regression with physical objective indicators in post war neighbourhoods.

	Neighbourhood Satisfaction
VARIABLES	Marginal effects
% dwellings with facilities within standard distance	-0.140*
	(0.0848)
% dwellings with tram stops within standard distance	-0.00919
	(0.0281)
% dwellings with underground stops within standard distance	0.0490*
	(0.0280)
% of households that finds the state of maintenance of buildings in the neighbourhood good.	0.511***
	(0.0878)

% of housing with overcrowding.	-1.032**
	(0.523)
Observations	34

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.3.2 Social Factors

The selection of social measures focuses on social bonding and interaction of people within the community as well as availability and perception of places to interact inside the neighbourhood. Some indicators include connection to the neighbourhood and interaction with neighbours.

1) Pre-War Neighbourhoods

Through the statistical description (table 26), it is possible to observe a rough picture of the reality regarding some social trends. While a high percentage of residents affirms that likes your own neighbourhood, a low percentage of locals doesn't know each other neither participate in cultural activities. The last one may suggest that although residents usually find enough places for joint activities in the neighbourhood, they don't commonly take part on cultural events.

Table 26 Descriptive analysis of social factors in pre-war neighbourhoods.

Variables	Obs.	Mean	Std. Deviation	Minimum	Maximum
% of residents who feels connected to neighbourhood	31	0.53	0.11	0.34	0.78
% of residents who likes their own neighbourhood	31	0.71	0.13	0.47	0.94
% of residents who says that locals know each other	31	0.36	0.09	0.19	0.58
% of residents who says that locals help each other	31	0.53	0.10	0.42	0.79
% of residents who says they have no problems with local residents.	31	0.67	0.06	0.55	0.81
% residents which says that the relationship between ethnic groups in the neighbourhood is good	31	0.48	0.07	0.32	0.60
% residents that says that are enough places for joint activities in the neighbourhood	31	0.50	0.09	0.32	0.78
% of residents that participate in cultural activities in the neighbourhood monthly	31	0.18	0.05	0.09	0.31
% of residents who are considered "non-native	31	0.60	0.17	0.23	0.86

% of households with low income"	31	0.57	0.14	0.26	0.77

The statistical analysis (table 27 and 28) was run to ascertain which indicators encourage or discourage neighbourhood satisfaction. Residents who likes their own neighbourhood and enough places for joint activities were seen to have a great influence on neighbourhood satisfaction with an increase of 57% and 35%. In addition, residents who help each other, residents who have no problems with locals and residents who participate in cultural activities also increase neighbourhood satisfaction, increasing it by 47%, 34% and 69%. On the other hand, relationship between ethnic groups and households with low income have a great impact on satisfaction, decreasing it by 42 and 61%. Moreover, % of "non-natives" residents cause a decrease in neighbourhood satisfaction by 27%.

Table 27 Regression with social subjective indicators in pre-war neighbourhoods.

	Neighbourhood Satisfaction
VARIABLES	Marginal effects
% of residents who feels connected to neighbourhood	0.0233
	(0.222)
% of residents who likes their own neighbourhood	0.567***
	(0.134)
% of residents who says that locals know each other	-0.229
	(0.210)
% of residents who says that locals help each other	0.471**
	(0.230)
% of residents who says they have no problems with local residents.	0.354*
	(0.200)
% residents which says that the relationship between ethnic groups in the neighbourhood is good	-0.422***
	(0.136)
% residents that says that are enough places for joint activities in the neighbourhood	0.340***
	(0.120)
Observations	31

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 28 Regression with social objective indicators in pre-war neighbourhoods.

	Neighbourhood Satisfaction
VARIABLES	Marginal effects
% of residents that participate in cultural activities in the neighbourhood monthly	0.685**
	(0.308)
% of households with low income	-0.606***
	(0.205)
% of residents who are considered "non-native"	-0.265*
	(0.160)
Observations	31

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

2) Post War Neighbourhoods

As pre-war neighbourhoods, there is a high percentage of residents that likes your own neighbourhood and have no problem with locals while there is a low mean of residents who participate in cultural activities within the neighbourhoods. However, when it comes to the percentage of non-native people and low-income households, it is much lower in post war neighbourhoods. In addition, it is highlighted the discrepancy among the neighbourhoods of residents that knows each other, with a minimum of less than 1% and a maximum of 81% (table 29).

Table 29 Descriptive analysis of social factors in post-war neighbourhoods.

Variables	Obs	Mean	Std. Deviation	Minimum	Maximum
% of residents who feels connected to neighbourhood	34	0.59	0.13	0.38	0.87
% of residents who likes their own neighbourhood	34	0.79	0.11	0.59	0.92
% of residents who says that locals know each other	34	0.42	0.19	0.03	0.81
% of residents who says that locals help each other	34	0.60	0.15	0.30	0.93
% of residents who says they have no problems with local residents.	34	0.71	0.72	0.46	0.81
% of residents that participate in cultural activities in the neighbourhood monthly	34	0.15	0.04	0.08	0.29
% of residents who are considered "non-native"	34	0.43	0.14	0.21	0.70
% of households with low income	34	0.44	0.13	0.20	0.72

In post war neighbourhoods, residents who likes your own neighbourhood, residents who have no problem with locals and households with low income have a great influence in neighbourhood satisfaction. The first and second one shows an increase of 65% and 37% while and the latter shows a decrease of 74%. Differently from pre-war neighbourhoods which is not significant, the feeling of connexion with the neighbourhood increases the levels of satisfaction by 22%. On the other hand, residents considered as "non-native" makes neighbourhood satisfaction decrease by 11% (table 30 and 31).

Table 30 Regression with social subjective indicators in post war neighbourhoods.

	Neighbourhood Satisfaction
VARIABLES	Marginal effects
% of residents who feels connected to neighbourhood	0.221*
	(0.119)

% of residents who likes their own neighbourhood	0.650***
	(0.114)
% of residents who says that locals help each other	-0.0644
	(0.0974)
% of residents who says they have no problems with local residents.	0.366**
	(0.146)
Observations	34

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 31 Regression with social objective indicators in post war neighbourhoods.

	Neighbourhood Satisfaction
VARIABLES	Marginal effects
% of residents that participate in cultural activities in the neighbourhood monthly	0.152
	(0.243)
% of households with low income	-0.744***
	(0.0807)
% of residents who are considered “non-native	-0.111*
	(0.0624)
Observations	34

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.3.3 Safety Factors

The selection of safety measures reflects the perception of people in relation to different kinds of crimes inside the neighbourhood as well as their occurrences. Subjective indicators consist of percentage of residents who indicated determined crime (e.g. theft) often occur as a neighbourhood problem, while objective indicators are the number of crimes per thousand habitants.

1) Pre-War Neighbourhoods

The assessment of crimes occurring as a neighbourhood problem are low, usually with a mean of around 10% for all subjective indicators and no considerably distinction between the minimum and the maximum. Similarly, the objective indicators which are measured per thousand habitants, does not present a considerably high mean for most of the categories, with an exception for reports on environmental inconvenience. The latter one showed a mean of 32 numbers per thousand habitants, reaching up to almost 48 in a maximum scenario (table 32).

Table 32 Descriptive analysis of safety factors in pre-war neighbourhoods.

Variable	Obs	Mean	Std. Deviation	Minimum	Maximum
Theft of bike often occur as a neighbourhood problem	31	0.10	0.04	0.03	0.19

Burglary often occur as a neighbourhood problem	31	0.14	0.08	0.02	0.19
Violent crimes often occur as a neighbourhood problem	31	0.08	0.05	0	0.17
Vandalism occurs as a neighbourhood problem	31	0.10	0,04	0.02	0.19
Drug nuisance is often perceived as a neighborhood problem	31	0.10	0.06	0.02	0.25
Nuisance is often perceived as a neighbourhood problem.	31	0.12	0.04	0.04	0.23
Number of thefts on bike (per thousand habitants)	31	10.1	5.56	4.13	23.7
Number of reports on pickpockets (per thousand habitants)	31	1.53	2.30	0.25	10.1
Number of violent crimes (per thousand habitants)	31	2.24	0.85	0.58	4.05
Number of vandalism crimes (per thousand habitants)	31	7.30	2.20	3.01	13.26
Number of burglaries crimes (per thousand habitants)	31	8.11	4.10	3.25	18.11
Number of reports on drug cases (per thousand habitants)	31	1.32	0.89	0.20	5.08
Number of reports on environmental inconvenience (per thousand habitants).	31	32.1	7.93	18.1	47.8

As expected, regarding the inferential analysis (table 33 and 34), most of the indicators of safety were seen to decrease the level of neighbourhood satisfaction. The assessment of nuisance and violent crimes often occurring as neighbourhood problems were seen to be significant in decreasing neighbourhood satisfaction by around 101% and 129%. Furthermore, the number per thousand habitants of theft of bikes and reports on environmental inconvenience were also seen to be significant for neighbourhood satisfaction, with a decrease of almost 2% and 0.6% respectively.

Table 33 Regression analysis of safety subjective indicators in pre-war neighbourhoods.

	Neighbourhood Satisfaction
VARIABLES	Marginal effects
Theft of bike often occur as a neighbourhood problem	0.162
	(0.436)
Burglary often occur as a neighbourhood problem	-0.120
	(0.164)
Violent crimes often occur as a neighbourhood problem	-1.069**
	(0.542)
Vandalism occurs as a neighbourhood problem	-0.650
	(0.436)
Drug nuisance is often perceived as a neighbourhood problem	0.312
	(0.365)

Nuisance is often perceived as a neighbourhood problem.	-1.294***
	(0.405)
Observations	31

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 34 Regression analysis of safety objective indicators in pre-war neighbourhoods.

	Neighbourhood Satisfaction
VARIABLES	Marginal effects
Number of thefts on bike (per thousand habitants)	-0.0170***
	(0.00220)
Number of reports on pickpockets (per thousand habitants)	-0.00330
	(0.00447)
Number of violent crimes (per thousand habitants)	-0.0294
	(0.0204)
Number of vandalism crimes (per thousand habitants)	0.00159
	(0.00662)
Number of burglaries crimes (per thousand habitants)	-0.00274
	(0.00278)
Number of reports on drug cases (per thousand habitants)	0.00289
	(0.0143)
Number of reports on environmental inconvenience (per thousand habitants).	-0.00596***
	(0.00162)
Observations	31

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

2) Post War Neighbourhoods

Similarly to pre-war neighbourhoods, the evaluation of crimes occurring as a neighbourhood problem are usually low and there is no considerably contrast between the minimum and the maximum, with the exception of burglary. The percentage of people that points out burglary occurs as a neighbourhood problem vary from a minimum of 2% to a maximum of 68% within the neighbourhoods. The mean of this indicator is 17%, higher than other crimes. The objective indicator of reports of environmental inconvenience are also high, going from 10 to 134 numbers per thousand habitants within post war urban areas. Additionally, the number on pickpocket crimes presents a high contrast among the neighbourhoods, in which the minimum are 0 and the maximum 232 reports per thousand habitants (table 35).

Table 35 Descriptive analysis of safety factors in post-war neighbourhoods.

Variables	Obs	Mean	Std. Deviation	Minimum	Maximum
Burglary often occur as a neighbourhood problem	34	0.17	0.12	0.02	0.68

Violent crimes often occur as a neighbourhood problem	34	0.07	0.05	0	0.16
Vandalism occurs as a neighbourhood problem	34	0.09	0.04	0.01	0.22
Drug nuisance is often perceived as a neighbourhood problem	34	0.06	0.04	0	0.15
Nuisance is often perceived as a neighbourhood problem.	34	0.08	0.04	0.02	0.19
Number of thefts on car (per thousand habitants)	34	1.51	0.74	0	4.20
Number of reports on pickpockets (per thousand habitants)	34	12.4	41.6	0	232
Number of burglaries crimes (per thousand habitants)	34	9.44	5.45	2.65	31.2
Number of reports on environmental inconvenience (per thousand habitants).	34	34.8	30.5	9.64	134

Before running the statistical analysis, a log transformation was performed in two indicators, number of reports on environmental inconvenience and the report of pickpockets. This log transformation was necessary as both indicators presented a high asymmetry and heavy tail distribution along the data.

