Measuring Walkability through Street Design in Groningen and Athens

Monastiraki Square in Athens, picture taken by Tom de Jong, 2018

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Summary

To measure if there is a relationship between the urban street design and people their enjoyment of the streets in terms of walkability, the street design in several neighbourhoods of different types were scored using a single standard, and people using these streets were surveyed about their opinions of these streets. These neighbourhoods were in Athens, Greece, and in Groningen, the Netherlands. Distinctions were made between urban and suburban streets, and commercial and residential streets. A negative relationship was found between the height of the score of the streets using this standard and people's opinions of the streets. Qualitative data collected in this research suggests that the scoring standard had too weak an emphasis on the presence of trees or other greenery. Differences were found between urban and suburban streets and between commercial and residential streets. No differences of opinions were found based on the personal characteristics of the respondents.

Structure of the thesis

First, the importance of walkability will be explored in the Background section, then the research problem will be explained, followed by a development of the theoretical framework, exploring different ways of measuring walkability, and choosing one way of measuring walkability for this research. Based on this framework, a conceptual model will be developed and hypotheses will be made. A methodology will be developed based on practical considerations and its ability to test the hypotheses. Afterwards the results of the data analysis will be presented, and finally, the main conclusions of this research along with a comparison to previous research, and suggestions for further research.

Background

According to the World Health Organization (2018), obesity rates have nearly tripled from 1975 to 2016. The World Health Organization (2016) also reports that 80% of people globally living in urban areas are exposed to air which does not meet the minimal standards for air quality of the World Health Organization. From 2013 to 2014, traffic congestion has gotten worse in 95 out of America's largest 100 metro areas, up from 65 metro areas which experienced more traffic congestion from 2012 to 2013 (Shrank et al., 2015). The Paris Agreement on climate change encourages countries to reduce their greenhouse gas emissions and pursue sustainable development (United Nations, 2016).

Improving walkability can be a strategy for pursuing this sustainable development, reducing air pollution, improving health, and reducing traffic congestion. Haskell et al. (2007) recommend that healthy adults aged 18 to 65 walk briskly (5 kilometers or 3 miles per hour) for 30 minutes five days a week, in order to improve and maintain their health. In older adults, walking can also maintain and improve mobility, allowing them to function independently (Pahor et al., 2014). Even walking for only 15 minutes a day might improve the health of individuals (Wen et al., 2011). Walking and cycling are also linked with lower rates of obesity and improved health (Bassett et al., 2008, 2010, Frank, Andresen, and Schmid 2004).

Air pollution also has a negative effect on health and life expectancy (Pope, Ezzati, and Dockery, 2009, Kampa and Castanas, 2007). Increased exposure to traffic also has a detrimental effect on children's lung function (Gauderman et al., 2007, Ierodiakonou et al., 2015). Traffic and traffic congestion have a negative effect on the air quality (HEI Panel on the Health Effects of Traffic-Related Air Pollution, 2010, Zhang and Batterman, 2014).

Obesogenic environments can also be dealt with by changing the built environment to promote a healthier lifestyle. This will also have implications in terms of spatial justice as the obesogenic environments are unevenly distributed across different types of neighbourhoods and thus different groups of people (Lake and Townshend, 2006).

Improving walkability could also be a way of improving the economy and raising the land value of neighbourhoods affected by the improvements (Carrey et al., 2015, Litman, 2003, Pivo and Fisher, 2010). This is of particular interest to Greece, which is still suffering from the aftermath of the economic recession of 2008.

By improving walkability, and thus inducing more people to walk, the health of the population can be improved, car usage can be decreased, which will decrease traffic congestion and air pollution, further improving the health of people, and reduced car usage will also reduce greenhouse gas emissions.

Research Problem

The aim of this research is to measure various different streets in different neighbourhoods in Athens, Greece, and in Groningen, the Netherlands using one standard of walkability and to compare the outcome of this standard of walkability with how people using the streets experience the walkability of these streets. The central research question is thus:

Is there a relationship between the Measured Walkability of streets in relation to the characteristics of the streets, and the experiences of people walking through these streets?

For the purposes of this research, the characteristics of the streets will be understood as the design of the streets, and the land use of the streets. For example, the amount of windows, the amount of street furniture, the colours of the buildings, and whether the land use is predominately residential or commercial or whether the street is in an urban area or in a suburban area. The characteristics of the people will be their demographic characteristics such as gender, age, or whether they are from an urban or rural background.

In order to answer this question, this research also aims to answer the following secondary questions:

1: What are the different standards of walkability?
2: Is there a relationship between the Measured Walkability of a street and the Experienced Walkability of a street? (Measured Walkability referring to the score of the standard of walkability used, and Experienced Walkability referring to the experiences of respondents using the streets)
3: Are there differences between how groups of people (e.g. women, the elderly, tourists) experience walkability?
4: Are there differences between measured walkability and experienced walkability depending on the type of usage of the streets (i.e. residential or commercial)?
5: Are there differences between the measured walkability and the experienced walkability depending on the type of neighbourhood (urban or suburban)?

Theoretical Framework

In measuring walkability, neighbourhood characteristics are most often employed, looking at the density of residents or jobs, the mixture of land uses, or the connectivity based on the number of intersections (Leslie et al., 2007, Agampatian, 2014, Tribbey et al., 2016). These measures however do not look at design of the streets themselves or on the experiences of the people using the streets, which is what this research aims to focus on.

There have been attempts to quantify and measure the walkability on a street level however. Ewing et al. (2005a) created a framework in which five categories of elements influence the walkability of a street. These five were arrived at through an analysis of urban design literature, which first produced nine different categories. Footage was shot of streets in different cities across the United States, which was first rated on to what degree they matched the categories, before being shown to urban design experts for them to rate. Afterwards, it was found that there was no statistically significant relationship between the walkability ratings and four of the nine categories. The remaining five categories are ***Imageability*** (Imageability is the quality of a place that makes it distinct, recognizable, and memorable)*,* ***Enclosure*** (Enclosure refers to the degree to which streets and other public spaces are visually defined by buildings, walls, trees, and other elements)*,* ***Human Scale*** (Human scale refers to a size, texture, and articulation of physical elements that match the size and proportions of humans and, equally important, correspond to the speed at which humans walk)*,* ***Transparency*** (Transparency refers to the degree to which people can see or perceive what lies beyond the edge of a street or other public space and, more specifically, the degree to which people can see or perceive human activity beyond the edge of a street or other public space)*, and* ***Complexity*** (Complexity refers to the visual richness of a place). The factors influencing each of these categories were then weighted by the experts before being turned into a field manual measuring things like buildings, street walls, windows, and wall colours (Ewing et al., 2005b). See figure 1 for the full scoring sheet.

measuring urban design qualities scoring sheet	auditor		
street from	date & time		
step	recorded value	multiplier	(multiplier) x (recorded value)
imageability			
1. number of courtyards, plazas, and parks (both sides, within study area)		0.41	
2. number of major landscape features (both sides, beyond study area)		0.72	
3. proportion historic building frontage (both sides, within study area)		0.97	
4. number of buildings with identifiers (both sides, within study area)		0.11	
5. number of buildings with non-rectangular shapes (both sides, within study area)		0.08	
6. presence of outdoor dining (your side, within study area)		0.64	
7. number of people (your side, within study area) Walk through 1			
Walk through 2			
Walk through 3			
Walk through 4			
Total			
Total divided by 4		0.02	
8. noise level (both sides, within study area) Walk through 1			
Walk through 2			
Walk through 3			
Walk through 4			
Total			
Total divided by 4		-0.18	
		add constant	+2.44
		imageablity score	
enclosure			
1. number of long sight lines (both sides, beyond study area)		-0.31	
2a. proportion street wall (your side, within study area)		0.72	
2b. proportion street wall (opposite side, within study area)		0.94	
3a. proportion sky (ahead, beyond study area)		-1.42	
3b. proportion sky (across, beyond study area)		-2.19	
		add constant	+2.57
		enlosure score	
human scale			
1. number of long sight lines (both sides, beyond study area) *from above		-0.74	
2. proportion windows at street level (your side, within study area)		1.10	
3. average building height (your side, within study area)		-0.003	
4. number of small planters (your side, within study area)		0.05	
5. number of pieces of street furniture and other street items (your side, within study area)		0.04	
		add constant	+2.61
		human scale score	
transparency			
1. proportion windows at street level (your side, within study area)		1.22	
2. proportion street wall (your side, beyond study area) *from above		0.67	
3. proportion active uses (your side, within study area)		0.53	
		add constant	+1.71
		transparency score	
complexity			
1. number of buildings (both sides, beyond study area)		0.05	
2a. number of basic building colors (both sides, beyond study area)		0.23	
2b. number of basic accent colors (both sides, beyond study area)		0.12	
3. presence of outdoor dining (your side, within study area) *from above		0.42	
4. number of pieces of public art (both sdies, within study area)		0.29	
5. number of walking pedestrians (your side, within study area) Walk through 1			
Walk through 2			
Walk through 3			
Walk through 4			
Total			
Total divided by 4		0.03	
		add constant	+2.61
		complexity score	

Figure 1 - Scoring sheet from Ewing et al. (2005b)

A different standard is the Irvine Minnesota Inventory, which is organized into four different domains, accessibility, pleasurability, perceived safety from traffic, and perceived safety from crime, totalling 162 different items. ***Accessibility*** is the perceived ease with which destinations can be reached and terrain can be traversed during physical activity for travel and/or recreation. ***Pleasurability*** is the perceived attractiveness of the setting for physical activity for travel and/or recreation. ***Perceived safety from traffic*** involves individuals' beliefs that limited opportunities exist in the setting for injury from autos or other vehicles. ***Perceived safety from crime*** involves individuals' beliefs that limited opportunities exist in the setting for crime victimization or harassment during physical activity for travel and/or recreation (Day et al., 2006). Day et al. first reviewed other auditing tools and literature to identify which features could be objectively measured, before doing focus group interviews with low income people, teenagers, and nonwhite college students to expanded on this. Afterwards, the researchers went into various different cities and recorded other things which could be of influence. Their findings were then presented to a panel of experts for feedback, with the final result being the extensive list of a 162 different items (see Appendix A).

