Groningen: the 17 minute city?

A study on the perception of walkable distance and the encouraging and restricting policies for walking in Groningen

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Source: (Leverette, 2013)

Abstract

Walking is a healthy, environmentally conscious, and sustainable alternative to driving. However, not everyone walks as their main mode of transportation, and the distance people can and want to walk can vary. There are also factors that encourage and restrict people from walking. This paper aims to determine how far residents of Groningen are willing to walk, and explore the importance of factors that might impact their decision to walk. It also discusses the restricting and encouraging policies for walking in the municipality of Groningen. Results have discovered that the distance that people are willing to walk is roughly in line with the concept of the 15-minute city, but that many people are even willing to walk above that threshold, depending on the purpose. Results may be used by local governments to make decisions on how to plan cities based on walking distances that are realistic to their population. Further research can look into the encouraging factors in other places around the world, and also the habits of those who walk more frequently.

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1. Introduction

When it comes to mobility transitions, shifting away from a car-based society is an important step. Walking is a sustainable alternative that provides health, mental health, and financial benefits compared to driving. However, one of the biggest downfalls of walking is its limited range compared to other modes of transport. In many places a car can go significantly faster than a walking human, so making the switch from driving to walking is rather difficult in a practical sense.

This study will aim to discover how far people are willing to walk, and what factors contribute to that. The results of this study will build upon walkability research, which may in turn help with policy making in local government. Furthermore, this research has both theoretical and societal relevance. This study will build upon existing literature about walkability and walkable distance by attempting to figure out the factors which determine how far someone would walk. The results can also be used to challenge the idea of the 15-minute city; a concept developed by Carlos Moreno (UNFCCC, 2021). Since this concept is not rooted in any ideas based on how far people actually walk or are willing to walk and is more of a planning strategy to have necessary facilities accessible within 15 minutes, the results of this study can be used to adapt the 15-minute city concept. It might also, however, support the 15-minute city concept. The societal relevance of this research is that walking can significantly reduce an individual's carbon footprint, helping to reduce the effects of climate change overall. Additionally, reducing car emissions helps increase air quality (West et. al., 2013) and can overall improve people's health. By figuring out what entices people to make the switch from driving to walking, it might give an insight into how other people can make that same switch.

1.1 Research aim

While perceived walkability is how walk-friendly an area is seen by the people who live there (De Vos et. al., 2023), this paper will aim to determine how far people actually think is walkable, by asking them the maximum distances they are willing to walk to certain places. The main research question is therefore stated as follows:

How far are individuals of Groningen willing to walk to certain destinations in their daily lives?

The sub questions that will be used to answer the research question are:

1. *What factors influence an individual's willingness to walk?*
2. *What would it take for people to walk more?*
3. *What are the restricting and encouraging policies for walking in the municipality of Groningen?*

1.2 Structure

This thesis will present the theoretical framework surrounding the factors that influence walking behavior and perceived walking distance in Section 2, outline the methodology of the research in Section 3, present the results in Section 4, discuss the findings in Section 5, and finally, state the conclusion of the study in Section 6.

2. Theoretical framework

John Urry (2004) discusses the rise of the self-expanding system of automobility in the 20th century, and proposes an eventual transition to a post-car society. With rising issues of climate change, it may be necessary for individuals to change their travel behavior sooner than expected. Some of the effects that motorized vehicles have on the environment are air pollution (and CO_2 emissions), traffic congestion in urban areas, and even noise pollution. Transportation accounts for nearly one fourth of all CO_2 emissions (Glazener et. al., 2022). Walking is a healthy and sustainable alternative to driving, and results in zero CO_2 emissions. Getting people to switch from driving to walking could improve the health of the environment, and as a result improve the health of people. This section will look at the literature relating to the factors that determine how far people are willing to walk, as well as look at the literature about walking as a niche practice.

2.1 Factors that determine willingness to walk

The way that people perceive the walkability of the place they live in can have an impact on how much they walk. This is an important concept in the way that it relates to objective walkability, and has an impact on how walkable someone perceives their neighborhood. Arvidsson et. al. (2012) conclude that, from a sample of 1,925 individuals in Stockholm, only about two-thirds of them perceived the walkability of their neighborhood for what it actually was. The remaining one-third perceived the walkability of their neighborhood as being low, when objectively it was high.

There are several factors which can influence perceived walkability. The conceptual model shown below (De Vos et. al., 2023) shows that objective walkability as well as walking attitudes and residential location, affect perceived walkability. This in turn will likely have an impact on the distance one is willing to walk (or reported walking distance). The model also explains that perceived walkability can influence people's behavior when it comes to physical activity.

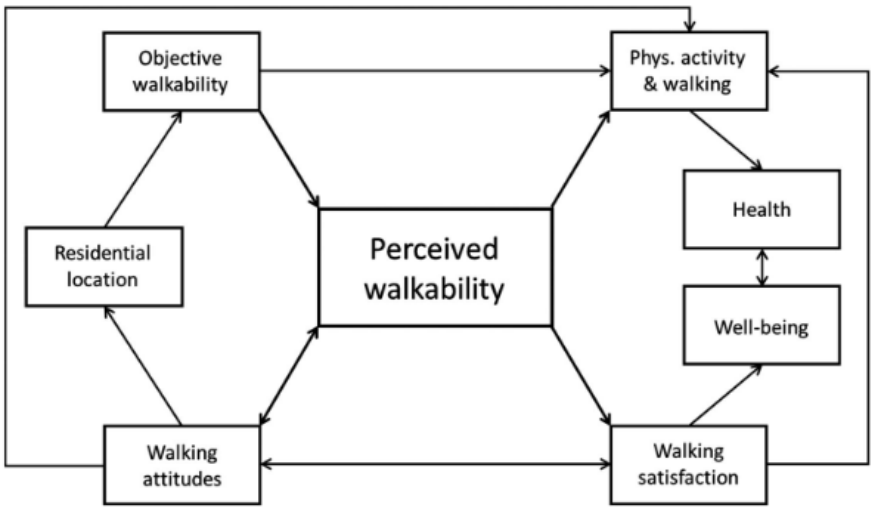

Figure 1: Conceptual model by De Vos et. al. (2023) on Perceived walkability

A study by Mohiuddin et. al. (2022) concluded that amongst students in Bangladesh, perception of safety from crime had an impact on their decision to walk when commuting to school or work compared to non-students. With the non-students, perceptive walkability was a greater factor.

Studies have also shown that areas with nature and greenery such as parks or gardens are attractive for walking, cycling, and other sorts of physical activities (Lu et. al., 2018). However, when it comes to residents in urban areas, parks are often separate from people's daily walking routes and therefore the park is a *destination* where one goes to do physical activities. Having greenery at eye level on streets may encourage people to walk more in their daily lives, as it is more inviting and shown to have positive impacts on health (Lu et. al., 2018).

Transport mode may also influence whether someone chooses to walk. In the Netherlands between 2010 and 2017, there has been a slight decrease in walking among people younger than 50 years (Ministry of Infrastructure and Water Management, 2019). At the same time, the Netherlands has seen an increase in car ownership and usage outside of the G4 cities (Amsterdam, Rotterdam, The Hague, and Utrecht) (Ministry of Infrastructure and Water Management, 2022). A study in the USA found that frequent car-users develop a lower threshold for walking compared to non-frequent car-users (Loukopoulos & Gärling, 2005). There are certain reasons which car users give for opting to drive over walking. For example, having goods to carry, having to drive family members, the distance being too long, poor weather conditions, being short on time, etc. are common reasons why people decide to drive (Mackett, 2003).

Whether or not someone walks frequently has also been shown to have an impact on how someone perceives certain distances. However, it is uncertain as to which direction it influences. Ralph et. al. (2020), for example, found that those who walk often tend to perceive distances as closer than those who do not walk as frequently. On the other hand, McCormack et. al. (2008) found that those who walk more than 25 minutes per week for transportation overestimated the

distance to a supermarket, compared to those who walk less. The discrepancy between these findings might have to do with limitations of the study design of McCormack et. al. (2008).

2.2 Walking distance and walking as a niche practice

What is walking distance? This question can vary greatly depending on who is asked. There are a lot of articles that try to quantify this measure, yet there is no consensus among them. In a study among US residents, results showed that 65% of walking trips that are made are greater than ¼ mile, or approximately 400 meters (Yang and Diez-Roux, 2012). Subsequently, it showed that about 20% of trips have a duration of over 15 minutes. The median walking distance was 10 minutes and ½ mile, or about 800 meters. However, walking distance also greatly depends on the purpose of the trip. A study done in Spain concluded that for commutes to school, children were willing to walk around 875 meters and adolescents were willing to walk around 1,350 meters (Rodriguez-Lopez et. al., 2017).