The inferential analysis (table 36 and 37) shows that more safety indicators seem to be significant for neighbourhood satisfaction. Evaluation of safety issues, such as burglary, drug nuisance and nuisance often perceived as a neighbourhood problem, were significant and decreases satisfaction by 33%, 95% and 149%, respectively. Similarly, the number per thousands of habitants of thefts of car, reports on pickpockets and reports on environmental inconvenience are also significant for neighbourhood satisfaction, with a decrease of 6%, 0,3% and 0,3%, respectively.

Table 36 Regression analysis of safety subjective indicators in post war neighbourhoods.

	Neighbourhood Satisfaction
VARIABLES	Marginal effects
Burglary often occur as a neighbourhood problem	-0.327**
	(0.147)
Violent crimes often occur as a neighbourhood problem	0.532
	(0.532)
Vandalism occurs as a neighbourhood problem	-0.0155
	(0.388)
Drug nuisance is often perceived as a neighbourhood problem	-0.951**
	(0.460)
Nuisance is often perceived as a neighbourhood problem.	-1.494***
	(0.353)
Observations	34

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 37 Regression analysis of safety objective indicators in post war neighbourhoods.

	Neighbourhood Satisfaction
VARIABLES	Marginal effects
Number of thefts on car (per thousand habitants)	0.0164
	(0.0216)
(log) Number of reports on pickpockets (per thousand habitants)	-0.0580***
	(0.0133)
Number of burglaries crimes (per thousand habitants)	0.00111
	(0.00271)
(log) Number of reports on environmental inconvenience (per thousand habitants)	-0.167***
	(0.0381)
Observations	34

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.3.4 Creation of an Index

After determining through inferential analysis the most significant indicators within neighbourhood factors for pre-war and post war neighbourhoods, the next step consisted in generating index that could encapsulate their total effect to investigate the extent of their influence. Subjective and objective assessments were grouped together under the categories established: physical, social and safety.

For this matter, the method of Principal Component Analysis (PCA) was used to compress the data in the format of an index, by estimating parameters of the principal components of the models in each category. The descriptive table with the generated index of physical, social and safety are as follow (table 38 and 39):

Table 38 Index factors in pre-war neighbourhoods.

Variables	Obs	Mean	Std. Deviation	Minimum	Maximum
Physical Index	31	3.36	1.98	-2.96	4.61
Social Index	31	1.18	2.15	-4.95	2.72
Safety Index	31	1.81	1.56	-2.97	3.25

Table 39 Index factors in post war neighbourhoods

Variables	Obs	Mean	Std. Deviation	Minimum	Maximum
Physical Index	34	1.85	1.00	-1.68	2.06
Social Index	34	-1.42	1.00	-1.88	1.28
Safety Index	34	2.00	1.52	-1.57	2.41

4.3.5 Spatial Features of the Urban Built Environment

In order to investigate the spatial features of the urban built environment, a division between two parts was necessary. Firstly, the software Depth Map was used in order to analyse the macro scale measures of space syntax, divided into segment integration analyses with metrical radius and angular choice analysis with metrical radius. The map, containing representation of all main roads, residential streets and highways, was initially converted into an Axial map. Although not used to extract measures, the Axial map was necessary for a further conversion into a Segment map, where all the macro scale values were taken. Second, the software Google Maps was used to extract the micro scale measure of inter-visibility of entrances and windows, which is the only one considered in this thesis research. The degree of inter-visibility between buildings and the street was categorized into a Likert Scale (1-5), mainly taking into consideration the main streets of the neighbourhoods.

1) Macro Scale

The space syntax tool provides values for the entire network structure, as this thesis deal with the scale of the neighbourhood, it was necessary to demarcate each one in order to extract the values separately. This demarcation was done with the help of Google Maps, in which was possible to see the boundaries and network of each neighbourhood.

The measurements extracted for each neighbourhood consisted in two parts: segment integration analyses with metrical radius and angular choice analysis with metrical radius. Each one was calculated with a high metrical radius for a global value (R20) and a low metrical radius for a local value (R02).

Segment integration Analysis:

- Global segment integration with a high metrical radius – refers to how spatially integrated is the neighbourhood (street network) in relation to the city

- Local segment integration with a low metrical radius – refers to how spatially integrated is the neighbourhood (street network) with its surroundings.

Angular choice analysis:

- Angular choice with a high metrical radius – refers to how connected the neighbourhood (street network) is regarding the location of the main routes in the city.

- Angular choice with a low metrical radius – refers to the potential creation of local vital centres inside the neighbourhood.

The division between pre-war and post war neighbourhood continues valid, being exemplified through their descriptive analysis in the tables 40 and 41. In general, pre-war neighbourhoods presents better values for segment integration and angular analysis than post war neighbourhoods.

Table 40 Descriptive segment integration and angular choice analysis for pre-war neighbourhoods.

Variables	Obs	Mean	Std. Deviation	Minimum	Maximum

Global segment integration	31	0.653	0.059	0.501	0.723
Local segment integration	31	0.412	0.140	0.116	0.601
Global angular choice	31	0.009	0.005	0.001	0.021
Local angular choice	31	0.046	0.020	0.009	0.088

Table 41 Descriptive metrical and angular analysis for post war neighbourhoods.

Variables	Obs	Mean	Std. Deviation	Minimum	Maximum
Global segment integration	34	0.573	0.093	0.401	0.768
Local segment integration	34	0.240	0.111	0.092	0.511
Global angular choice	34	0.014	0.040	0.001	0.038
Local angular choice	34	0.024	0.013	0.003	0.055

The maps with segment analysis of integration (figure 15 and figure 16) shows that both pre-war and post war neighbourhoods contain areas with high segment integration. The areas highlighted as the most globally and locally integrated are neighbourhoods which are close or located on the city centre. This integration diminishes significantly in the direction of the periphery, which seems to be quite unconnected from the rest of the city. However, it is important to highlight that not all the neighbourhoods follow this pattern, Katendrecht, for example, is located close to the heart of the city but presents low values for both measures.

If comparing these results to type of neighbourhoods, it is highlighted that high measures of segment integration come from neighbourhoods' correspondents to type 1 and 2, which are functionally mixed districts and compact city districts, respectively. In turn, the least integrated neighbourhoods are correspondents to type 4 and 5, which are green suburbs and old villages, respectively. In general, pre-war urban areas seem to have higher measures of segment integration than post wars ones. The analysis shows that green neighbourhood's exhibit larger open spaces (e.g parks and green belts), but less street networks. The post war neighbourhoods which have high values of segment integration on their street network are in the city centre of Rotterdam, which the street pattern was retained after the bombing. This means that only the buildings are new constructions, which contributes to lower values on the micro scale level, as there are a lot of blind walls etc.

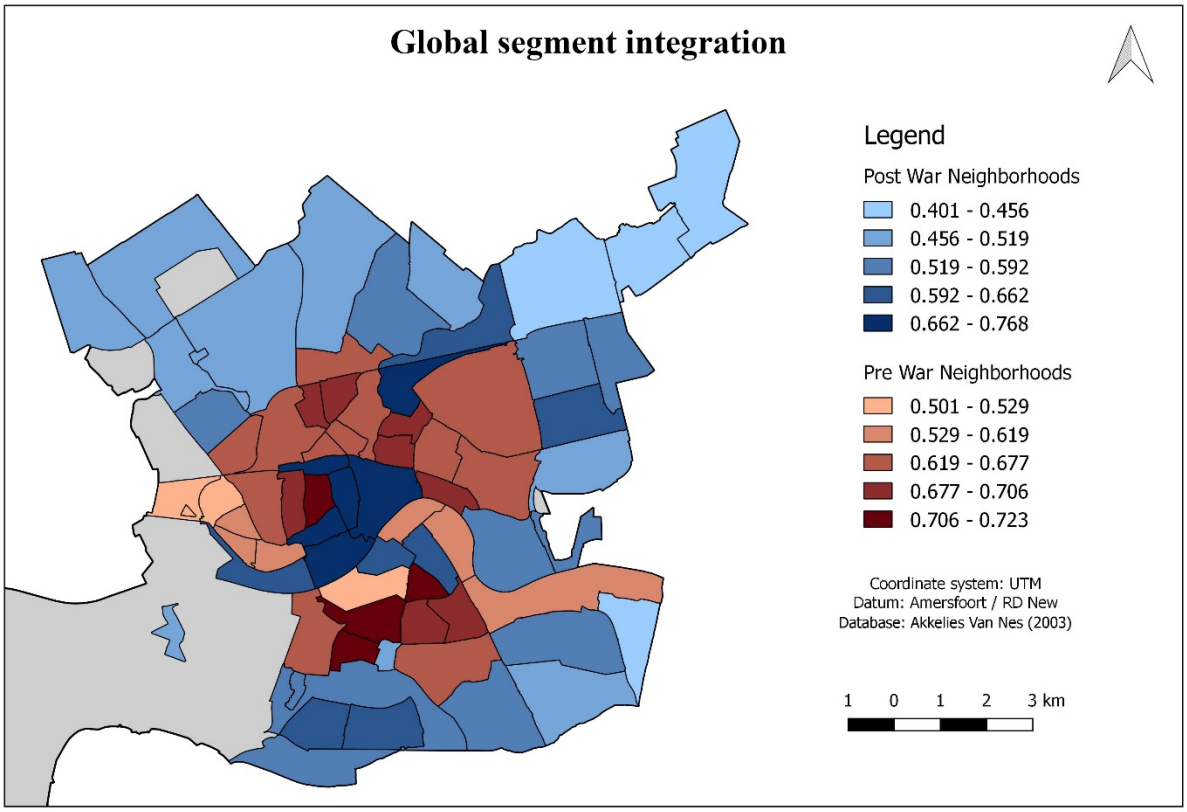


Figure 15 Global segment integration of metrical analysis (R20) of the study area. Own map.

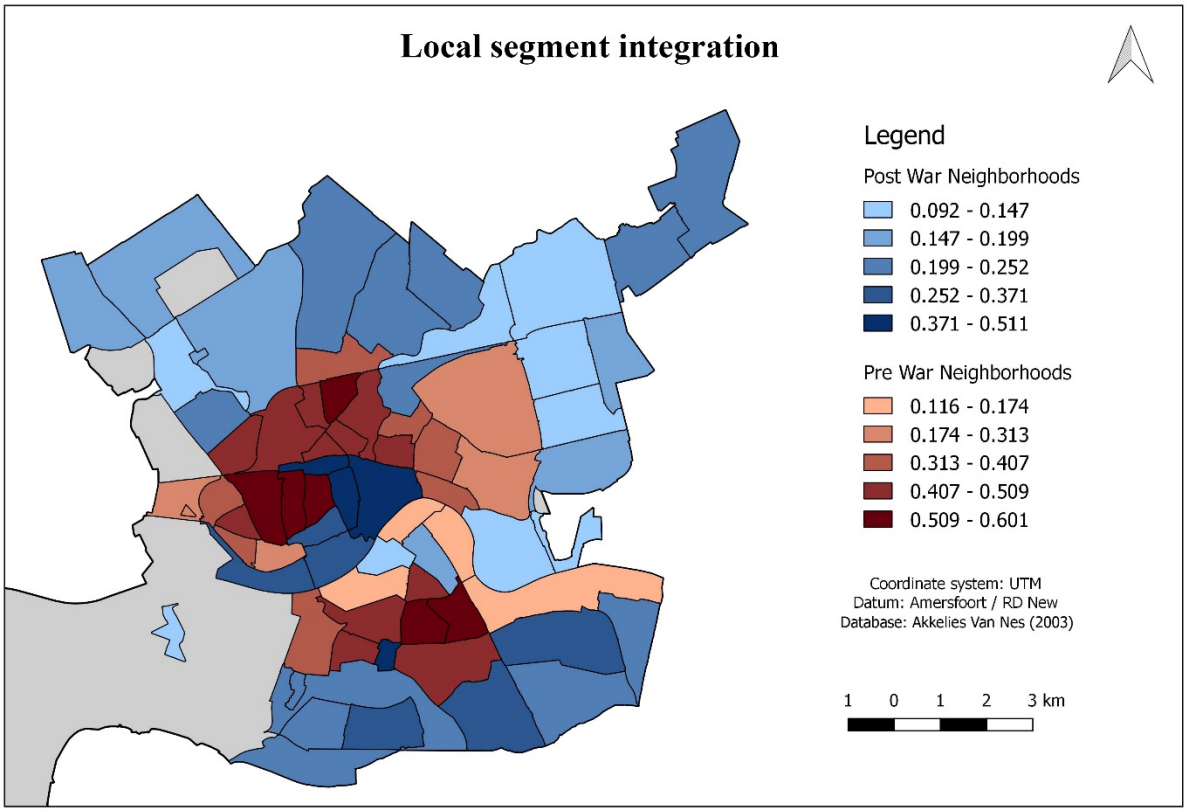


Figure 16 Local segment integration of metrical analysis (R2) of the study area. Own map.