Clifton, Livi, and Rodríguez (2007) created PEDS, a measurement linking the ***street environment***, ***pedestrian facilities***, ***road attributes***, and ***walking environment*** to the walkability of a street. They arrived at this by analysing other walkability audit tools, such as the above Irvine Minnesota Inventory, and expanding upon them when factors were missing or condensing these audit tools to make them more time efficient (see Appendix B).

Due to time limitations, only one of these measures will be used for this research project. Ewing et al's model has been chosen due to its ability to give a score on the street design allowing for more and easier comparisons between streets and between this measure of walkability and the experienced walkability of respondents.

While the above standards do make distinctions between various types of land usage (e.g. commercial or residential), it has not been explored whether people experience walkability differently in streets specifically designed for commercial use compared to streets with mixed usage or solely residential usage, or whether people experience walkability differently in urban or suburban areas.

William H. Whyte (1988) noticed in his research on New York City parks and plazas that men and women behaved differently in these public spaces, with women preferring to sit in cleaner places and more secluded ones. Whether men and women also experience walkability in public spaces differently has not yet been explored as a research topic.

Although some research has been done into the perspectives of tourists in regards to walkability (Farkić et al., 2015, Aranburu, Plaza and Esteban, 2016), it remains a little explored subject.

Conceptual Model

This research aims to measure several different streets in Athens, Greece, and Groningen, the Netherlands using the the standard put forward by Ewing et al (2005b). In figure 2, a conceptual model is laid out visualizing Ewing et al's model. To see all the factors involved in Ewing et al's model, see figure 1. Further, to measure the use of these standards, they will be compared to the walkability ratings respondents give these streets. To see if different people experience walkability differently, the respondents will be asked for their age, gender, if they are a local or a tourist (if they are a tourist, then from what country they come from), if they have any injuries or disabilities which affect their ability to walk, and if they are from a rural or urban background. To examine if they also experience different types of areas different (commercial or residential, urban or suburban), the predominant land usage type of the area where the respondent was questioned will also be recorded. See figure 3 for a visualization of this model.

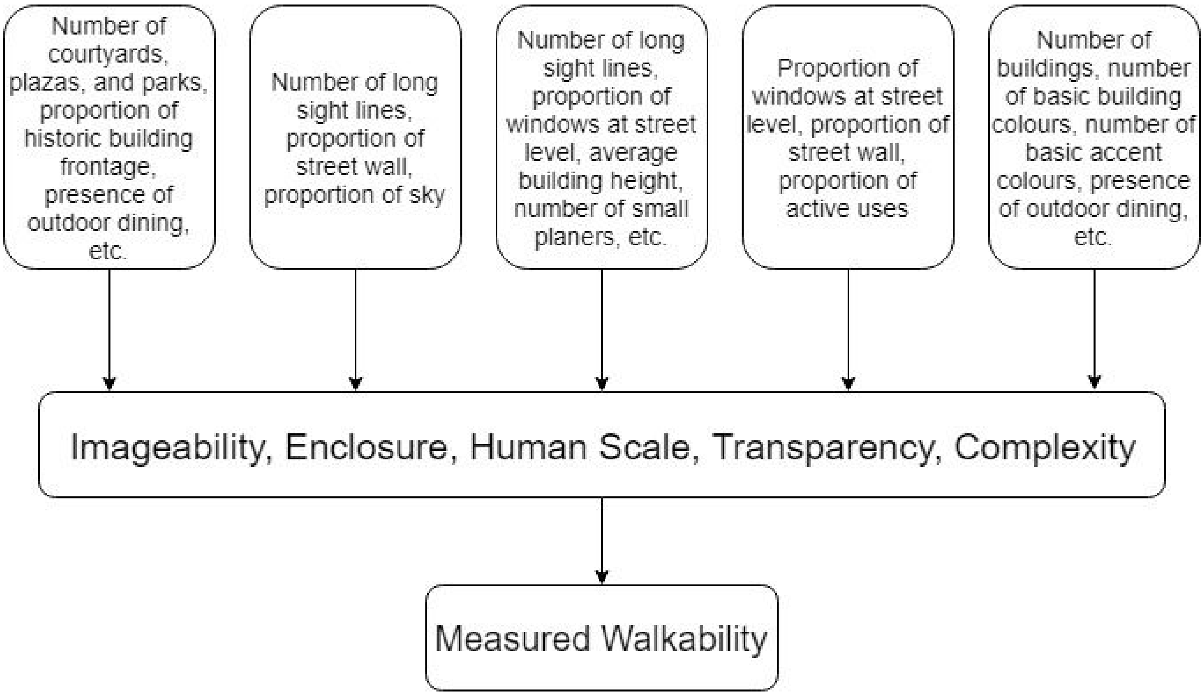


Figure 2 - Conceptual model for Measured Walkability.

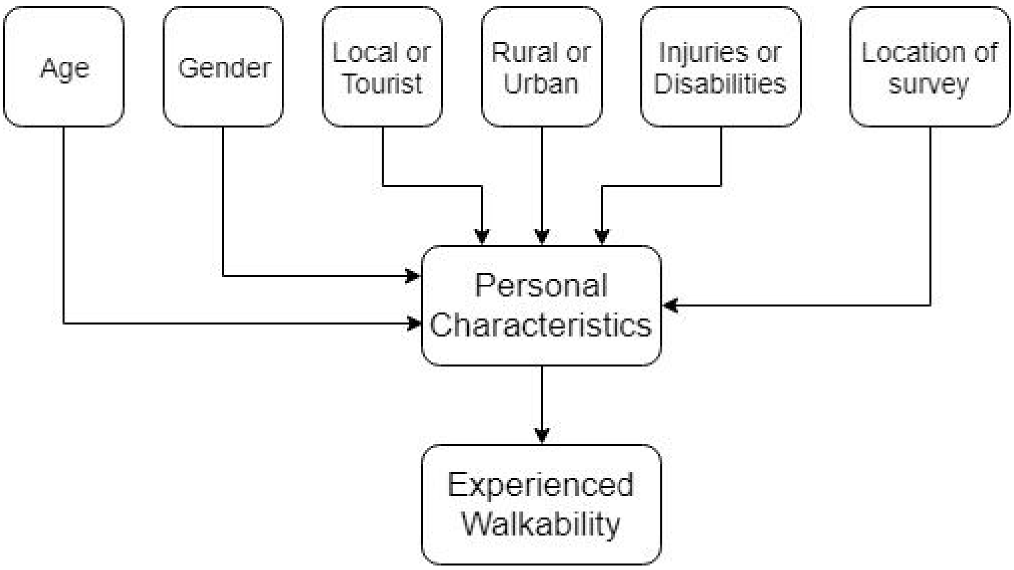


Figure 3 - Conceptual model for Experienced Walkability.

Hypotheses

Based on the theoretical framework and the conceptual models, this research aims to test the following hypotheses;

Hypothesis 1 - There is a positive correlation between Measured Walkability and the Experienced Walkability scores.
Hypothesis 2 - There are differences in the Experienced Walkability scores of different groups of people surveyed.
Hypothesis 3 - There are differences in the Experienced Walkability of the respondents depending on the predominant land usage type of the street.
Hypothesis 4 - There are differences in the Experienced Walkability of the respondents depending on the neighbourhood type.
Hypothesis 5 - There are differences in the Measured Walkability of the streets depending on the neighbourhood type.
Hypothesis 6 - There are differences in the Measured Walkability scores of the streets depending on the predominant land usage type of the street.