There are some individuals who already find themselves living "post-car", by walking as their means of transportation. Whether they walk out of enjoyment or necessity, they walk more than the average person in today's world. What many of these individuals have in common is walking for well-being and pleasure (Christie, 2018). For the average person, however, motivation is required to incorporate more walking in their daily lives. The needs of pedestrians are often forgotten in planning practices (Fonseca et. al., 2022), which can demotivate walking. Therefore, measures are needed to make walking more pleasurable and easier to integrate into people's daily lives (Christie, 2018).

2.3 Conceptual Model

Figure 2: Conceptual model for perception of walkable distance

The conceptual model in figure 2 shows the hypothesis for the variables in this study. Based on the variables which are believed to influence one's perceived walkable distance according to the literature discussed above, are: 1) walking enjoyment, 2) the objective walkability of the area in which they live, 3) proximity to green space, 4) the most used transport mode, and 5) safety of their residential area.

2.4 Hypothesis

The hypothesis is that the variables stated in the conceptual model will have an impact on the distance that people are willing to walk. For example, those who live in a more objectively walkable neighborhood will report that they are willing to walk further distances than someone who lives in a less walkable neighborhood. Furthermore, it is predicted that individuals with a higher walking enjoyment will report higher walking distances, and those who live in safe areas will report higher walking distance. For transportation use, it is predicted that those who drive as their main transport mode will report lower distances than those who take public transportation or use active modes of transport.

3. Methodology

The aim of this research is to determine how far people think is "walkable." The central research question is therefore:

How far are individuals of Groningen willing to walk to certain destinations in their daily lives?

The following sub questions will be used to answer the main research question:

1. *What factors influence an individual's willingness to walk?*
2. *What would it take for people to walk more?*
3. *What are the restricting and encouraging policies for walking in the municipality of Groningen?*

In order to answer the main and sub research questions, several methods are used. A combination of qualitative and quantitative data is gathered in a mixed methods approach. To determine the factors relating to willingness to walk and the factors that influence the distance someone is willing to walk, a survey via Maptionnaire was created. To quantify the variables, the distance that one is willing to go will be measured by minutes walking; with the average walking speed being around 5 km per hour, 1 km distance would be approximately 12 minutes walking.

3.1 Data Collection

3.1.1 Willingness to walk

In order to figure out the factors that relate to an individual's willingness to walk, a questionnaire was created and distributed. The questionnaire was created through the website Maptionnaire, since some of the data is linked to the location in which the individuals live. It also allowed respondents to answer some questions interactively (drawing the border of their neighborhood on the map.

Respondents were asked to answer how far they are willing to walk in number of minutes, rather than in distance (for example kilometers). By using the average walking speed of 5 km/hour, the distance they are willing to walk can be calculated from their response in minutes. The reason for posing the question in this way is that people will likely give a more accurate representation of how far they are willing to walk. Furthermore, it is easier to answer and does not require the respondent to refer to a source such as Google maps to calculate the distance they would walk.

After collecting the data from the questionnaire, statistical analysis through SPSS is used to figure out the degree to which each variable impacts the respondents' willingness to walk.

The population group for this study is residents in Groningen, since perceived walkability is also affected by objective walkability. Therefore, the first question that is asked is which neighborhood they live in. If they do not live in Groningen, they should not answer this question and discontinue the survey. The map of the neighborhood borders (Figure 3) was shown on the questionnaire for respondents to identify their neighborhood.

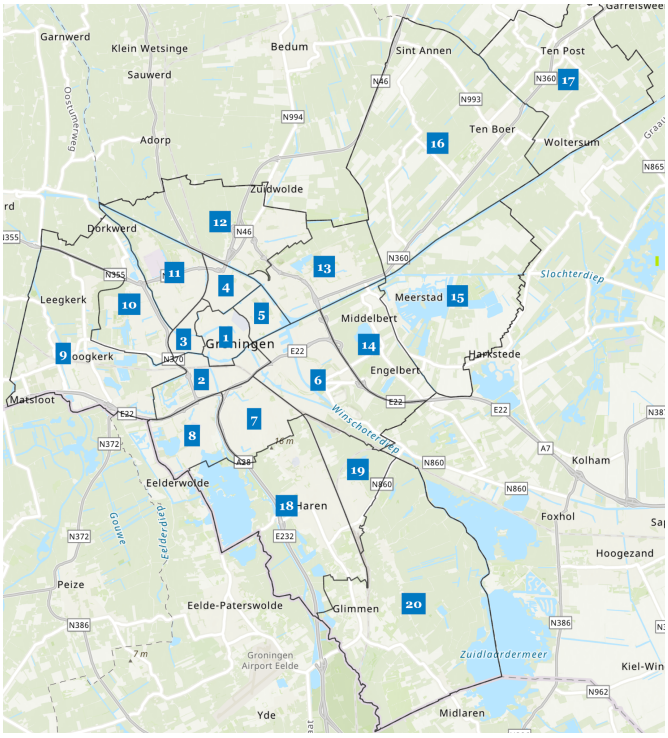

Figure 3: Map of Groningen split by neighborhoods

Participants were recruited through personal contacts as well as by distributing flyers with the QR code linked to the questionnaire. The survey was created in both English and Dutch to be able to reach the widest audience possible. The survey was open for approximately 5 weeks.

3.1.2 Walkability

There are different ways to calculate the walkability of a place. Figure 4 shows multiple ways it can be done (Agampatian, 2014). The index which has been used for this study is Walkability

Index II by Frank et al., 2010. It uses the following factors: 1) Net residential density, 2) Commercial density, 3) Land use mix, and 4) Street connectivity. The data for the walkability of each neighborhood in Groningen was calculated by Geurts (2023) using the method by Frank et. al. (2010).

1. Walkability Index I (Lachapelle et al., 2011)
Walkability index is calculated at the block group level across each region using the sum of the z-scores of: i. Net residential density ii. Intersection density iii. Retail floor area ratio iv. Entropy based measure of land use mix.
2. Walkability Index II (Frank et al., 2010)
Walkability index is calculated at the block group level across each region using the sum of the z-scores of: i. Net residential density: No. of residential units per acre designated for residential use within a neighborhood buffer. ii. Commercial density (or Retail Floor Area Ratio): Amount of area designated for commercial use within a neighborhood buffer, using a ratio of commercial floor area to commercial land area. iii. Land use mix (mixed use index): The evenness of square footage distribution across residential, commercial (including retail and services), entertainment, and office development within a neighborhood buffer. iv. Street connectivity: Number of street intersections in a neighborhood buffer.
3. Walkability Index III (Frank et al., 2009)
This walkability index is based on: i. Net residential density: Ratio of residential units to the land area devoted to residential use per block group. ii. Retail floor area ratio: Retail building floor area footprint divided by retail land floor area footprint. iii. Land use mix: The mix measure considered 5 land use types: residential, retail, entertainment, office and institutional. Values were normalized between 0 and 1, with 0 being fully homogenous use and 1 indicating a completely even distribution of floor area across the five uses. iv. Intersection density: Ratio between the number of true intersections (three or more legs) to the land area of the block group in acre. The four calculated values were normalized using a z score = [(2x"z-intersection density") + ("z-net residential density")+("z-retail floor area ratio")+("z-land use mix")

Figure 4: Walkability Indices (Agampatian, 2014)

3.1.3 Restricting and encouraging policies

The second sub-question, regarding the restricting and encouraging policies for walking, is answered through a literature review/desk research. For this part of the research, qualitative research is done through gathering secondary data. A mix of government websites and sources from the municipality of Groningen, as well as peer reviewed articles, are utilized to answer this question.

3.2 Data Analysis

To determine the correlation between the variables walking enjoyment, perceived traffic safety, and perceived crime in the neighborhood with willingness to walk, Spearman's rank correlation

test is used. This is because the variables are ordinal and continuous and therefore linear regression is not as accurate. One Way Analysis of Variance (ANOVA) was used to analyze the correlation between transport mode and willingness to walk.

3.3 Quality and Validity of Data

The responses obtained from the survey had some shortcomings, meaning that the results from the statistical analysis can not be generalized. There was not an equal representation of each neighborhood, and the age group 18-24 is overrepresented. Furthermore, most of the respondents report that they use either walking or biking as their main mode of transportation. Both modes are active and sustainable, so encouraging bike users to make the switch to walking does not solve much in terms of emitting less pollution or contributing to a healthier lifestyle. However, it is still interesting to understand the reasons why people decide to walk. Furthermore, the reasons why bike users decide to walk might be similar to the reasons why car users would decide to walk. Another consideration is that people might not give an accurate estimation of what they are willing to walk. Some might overestimate the distance, while others may underestimate it. More research should be conducted on people's true walking behaviors.

3.4 Ethical Considerations

The questionnaire respondents were given a brief overview of the study on the first page of the questionnaire. They were encouraged to answer all parts of the questionnaire, though not all were mandatory due to the nature of some questions and the capabilities of the Maptionnaire platform. However, participation was voluntary, and respondents could stop the questionnaire at any time. In order to maintain a degree of anonymity, rather than asking participants to locate their home address on the survey, they are instead asked to indicate the neighborhood in which they live. Therefore, the walkability of each neighborhood can still be calculated and then connected back to their other responses.