The distribution of angular choice analysis (figure 17 and 18) provides a similar explanation with what has been stated about network integration, as the areas close to the city centre also seen to be more integrated than the edges of the city both locally and globally, with a few exceptions. The map highlight neighborhoods such as Katrendecht, Afrikaanderwijk and Kop van Zuid, to be highly integrated, which means that their main routes are well connected in relation to the rest of the city and that they are likely to be passed in a trip. However, when it comes to the local angular choice analysis, which refers to the potential of local city centers inside the neighborhood, Katrendecht and Kop van Zuid shows lower values. Surprisingly, a few post war neighborhoods located close to the periphery presents higher values for local angular choice analysis, hence their potential for vital local centers are high.

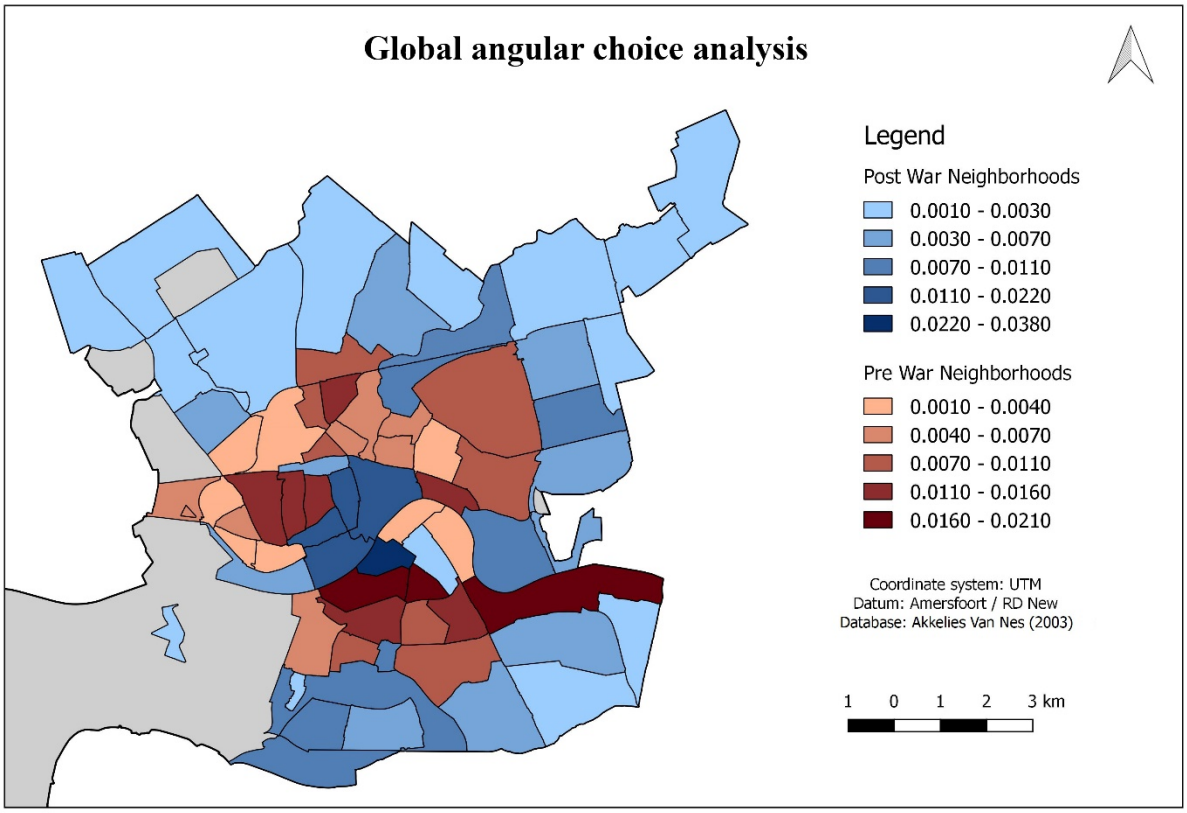


Figure 17 Global angular choice with high metrical radius of the study area. Own map.

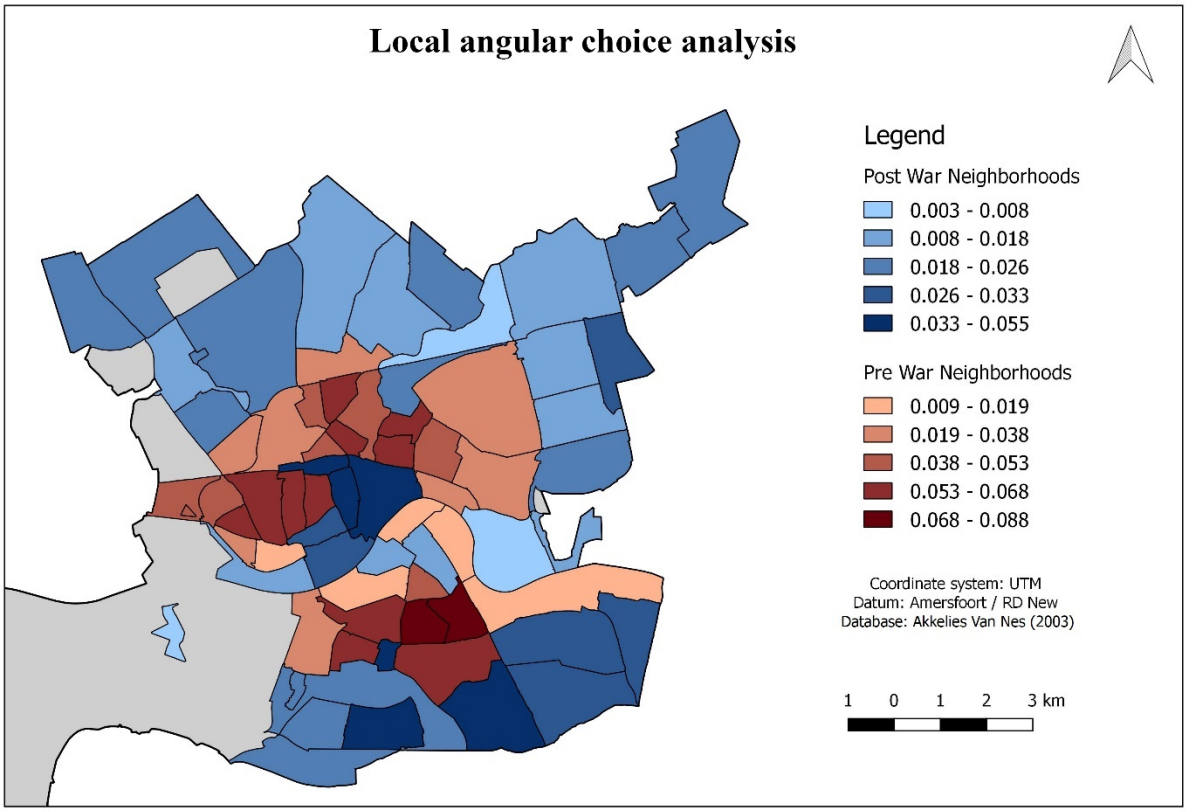


Figure 18 Local angular choice with low metrical radius of the study area. Own map

2) Micro Scale

The degree of inter-visibility of windows and entrances in the ground floor between the buildings and street was categorized in a Likert Scale, in which (1) is very high, (2) high, (3) medium (4) low and (5) very low. The analysis divided pre-war and post war neighborhoods which can be visualized in the map below (figure 19).

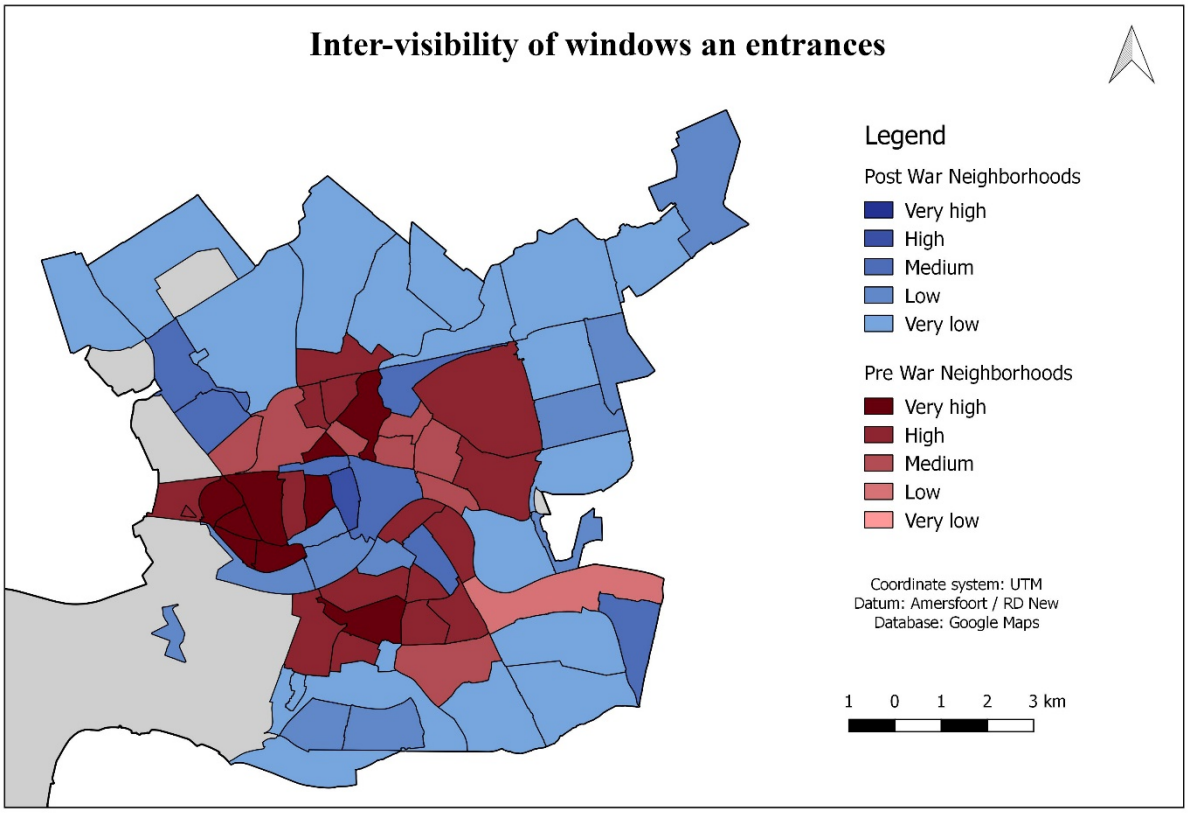


Figure 19 Inter-visibility of doors and entrances in pre-war and post war neighbourhoods. Own map

Through the map, it was clear that pre-war neighborhoods have a higher degree of inter-visibility than post war neighborhoods. Pre-war neighborhoods usually have buildings facing each other and closer to the street than post war neighborhoods. In addition, the latter one usually shows facades with hedges and walls, creating blockages in the view. Some examples of the final categorization among can be seen in the pictures below (figure 20).

Figure 20 Street with high degree of inter-visibility (Hillesluis) x street with low degree of inter-visibility (Pendrecht).

4.4 Empirical Results

This section presents the empirical results achieved for both neighbourhood factors and spatial features of the built environment.