Methodology

This research is based on primary data collection in Athens, Greece, and in Groningen, the Netherlands in several particular neighbourhoods. Kolonaki, Exarcheia, Pefki, Marousi, and Monastiraki in Athens, and De Wijert-Zuid, Oosterpoortbuurt, and the Binnenstad. These neighbourhoods were selected to get a comparison between a higher income neighbourhood, Kolonaki, a lower income neighbourhood, Exarcheia, which are both close to the center of Athens, and a suburban neighbourhood, Pefki. Marousi, a suburban city, Monastiraki, a neighbourhood in the center of Athens, will be compared for their commercial streets. De Wijert-Zuid is a suburban residential neighbourhood, which will be compared with the Oosterpoortbuurt close to the center of Groningen. Only commercial streets of the Binnenstad in the center of Groningen will be measured. In order to collect data surveys will be held targeting pedestrian street users and residents of the street. These surveys will be completely anonymous.

The were two main limitations of this research. First, the data collection was time consuming, which limited the amount of streets and neighbourhoods which could be measured. As such, of every neighbourhood only five streets would be measured, leading to a total of 40 streets being measured, 25 in Athens and 15 in Groningen. And second, due to language barriers, time constraints, and a response rate of one in forty people, the collection of data from respondents in Athens was unsuccessful so for the research concerning the Experienced Walkability only data collected in Groningen was used.

For this research project, primary data was collected in three forms. For the first form, an observer went out into the field to collect data using the scoring sheet of Ewing et al (2005b). This sheet will give five different scores on **imageability**, **enclosure**, **human scale**,

transparency, and **complexity**. These scores together give an overall score of walkability which is an interval variable. This value was used to test whether there are differences between the measured and experience walkability.

The second form of data collection is surveys from respondents using the same streets as measured with Ewing et al's scoring sheet. This data was collected during the day, during dry and predominantly sunny weather, and was be written down per respondent. In the context of doing ethical research, efforts were made to not raise concerns, or hopes, about any possible interventions in the built environment, efforts were made to present the data collection as being solely part of a research project and not related to any potential redevelopment plans of the neighbourhood (Clifford, French, and Valentine, 2010). This survey asked the respondents their gender, age, whether they are tourists or locals, if they are tourists then what their country of origin is, if they have any injuries or disabilities which affect their ability to walk, if they are from a rural or urban background, and finally, how they would rate their walking experience. Further, the type of street and neighbourhood the survey was taken in will also be recorded. This data allowed for comparisons to be made between different groups of people, and see which factors influence their experienced walkability the strongest. Further, this data was used to see if people experience walkability differently in residential or commercial streets, or in urban or suburban streets. It was attempted to have a fairly even balance between male and female respondents, and to have enough tourists within the sample size to make comparisons to locals. See Appendix C for an English translation of the survey.

The last form of data collection was very short interviews from various different respondents depending on their willingness to cooperate. These were open interviews, asking the respondents to elaborate on the their walking experience, specifically, why they did or did not enjoy a street and what things influenced this, along with their opinions on the street design. Follow-up questions were asked depending on the responses.

Statistical tests were used to analyze the data. To answer the first secondary question (*Is there a relationship between the Measured Walkability of a street and the Experienced Walkability of a street?)*, the Measured and Experienced Walkability are both ratio variables and were tested using the Pearson correlation test, which measures the presence of a linear correlation between two variables and the strength of this correlation.

To answer the third secondary question (*Are there differences between how groups of people (e.g. women, tourists) experience walkability?)* several tests were done. A multiple linear regression analysis was done to see how the different personal factors influence the experienced walkability of respondents. Further, independent samples t-tests were done to see if there are differences in the responses between men and women, locals and tourists, and people from a rural or urban background. And finally, another Pearson correlation test was done to determine if there is a correlation between age and the Experienced Walkability.

To answer the fourth and fifth secondary questions (*Are there differences between Measured Walkability and Experienced Walkability depending on the type of usage of the streets (i.e. residential or commercial)? Are there differences between the Measured*

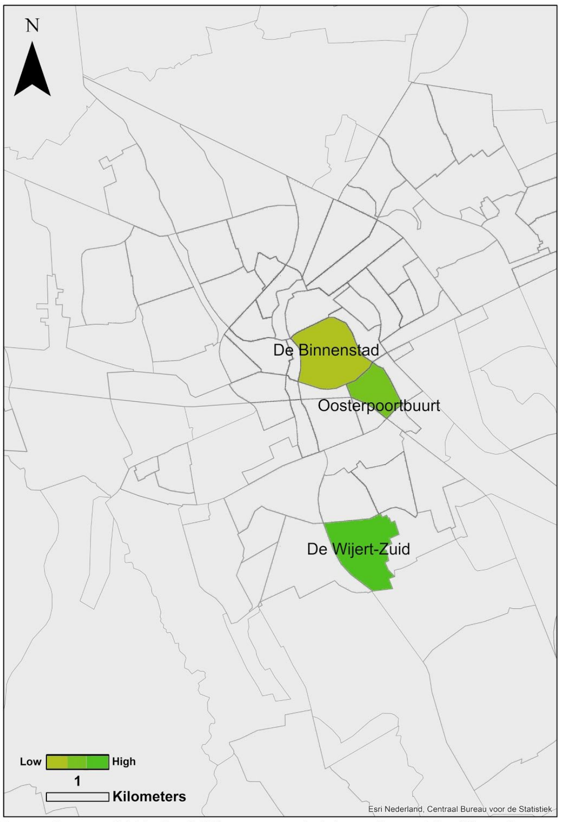
Walkability and the Experienced Walkability depending on the type of neighbourhood (Central or suburban)?), independent samples t-tests were done to see if there is a difference between the measured or experienced walkability, and the type of street or neighbourhood they are in. The Mann-Whitney U test, a non-parametric alternative test, was also done due to the relatively small sample size.

Results

Quantitative data

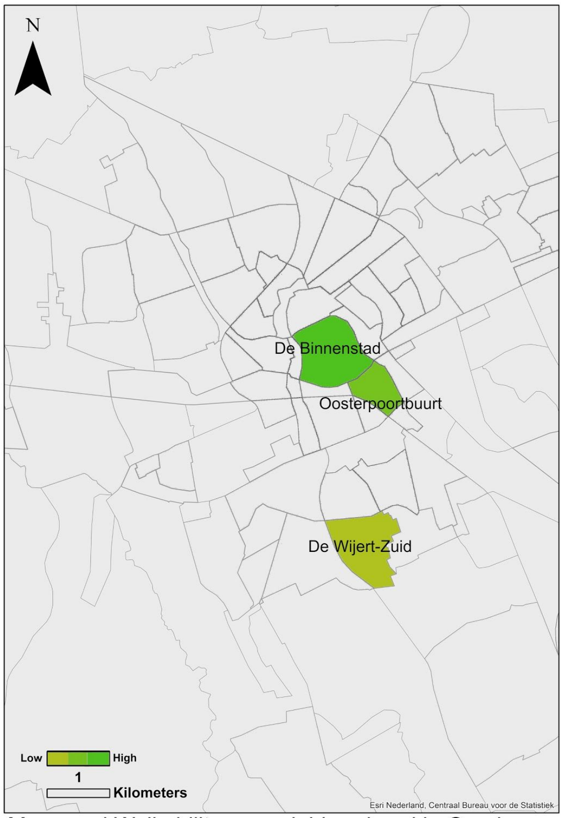
Given the nature of the streets, before the collected data could be analyzed, some of it had to be transformed so as to make comparisons more fair and possible. The main issue here being that the streets which were measured were not all of the same length and size. Ewing et al recommend that for their model, the data is collected per block or per a certain amount of steps. This however still presented some problems given that the streets did not have blocks of the same sizes, and given that they end at different distances, doing it by steps would possible either leave out parts of the street or result in measurements where some streets would have 3 full measurement sheets and others 2 and a half measurement sheets. Although this approach can be beneficial when one is focussing on a specific street and how things can be improved within that street, for the purposes of this research however, it was important to be able to make comparisons betweens streets. To do this, the measurements were taken for the entire street (or where there was a logical cut-off point) and the scores these measurements produced were then averaged out to a score per hundred meters. These scores per hundred meters were then also averaged per neighbourhood.

Going by neighbourhood, Monastiraki in Athens scored the highest on the Measured Walkability, followed by Marousi in Athens, the Binnenstad in Groningen, Oosterpoortbuurt in Groningen, Exarcheia in Athens, Kolonaki in Athens, Pefki in Athens, and last, De Wijert-Zuid in Groningen. However, despite De Wijert-Zuid scoring the worst in terms of the Measured Walkability, it did score highest on the Experienced Walkability, followed by the Oosterpoortbuurt, and despite scoring the third highest in Measured Walkability, the Binnenstad scored the worst in Experienced Walkability. See Appendix D for a table of the results. See figures 4 and 5 for the results in Groningen and figures 6 and 7 for the results in Athens..



Experienced Walkability per neighbourhood in Groningen

Figure 4.



Measured Walkability per neighbourhood in Groningen

Figure 5.