4. Results

4.1 Overview of respondents

The chart below shows the age distribution of the respondents. The majority of respondents were of the age group 18 to 24 years, making up slightly more than 80 percent of the total respondents. This is followed by respondents aged 25-29, 30-39, then 40-49 and 50-59. No responses were received for the age group 60+.

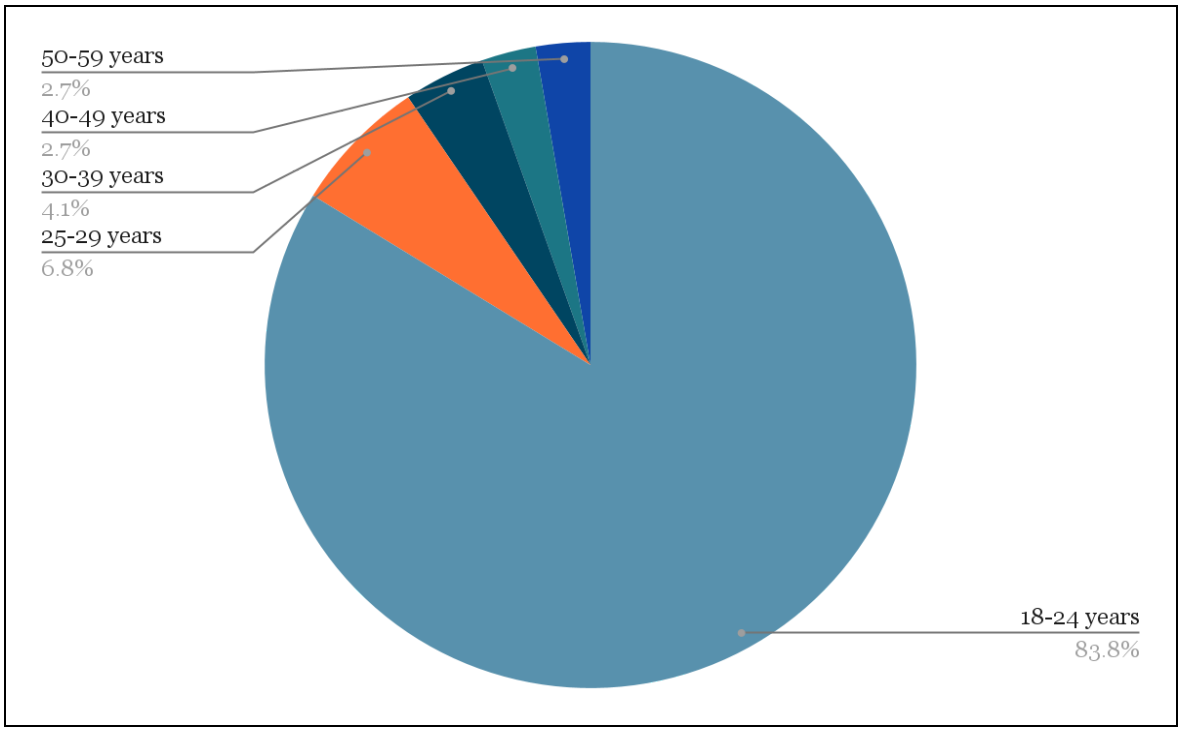

Figure 5: Chart of respondents' ages

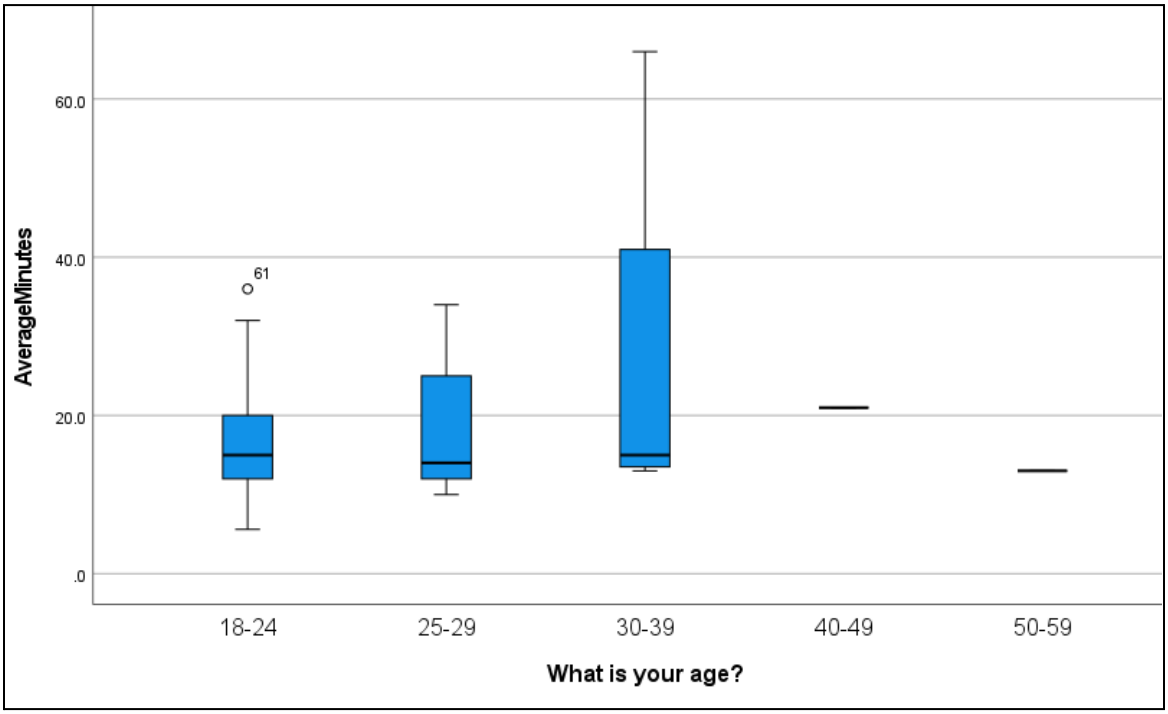

Figure 6: Box and whisker plot of average minutes (by age)

The box plot above shows the range of responses per age group, for the average number of minutes they are willing to walk. The main age group that will be analyzed is 18-24 since that group had the most respondents. The responses range from 5 minutes to 36 minutes, with an average of about 16.5 minutes.

The graph below (figure 7) shows the distribution of the neighborhoods in which the respondents live. Figure 6 shows the population of each neighborhood according to CBS data of 2022. The number of respondents that were obtained for each neighborhood does not fully correspond to the population of residents per neighborhood, so the sample obtained is not completely representative of the true population. Additionally, there are some neighborhoods for which no responses were obtained, so they have been ruled out of the final calculations.