4.4.1 Neighborhood Factors and Spatial features

Before pursuing the statistical analysis, some tests were performed to check the data distribution and the chances of collinearity. In this sense, the data of global angular choice analysis in post war neighborhoods was detected with skewed distribution, hence a log transformation was applied. Moreover, the VIF test showed that the measure of local segment integration was highly colinear with the rest, therefore it was necessary to dispose it to minimize errors in the statistical analysis.

The regressions above shows the inferential analysis between the indexes created (physical, social and safety) and spatial features.

1) Physical Index

The regression analysis (table 42) in pre-war neighbourhoods shows that the angular measures of space syntax are associated with the physical index. The potential of creation of local vital centres (local angular choice) and through movement (global angular choice) positively affect physical factors by a coefficient of 33.26 and 55.85 units. As for post war neighbourhoods, the potential through movement shows a positive association by a coefficient of 0.80 units.

Table 42 Regression between the physical index and spatial features

	Pre-War Neighbourhoods		Post War Neighbourhoods
VARIABLES	Physical Index	VARIABLES	Physical Index
Angular Local	33.26***	Angular Local	-32.54
	(8.559)		(23.72)
Angular Global	55.89**	Angular Global (log)	0.807*
	(26.31)		(0.397)
Integration Global	1.363	Integration Global	-4.858
	(2.980)		(5.426)
Inter-visibility	0.250	Inter-visibility	0.0401
	(0.175)		(0.396)
Constant	-0.363	Constant	7.586
	(1.679)		(5.660)
Observations	31	Observations	34
R-squared	0.512	R-squared	0.231

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

2) Social Index

Both pre-war and post-war urban areas shows a relation between the local angular choice analysis and the social index. In pre-war neighborhoods there is a positive impact by a coefficient of 23.61 units while in post war neighborhood there is a positive effect by a coefficient of 28.63 units. Moreover, the inter-visibility of windows and entrances in pre-war neighborhoods has a positive effect in the safety index by a coefficient of 0.41 units (table 43).

Table 43 Regression between the social index and spatial features.

	Pre-War Neighbourhoods		Post-War Neighbourhoods
VARIABLES	Social Index	VARIABLES	Social Index
Angular Local	23.61**	Angular Local	28.63**
	(9.990)		(13.57)
Angular Global	-15.00	Angular Global (log)	0.124
	(30.71)		(0.227)
Integration Global	-4.668	Integration Global	2.108
	(3.478)		(3.105)
Inter-visibility	0.411*	Inter-visibility	-0.0773
	(0.204)		(0.227)
Constant	2.910	Constant	0.459
	(1.960)		(3.239)
Observations	31	Observations	34
R-squared	0.335	R-squared	0.195

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

3) Safety Index

Similarly, with social index, both pre-war and post war neighborhoods show an association between the safety index and the local angular choice analysis. This relation is positively affected by a coefficient of 32.43 and 44.33 units, for pre-war and post-war urban areas respectively. In addition, the degree of inter-visibility in pre-war neighborhoods also positively affected by the safety index by a coefficient of 0.63 units (table 44).

Table 44 Regression between the safety index and spatial features.

	Pre-War Neighbourhoods		Post War Neighbourhoods
VARIABLES	Safety Index	VARIABLES	Safety Index
Angular Local	32.43**	Angular Local	44.33***
	(15.38)		(10.48)
Angular Global	-64.91	Angular Global (log)	-0.0227
	(47.29)		(0.178)
Integration Global	0.625	Integration Global	3.283
	(5.356)		(2.348)
Inter-visibility	0.632*	Inter-visibility	-0.0310
	(0.315)		(0.173)
Constant	-0.0480	Constant	-3.003
	(3.018)		(2.474)
Observations	31	Observations	30
R-squared	0.355	R-squared	0.591

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.4.2 Spatial Features of the urban built environment

This section presents an analysis of the least satisfied and most satisfied neighborhoods in each category. Each one is examined and compared concerning selected spatial features: local and global segment integration with the use of space syntax, as analysed to and through-movement and inter-visibility of entrances at ground level.

In relation to post war neighborhoods, the second least satisfied (Zuidwijk) and the second most satisfied (Molenlaankwartier) were considered for analysis, as both would give a better panorama of the reality, rather than the least and the most satisfied (Heijplaat and CS Kwartier respectively). Heijplaat is a neighborhood "peninsula" among the harbor and industry while CS Kwartier is almost entirely composed by the central station.

Tarwewijk

Tarwewijk is a pre-war district with a great young population. It is a residential neighborhood with a total population of 12.200 inhabitants. It is a multicultural neighborhood with almost 80% of its inhabitants being non-natives. The shops are mainly located at the edges of the neighborhood, mainly at Dordtselaan, Pleinweg and Hellevoetstraat streets. The business is mainly located at mixed use buildings, with residences on the top floor.

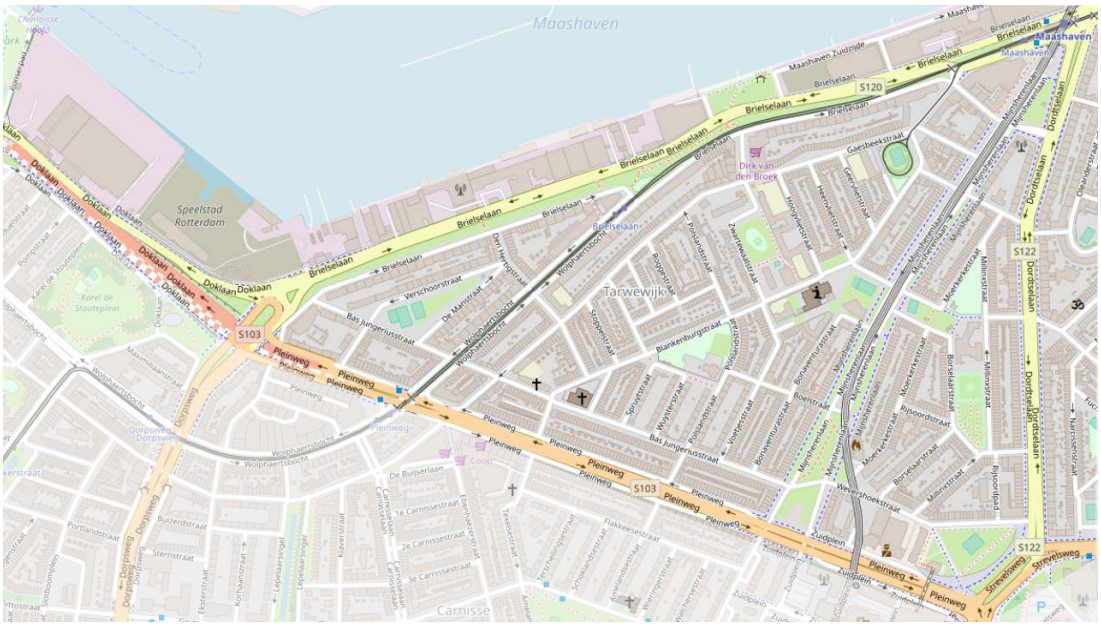


Figure 21 Map of Tarwewijk. Source: Open Street Maps,2018.

The following pictures (figure 22) presents the local (left) and global (right) segment integration analysis as well as, and the local (left) and global (right) angular choice analysis, red and yellow shades indicate higher integration, while greens and blues shades point out less integration. More integration means easily accessible routes while less integration can be interpreted as higher segregation or complicated paths.

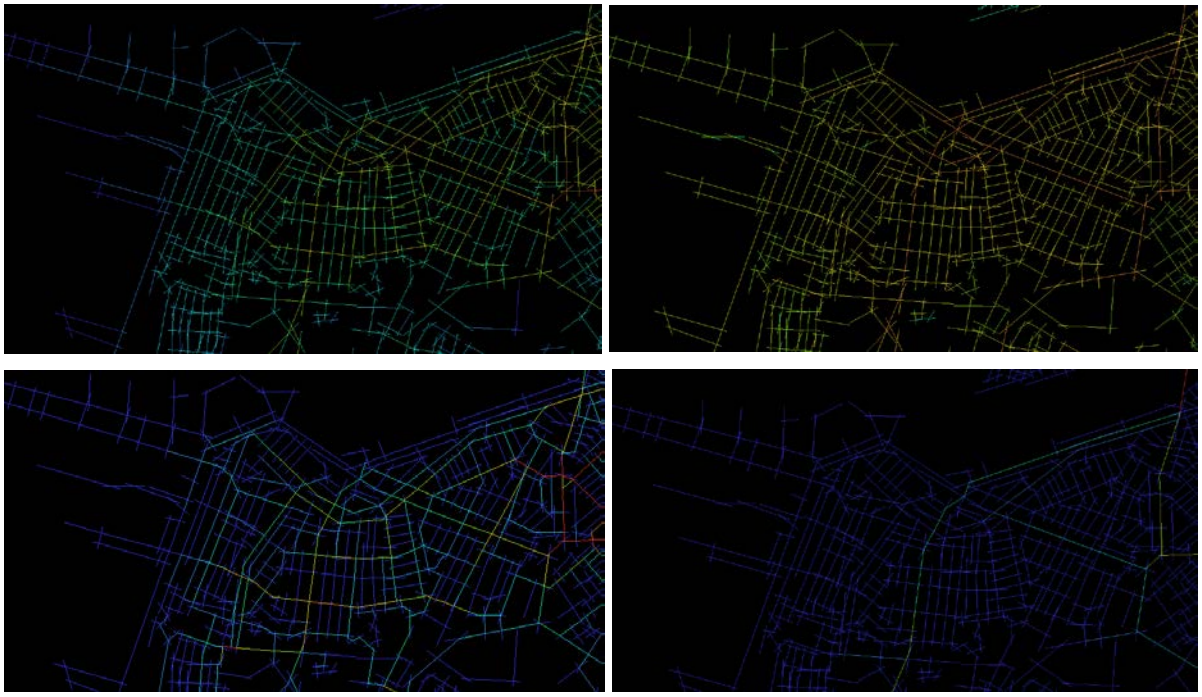


Figure 22 Top showing local (left) and global (right) segment integration analysis of metrical distance and bottom showing local angular choice with metrical radius analysis (r02, left) and global angular choice with metrical radius (R20, right) in Tarwewijk.

The space syntax analysis shows that mentioned streets with commercial activities are some of the more locally and globally integrated in the neighbourhood. The residential areas of the neighbourhoods are the less integrated, mainly when it comes to the global integration. In the angular analyses with a high metrical radius, the main routes are located around the neighbourhood and associated with through movement, leading towards other surrounding neighbourhoods. In the angular analyses with a low metrical radius, the local shopping streets are highlighted.

The images (figure 23) below show a micro scale relation between buildings and streets in Tarwewijk. The inter-visibility of windows and entrances are generally high both in main streets and residential areas, with high density of entrances and short distances between the building and the streets.

Figure 23 High inter-visibility of windows and entrances in Tarwewijk.

Kralingen Oost/Bos

Kralingen Oost is a characteristic residential neighbourhood with a historic appearance and is known for its green living environment, including the presence of the Kralingen Bos. Large part of the neighbourhood area is a protected cityscape. The neighbourhood currently has approximately 8,100 inhabitants, mainly consisted by native residents. There is a large number of students living in the area due to the presence of the educational institutions and the area is well served of facilities and commercial activities in general. The main commercial activities are distributed along Oudedijk/S-Gravenweg, Lusthofstraat, Oostzeedijk and Avenue Concordia.

Figure 24 Map of Kralingen Oost. Source: Open Street Maps, 2018.

The space syntax analysis (figure 25) shows that the streets with main commercial activities are some of the most locally integrated streets as well as usually the attractors of movement and where the shops would naturally locate. As in Tarwewijk, in the angular analyses with a high metrical radius, the main routes are in the edge of the neighbourhood, leading to other neighbourhoods. In this context, the roads A16 and E19 are highlighted as the most global integrated streets and associated with through movement.