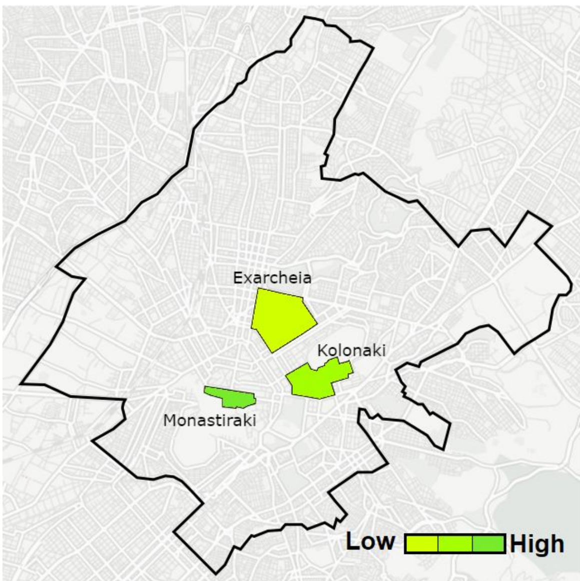


Figure 6 - Measured Walkability per neighbourhood in Athens

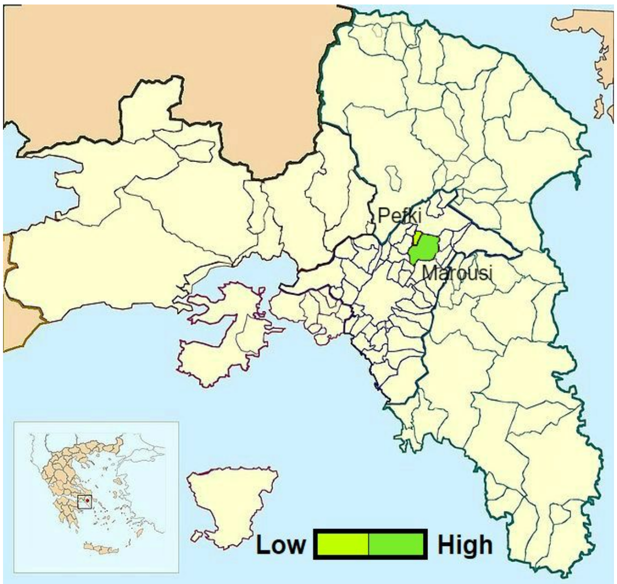


Figure 7 - Measured Walkability in Pefki and Marousi.

Testing the first hypothesis, whether there is a positive correlation between Measured Walkability and Experienced Walkability, was the most important part of this research project. However, as explained above, this could only be tested using the data collected in

Groningen. As such, this hypothesis was tested on 15 streets, measured in 5 different neighbourhoods. An urban commercial neighbourhood, an urban residential neighbourhood, and a suburban residential neighbourhood. In each of the commercial streets 15 people were surveyed, and 10 people in each of the residential streets, leading to a total of a 175 surveys. The scores the respondents gave on a scale of 0 to 100 were averaged out per street, before testing if there was a correlation using the Pearson correlation test. With a significance of 0.029, it is likely that there is a correlation between the Measured and Experienced Walkability scores. However, it is a strong negative relationship of -0.564, meaning that with an increase in the Measured Walkability, there is also a decrease in the Experienced Walkability.

Given the fairly small sample size however, two non-parametric tests were also taken. The Kendall's Tau-b test and the Spearman rank-order test are both non-parametric alternatives to the Pearson correlation test. The Kendall's Tau-b test finds a negative correlation of -0.367, however the significance of this is only 0.059. The Spearman rank-order test also finds a negative correlation of -0.589 at a significance of 0.021. Looking at these three tests, it seems likely that there is a negative correlation and that the first hypothesis was proven incorrect.

Hypothesis 1 - *There is a positive correlation between Measured Walkability and the Experienced Walkability scores.* - **False** - A negative correlation was found.

The second hypothesis, whether there are differences in the Experienced Walkability scores of different groups of people surveyed was first analyzed using a multiple linear regression analysis, based on age, gender, local/tourist background, rural/urban background, and if they had any injuries or disabilities. However, none of these factors came back with having a significant effect. Afterwards, these factors were gone through individually to see if different tests might yield different results. The factors gender, local/tourist background, rural/urban background, and if they had any injuries or disabilities, were all analyzed using independent samples t-tests. Of the total of 175 respondents, 89 were women and 86 were men. 135 were locals and 40 were tourists. 145 were from an urban background and 30 from a rural background. And 155 had no injuries or disabilities and 20 did.

No significant differences however could be found between any of these groups. Respectively, these factors had a significance of 0.695 for differences based on gender, 0.364 for differences based on local/tourist background, 0,731 for differences based on rural/urban background, and 0.819 for differences based on having an injuries or disabilities. For the factor age however, another Pearson correlation test was done, along with the non-parametric alternatives of the Kendall's Tau-b and the Spearman rank-order test. The Pearson correlation test had a weak positive correlation of 0.109, although it was not significant at 0.151. The Kendall's Tau-b test a 0.084 correlation, at 0.140 significance, and the Spearman rank-order test gave 0.109 correlation at 0.152 significance. In short, none of the personal characteristics of the respondents had any significant differences between them.

Hypothesis 2 - *There are differences in the Experienced Walkability scores of different groups of people surveyed.* - **False** - No significant differences could be found.

To test the third and fourth hypothesis, whether there are differences in the Experienced Walkability of the respondents depending on the predominant land usage type of the street or on the neighbourhood type, another pair of independent samples t-tests were done. Of the 175 people surveyed, 100 of them were in residential streets and 75 in commercial streets. The residential streets had a mean Experienced Walkability grade of 78,6 and the commercial streets had a mean Experienced Walkability grade of 75,3. This difference between these two means was significant at 0.021, meaning that it is likely that there is a difference in the mean Experienced Walkability grades between the residential and commercial streets.

For the fourth hypothesis, 125 of the people surveyed were in urban streets, and 50 people in suburban streets. The urban streets had a mean Experienced Walkability grade of 75,64 and the suburban streets had a mean Experienced Walkability grade of 81,10. The difference between these two means was significant at 0.000, meaning that it is likely that there is a difference between these two types of areas.

Hypothesis 3 - *There are differences in the Experienced Walkability of the respondents depending on the predominant land usage type of the street. -* **True** - Residential streets scored higher than commercial streets.

Hypothesis 4 - *There are differences in the Experienced Walkability of the respondents depending on the neighbourhood type.* - **True** - Suburban streets scored higher than urban streets.

The same independent samples t-tests were done for hypotheses five and six. Of the 40 streets measured in total, 25 were urban streets and 15 were suburban streets. The urban streets had a mean Measured Walkability average per 100 meters of 3.27, and the suburban streets has a mean Measured Walkability average per 100 meters of 2.51. This was not a significant difference at 0.272 significance. The Mann-Whitney U test had a mean rank of 17 for the suburban streets and a mean rank of 22.6 for the urban streets, but this was not a significant difference at 0.142 significance. For the sixth hypothesis, 25 of the streets were residential and 15 were commercial. The residential streets had a mean Measured Walkability average per 100 meters of 4,56 and the commercial streets had a mean Measured Walkability average per 100 meters of 2,05. This was a significant difference with 0.000 significance, meaning that there is likely a difference between the means of these two types of streets. The Mann-Whitney U test had a mean rank of 13,84 for the residential streets, and 31,60 for the commercial streets, which also gave a significant difference with 0.000 significance.

Hypothesis 5 - *There are differences in the Measured Walkability of the streets depending on the neighbourhood type.* - **False** - No significant differences could be found.

Hypothesis 6 - *There are differences in the Measured Walkability scores of the streets depending on the predominant land usage type of the street.* - **True** - A significant difference was found with commercial streets scoring higher than residential streets.

Qualitative data

As mentioned earlier, there was also a qualitative part to this research, in the form of short interviews with respondents about they liked and disliked about the street they were interviewed in. These short interviews could provide some insight as to why there is a negative correlation between the Measured Walkability and the Experienced Walkability.

The responses varied per street and per neighbourhood. In De Wijert-Zuid, where people were generally very positive about their streets, three main themes emerged during the interviews. Two things which people liked about these streets is that they had a lot of room for pedestrians, and that there was a lot of green there in terms of trees, shrubs, plants, and gardens. And the main thing which they disliked about the streets was that the traffic safety could be improved, as some of the vehicles using these streets were considered to be reckless and breaking the speed limits.

In the Oosterpoortbuurt however, the themes were of a different nature. What was liked was the social environment of having a diverse neighbourhood of people, along with the fairly central location of this neighbourhood in Groningen, further the neighbourhood was also described as being relatively peaceful and easy to walk around it. The complaints here were in, in some streets particularly, about the lack of green, and that the students which live in this neighbourhood park their bicycles on the sidewalks, creating an untidy image of the street, which could sometimes also be difficult to walk through if there were a lot of bicycles in a particular part of the street, or if some had fallen over.