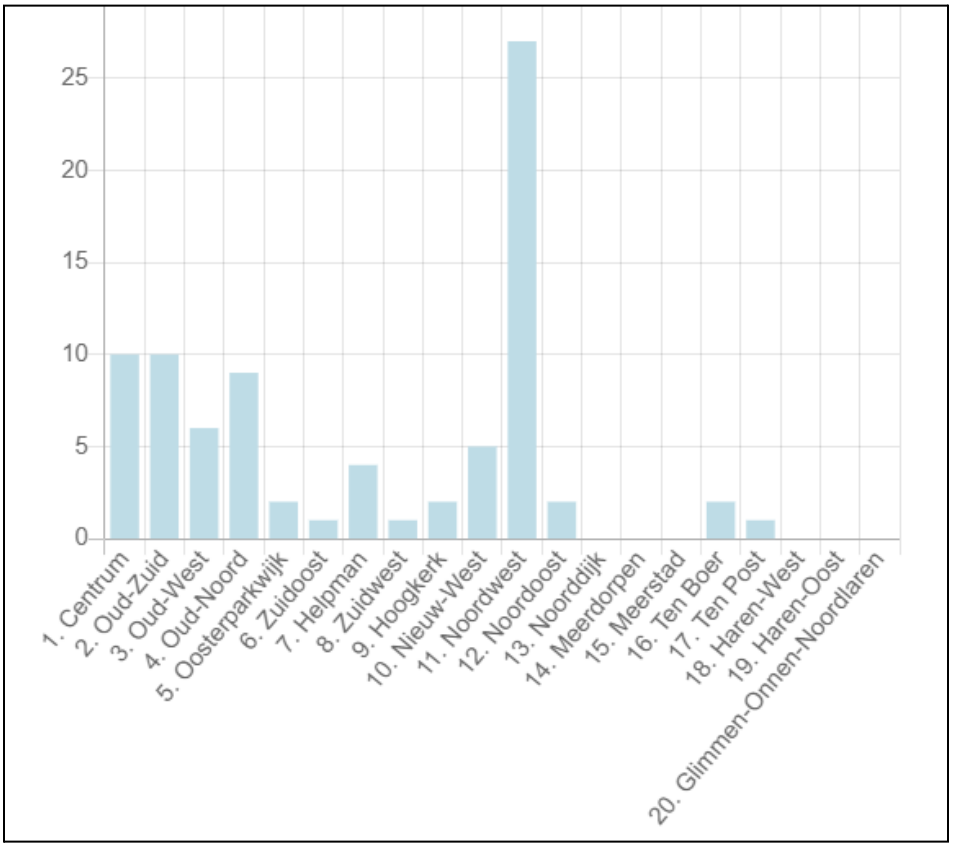

Figure 7: Distribution of responses per neighborhood

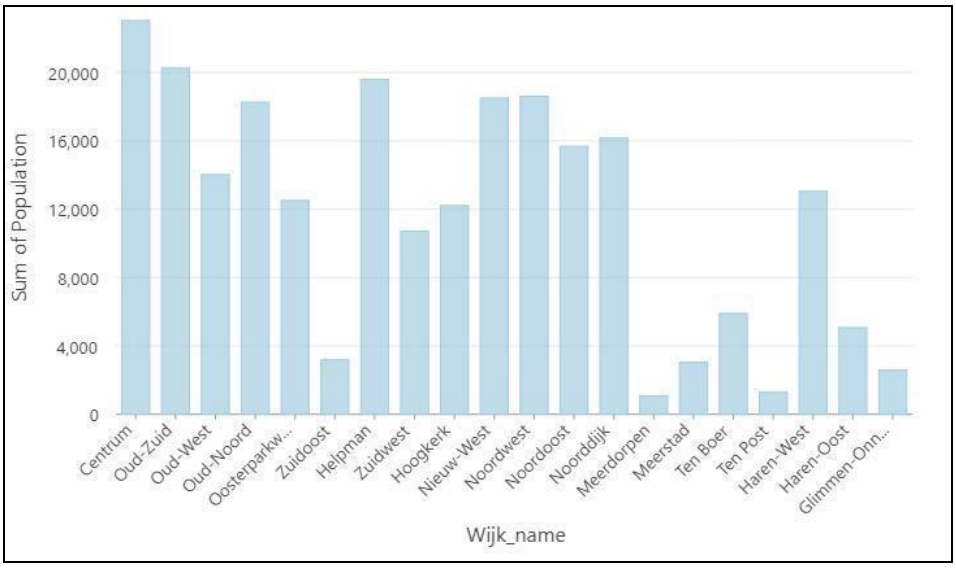

Figure 8: Population distribution by neighborhood (Data from CBS 2022)

4.2 Questionnaire results

4.2.1 How far would you walk?

The following table shows an overview of the results from the question, "How far would you be willing to walk?". For each destination (supermarket, school or work, shopping, restaurant, and meeting with a friend), the average response in minutes has been calculated.

Destination	Average response in minutes
Supermarket	11.7
School or Work	17.9
Shopping	16.1
Restaurant	18.8
Meet with a friend	22.2
Total	17.3

Table 1: Average response in minutes for "How far would you be willing to walk?"

The map below shows the average reported distance per neighborhood. The averages per neighborhood of each destination separately can be found in Appendix 2.

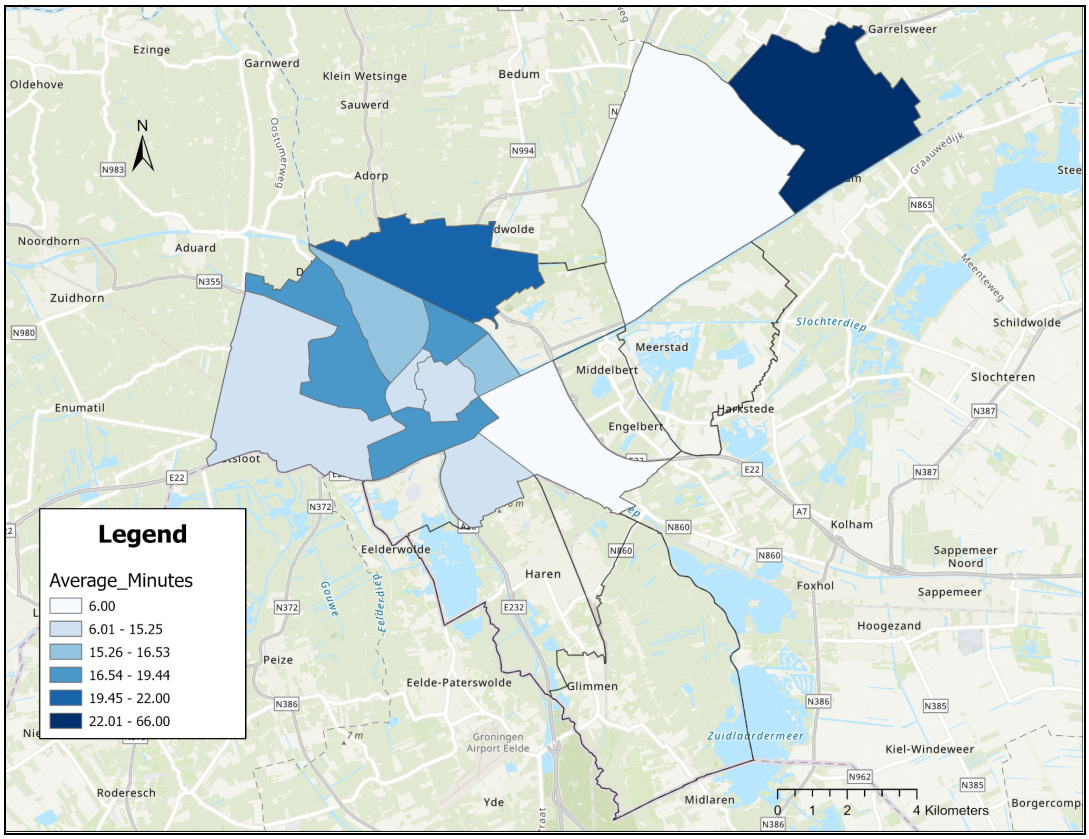

Figure 9: Map of average response in minutes for willingness to walk

The results indicate that people are willing to walk the longest distances to meet with a friend, and shortest distances to go to the supermarket. In the open question asking, "what factors influence your decision to walk," many respondents wrote that if they are going grocery shopping, they will choose an alternative transport mode because they do not want to carry lots of groceries for a while. In total, the average distance people are willing to walk is around 17.3 minutes.

4.2.2 Safety

From the Spearman's rank correlation test, it can be concluded that for the sample of respondents that was obtained for this study, safety does not correlate with the number of minutes one is willing to walk. The p-values for both traffic safety and crime were larger than 0.05, leading to the assumption that there is no effect of safety on willingness to walk. However, it is unknown as to why this is the case. This finding goes against the literature that perception of safety has an impact on whether or not someone walks. It could be the case that Groningen is a relatively safe city (Politie, 2014) and therefore everyone has a similar perception of safety.

4.2.3 Transport mode

For transport mode, a One Way Analysis of Variance test was used to determine if the mode of transportation one uses has an influence on willingness to walk. First, the most frequently used

transport mode was analyzed. The data was tested for normality through QQ-plots and proved to be roughly normal, so the ANOVA test could be used. (There were not enough respondents who used their car, scooter, or public transport as their main transportation mode to be included in the test.) The test was not significant with a p-value of 0.943. Therefore, the number of minutes that those who bike as their main mode of transportation are willing to walk does not differ significantly from those who walk as their main mode of transportation.

The second most frequently used transport mode was tested the same way, using One-Way ANOVA. Similarly to the most frequently used transport mode, the test was not significant with a p-value of 0.815. From these tests it appears that the mode of transportation which someone takes does not significantly influence how far someone is willing to walk.

4.2.4 Walkability

The walkability of each neighborhood is shown in the map below. It is calculated per "buurt", so this study will look at the amount of "high scoring" buurten per neighborhood. Note: the data for the neighborhoods of Ten Boer and Ten Post are not available. "Low scoring" neighborhoods are identified by those with a score of below -1.19. "Average scoring" neighborhoods are identified as having a score between -1.19 and 1.47. "High scoring" neighborhoods will be defined by the proportion of "buurten" that have a Walkability Index (WAI) of greater than 1.47.