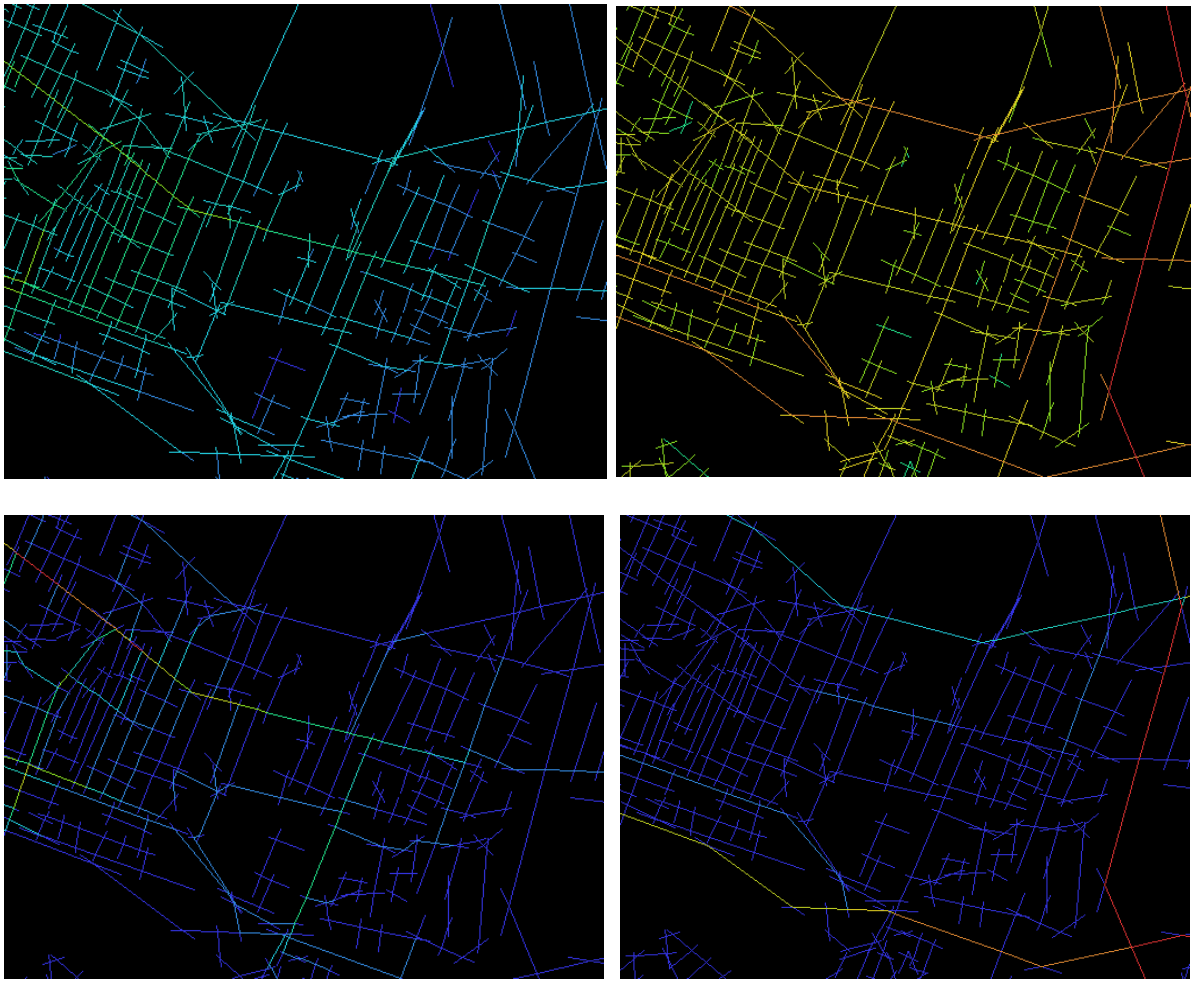


Figure 25 Top showing local (left) and global (right) segment integration analysis of metrical distance and bottom showing local angular choice with metrical radius analysis (r02, left) and global angular choice with metrical radius (R20, right) in Kralingen Oost.

Most of the streets in Kralingen Oost either presents a high density of entrances or are narrow, ensuring a good inter-visibility. The exception is on Kralingse Bos and a few stretches of S-Gravenweg streets, where there is either a large presence of green, the park, canals and wide streets acting as boundaries (figure 26).

Figure 26 High inter-visibility of windows and entrances in Kralingen Oost/Bos x low inter-visibility of windows entrances at Kralinge Bos and a stretch of S-Gravenweg streets.

Zuidwijk

Zuidwijk is a post war urban area built in the fifties at high speed to supply the major shortage of living space in Rotterdam after the II WW. In the 1990's, the neighbourhood was further restructured with demolition and new construction in some areas. The neighbourhood has approximately 12.000 inhabitants with a uniform population composition, in which the number of young and old people are balanced. The neighbourhood is characterized for its spacious layout, greenery, good public transport and excellent facilities, including shops. Most stores are located on the Slinge street.

Figure 27 Map of Zuidwijk. Source: Open Street Maps, 2018.

Considering the space syntax analysis (figure 28), the streets Slinge, Meyenhage and Langenhorst appear as locally-integrated streets, also where the main shops in the neighbourhood are located and attractors of movement. In addition, the street Schere also appear to be locally integrated when considering the local angular analysis. The residential areas of the neighbourhoods are the less integrated, mainly when it comes to the global segment integration. Moreover, the global analyses indicate that Slinge, Meyenhage and a few of the

streets surrounding the neighbourhood are the most globally integrated and the attractors of through-movement in the area. In addition, these streets also lead towards to other surrounding neighbourhoods.

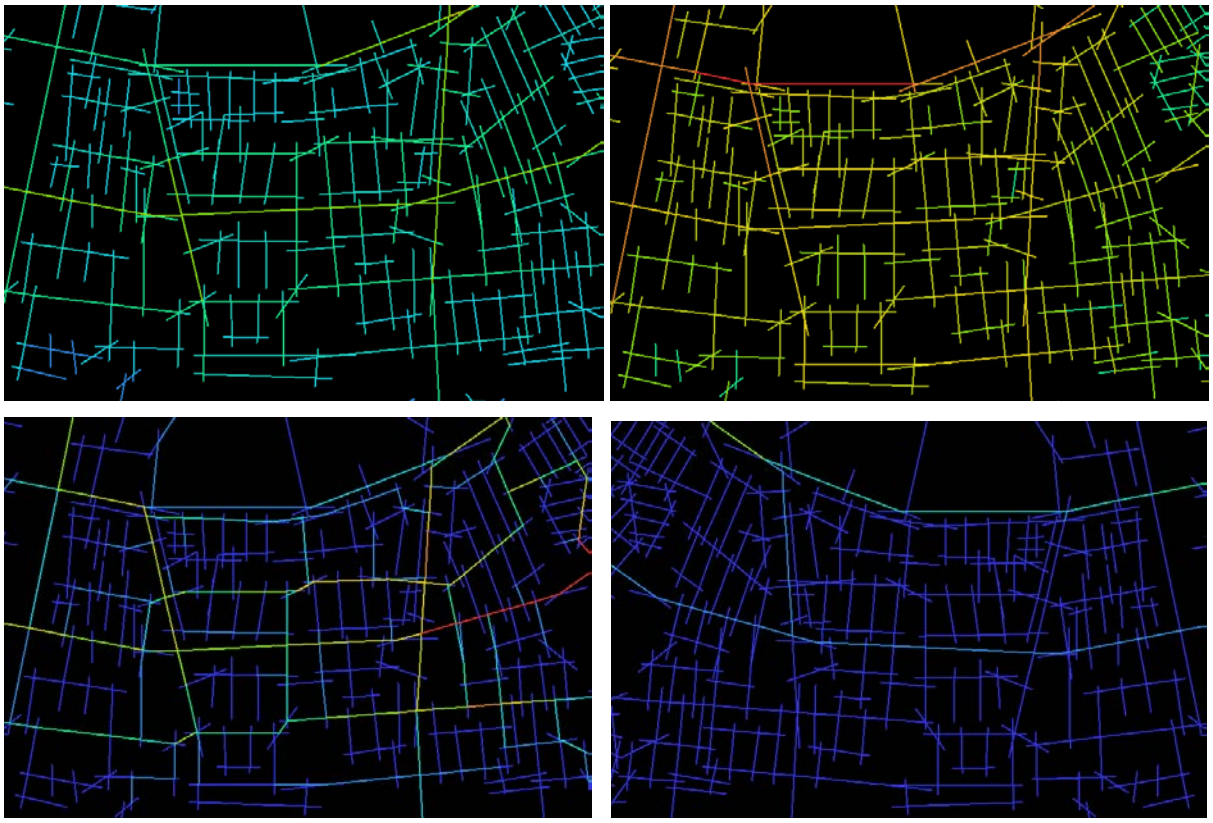


Figure 28 Top showing local (left) and global (right) segment integration analysis of metrical distance and bottom showing local angular choice with metrical radius analysis (r02, left) and global angular choice with metrical radius (R20, right) in Zuidwijk.

As can be drawn from the pictures below (figure 29), the inter-visibility in the neighbourhood is reduced in most streets. Although some of the streets have high density of entrances, they are constituted by garage doors. In addition, others have basement with hedges creating a blockage in the view between the building and the street. In addition, large distances between buildings or building faces different directions also accounts for a low inter-visibility in Zuidwijk.

Figure 29 Poor inter-visibility of windows and entrances in Zuidwijk.

Molenlaankwartier

Molenlaankwartier counts with a population of around 8.000 inhabitants and it is considered a "garden city", mainly consisted by post-war single-family houses and lots of greenery. Differently from Tarwewijk and Kralingen, which mostly follow the traditional pattern with building entrances facing the street, Molenlaankwartier has many of its buildings facing hedges and pedestrian walks, far from the streets itself. The neighbourhood does not have many commercial activities, being mainly concentrated at Van Beethovensingel street.

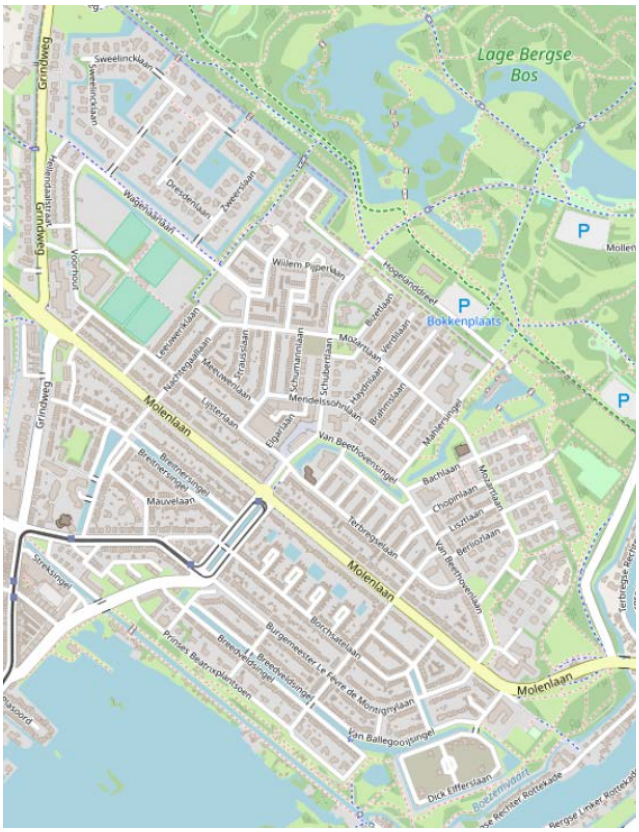


Figure 30 Map of Molenlaankwartier. Source: Open Street Maps, 2018.

In general, the space syntax analysis (figure 31) shows that Molenlaankwartier is very segregated and relatively disconnected to its surrounding neighbourhoods as well as the main route net from Rotterdam. The main street Molenlaan, the street with commercial activity Van Beethovensingel and Nachtegaallaan are slightly highlighted in the angular coice analyses with a low metrical radius, however, there is no formation of a solid vital centre inside the neighbourhood. Globally, the main street Molenlaan is slightly highlighted along with a few streets surrounding the neighbourhood.