And lastly, in De Binnenstad the likes were mostly centered around the shops in these streets, and the old architecture. The complaints in this area were in some streets about the amount of cyclists going through, making it very difficult and sometimes even dangerous to walk through these streets, but the most often repeated complaint was about the lack of green.

The closer one got from De Wijert-Zuid to De Binnenstad, the less green one would find. The same pattern was also found in Athens, where the suburban neighbourhoods Pefki and Marousi had a lot more green than the urban neighbourhoods of Exarcheia, Kolonaki, and Monastiraki. Although a limited amount data has been collected on this during this research project, from the short interviews it would appear that the lack of green is the main reason for the lack of a positive correlation between the Measured Walkability and the Experienced Walkability. See figures 8, 9, 10 and 11 for a comparison of the amount of green between urban and suburban neighbourhoods.

Figure 8 - Marsmanlaan, De Wijert-Zuid
Picture taken from Google Street View, 2015

Figure 9 - Oosterstraat, De Binnenstad
Picture taken from Google Street View, 2017

Figure 10 - Tsamadou, Exarcheia
Picture taken by Tom de Jong, 2018

Figure 11 - Mpoumpoulinas, Pefki
Picture taken by Tom de Jong, 2018

Reliability of the data

In order to make the comparisons between streets fair, the data was all collected during daytime when it was sunny weather, with either a clear sky or lightly clouded. Care was also taken to only collect data when the shops would be open. This was of particular importance in Marousi where the shops would close at around 3 in the afternoon. Further, the sunny weather also meant that there would probably be more people outside, and thus more possible respondents. However, some of the data was also left to personal interpretation.

For example, some pieces were counted as being street furniture, whereas other people might count them as being small planters. Although this particular data was collected by one person, any such discrepancies were at least done so relatively consistently. Another point where the data is a little unreliable is in the height of the buildings. These estimations were also done relatively consistently, in some streets in Athens this was difficult to measure, given that in some streets the buildings were thus clustered together, that it was difficult to see where they exactly ended and thus it was difficult to estimate how high they were. This probably didn't have much of an effect on the overall quality and outcomes of the data however as the influence of 3 meters of building height has a fairly small effect on the scoring outcomes. More importantly however is that there was a level of self-selection in regards to the surveys. If people disliked walking in a certain street then they would probably avoid walking there or even living in that street, and if they liked walking there then they would be more inclined to walk there, or even to move to that street. This means that the surveys likely had a systematic bias in favour of higher scores. This doesn't invalidate the research however. If anything, it means that the negative correlation of **Hypothesis 1** as discussed above might be even more negative.

Conclusions and Discussion

Going back to the research questions asked in the beginning, several answers have been found to these questions, along with some indications for potential future research.

1: What are the different standards of walkability?

Several different standards had been found, with different strengths and weaknesses. These could focus on census data in regards to resident or job density, the mixture of land uses, or the level of connectivity between streets. But they could also focus more on the street design, looking at what features are present on the streets themselves. And these standards could be an inventory like the one developed by Day et al. (2006) or the one developed by Clifton, Livi, and Rodriguez (2007). But efforts have also been made to score the streets based on the urban design, like the standard of Ewing et al. (2005b) which was used in this research.

2: Is there a relationship between the Measured Walkability of a street and the Experienced Walkability of a street? (Measured Walkability referring to the score of the standard of walkability used, and Experienced Walkability referring to the experiences of respondents using the streets)

This question was the main focus of this research project. While a correlation was found between the Measured Walkability and the Experienced Walkability of a street, it turned out the be a strong negative correlation. The qualitative data indicated that this might be due to the Measured Walkability not accurately reflecting the importance of green space. While it does take into account small planters, large shrubs, hedges, or even trees are left out of the equation. Further, all the factors in the Measured Walkability are presumed to have a linear effect on the walkability of a street but it might be possible to have too much of a good thing, with too many pieces of street furniture or too many other pedestrians making it more difficult and also less enjoyable to walk through a street, rather than making the experience more enjoyable. Further research on possible improvements to Ewing et al's model of walkability taking this into account could be very beneficial as it could be a useful tool for residents and policy makers to measure and improve the walkability of their streets.

3: Are there differences between how groups of people (e.g. women, the elderly, tourists) experience walkability?

Although no significant differences could be found based on any of the personal characteristics of the respondents in regards to their Experienced Walkability, more research could still be done on the tourist experience of walkability. Most of the respondents labelled as tourists in this research, came from the area surrounding the city of Groningen and were also very familiar with the city and had been there many times. This research might produce different results in areas with more tourists coming there for the first time, or who have only been a few times.

4: Are there differences between Measured Walkability and Experienced Walkability depending on the type of usage of the streets (i.e. residential or commercial)?

Differences could be measured for both Measured Walkability and Experienced Walkability depending on the type of land use was predominant in the street, i.e. residential or commercial. The Measured Walkability would rate the commercial streets higher, and the Experienced Walkability would rate the residential streets higher however.

5: Are there differences between the Measured Walkability and the Experienced Walkability depending on the type of neighbourhood (urban or suburban)?

No significant differences were found for the Measured Walkability depending on the type of neighbourhood (urban or suburban), but there was a difference in how the Experienced Walkability rated these neighbourhoods, rating the suburban streets higher than the urban streets.

In terms of Measured Walkability, similar research using the same standard of walkability as laid out by Ewing et al. (2005b) was conducted in Salt Lake City, in the United States. There is a similar pattern in Salt Lake City as there is in Groningen and Athens where streets lying in the center of the city were more densely developed and thus scored higher than their less dense, suburban counterparts. However, unlike the streets measured in Groningen and Athens, the commercial streets in Salt Lake City did not necessarily score higher than residential streets. Certain commercial streets in Salt Lake City have large parking lots and thus a very low density, causing these streets to score relatively low on Measured Walkability (Wasatch Front Regional Council, 2016). Further, like in Groningen and Athens, another similar pattern exists where the closer one gets to the center of the city, the less green one will find.

References:

Agampatian, R. (2018). *Using GIS to measure walkability: A Case study in New York City*. Stockholm, Sweden: Royal Institute of Technology (KTH).

Aranburu, I., Plaza, B. and Esteban, M. (2016). Sustainable Cultural Tourism in Urban Destinations: Does Space Matter?. *Sustainability*, 8(12), p.699.

Bassett, D., Pucher, J., Buehler, R., Thompson, D. and Crouter, S. (2008). Walking, Cycling, and Obesity Rates in Europe, North America, and Australia. *Journal of Physical Activity and Health*, 5(6), pp.795-814.

Carey, K., Williams, S., MacCleery, R., Winters, M., Galdes, C., Brennan, M., Mulligan, J., Rose, D., Van Buskirk, B., Arc Group Ltd, Chapman, C., Belden, N., Russonello, J. and Lien, C. (2015). *America in 2015 - A ULI Survey of Views on Housing, Transportation, and Community*. Urban Land Institute.

Clifford, N., French, S. and Valentine, G. (2010). *Key methods in geography*. Los Angeles, Calif.: Sage.

Clifton, K., Livi Smith, A. and Rodriguez, D. (2007). The development and testing of an audit for the pedestrian environment. *Landscape and Urban Planning*, 80(1-2), pp.95-110.

Day, K., Boarnet, M., Alfonzo, M. and Forsyth, A. (2006). The Irvine–Minnesota Inventory to Measure Built Environments. *American Journal of Preventive Medicine*, 30(2), pp.144-152.

Ewing, R., Clemente, O., Handy, S. and Brownson, R. (2005b). *Measuring urban design qualities an illustrated field manual*. Robert Wood Johnson Foundation.

Ewing, R., Clemente, O., Handy, S., Brownson, R. and Winston, E. (2005a). *Identifying and Measuring Urban Design Qualities Related to Walkability*. Robert Wood Johnson Foundation.

Farkic, J., Peric, D., Lesjak, M. and Petelin, M. (2015). Urban walking: Perspectives of locals and tourists. *Geographica Pannonica*, 19(4), pp.212-222.

Frank, L., Andresen, M. and Schmid, T. (2004). Obesity relationships with community design, physical activity, and time spent in cars. *American Journal of Preventive Medicine*, 27(2), pp.87-96.

Gauderman, W., Vora, H., McConnell, R., Berhane, K., Gilliland, F., Thomas, D., Lurmann, F., Avol, E., Kunzli, N., Jerrett, M. and Peters, J. (2007). Effect of exposure to traffic on lung development from 10 to 18 years of age: a cohort study. *The Lancet*, 369(9561), pp.571-577.

Haskell, W., Lee, I., Pate, R., Powell, K., Blair, S., Franklin, B., Macera, C., Heath, G., Thompson, P. and Bauman, A. (2007). Physical Activity and Public Health. *Medicine & Science in Sports & Exercise*, 39(8), pp.1423-1434.

HEI Panel on the Health Effects of Traffic-Related Air Pollution. (2010). *Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects.* HEI Special Report 17. Health Effects Institute, Boston, MA.