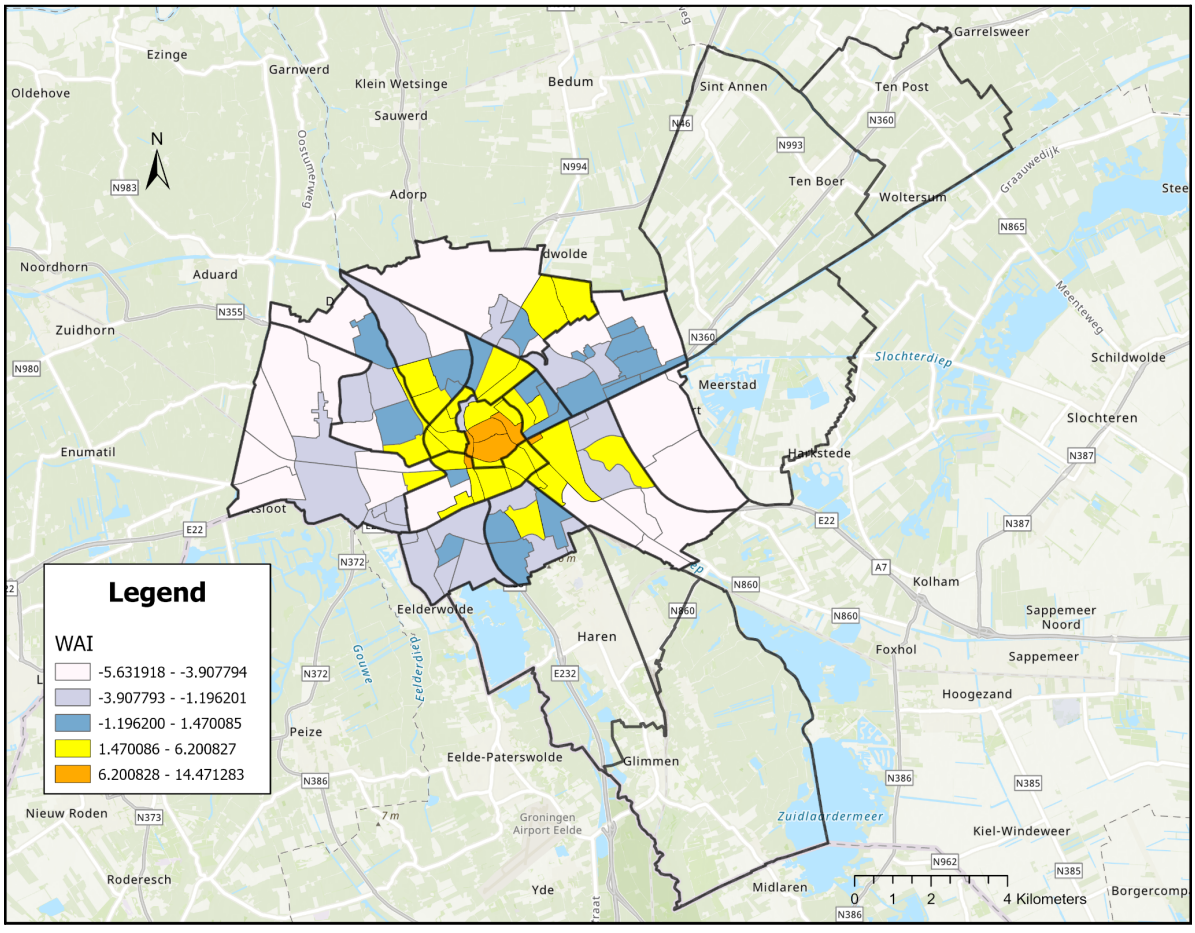

Figure 10: Map of walkability index per "buurt", split by neighborhood boundaries

The neighborhood with the highest number of high scoring “buurten” is Oud-West, with 100% of its “buurten” scoring above 1.47. The map below shows the percentage of high scoring “buurten” per neighborhood. By looking at the maps, there does not appear to be a correlation between walkability and reported walking distance. To test this, a Spearman’s rank correlation test was performed (see appendix 3), and confirmed a lack of correlation between the two variables. While contrary to the literature, possible reasons could be that someone in the city center is used to facilities being close by and therefore not be willing to walk as far as someone who is used to having to walk longer distances to get to a grocery store or school, for example. Additionally, the study by Mohiuddin et. al. (2022) found that perceptive walkability had a greater influence on non-students than students. Since this study obtained responses from mainly 18-24 year olds (most of which students), this could be another possible reasoning for walkability having a low influence on reported walking distance.

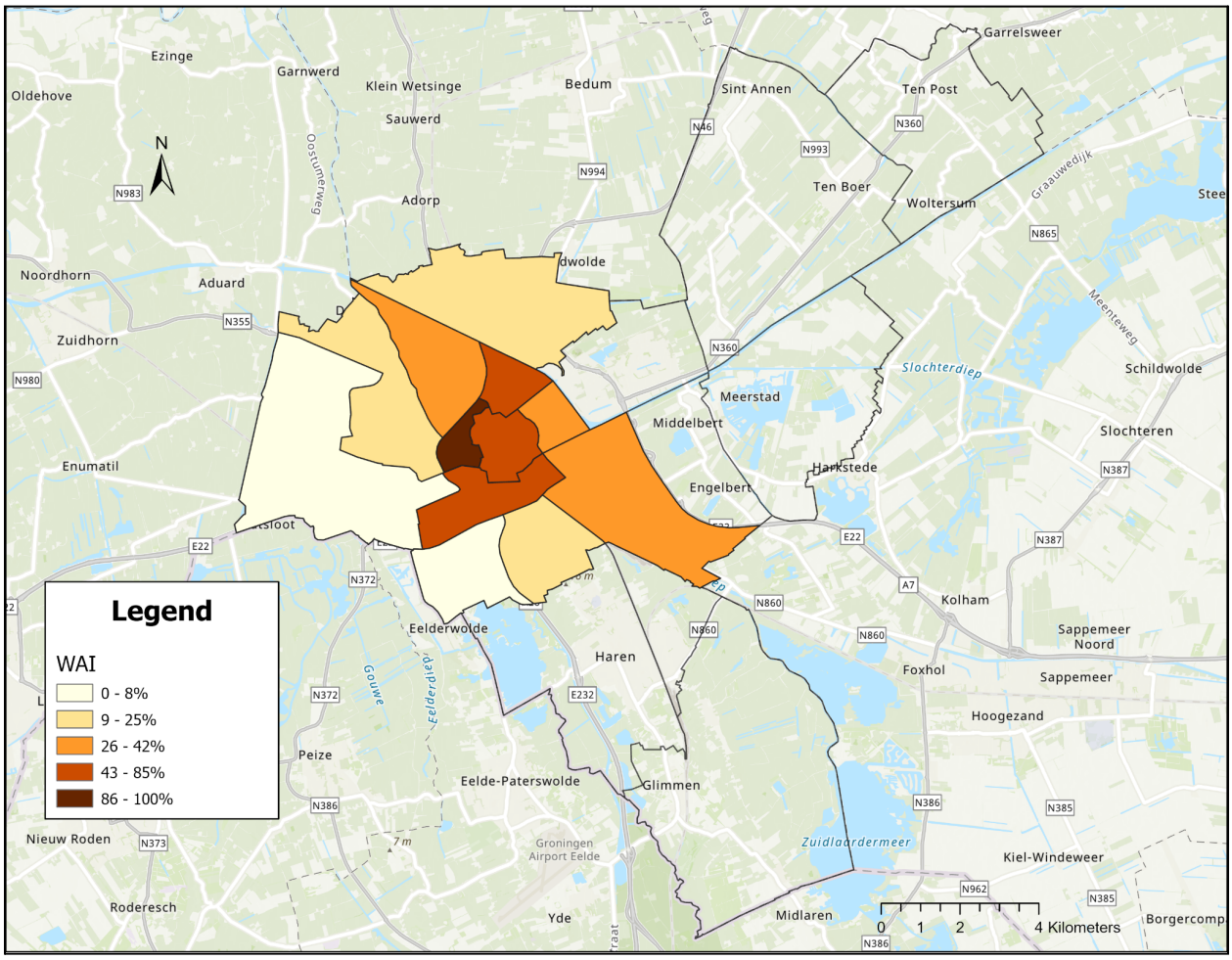

Figure 11: Map walkability index in terms of percentage of high scoring “buurten”

4.2.5 Walking enjoyment

Respondents were asked to answer on a scale from 1 to 10, how much they enjoy walking. The results are shown in the map below (figure 12) with the average response per neighborhood. The neighborhood that reported the highest walking enjoyment (9 out of 10) was Ten Post, followed by Centrum, Oud-Zuid, and Oud-West. The neighborhood that reported the least walking enjoyment out of all the neighborhoods (2 out of 10) is Zuidoost.