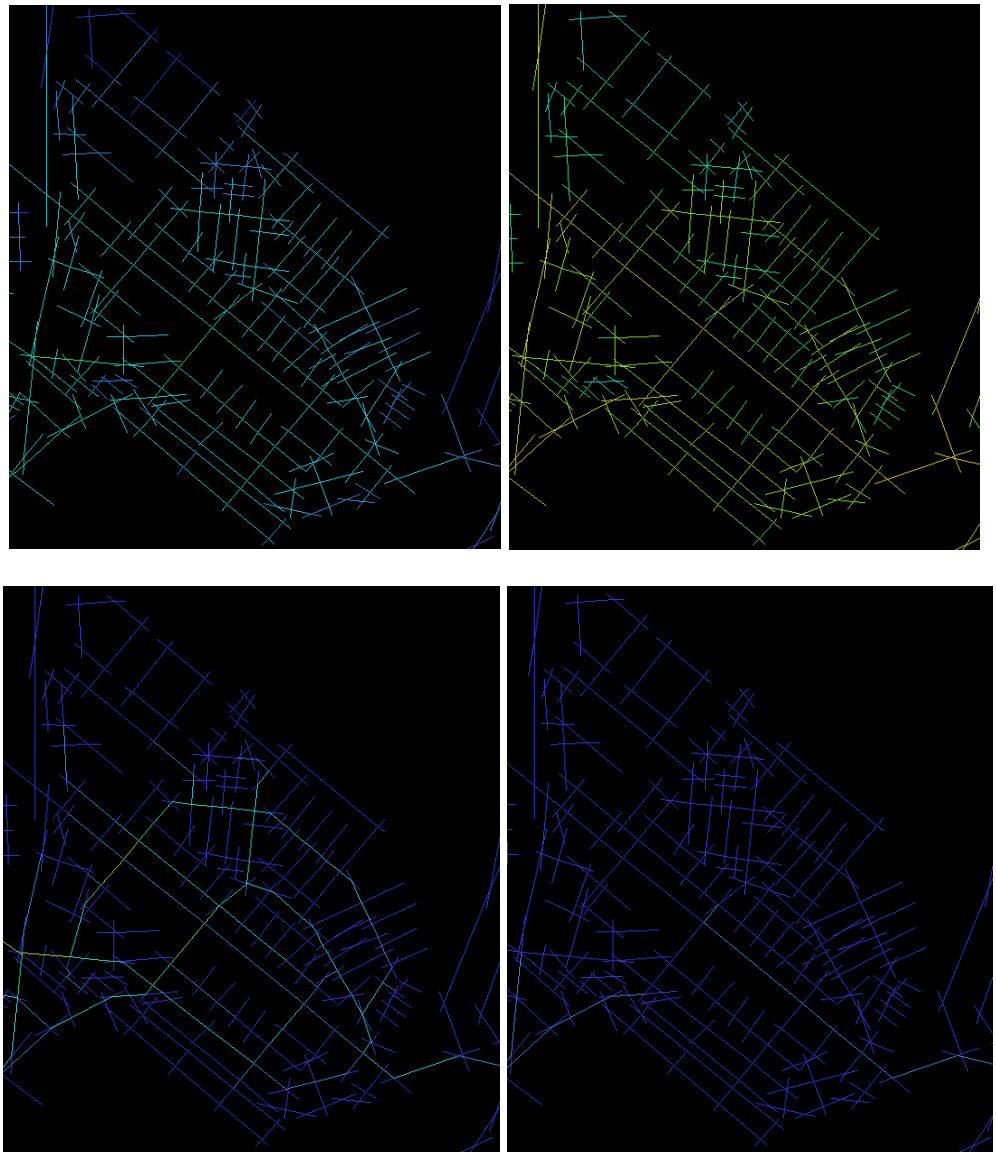


Figure 31 Top showing local (left) and global (right) segment integration analysis of metrical distance and bottom showing local angular choice with metrical radius analysis (r02, left) and global angular choice with metrical radius (R20, right) in Molelaankwartier.

The degree of inter-visibility between buildings and streets in Molelaankwartier are mostly reduced. Although there is usually high density of entrances in the buildings, the area consists mostly of houses having their facades covered by hedges. In addition, in some streets the distance between the building and streets are relatively far, with the presence of pedestrian walks in the middle. Furthermore, a few buildings face canals and green areas, which act as boundaries (figure 32). All these streets usually lack active functions, such as commercial activities, on the ground floor. The street with commercial activity, Van Beethovensingel, also present lawns and pedestrian walks making the buildings further to the street.

Figure 32 Poor inter-visibility of windows and entrances in Molenlaankwartier.

Lastly, the table below (table 45) shows all the space syntax values achieved for the four neighborhoods studied. It gives a good panorama in numbers and proves what has been said in relation to the level of integration and potential movement for each neighborhood,

Table 45 Metrical and angular values for four neighbourhoods.

Variables	Tarwewijk	Kralingen Oost/Bos	Zuidwijk	Molenlaankwartier
Global Integration	0.721	0.661	0.654	0.519
Local Integration	0.509	0.272	0.371	0.234
Global Angular	0.013	0.011	0.005	0.003
Local Angular	0.057	0.025	0.044	0.023

Chapter 5: Conclusions and recommendations

5.1 Research results

5.1.1 What are the indicators of physical, social and safety factors that significantly influence satisfaction in pre-war and post war neighborhoods?

The indicators that significantly influences neighborhood satisfaction in pre-war and post war neighborhoods can be seen in the table below (table 46). In some cases, there is a space in blank within the table because the amount and type of indicators that influence satisfaction are different in each kind.

Table 46 Significant indicators of all neighbourhood factors for pre-war and post war neighbourhoods.

Pre-War Neighborhoods	Post War Neighborhoods
PHYSICAL (subjective and objective)	
% of households satisfied with the range of facilities together. ***	% of households satisfied with the range of facilities together. ***
% of household find buildings in the neighbourhood attractive. ***	% of household find buildings in the neighbourhood attractive. **
% of households satisfied with the current home. ***	% of households satisfied with the current home. ***
% dwellings with facilities within standard distance. ***	% of households indicating that green spaces are sufficiently available. *
% of households that finds the state of maintenance of buildings in the neighbourhood good. ***	% dwellings with facilities within standard distance. -*
% of housing with overcrowding. -***	% of households that finds the state of maintenance of buildings in the neighbourhood good. ***
	% of housing with overcrowding. -*
	% dwellings with underground stops within standard distance. *
SOCIAL (subjective and objective)	
% of residents who likes their own neighbourhood. ***	% of residents who likes their own neighbourhood. ***
% of residents who says they have no problems with locals. *	% of residents who says they have no problems with locals. **
% of residents who says that locals help each other. **	% of residents who feels connected to neighbourhood. *
% residents which says that the relationship between ethnic groups in the neighbourhood is good. -***	% of households with low income. -***
% residents that says that are enough places for joint activities in the neighbourhood. ***	% of residents who are considered “non-native. -*
% of residents that participate in cultural activities in the neighbourhood monthly. **	
% of households with low income. -***	
% of residents who are considered “non-native”. -*	
SAFETY (subjective and objective)	
Nuisance is often perceived as a neighbourhood problem. ***	Nuisance perceived as a neighbourhood problem. -**

Violent crimes often occur as a neighbourhood problem. -**	Burglary often occur as a neighbourhood problem. -**
Number of thefts on bike. ***	Drug nuisance perceived as a neighbourhood problem. -***
Number of reports on environmental inconvenience. -***	(log) Number of reports on pickpockets. -***
	(log) Number of reports on environmental inconvenience. -***

*** p<0.01, ** p<0.05, * p<0.1

It can be dram from the analysis that a great part of the indicators which are significant in pre-war neighborhoods are also significant on post war, sometimes with different intensities. Overall, this indicates similarities between those two types of neighborhood in relation to be satisfied with the neighborhood, and hence with life. For example, satisfaction with own home and finding buildings attractive was proven to be very significant on the two circumstances as well as the percentages of houses with overcrowding and the state of maintenance buildings. This indicates that the situation of the dwellings is very important when assessing satisfaction, especially when you consider a city such Rotterdam which the demand for housing is quite challenging. Some indicators were pretty expected to influence satisfaction, such as the fact of liking in their own neighborhood and the percentage of households with low income. The latter one indicates that both kinds of neighborhoods present different average income levels. In addition, it seems that both cases contain neighborhoods which are are not good at integrating people from different ethnicities. This might cause spatial segregation which contributes to social segregation.

Other examples highlight the difference between satisfaction in pre-war and post war neighborhoods. Dwellings with facilities within standard distance influences positively neighborhood satisfaction in pre-war urban areas while in post war influences negatively. An explanation for that might be due that generally post-war neighborhoods prefer quiet urban environments, close to the nature and far from commercial activities, among others. This is highlighted even more by the significance of green areas to post war neighborhoods. Moreover, pre-war neighborhood indicates that having enough places for joint activities and participating in cultural activities are important to satisfaction. In relation to safety, the number of bike thefts was significant to pre-war neighborhoods while the report on pickpockets was significant on post war neighborhoods. While it is true that bike theft is a common occurrence for all Rotterdam, thefts such as pickpocketing's might occur more when there are no "eyes in the street". This situation usually occurs with post war neighborhoods as there is a low inter-visibility from the buildings to the street.

Both subjective and objective assessments of indicators from the neighborhood factors studied seen to be important to measure satisfaction. However, it was highlighted that for both kinds of neighborhoods, subjective indicators have generally a greater impression on satisfaction than objectives, as it was previously assumed by the literature review.

5.1.2 What are the spatial features of the built environment of the least and most satisfied pre-war and post war neighborhoods?

The examination of the neighborhoods: Tarwewijk, Zuidwijk, Kralingen Oost and Molelankwartier regarding their spatial features identify the first two as residential areas with a stronger commercial activity while the last two follows the pattern of traditional residential

neighborhoods. In addition, the first two can be characterized as multicultural neighborhoods, with a large population composed by non-natives whereas the last two are predominantly natives.

In general, the space syntax analyses indicate a good correlation among a high value of local segment integration and to-movement (local angular choice), considering the important shopping streets in the neighborhood. Similarly, high global segment integration and through-movement (global angular choice) were also a positive predictor of main routes. This agrees with past studies by Hillier, López and van Nes. In this context, Tarwewijk and Zuidwijk are the most integrated and main attractors of movement in a local radius, highlighting it potential to host local vital centers and its good connection within the neighborhood. Concurrently, Tarwewijk and Kralingen Oost are the most integrated neighborhoods in relation to the city and a good predictor of movement in a global scale. This means that their street networks are likely to be passed when making trips in the city, highlighting the potential for a route. Finally, Molelaankwartier was the neighborhood with poorest space syntax values for all categories, which implies that it presents segregated street networks from the rest of the city and does not show a potential neither for "to and through movement" (see table 42).

Furthermore, the four neighborhoods present mostly high density of entrances, however not all of them shows a high inter-visibility of entrances. The pre-war neighborhoods, Tarwewijk and Kralingen Oos shows high values of inter-visibility, while Zuidwijk and Molelaankwartier presents low values.

5.1.3 How does selected spatial features of the urban built environment influences neighborhood factors?

From the observed analysis between neighborhood factors and spatial features in pre-war and post war neighborhoods, the specifically measure of angular analysis in a local radius is seen to significantly influence all the indexes, except for the physical index in post war urban areas. As local angular analysis refers to the potential of "to movement" inside the neighborhood and the presence of local vital centers, it is no surprise that it instigates a positive association with physical, social and safety factors. In this context, the literature establishes that the presence of people in the neighborhood added to commercial activities enhances the perception of safety, stimulates social interactions in the urban environment and value the condition of dwellings in the neighborhood, among others. The global angular analysis was seen to be associated with physical factors in both cases. This result assumes that the positive potential of "though movement" have an association with the street network as well as the presence of facilities, accessible public transport and overall condition of dwellings/ buildings in the neighborhood.

Surprisingly, the inter-visibility of windows and entrances were positively associated with social and safety factors only in pre-war neighborhoods. There is a large body of literature which approaches the concept "eyes to the street" as facilitators of social interaction and bonding within the neighborhood as well as it enhances the feeling of safety and even prevents, to an extent certain, crime to happens. This happens because more people can naturally see the movement of the street, creating living places. This association, however, it is not seen in post war neighborhoods, which might imply that its degree of inter-visibility was not enough to make any association.