Ierodiakonou, D., Zanobetti, A., Coull, B., Melly, S., Postma, D., Boezen, H., Vonk, J., Williams, P., Shapiro, G., McKone, E., Hallstrand, T., Koenig, J., Schildcrout, J., Lumley, T., Fuhlbrigge, A., Koutrakis, P., Schwartz, J., Weiss, S. and Gold, D. (2016). Ambient air pollution, lung function, and airway responsiveness in asthmatic children. *Journal of Allergy and Clinical Immunology*, 137(2), pp.390-399.

Kampa, M. and Castanas, E. (2008). Human health effects of air pollution. *Environmental Pollution*, 151(2), pp.362-367.

Lake, A. and Townshend, T. (2006). Obesogenic environments: exploring the built and food environments. *The journal of the Royal Society for the Promotion of Health*, 126(6), pp.262-267.

Leslie, E., Coffee, N., Frank, L., Owen, N., Bauman, A. and Hugo, G. (2007). Walkability of local communities: Using geographic information systems to objectively assess relevant environmental attributes. *Health & Place*, 13(1), pp.111-122.

Litman, T. (2017). *Economic Value of Walkability*. Victoria Transport Policy Institute.

Pahor, M., Guralnik, J., Ambrosius, W., Blair, S., Bonds, D., Church, T., Espeland, M., Fielding, R., Gill, T., Groessl, E., King, A., Kritchevsky, S., Manini, T., McDermott, M., Miller, M., Newman, A.,

Rejeski, W., Sink, K. and Williamson, J. (2014). Effect of Structured Physical Activity on Prevention of Major Mobility Disability in Older Adults. *JAMA*, 311(23), p.2387.
Pivo, G. and Fisher, J. (2010). The Walkability Premium in Commercial Real Estate Investments. *Real Estate Economics*, 39(2), pp.185-219.
Pope, C., Ezzati, M. and Dockery, D. (2009). Fine-Particulate Air Pollution and Life Expectancy in the United States. *New England Journal of Medicine*, 360(4), pp.376-386.
Schrank, D., Eisele, B., Lomax, T. and Bak, J. (2015). *2015 Urban Mobility Scorecard*. Texas A&M Transportation Institute and the Texas A&M University System.
Tribby, C., Miller, H., Brown, B., Werner, C. and Smith, K. (2015). Assessing built environment walkability using activity-space summary measures. *Journal of Transport and Land Use*.
United Nations (2016). *Paris Agreement*. Paris: United Nations, pp.1-27.
Wasatch Front Regional Council. (2018). *Wasatch Front Regional Council (WFRC) | Association of Governments*. [online] Available at: https://arcg.is/T8SyW [Accessed 10 Jun. 2018].
Wen, C., Wai, J., Tsai, M., Yang, Y., Cheng, T., Lee, M., Chan, H., Tsao, C., Tsai, S. and Wu, X. (2011). Minimum amount of physical activity for reduced mortality and extended life expectancy: a prospective cohort study. *The Lancet*, 378(9798), pp.1244-1253.
White, W. (1988). *City*. New York: Doubleday.
World Health Organization. (2016). *Air pollution levels rising in many of the world's poorest cities*. [online] Available at: http://www.who.int/mediacentre/news/releases/2016/air-pollution-rising/en/ [Accessed 5 Mar. 2018].
World Health Organization. (2018). *Obesity and overweight*. [online] Available at: http://www.who.int/mediacentre/factsheets/fs311/en/ [Accessed 5 Mar. 2018].
Zhang, K. and Batterman, S. (2013). Air pollution and health risks due to vehicle traffic. *Science of The Total Environment*, 450-451, pp.307-316.

APPENDIX A

Date			1	2	3	4	5	6	7	8
Observer										
Area #										
Answer questions 1-6 based on this end of the area										
Intersection										
Neighborhood Identification										
1. Are there **monuments or markers** including neighborhood entry signs that indicate that one is entering a special district or area?	1	yes = 1; no = 0								
Views										
11a. Is this area characterized by having a significant open view of an object or scene that is not on the area? The view must be a prominent one.	22	yes = 1; no = 0								
11b. How attractive is the open view?	23	attractive = 3; neutral = 2; unattractive = 1; NA (no views) = 8								
Begin walking along area to answer questions 12-68										
12a. What types of land uses are present on this area? Mark all that apply.										
Residential										
Single family home - detached	24	yes = 1; no = 0								
Single family home/duplex - attached (2 units or fewer)	25	yes = 1; no = 0								
Town home/condo/apartment housing (3 units or more)	26	yes = 1; no = 0								
Mobile homes (includes manufactured homes)	27	yes = 1; no = 0								
Residential, other	28	yes = 1; no = 0								
School										
Elementary, middle or junior high school	29	yes = 1; no = 0								
High school	30	yes = 1; no = 0								
University or college (includes all types of building forms)	31	yes = 1; no = 0								
School, other	32	yes = 1; no = 0								
Public Space										
Plaza, square, park, playground, landscaped open space, playing fields, garden	33	yes = 1; no = 0								
Public space, other	34	yes = 1; no = 0								

IRVINE MINNESOTA INVENTORY: AREA VERSION PAGE 1

			1	2	3	4	5	6	7	8
Recreational/Leisure/Fitness										
Gym/fitness center (also includes yoga/pilates studios, etc.)	35	yes = 1; no = 0								
Movie theater	36	yes = 1; no = 0								
Recreational, other	37	yes = 1; no = 0								
Public/Civic Building										
Community center or library	38	yes = 1; no = 0								
Museum, auditorium, concert hall, theater	39	yes = 1; no = 0								
Post office, police station, courthouse, Department of Motor Vehicles	40	yes = 1; no = 0								
Public building, other	41	yes = 1; no = 0								
Institutional										
Religious institution (church, temple, mosque, etc.)	42	yes = 1; no = 0								
Hospital, medical facility, health clinic	43	yes = 1; no = 0								
Institutional, other	44	yes = 1; no = 0								
Commercial										
Retail stores/restaurant	45	yes = 1; no = 0								
Bank/financial service	46	yes = 1; no = 0								
Hotel/hospitality	47	yes = 1; no = 0								
Car dealership	48	yes = 1; no = 0								
Gas/service station	49	yes = 1; no = 0								
Commercial, other	50	yes = 1; no = 0								
Office/Service										
Offices	51	yes = 1; no = 0								
Service facilities (includes insurance offices, funeral homes, dry cleaning, Laundromats, etc.)	52	yes = 1; no = 0								
Office/service, other	53	yes = 1; no = 0								
Industrial/Manufacturing										
Light industrial (e.g., auto paint and auto body repair shops; i.e. clean industries)	54	yes = 1; no = 0								
Medium or heavy industrial (e.g. chemical plants, oil wells, etc.)	55	yes = 1; no = 0								
Industrial, other	56	yes = 1; no = 0								
Other										
Harbor/marina	57	yes = 1; no = 0								
Undeveloped land	58	yes = 1; no = 0								
Agricultural land, ranch, farming	59	yes = 1; no = 0								
Nature feature	60	yes = 1; no = 0								
Other	61	yes = 1; no = 0								

IRVINE MINNESOTA INVENTORY: AREA VERSION PAGE 2

			1	2	3	4	5	6	7	8
12b. Do the buildings in this area contain vertical-mixed use, that is, the building has different land uses on different floors of the building?	62	yes = 1; no = 0; NA (no buildings>1 story) = 8								
12c. Determine whether any of these **distinctive retail types** are present (focusing on the form of the building).										
Big box shops (includes super stores or warehouse stores)	63	yes = 1; no = 0								
Shopping mall	64	yes = 1; no = 0								
Strip mall/row of shops	65	yes = 1; no = 0								
Drive-thru	66	yes = 1; no = 0								
13a. Mark off all types of public space(s) on this area and how attractive it is.										
Park/playground	67	attractive = 3; neutral = 2; unattractive = 1; 0 = no space								
Playing or sport field	68	attractive = 3; neutral = 2; unattractive = 1; 0 = no space								
Plaza /square /courtyard	69	attractive = 3; neutral = 2; unattractive = 1; 0 = no space								
Public garden	70	attractive = 3; neutral = 2; unattractive = 1; 0 = no space								
Beach	71	attractive = 3; neutral = 2; unattractive = 1; 0 = no space								
Other	72	attractive = 3; neutral = 2; unattractive = 1; 0 = no space								
13b. Is it possible for the general public to **use the public space**(s)?	73	unclear = 2; yes = 1; no = 0; NA = 8								
Other Land Uses										
14. How many of these land uses are present on this area?										
Bars/night clubs	74	some/a lot = 3; few = 2; none = 0								
Adult uses	75	some/a lot = 3; few = 2; none = 0								
Check cashing stores/pawn shops/bail bond stores	76	some/a lot = 3; few = 2; none = 0								
Liquor stores	77	some/a lot = 3; few = 2; none = 0								
15. How many of the following gathering places are on this area?										
Restaurants	78	some/a lot = 3; few = 2; none = 0								
Coffee shops	79	some/a lot = 3; few = 2; none = 0								
Libraries/bookstores	80	some/a lot = 3; few = 2; none = 0								
"Corner" store	81	some/a lot = 3; few = 2; none = 0								
Art or craft galleries	82	some/a lot = 3; few = 2; none = 0								
Farmers market	83	yes = 1; no = 0								