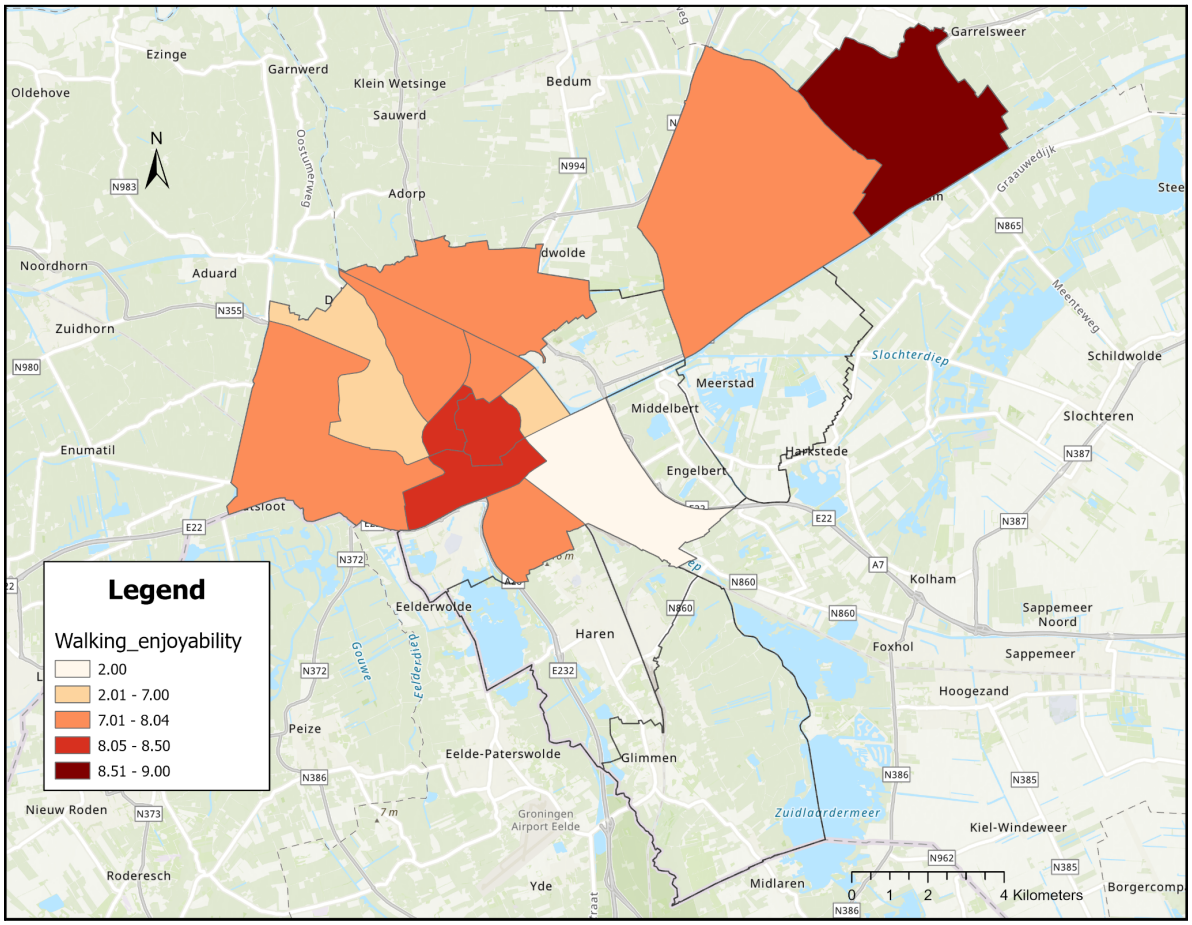

Figure 12: Map of average walking enjoyability per neighborhood

It can be noted that there appears to be a correlation between walking enjoyment and the number of minutes one is willing to walk. This is confirmed by the results of the Spearman's rank correlation test that found that walking enjoyability has a moderate positive correlation with reported walking distance (see Appendix 3).

4.2.6 Reported encouraging factors

For the question "*What would it take for you to walk more in your daily life*?," a range of responses were given. Reasons such as "more greenery", "more free time", "better weather" and "better walking infrastructure/less car infrastructure" were commonly reported. A lack of alternative transport options (for example, if they had no access to a bike or public transport)

was also a recurring reason. Other respondents reported that having more motivation would help them walk more, while some said that having someone to walk *with* would encourage them to walk more. These results are in line with the findings of Yang and Diez-Roux (2012) who state that proximity to destinations and the presence of other walkers influence walking behavior.

4.2.7 What factors influence the decision to walk?

This open question allowed respondents to report the factors which they believe influence their decision to walk; not necessarily how *far* they walk. The table below shows a tally count of the factors reported, categorized into 14 different categories. The most commonly reported factor is weather, followed by time and walking route/environment. For the walking route/environment category, many respondents reported that they would walk if it was in nature or through areas with greenery. These results are in line with findings from Mackett (2003) which found that some of the main reasons people have for taking the car are that they have to carry heavy goods (luggage), they are short on time, or they have to travel a long way (distance). One of the other reasons was that they had to give a ride to family, but since the majority of the respondents in this study were ages 18-24 (and mostly students) this was not a factor that influenced their decision to walk.

Factor	**Count**
Weather	58
Time	38
Walking route/environment	22
Distance	12
Motivation or mood	12
Purpose of trip/amount of luggage	7
Traffic situation	5
Lack of another transport mode	5
Safety	4
Walking infrastructure	4
Health	3
Season	1
Familiar Route	1
People to walk with	1

Table 2: Tally of responses to the question, "What influences your decision to walk?"

5. Discussion

5.1 What can be done to encourage walking

A significant number of respondents (over half) stated that time was a factor that influenced their decision to walk. Having amenities that are closer would help to cut down on the time it takes to walk, therefore encouraging people to walk more. This means walking more frequently and for shorter distances. Priority for pedestrians at crossings would also help to achieve shorter walking times. Additionally, adding more greenery along sidewalks and having better walking infrastructure would encourage residents of Groningen to walk more. More research can be done to determine what could be done to encourage car-users to walk more, since this study lacks data to make a substantial conclusion about that.

5.2 Who walks the most?

To understand the behaviors of people who walk above average, it is worth looking into their habits and preferences. Of the respondents aged 18-24, there were 14 respondents whose average minutes were above the third quartile, of which there is one outlier. The one outlier reported that they are willing to walk an average of 36 minutes. This individual walks as their main mode of transportation, and uses public transportation as their second most used mode of transportation. Of the upper quartile responses, this individual is the only one to walk as their main transport mode. The other responses in the upper quartile primarily use the bike or e-bike, and secondarily walk, use the car, or use public transportation, and their motivations for walking are relatively similar to the rest of the respondents' motivations.

5.3 Restricting and encouraging policies

Groningen is a progressive city in terms of encouraging active modes of transport, and discouraging car use (Gemeente Groningen, 2022). The city's Sustainable Urban Mobility Plan, *Groningen Well on the Way*, outlines measures taken to reduce car usage in the inner city as well as demonstrate how it will be inclusive of active transport modes. Quoted from the mobility plan, "Because the city is compact, most amenities are within biking and walking distance of each other" (Gemeente Groningen, 2022). The city has a high emphasis on social cohesion and sees streets as more than just a tool for mobility; it sees them as a place for social interactions. Therefore, a high value is placed on making the streets attractive and safe for walking.

There are also some hindrances to walking, not due to cars but due to bikes. In some areas of the city, there is a higher priority placed on bicycle paths than sidewalks, forcing pedestrians to use the bike path. Though sometimes the paths are meant for both, having to walk with bicycles rushing by is not a preferred scenario for many.

There are no explicit laws or policies that outright restrict or encourage walking; rather, it has to do with the infrastructure available to pedestrians and the initiatives from the local government to make the city more car-free. There are ways in which the municipality of Groningen could

improve, namely adding more pedestrian friendly sidewalks alongside bike paths, or adding greenery to streets to make them more attractive for walking. Additionally, ensuring that important amenities are within walking distance, especially in neighborhoods outside of the city, might encourage people to use active modes of transport. Another measure to take could be giving priority to pedestrians at road intersections, to cut down on travel time by foot.

6. Conclusions

This study concludes that the city of Groningen has many encouraging policies for walking and has strong ambitions to further eliminate cars from the city and make way for active modes of transport. From the questionnaire, walking attitude is the most influential factor that determines how far someone is willing to walk, while transport mode, safety, and walkability appear to have no significant impact.

The questionnaire results show that many people are willing to walk slightly *more* than 15 minutes, which is an interesting finding. While the 15-minute city is a popular concept, Groningen planners can use these results to plan cities according to how far people in Groningen are willing to walk, although more data should be collected first. According to this study, supermarkets should be roughly within 11 minutes walking distance, whereas schools and shops can be slightly more than 15 minutes away. For non-daily trips such as meeting with a friend or going to a restaurant (trips that do not require carrying much luggage) slightly over 20 minutes is an appropriate length. Overall, however, walking distances are underestimated and people are often willing to walk further distances than planners might expect.

Identifying the behaviors and walking habits of young people can give an insight into how the future of our transportation will look. Young people aged 18-24 are at an age where they probably do not have the means to purchase a car, and rely on other transportation modes. This is a critical moment in these people's lives, as their mindset now can be a strong factor in whether or not the use of cars will continue to grow. Encouraging walking as a mode of transport can lead to an overall healthier population and healthier, cleaner cities. This can be done by supporting those who already walk frequently, and by making it easier for those who are less inclined to, for example by improving pedestrian infrastructure or reducing the amount of cars on roads.