Finally, it is important to highlight that these results are a general estimation of specifically indicators composing each index. This, added to the method of forming the index itself, might

differ to an extent with other research's results which relates spatial features to social and safety aspects.

5.1.4 To what extent does neighborhood factors (physical, social and safety) and spatial features' impact on neighborhood satisfaction in pre and post war neighborhoods in Rotterdam, The Netherlands?

Previous literature review assert neighborhood factors (physical, social and safety) to act as determinants predictors of satisfaction in the neighborhood scale (see table 47). In relation to pre-war neighborhoods, all factors studied have a strong association with neighborhood satisfaction. However, it is important to state that the intensity and the relationship between the independent and dependent variables vary. Physical factors, which represents housing situation and perception/access to facilities, services and public transport, positively increases neighbourhood satisfaction by 4% points. Social factors, which represent measures of interaction, bonding and personal situation, were seen to surprisingly influence satisfaction negatively. This, however, can be explained by some of the individual indicators (and its intensity) which compose the index. In this context, households with low income and non-native residents and are perceived to enforce a negative statistical effect, hence generating a decrease in satisfaction by 2% points. Finally, safety factors, which approach the perception and reports on crimes, were seen to provoke a negative association with neighbourhood satisfaction, decreasing it by around 3% points. This can also be explained by the indicators which compose the index.

As to post war neighborhoods, only social and safety factors statistically influences on satisfaction, with social factors presenting a higher significance. In this context, social factors instigate a positive influence with an increase of 7% points in neighborhood satisfaction. Differently from pre-war neighborhoods, the social index in post war neighborhoods may have a positive impact due to the intensity of significant individual indicators acting upon it. This might mean that liking their own neighborhood and having no problem with residents, for example, reinforces a positive statistical relationship. As expected, safety factors also provoke a negative association with neighbourhood satisfaction, decreasing it by almost 2% points. However, it is highlighted that the safety index impact on satisfaction does not provide a strong significance if compared to all others, as its significance lies within the 90% confidence interval. It is interesting to note that the control variable of average income had a great impact in post war neighbourhoods, but not in pre-war neighbourhoods.

Finally, it is important to state that the quantifiable amount in which satisfaction is increased or decreases (the value of the coefficient), may have been influenced by how the index were generated, in this case using the PCA method, which compacted its measures.

Table 47 Influence of physical, social and safety index in neighbourhood satisfaction.

Pre-War Neighbourhoods	Neighbourhood Satisfaction	Post War Neighbourhoods	Neighbourhood Satisfaction
VARIABLES	Marginal effects	VARIABLES	Marginal effects
Safety Index	-0.0338**	Safety Index	-0.0167*
	(0.0144)		(0.00926)
Social Index	-0.0212***	Social Index	0.0714***
	(0.00801)		(0.0136)
Physical Index	0.0408**	Physical Index	0.000174

	(0.0190)		(0.0164)
Average Income (log)	0.0684	Average Income (log)	0.171***
	(0.125)		(0.0655)
Observations	31	Observations	34

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Regarding spatial features of the urban environment, in pre-war neighbourhoods' local angular choice analysis and inter-visibility of windows and entrances shows a statistical association with neighbourhood satisfaction. The first one cause a positive relationship with the dependent variable by 47% points while inter-visibility has a positive impact on neighbourhood satisfaction with an increase of 3%. This means that the potential of local vital centres and the degree of inter-visibility from the building to street assess satisfaction positively, as they enhance the presence of facilities (including commercial activities), people on the streets and the feeling of safety.

In relation to post war neighbourhoods, only global segment integration shows an association with neighbourhood satisfaction, with an increase of 33%. This might imply that the more globally integrated post war urban areas are (as they are usually less integrated than pre-war neighbourhoods) more satisfied they will be with the neighbourhood.

Finally, it can be drawn that the average income in both kind of neighbourhoods are very significant to neighbourhood satisfaction. Taking into consideration its confidence interval, this may imply that this social characteristic reflects satisfaction even more than spatial features.

Table 48 The influence of spatial features in neighbourhood satisfaction.

Pre-War Neighbourhoods	Neighbourhood Satisfaction	Post War Neighbourhoods	Neighbourhood Satisfaction
VARIABLES	Marginal effects	VARIABLES	Marginal effects
Angular Local	0.4745**	Angular Local	0.0341
	(1.635)		(0.900)
Angular Global	0.0215	Angular Global	-0.357
	(2.259)		(0.414)
Integration Global	-0.380	Integration Global	0.330**
	(0.308)		(0.165)
Inter-visibility	0.0330*	Inter-visibility	0.00517
	(0.0172)		(0.0146)
Average Income (log)	0.525***	Average Income (log)	0.419***
	(0.0963)		(0.0552)
Observations	31	Observations	34

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.2 Recommendations for further research

This research can be configured mainly as a quantitative analysis of the relation of neighborhood factors (physical, social and safety) with neighborhood satisfaction as well as preliminary attempt to understand the relation of satisfaction with spatial features.

Further research should go beyond the statistical part and seek to discover why exact indicators influences differently satisfaction in pre-war and post war neighborhoods. This will allow to give an insight why the extension of neighborhood factors impacting on satisfaction are also different. This might be achieved by choosing to do a study case with qualitative analysis. The qualitative analysis should come from interviews collected from locals' residents, for example. This would bring altogether a different perspective as well as provide depth to the analysis.

Regarding the relation between spatial features and neighborhood satisfaction, it is recommended that all micro scale characteristics should be used in order to provide new insights of those characteristics. In addition, the researcher should try to get data of satisfaction at the street scale. This would make the correlation with macro and micro scales more specific and coherent to it measures, which are the scope of the street.

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Annex 1: Cronbach's Alpha and Correlation Analysis

Cronbach's Alpha (Pre-war Neighborhoods)

Indicators Selected:

- "% of households satisfied with quality street lighting
- % of households satisfied with maintenance of cycle paths
- % of households satisfied with maintenance of pavements
- % of households satisfied with safety of pavements
- % of households satisfied with safety of sidewalks"

Scale reliability coefficient: 0.8993

New aggregate indicator: "% of households (very) satisfied with neighbourhood services"

Indicators Selected:

- "% of houses with baker within standard distance
- % of houses with butcher within standard distance
- % of houses with greengrocer within standard distance
- % of houses with sports hall within standard distance
- % of houses with pharmacy within standard distance
- % of houses with general practice within standard distance
- % of houses with playground within standard distance
- % of houses with schools within standard distance."

Scale reliability coefficient: 0.8615

New aggregate indicator:"% of dwellings with facilities within standard distance"

Indicators Selected:

- "Threatening often occurs as a neighborhood problem
- Violent offenses often occur as a neighborhood problem
- Robbery with violence often occurs as a neighborhood problem"

Scale reliability coefficient: 0.9218

New aggregate indicator: Violent crimes often occur as a neighborhood problem.

Indicators Selected:

- "Haze wall or buildings often occurs as a neighborhood problem.
- Destruction of telephone, tram or bus booths often occurs as a neighborhood problem.
- Destruction of street furniture often occurs as a neighborhood problem."

Scale reliability coefficient: 0.6784

New aggregate indicator:"% of residents who indicated that vandalism occurs as a problem"

Indicators Selected:

- "Number of crimes of threats (per thousand habitants)

- Number of crimes of abuse (per thousand habitants)
- Number of crimes of threats (per thousand habitants)
- Number of crimes of robbery with violence (per thousand habitants)”

Scale reliability coefficient: 0.6862

New aggregate indicator:"% number of violent crimes per thousand habitants"

Cronbach’s Alpha (Post war Neighborhoods)

Indicators Selected:

- “% of households satisfied with quality street lighting
- % of households satisfied with maintenance of cycle paths
- % of households satisfied with maintenance of pavements
- % of households satisfied with safety of pavements
- % of households satisfied with safety of sidewalks”

Scale reliability coefficient: 0.8059

New aggregate indicator: "% of households (very) satisfied with neighbourhood services"

Indicators Selected:

- “% of houses with baker within standard distance
- % of houses with butcher within standard distance
- % of houses with greengrocer within standard distance
- % of houses with sports hall within standard distance
- % of houses with pharmacy within standard distance
- % of houses with general practice within standard distance
- % of houses with playground within standard distance
- % of houses with schools within standard distance.”

Scale reliability coefficient: 0.7182

New aggregate indicator:"% of dwellings with facilities within standard distance"

Indicators selected:

- Threatening often occurs as a neighborhood problem
- Violent offenses often occur as a neighborhood problem
- Robbery with violence often occurs as a neighborhood problem

Scale reliability coefficient: 0.9107

New aggregate indicator: Violent crimes often occur as a neighborhood problem

Indicators Selected:

- “Haze wall or buildings often occurs as a neighborhood problem.
- Destruction of telephone, tram or bus booths often occurs as a neighborhood problem.
- Destruction of street furniture often occurs as a neighborhood problem.”

Scale reliability coefficient: 0.6265

New aggregate indicator:"% of residents who indicated that vandalism occurs as a problem"

Indicators Selected:

- “Number of crimes of threats (per thousand habitants)
- Number of crimes of abuse (per thousand habitants)
- Number of crimes of threats (per thousand habitants)
- Number of crimes of robbery with violence (per thousand habitants)”

Scale reliability coefficient: 0.7279

New aggregate indicator:"% number of violent crimes per thousand habitants"

Pearson bivariate correlation Analysis

Table 49 Pearson's bivariate correlation analysis for all indicators in pre and post war neighbourhoods.

Variables	Type	Pre-War Neighborhoods Correlation value	Post War Neighborhoods Correlation value
Satisfaction with facilities	Subjective	0.6853	0.5644
Satisfaction with services	Subjective	0.7724	0.4569
Public transport available	Subjective	-0.2082	-0.0821
Greenery available	Subjective	0.5146	0.2359
Satisfaction with housing	Subjective	0.8996	0.8834
Find buildings attractive	Subjective	0.9036	0.7423
Facilities within standard distance	Objective	-0.3890	-0.4180
Houses with overcrowd	Objective	-0.7029	-0.0461
State of maintenance of buildings	Objective	0.8228	0.7825
Metro within standard distance	Objective	0.0274	0.2530
Tram within standard distance	Objective	-0.3744	-0.2734
Connection to the neighbourhood	Subjective	0.8164	0.5144
Like the neighbourhood	Subjective	0.8953	0.9111
Residents which help each other	Subjective	0.7113	0.2819
Residents which know each other	Subjective	0.4646	0.0291
No problems with local residents	Subjective	0.7334	0.6820
Relationship between ethnic groups	Subjective	-0.3472	-0.0702
Space for joint activities	Subjective	-0.0598	-0.1057
Neighbour contact	Objective	-0.1650	-0.1854
Live in the neighbourhood for long time	Objective	0.0328	0.0806
Participation in cultural events	Objective	-0.3701	-0.4938

Households with low income	Objective	-0.7987	-0.8844
Non-natives	Objective	-0.7943	-0.4412
Perception of theft of bikes	Subjective	-0.5569	0.0838
Perception of theft of cars	Subjective	-0.1268	-0.1015
Perception of burglary	Subjective	-0.4948	-0.4520
Perception of violent crimes	Subjective	-0.8384	-0.5990
Perception of vandalism	Subjective	-0.7947	-0.5280
Perception of drug nuisance	Subjective	-0.7228	-0.5300
Perception of nuisance	Subjective	-0.8300	-0.7528
Reports on theft of bike	Objective	0.7427	0.1108
Reports on theft of cars	Objective	0.1625	0.3375
Reports on theft pickpocket	Objective	-0.2349	0.2759
Reports on burglaries	Objective	-0.3650	-0.2544
Number of violent crimes	Objective	-0.5251	0.1839
Reports on vandalism	Objective	-0.3518	0.0318
Reports on environmental inconvenience	Objective	-0.3469	0.2101
Reports on drugs nuisance	Objective	-0.2566	-0.0914

Table 50 Correlation analysis values.