			1	2	3	4	5	6	7	8
16. Are these nature features present on this area?										
Open field/golf course	84	yes = 1; no = 0								
Lake/pond	85	yes = 1; no = 0								
Fountain/reflecting pool	86	yes = 1; no = 0								
Stream/river/canal/creek	87	yes = 1; no = 0								
Forest or woods	88	yes = 1; no = 0								
Ocean	89	yes = 1; no = 0								
Mountain or hills	90	yes = 1; no = 0								
Desert	91	yes = 1; no = 0								
Barriers										
17. Are the following barriers present on this area. Check all that apply, and whether barrier can be overcome e.g. there's a pedestrian bridge.										
Highway (elevated or below ground)	92	no barrier = 0; can be overcome = 1; can be somewhat overcome = 2; can not be overcome = 3								
Railroad track	93	no barrier = 0; can be overcome = 1; can be somewhat overcome = 2; can not be overcome = 3								
Impassable land use (e.g., gated community, major industrial complex, etc.)	94	no barrier = 0; can be overcome = 1; can be somewhat overcome = 2; can not be overcome = 3								
River	95	no barrier = 0; can be overcome = 1; can be somewhat overcome = 2; can not be overcome = 3								
Drainage ditches	96	no barrier = 0; can be overcome = 1; can be somewhat overcome = 2; can not be overcome = 3								
Road with 6 or more lanes	97	no barrier = 0; can be overcome = 1; can be somewhat overcome = 2; can not be overcome = 3								
Other	98	no barrier = 0; can be overcome = 1; can be somewhat overcome = 2; can not be overcome = 3								

			1	2	3	4	5	6	7	8
18c. What is the **condition** or maintenance of the sidewalk?	101	moderate or good = 2; poor = 1; under repair = 0; NA = 8								
18d. Is there a decorative or unique paving that covers most or all of the sidewalk on the area? (e.g., bricks, tile, etc.)	102	yes = 1; no = 0; NA = 8								
18e. Determine how much of the sidewalk is covered by these **features that provide protection** from sun, rain, and/or snow.										
Arcades	103	some/ much of s'walk covered = 1; no/little covered = 0; NA = 8								
Awnings	104	some/ much of s'walk covered = 1; no/little covered = 0; NA = 8								
Other	105	some/ much of s'walk covered = 1; no/little covered = 0; NA = 8								
Steepness										
22. How steep or hilly is this area? Mark all that apply.										
Steep	116	yes = 1; no = 2								
Moderate	117	yes = 1; no = 2								
Flat or gentle	118	yes = 1; no = 2								
Sidewalk Amenities										
23. Are there outdoor dining areas (e.g. cafes, outdoor tables at coffee shops or plazas, etc) located on the area?	119	some/a lot = 3; few = 2; none = 0								
24. Indicate how many of each of the following street furniture/sidewalk amenities is/are present on the area.										
Benches (not a bus stop), chairs and/or ledges for sitting	120	some/a lot = 3; few = 2; none = 0								
Bus stops with seating	121	some/a lot = 3; few = 2; none = 0								
Heat lamps	122	some/a lot = 3; few = 2; none = 0								
Bike racks	123	some/a lot = 3; few = 2; none = 0								
25. Are there obvious public restrooms on this area that are clearly open to the public?	124	yes = 1; no = 0								
Street Trees										
26a. How many street trees are on this area? (Do not include trees that are not on the public right of way; street trees are typically between the sidewalk and the street or if there is no sidewalk, trees usually line the street)	125	some trees/trees along most or entire area = 1; none/few trees = 0								
26b. Is the **sidewalk shaded** by trees?	126	yes/somewhat = 1; no = 0; NA = 8								

			1	2	3	4	5	6	7	8
Buildings										
27. How many stories are most buildings on the area?	127	5 or more = 3; 3-4 stories = 2; 1-2 stories = 1; hts. vary, no predominant ht. = 0; NA (no buildings) = 8								
28. Are there abandoned buildings or lots on this area?	128	some/a lot = 3; few = 2; none = 0; NA=8								
Windows										
30. How many buildings on this area have windows with bars? (proporition)	130	some/a lot = 3; few = 2; none = 0; NA = 8								
Other Features of Buildings										
31. How many buildings on this area have front porches? (porches you can sit on)	131	some/a lot = 3; few = 2; none = 0; NA = 8								
32. How much of the area has blank walls or buildings with blank walls?	132	some/a lot = 3; few = 2; none = 0; NA = 8								
Garages										
33a. How many buildings have **garage doors** facing the street?	133	some/a lot = 3; few = 2; none = 0; NA = 8								
33b. How **prominent** are most garage doors when looking at the front of the buildings?	134	very = 3; somewhat = 2; not very/not visible = 0; NA = 8								
Parking										
34a. Is there a parking structure visible on this area (do not include parking structures that are completely underground)?	135	yes = 1; no = 0								
34b. Looking at the front of the parking structure on the street level floor, what is the **predominant use** that is visible to you?	136	parking = 2; varied = 1; not pkg. other uses = 0; NA = 8								
Maintenance										
36. Describe the general maintenance of the buildings on this area.	138	attractive = 3; neutral = 2; unattractive = 1; NA = 8								
37. How much graffiti is apparent on this area?	139	some/a lot = 3; little = 2; none = 0								
38. How much litter is apparent on this area?	140	some/a lot = 3; little = 2; none = 0								
39. Are there dumpsters visible on this area?	141	some/a lot = 3; few = 2; none = 0								
40. Is there visible electrical wiring overhead on the area?	142	some/a lot = 3; little = 2; none = 0								
Lighting										
41. Is there outdoor lighting on the area? (Include lighting that is intended to light public paths and public spaces)	143	yes = 1; no = 0								

			1	2	3	4	5	6	7	8
Freeways										
42. Is there a freeway overpass/underpass connected to this area?	144	under a freeway overpass =3; next to freeway = 2; IS a freeway overpass = 1; none of the above = 0								
Architecture/Design										
46. Rate the attractiveness of the area (design + maintenance)	154	attractive = 3; neutral = 2; unattractive = 1								
47. Does this area have buildings that appear to be historic? (old + detailed)	155	yes = 1; no = 0; NA = 8								
48. How interesting is the architecture/urban design of this area?	156	interesting = 3; somewhat interesting = 2; uninteresting = 1								
Other Features of the area										
49. How many street vendors or stalls are on this area? (do not count newspaper racks; there must be a person vending)	157	some/a lot = 3; few = 2; none = 0								
50. Is there public art that is visible on this area?	158	yes = 1; no = 0								
51. Are there billboards present on this area?	159	some/a lot = 3; few = 2; none = 0								
52. How safe do you feel walking on this area?	160	pretty/very safe = 1 not very safe/unsafe = 0								
Dogs										
53. Are there any loose/unsupervised/barking dogs on this area that seem menacing?	161	yes = 1; no = 0								
Olfactory Character										
54. Is the dominant smell unpleasant?	162	yes = 1; no = 0								

Audit tool from Day et al., 2006

APPENDIX B

Name: ____________________ Date: ____________________ Study Area: ____________________

Segment Number: ____________________ Time: ____________________ Weather: ____________________

Subjective Assessment: Segment…

Enter 1,2,3, or 4 for 1=Strongly Agree 2= Agree, 3=Disagree, 4=Strongly Agree

……is attractive for walking. ____ 1
……is attractive for cycling. ____ 2
……feels safe for walking. ____ 3
……feels safe for cycling. ____ 4

0. Segment type

Low volume road [ ] 1
High volume road [ ] 2
Bike or Ped path - skip section C [ ] 3

A. Environment

1. Uses in Segment *(all that apply)*

Housing - Single Family Detached [ ] 1
Housing- Multi-Family [ ] 2
Housing- Mobile Homes [ ] 3
Office/Institutional [ ] 4
Restaurant/Café/Commercial [ ] 5
Industrial [ ] 6
Vacant/Undeveloped [ ] 7
Recreation [ ] 8

2. Slope

Flat [ ] 1
Slight hill [ ] 2
Steep hill [ ] 3

3. Cul-de-sac/Dead-end

Segment has dead end [ ] 1
Segment continues [ ] 2
Road deadends but path continues [ ] 3

B. Pedestrian Facility *(skip if none present)*

4. Type(s) of pedestrian facility *(all that apply)*

Footpath (worn dirt path) [ ] 1
Paved trail [ ] 2
Sidewalk [ ] 3
Pedestrian Street (closed to cars) [ ] 4

The rest of the questions in section B refer to the best pedestrian facility selected above.