This study is not without its limitations. First, the questionnaire that was conducted may be unrepresentative of the total population of Groningen. With just over 70 respondents, this is not sufficient in generalizing the results for the entire population of Groningen. Some neighborhoods are unrepresented or only have one respondent, which is not in line with the true population sizes per neighborhood. Therefore, further time would need to be invested in order to more accurately sample the population and make conclusions. Furthermore, the majority of the respondents are of the age group 18-24, and thus assumptions about age must be made very carefully.

Further research can be done on the factors which influence walking in other parts of the world. Groningen has shown itself to be a very advanced city when it comes to efforts to increase

walkability, while there are many other places which this is not the case. It would be interesting to do this same research in a more car-oriented city or country, or where walking holds a lower priority in spatial planning. Carrying out a similar study might indicate that there are different variables that impact an individual's willingness to walk compared to those in a place like Groningen. Additionally, for the city of Groningen, more research could be conducted to find out about people's true walking behaviors and how some of the less-walkable neighborhoods can be improved for walking.

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8. Appendices

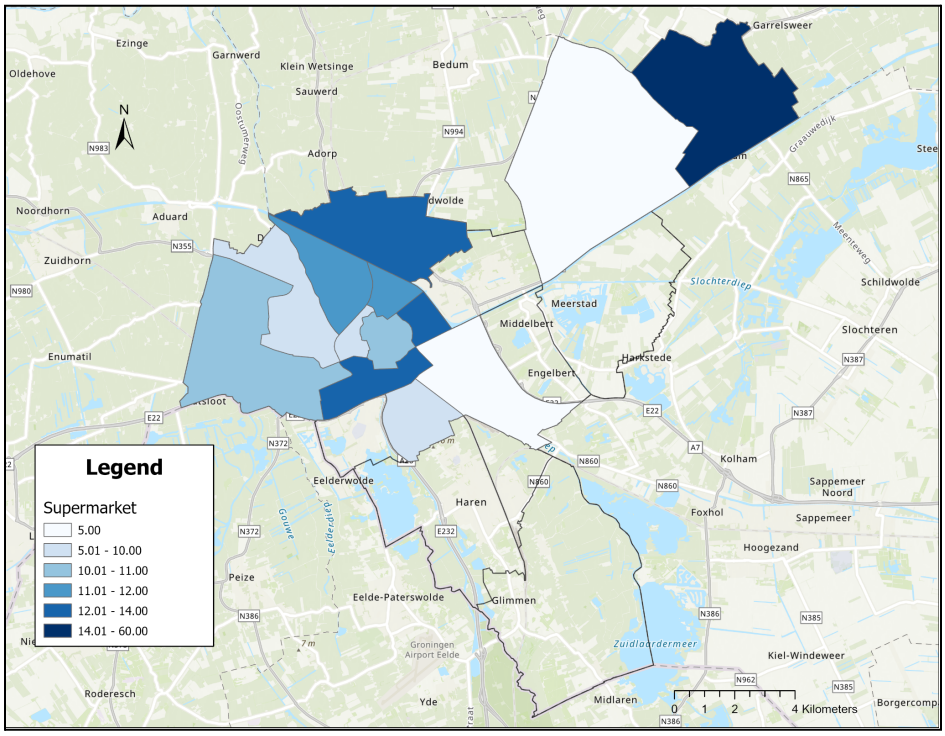
Appendix 1: Overview of questions from questionnaire

Question asked	**Variable measured**
In what neighborhood of Groningen do you live?	Objective walkability, proximity to green space
What is your age?	Age
On a scale from 1-10, how much do you enjoy walking?	Walking enjoyment
What would it take for you to walk more in your daily life?	Walking enjoyment
What is the maximum number of minutes you would be willing to walk to a supermarket?	Willingness to walk
What is the maximum number of minutes you would be willing to walk to your school or place of work?	Willingness to walk
What is the maximum number of minutes you would be willing to walk to go shopping?	Willingness to walk
What is the maximum number of minutes you would be willing to walk to a restaurant?	Willingness to walk
What is the maximum number of minutes you would be willing to walk to meet up with a friend?	Willingness to walk
What transport mode do you use most often on a daily basis?	Transport mode
What transport mode do you use second most often?	Transport mode
On a scale of 1-10 how safe do you think your neighborhood is in terms of traffic safety as a pedestrian?	Safety of residential area
On a scale of 1-10 how safe do you think your neighborhood is in terms of crime as a pedestrian?	Safety of residential area
What factors influence your decision to walk?	Other

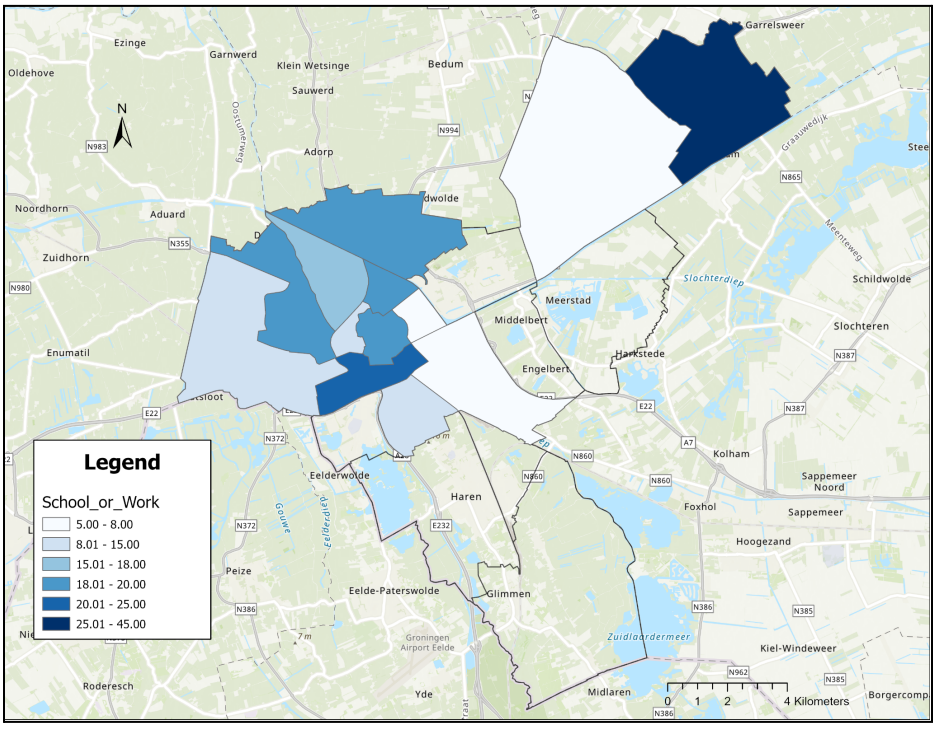
Appendix 2: Maps

1. How far would you walk…

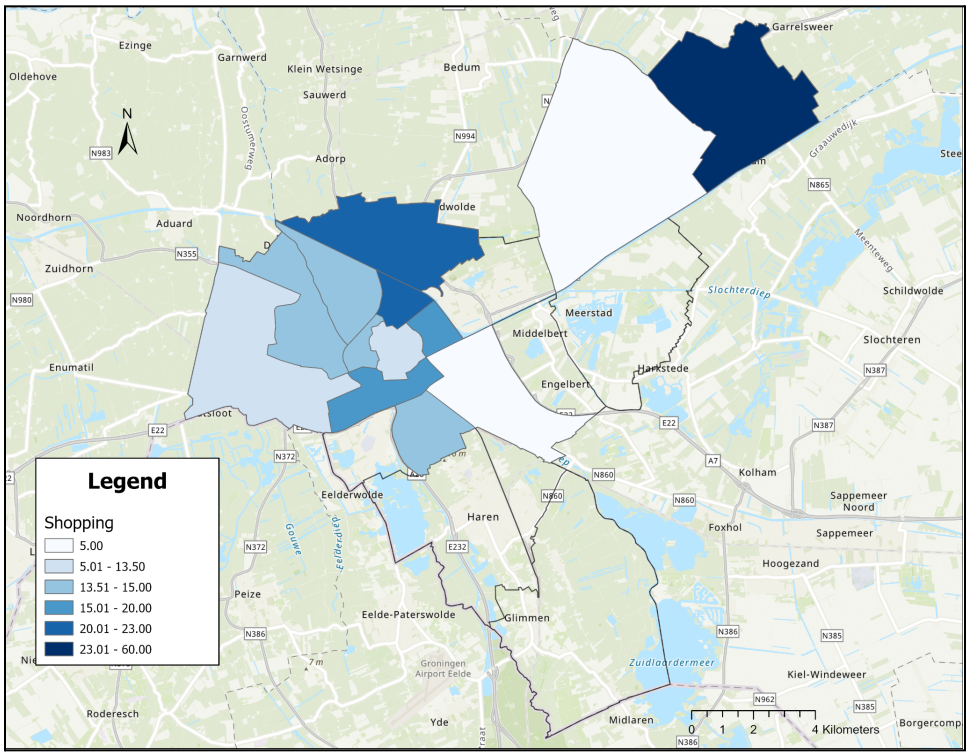
To go to the supermarket:



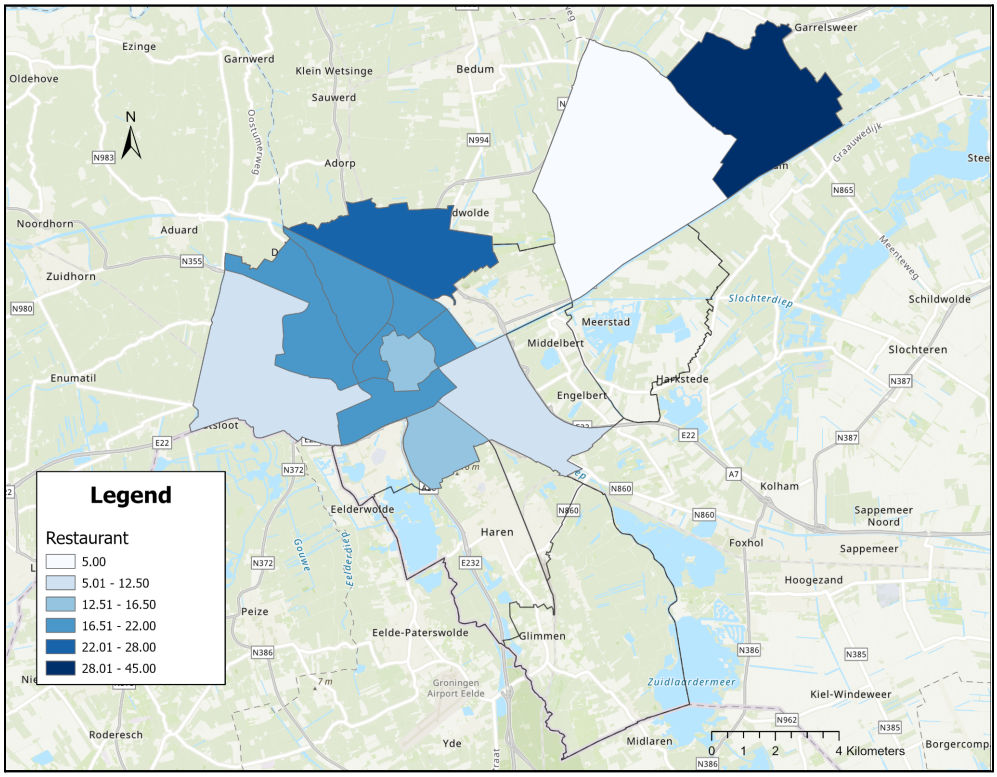
To commute to school or work:



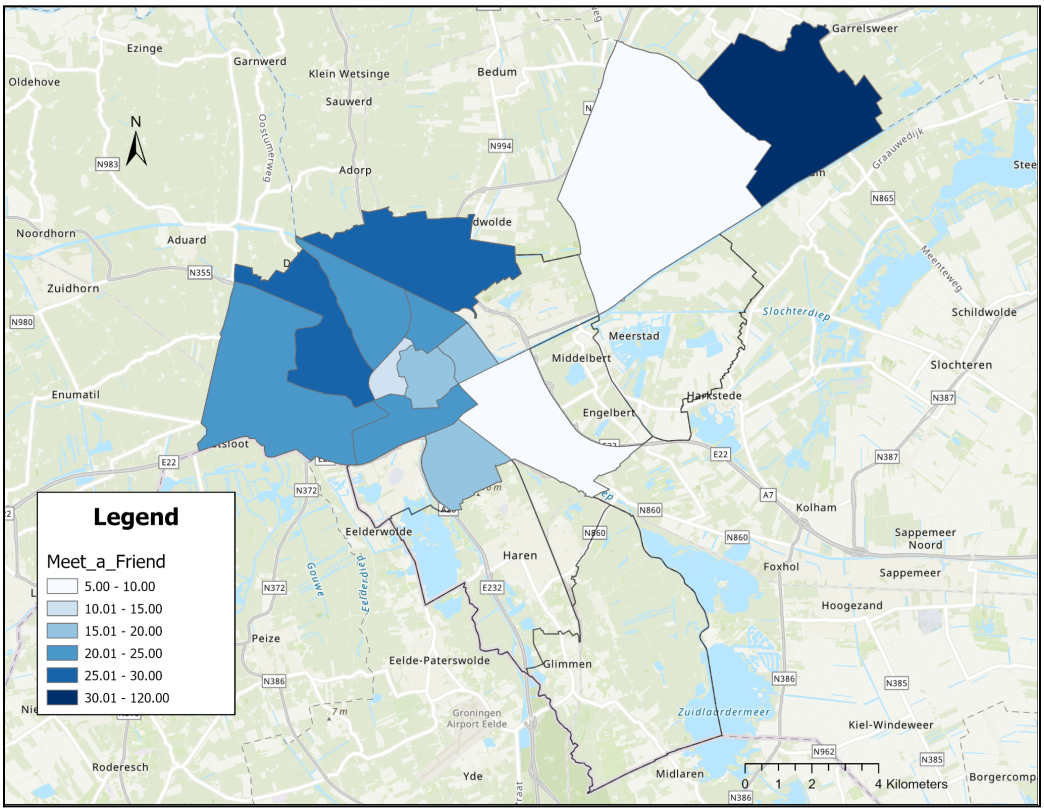
To go shopping:



To go to a restaurant:



To meet with a friend:



Appendix 3: Statistical Tests - SPSS Outputs

1. Spearman's Rho: Walking Enjoyment

Correlations

			On a scale from 1-10, how much do you enjoy walking?	AverageMinutes
Spearman's rho	On a scale from 1-10, how much do you enjoy walking?	Correlation Coefficient	1.000	.334**
		Sig. (2-tailed)	.	.004
		N	72	72
	AverageMinutes	Correlation Coefficient	.334**	1.000
		Sig. (2-tailed)	.004	.
		N	72	73

**. Correlation is significant at the 0.01 level (2-tailed).

2. Spearman's Rho: Traffic Safety in Neighborhood

Correlations

			AverageMinutes	On a scale of 1-10, how safe do you think your neighborhood is in terms of TRAFFIC SAFETY as a pedestrian?
Spearman's rho	AverageMinutes	Correlation Coefficient	1.000	.140
		Sig. (2-tailed)	.	.246
		N	73	71
	On a scale of 1-10, how safe do you think your neighborhood is in terms of TRAFFIC SAFETY as a pedestrian?	Correlation Coefficient	.140	1.000
		Sig. (2-tailed)	.246	.
		N	71	71

3. Spearman's Rho: Crime in Neighborhood

Correlations

			AverageMinutes	On a scale of 1-10, how safe do you think your neighborhood is in terms of CRIME as a pedestrian?
Spearman's rho	AverageMinutes	Correlation Coefficient	1.000	.141
		Sig. (2-tailed)	.	.247
		N	73	69
	On a scale of 1-10, how safe do you think your neighborhood is in terms of CRIME as a pedestrian?	Correlation Coefficient	.141	1.000
		Sig. (2-tailed)	.247	.
		N	69	69

4. One-Way ANOVA: Most Used Transport Mode

ANOVA

AverageMinutes

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	31.467	3	10.489	.128	.943
Within Groups	5671.022	69	82.189		
Total	5702.489	72			

Descriptives

AverageMinutes

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1	1	16.000	.	.	.	.	16.0	16.0
2	65	17.265	9.0655	1.1244	15.018	19.511	5.6	66.0
3	6	18.667	9.0701	3.7029	9.148	28.185	10.0	36.0
4	1	13.000	.	.	.	.	13.0	13.0
Total	73	17.304	8.8995	1.0416	15.228	19.381	5.6	66.0

Labels:

1 =Public Transport

2 = Bike (or e-bike)

3 = Walking

4= Moped/scooter/motorcycle

5. One-Way ANOVA: Second Most Used Transport Mode

ANOVA

AverageMinutes

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	76.998	3	25.666	.315	.815
Within Groups	5625.491	69	81.529		
Total	5702.489	72			

Descriptives

AverageMinutes

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
0	6	16.333	10.4051	4.2479	5.414	27.253	6.0	32.0
1	24	18.675	12.5224	2.5561	13.387	23.963	7.2	66.0
2	5	15.400	3.5777	1.6000	10.958	19.842	10.0	20.0
3	38	16.842	6.2088	1.0072	14.801	18.883	5.6	34.0
Total	73	17.304	8.8995	1.0416	15.228	19.381	5.6	66.0

Labels:

0 = Car

1 = Public Transport

2 = Bike (or e-bike)

3 = Walking

6. Spearman's Rank Correlation Test: Walkability

Correlations

			Walkability	AverageMinutes
Spearman's rho	Walkability	Correlation Coefficient	1.000	.058
		Sig. (2-tailed)	.	.632
		N	71	71
	AverageMinutes	Correlation Coefficient	.058	1.000
		Sig. (2-tailed)	.632	.
		N	71	73