Values for the correlation analysis
+.70 or higher: very strong positive relationship
+.40 to +.69: strong positive relationship
+.30 to +.39: moderate positive relationship
+.20 to +.29: weak positive relationship
+.01 to +.19: no or negligible relationship
-.01 to -.19: no or negligible relationship
-.20 to -.29: weak negative relationship
-.30 to -.39: moderate negative relationship
-.40 to -.69: strong negative relationship
-.70 or higher: very strong negative relationship

Annex 2: Spatial Distribution (maps)

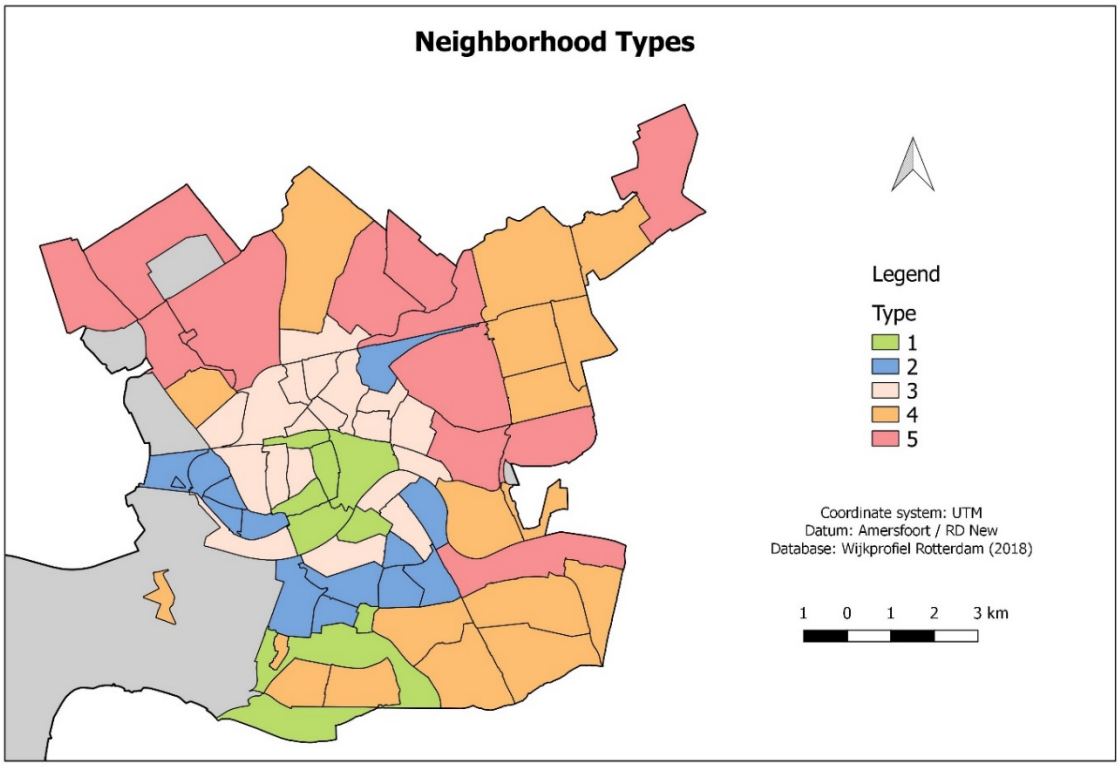
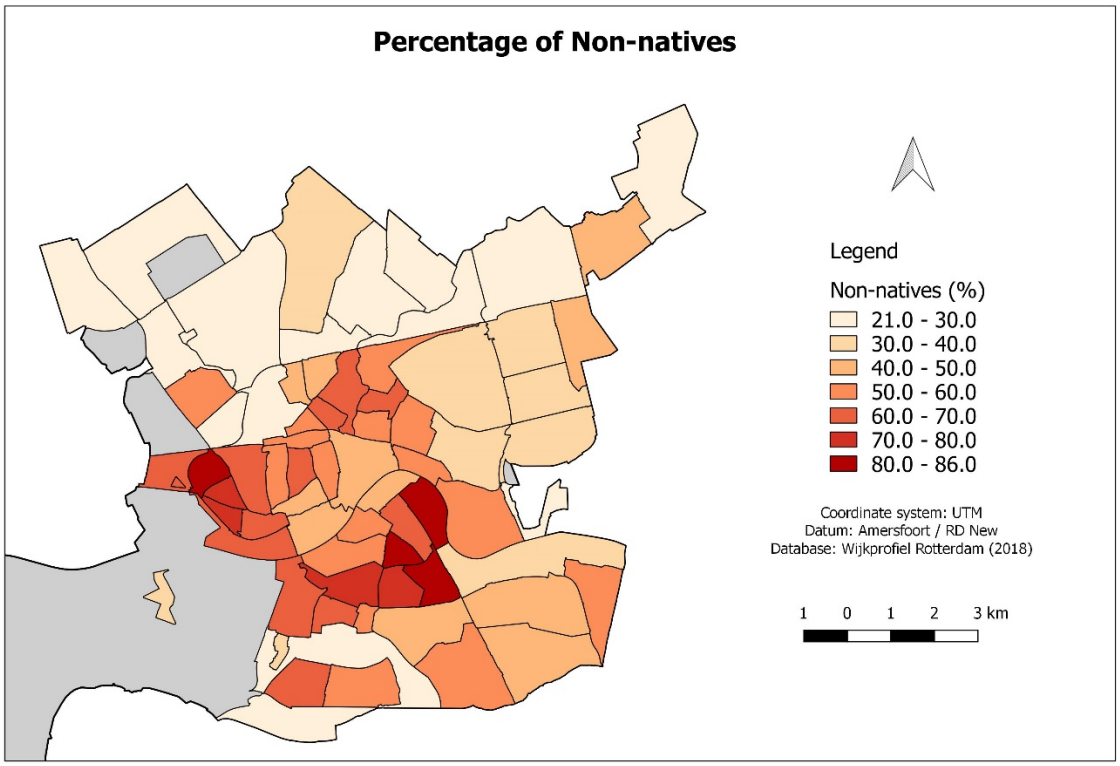


Figure 33 Neighbourhood types according to the Wijkprofiel Rotterdam.

Table 51 Percentage of non-natives through Rotterdam



Annex 3: Spatial Features (Macro and Micro Scale values)

Table 52 Inter-visibility values for pre-war and post war neighbourhoods.

Pre-war Neighbourhoods	Inter-visibility	Post war neighbourhoods	Inter-visibility
Tarwewijk	1	Zuidwijk	4
Carnisse	2	Wielewaal	5
Oud-Charlois	2	Zuidplein	5
Delfshaven	1	Pendrecht	4
Bospolder	1	Zuiderpark en Zuidrand	5
Tussendijken	1	Heijplaat	4
Spangen	1	Schiemond	4
Nieuwe Westen	1	Kop van Zuid	4
Middelland	2	Kop van Zuid-Entrepot	3
OudMathenesse/Witte Dorp	2	Schiebroek	5
Vreewijk	3	Hillegersberg-noord	5
Bloemhof	2	Terbregge	5
Hillesluis	2	Molenlaankwartier	5
Katendrecht	2	Lombardijen	5
Afrikaanderwijk	2	Beverwaard	3
Feijenoord	2	Groot IJsselmonde-Noord	5
Noordereiland	2	Groot IJsselmonde-Zuid	5
Hillegersberg-zuid	2	Nieuw Crooswijk	3
Oud IJsselmonde	4	De Esch	5
Rubroek	3	Kleinpolder	3
Oud Crooswijk	3	Overschie	3
Kralingen-west	3	NoordKethel/Schieveen/Zestienhoven	5
Struisenburg	3	s-Gravenland	5
Kralingen Oost/Kralingse Bos	2	Kralingseveer	4
Agniesebuurt	3	Prinsenland	4
Provenierswijk	1	The low country	5
Bergpolder	2	Ommoord	5
Liskwartier	2	Zevenkamp	5
Oude Noorden	1	Oosterflank	4
Blijdorp/Blijdorpsepolder	3	Nesselande	4
Oude Westen	1	Stadsdriehoek	3
		Cool	2
		CS-kwartier	3
		Nieuwe Werk/Dijkzigt	4

Table 53 Space syntax values for all neighbourhoods

Neighborhood	Local Angular	Global Angular	Local Integration	Global Integration
Tarwewijk	0.057	0.013	0.509	0.721
Carnisse	0.061	0.009	0.499	0.723
Oud-Charlois	0.038	0.005	0.371	0.655
Delfshaven	0.019	0.004	0.279	0.619
Bospolder	0.031	0.003	0.358	0.615
Tussendijken	0.068	0.007	0.464	0.599
Spangen	0.046	0.004	0.362	0.529
Nieuwe Westen	0.063	0.015	0.567	0.671
Middelland	0.061	0.013	0.572	0.687
OudMathenesse/Witte Dorp	0.043	0.006	0.313	0.527
Vreewijk	0.062	0.011	0.491	0.673
Bloemhof	0.088	0.011	0.601	0.698
Hillesluis	0.084	0.016	0.586	0.706
Katendrecht	0.013	0.019	0.132	0.501
Afrikaanderwijk	0.053	0.021	0.496	0.715
Feijenoord	0.009	0.002	0.132	0.571
Noordereiland	0.009	0.001	0.116	0.602
Hillegersberg-zuid	0.035	0.011	0.359	0.652
Oud IJsselmonde	0.016	0.019	0.174	0.612
Rubroek	0.057	0.005	0.475	0.701
Oud Crooswijk	0.056	0.007	0.407	0.691
Kralingen-west	0.043	0.003	0.382	0.652
Struisenburg	0.038	0.016	0.338	0.698
Kralingen Oost/Kralingse Bos	0.025	0.011	0.272	0.661
Agniesebuurt	0.066	0.006	0.499	0.664
Provenierswijk	0.048	0.011	0.491	0.669
Bergpolder	0.049	0.009	0.492	0.694
Liskwartier	0.063	0.013	0.552	0.702
Oude Noorden	0.052	0.005	0.437	0.662
Blijdorp/Blijdorpsepolder	0.034	0.004	0.491	0.677
Oude Westen	0.065	0.014	0.571	0.717
Zuidwijk	0.044	0.005	0.371	0.654
Wielewaal	0.026	0.002	0.234	0.569
Zuidplein	0.055	0.009	0.501	0.501
Pendrecht	0.019	0.011	0.252	0.622
Zuiderpark en Zuidrand	0.025	0.011	0.236	0.582
Heijplaat	0.003	0.001	0.092	0.471
Schiemond	0.017	0.006	0.281	0.632
Kop van Zuid	0.012	0.038	0.146	0.611
Kop van Zuid-Entrepot	0.012	0.003	0.199	0.623
Schiebroek	0.017	0.002	0.232	0.506
Hillegersberg-noord	0.018	0.005	0.228	0.544
Terbregge	0.006	0.008	0.102	0.662
Molenlaankwartier	0.023	0.003	0.234	0.519
Lombardijen	0.047	0.004	0.343	0.581

Beverwaard	0.029	0.002	0.213	0.456
Groot IJsselmonde-Noord	0.033	0.007	0.271	0.585
Groot IJsselmonde-Zuid	0.029	0.003	0.241	0.491
Nieuw Crooswijk	0.024	0.011	0.252	0.691
De Esch	0.008	0.011	0.109	0.592
Kleinpolder	0.023	0.005	0.221	0.552
Overschie	0.014	0.003	0.147	0.506
NoordKethel/Schieveen/Zestienhoven	0.023	0.001	0.187	0.494
s-Gravenland	0.021	0.007	0.181	0.509
Kralingseveer	0.013	0.006	0.138	0.551
Prinsenland	0.011	0.011	0.131	0.622
The low country	0.013	0.005	0.142	0.566
Ommoord	0.012	0.002	0.127	0.401
Zevenkamp	0.025	0.002	0.216	0.443
Oosterflank	0.028	0.003	0.195	0.552
Nesselande	0.026	0.002	0.216	0.429
Stadsdriehoek	0.047	0.021	0.456	0.768
Cool	0.051	0.017	0.511	0.755
CS-kwartier	0.047	0.007	0.482	0.714
Nieuwe Werk/Dijkzigt	0.032	0.022	0.281	0.749

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