5. Path material *(all that apply)*

Asphalt [ ] 1
Concrete [ ] 2
Paving Bricks or Flat stone [ ] 3
Gravel [ ] 4
Dirt or Sand [ ] 5

6. Path obstructions *(all that apply)*

Poles or Signs [ ] 1
Parked Cars [ ] 2
Trees [ ] 3
Garbage Cans [ ] 4
Other [ ] 5

7. Buffers between road and path *(all that apply)*

Hard Buffer
Fence [ ] 1
Trees [ ] 2
Hedges [ ] 3
Soft Buffer
Landscape [ ] 4
Grass [ ] 5
Path distance from curb (feet): ____ 6
Path width (feet): ____ 7

If no sidewalk,skip now to section C.

8. Sidewalk completeness/continuity

Sidewalk is complete [ ] 1
Sidewalk is **in**complete [ ] 2

9. Sidewalk connectivity to other sidewalks/crosswalks

number of connections ____ 1

10. Sidewalk condition/maintenance

Poor (many bumps/cracks/holes) [ ] 1
Fair (some bumps/cracks/holes) [ ] 2
Good (very few bumps/cracks/holes) [ ] 3
Under Repair [ ] 4

C. Road Attributes *(skip if path only)*

11. Condition of road

Poor (many bumps/cracks/holes) [ ] 1
Fair (some bumps/cracks/holes) [ ] 2
Good (very few bumps/cracks/holes) [ ] 3
Under Repair [ ] 4

12. Number of lanes

# of lanes to cross ____ 1

13. Posted speed limit

None posted [ ] 1
(mph): ____ 2

14. On-Street parking *(if pavement is unmarked, check only if cars parked)*

Parallel or Diagonal [ ] 1
Go to Q17 - None [ ] 2

15. Off-street parking lot spaces

	0-5	6-25	26+
If none go to Q17 -			

16. Must you walk through a parking lot to get to most buildings?

Yes [ ] 1
No [ ] 2

17. Driveways

There are driveways in segment [ ] 1
There are no driveways in segment [ ] 2

18. Traffic control devices *(all that apply)*

Traffic Light [ ] 1
Stop Sign [ ] 2
Traffic Circle [ ] 3
Speed bumps [ ] 4
Chicanes or chokers [ ] 5

19. Curb Cuts in segment

Yes [ ] 1
No [ ] 2

20. Crossing Aids in segment *(all that apply)*

Cars Must Stop
Pavement Markings [ ] 1
Yield to Ped Paddles [ ] 2
Pedestrian Signal [ ] 3
Crossing Aids
Median/Traffic Island [ ] 4
Curb Extension [ ] 5
Overpass/Underpass [ ] 6
Warnings to Cars
Pedestrian Crossing Street Sign [ ] 7
Flashing Warning [ ] 8

D. Walking/Cycling Environment

21. Lighting

None [ ] 1
Poor [ ] 2
Fair [ ] 3
Good [ ] 4

22. Amenities *(all that apply)*

Garbage cans [ ] 1
Benches [ ] 2
Water fountain [ ] 3
Bicycle parking [ ] 4
Street vendors/vending machines [ ] 5

23. Are there wayfinding aids?

No [ ] 1
Yes [ ] 2

24. Number of trees shading walking area

None or Very Few [ ] 1
Some [ ] 2
Many/Dense [ ] 3

25. Degree of enclosure

Little or no enclosure [ ] 1
Some enclosure [ ] 2
Highly enclosed [ ] 3

26. Powerlines along segment?

No [ ] 1
Low Voltage/Distribution Line [ ] 2
High Voltage/Transmission Line [ ] 3

27. Cleanliness (Is there litter, garbage, broken glass, or graffiti?)

None or Almost None [ ] 1
Yes Some [ ] 2
Yes Lots [ ] 3

28. Articulation in building designs

Little or no articulation [ ] 1
Some articulation [ ] 2
Highly articulated [ ] 3

29. Building setbacks from street

At edge of sidewalk [ ] 1
Within 20 feet of sidewalk [ ] 2
More than 20 feet from sidewalk [ ] 3

30. Bicycle lane

None or not marked [ ] 1
Striped bicycle lane [ ] 2

31. Transit facilities

No [ ] 1
Yes [ ] 2

Audit tool from Clifton, Livi, and Rodriguez, 2007

Appendix C

Hello, my name is Tom de Jong.

I am a student from the University of Groningen in the Netherlands and I am doing a research project on the walkability of streets in Athens, Greece, and in Groningen, the Netherlands. The survey consists of six questions. The questions are completely anonymous, and you are free to not answer them or stop the survey at any time.

Thank you for your cooperation.

What is your gender?	What is your age?	Are you here as a tourist or as a local resident? If you are here as a tourist, please specify your country of origin.	Do you have any injuries or disabilities which affect your ability to walk? No need to specify.	Are you from a rural or an urban background?	How would you rate your walking experienc e in this street on a scale from 0 to 100?	Location of survey
Female	21	Germany	No	Urban	80	Venizelou
Male	55	Local	Yes	Rural	40	Ermou

Note: Answers above are examples only.

Appendix D

Neighbourhood	Street	Average street score	Average Neighbourhood score	Average street grade	Average neighbourhood grade
Marousi	Ermou	3.25	4.25	NA	NA
Marousi	Dimitras	3.95	4.25	NA	NA
Marousi	Nik Plastira	4.98	4.25	NA	NA
Marousi	Dionisou	5.35	4.25	NA	NA
Marousi	Vassilissis Sofias	3.73	4.25	NA	NA
Monastiraki	Mitropoleos	13.27	6.34	NA	NA
Monastiraki	Ifestou	3.26	6.34	NA	NA
Monastiraki	Adrianou	6.75	6.34	NA	NA
Monastiraki	Pandrossou	3.91	6.34	NA	NA
Monastiraki	Aiolou	4.53	6.34	NA	NA
Pefki	Kanari	0.77	1.67	NA	NA
Pefki	Mikras Asias	1.21	1.67	NA	NA
Pefki	(Eastern Dagkli	1.75	1.67	NA	NA
Pefki	(Western) Dagkli	1.57	1.67	NA	NA
Pefki	Mpoumpoulinas	3.07	1.67	NA	NA
Exarcheia	Mpoumpoulinas	2.21	2.20	NA	NA
Exarcheia	Tsamandou	2.51	2.20	NA	NA
Exarcheia	Spirou Trikoupi	2.58	2.20	NA	NA
Exarcheia	Navarchou Notara	1.73	2.20	NA	NA
Exarcheia	Zaimi	1.98	2.20	NA	NA
Kolonaki	Ipsilantou	1.50	2.15	NA	NA
Kolonaki	Karneadou	1.65	2.15	NA	NA
Kolonaki	Alopekis	1.79	2.15	NA	NA
Kolonaki	Ploutarchou	3.31	2.15	NA	NA
Kolonaki	Irodotou	2.52	2.15	NA	NA
Oosterpoortbuurt	Van Julsinghastraat	2.85	2.58	74	76.1
Oosterpoortbuurt	Jacobstraat	2.68	2.58	76	76.1
Oosterpoortbuurt	Polderstraat	2.11	2.58	78.5	76.1
Oosterpoortbuurt	Oliemulderstraat	2.69	2.58	75.5	76.1
Oosterpoortbuurt	Warmoesstraat	2.57	2.58	76.5	76.1
De Wijert Zuid	Marsmanlaan	1.78	1.63	82.5	81.1

De Wijert Zuid	Van Moerkerkenlaan + Anton Coolenlaan	1.23	1.63	78	81.1
De Wijert Zuid	Ter Braaklaan	2.01	1.63	82	81.1
De Wijert Zuid	Aart van den Leeuwlaan + Leopoldlaan	1.43	1.63	81	81.1
De Wijert Zuid	Du Perronlaan	1.71	1.63	82	81.1
Binnenstad	Folkingestraat	3.15	3.08	77.33	75.33
Binnenstad	Oosterstraat	3.72	3.08	74.33	75.33
Binnenstad	Gelkingestraat	2.29	3.08	74	75.33
Binnenstad	Herestraat	3.91	3.08	77.33	75.33
Binnenstad	Oudekijk in het Jatstraat + Stoeldraaierstraat	2.35	3.08	73.67	75.33

Table of the results of the data collection. Average street score was calculated by adding the other measures (Imageability, Enclosure, Human Scale, Transparency, and Complexity as outlined by Ewing et al. (2005b)) together and dividing by five. This score was then standardized across all streets by calculating the score per 100m. The average neighbourhood score was calculated by adding the individual street scores together within a neighbourhood and then dividing it by five. Only the first two decimals included of all numbers. The scores here refer to the Measured Walkability of a street, and the grades refer to the Experienced Walkability of a street. The street Dagkli is divided into a western and eastern half, which are separated by the street El. Venizelou.