Time Flies When You Walk

THE EFFECTS OF ENVIRONMENTAL CHARACTERISTICS ON THE TIME-TRAVEL PERCEPTION OF PEDESTRIANS

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Figure 1 Logo Goudappel (Goudappel, n.d.)

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PREFACE

Dear reader,

With great pride and happiness, here before you is my thesis for the master's degree in Spatial Planning at Utrecht University. This thesis is the last step in completing a seven-year study course. From an applied sciences bachelor's degree to a university master's degree. Who would have expected me to write three different theses throughout my studies?

Throughout my bachelor's and master's degrees, I showed a keen interest in mobility, which I could translate into a topic for my master's thesis. Commissioned by Goudappel, I started working on the time-travel perception of pedestrians and which environmental characteristics influence it. The first thank you goes to the 40 participants who took the time to come and walk for me. Without them, my research had no ground to stand on. I am, therefore, incredibly grateful to those who participated. Doing statistical analyses for the first time was more challenging than predicted, making me even more proud of its results.

During my internship at Goudappel, I received much help from various experts, but an emphatic thank you to my two supervisors, Bas and Rick. Being able to get two different perspectives every week did me much good. The internship period flew by because of the good atmosphere. Finally, thanks also to my supervisor from UU, Katharina. I did not always understand every aspect of conducting scientific research, but you knew how to help me through the process perfectly.

A 20-week process compressed into a large volume of words.

Utrecht, June 2024

Eline

SUMMARY

The walkability of a place is determined by environmental characteristics such as footpath quality, social safety, and friendly appearance (CROW, 2023; Southworth, 2005). These characteristics can influence pedestrians' willingness to walk longer and their time-travel perception — the feeling of how quickly time passes during a walk (Gkavra, 2021). People see time as scarcity and want to make the most of it (van Hagen, 2011). Walkable routes could help make time well-spent and more enjoyable. This research aimed to determine how environmental characteristics influence pedestrians' willingness to walk for longer and enhance their time-travel perception on three walking networks in Utrecht. A mixed methods approach was used, with 40 participants walking three routes and completing surveys. Statistical analyses supported by qualitative data were used to draw conclusions. All this is to answer the following central question: *How do environmental characteristics contribute to enhance the time-travel perception for pedestrians?*

This research examined three walking networks: base (route A), plus (route B) and green (route C), with the expected quality increasing from A to C. Route C received the highest average scores for environmental characteristics but was perceived as monotonous. Route B was praised for ease of walking but scored low on monotony, friendliness and noise. Route A had the lowest expected and actual quality, was criticised for narrow footpaths and few seating options but still scored above 7. High-scoring characteristics enhance the walking experience, while low-scoring characteristics indicate areas for improvement. Regarding the time-travel perception, route A was the most positive, with the lowest overestimation of walking time despite its low environmental scores. Route C followed, and route B had the greatest overestimation. Environmental characteristic scores did not explain the differences in time-travel perception among the routes.

Not all environmental characteristics contribute to enhance the time-travel perception for pedestrians. The scores of the walking experience of a route are not a prerequisite for determining the time-travel perception of pedestrians. Nevertheless, the following characteristics positively contributed to enhancing the time-travel perception for pedestrians: the ability to find the way easily, diverse routes, plenty of greenery, the ability to pass someone easily, and footpath width. In addition, a few environmental characteristics negatively contributed to the time-travel perception: busyness, lack of seating options, and unfriendly appearance. As for the stimuli, it was found that familiarity with the area and the weather positively affected pedestrians' time-travel perception. By improving these significant characteristics, it is possible to create pedestrian-friendly environments that encourage longer walks, contributing to a healthier living environment centred around walking.

CONTENTS

GLOSSARY OF TERMS

Walkability	The extent to which the built environment provides comfort and safety for pedestrians, connects people and is visually attractive throughout the walking network to promote and encourage walking (Southworth, 2005).
Walking Experience	Perceived quality of the walking environment (Delgado-Ortiz et al., 2023).
Environmental Characteristics	Needs of a pedestrian are translated into identifiable and changeable elements of the environment (CROW, 2023).
Time-travel Perception	The experience of how quickly time goes by while walking from A to B (Gkavra, 2021).

1.0 INTRODUCTION

Did you achieve the goal of walking 10,000 steps today? Many people around the world continue to embrace this daily goal. It has been a popular trend for many years and originates from the ‘sixties when the first step counter was introduced in Japan. Currently, studies show a new number of steps that are necessary for achieving the health benefits of walking. Concluded was that the optimal amount is 8,800 steps a day. Still, motivation and living in a walkable environment are needed. Especially during COVID-19, the needs of a pedestrian came into focus. Meeting indoors was not possible for a long time, so walking became a popular alternative. However, many people did not live in an inviting location for walking and spent a large amount of time indoors (Paydar & Fard, 2021; Stens et al., 2023).

1.1 HEALTHY LIVING ENVIRONMENT

Cities must be liveable, climate goals must be achieved, and air quality should be improved. There has been a mobility transition to a more active way of moving around cities. This way, the appeal of a city should increase, as well as the city's health (CROW, 2023). A healthy city relates to creating a healthy living environment, which is achieved in an environment that feels safe and attractive. The National Institute for Public Health and the Environment of the Netherlands (RIVM) defines a healthy living environment as somewhere where it is inviting to engage with others, promotes healthy behaviour, and is nice to live in (RIVM, n.d.). This research will look at the case of Utrecht. The municipality of Utrecht (n.d.-b) defines a healthy urban living environment as “Pleasant to live in, with lots of greenery and nature. A city where everyone feels at home, and you can be yourself”. The city itself keeps growing. So, its goal is to provide space for growth but keep its current image (Municipality Utrecht, n.d.-b).

Increasing walkability in cities has many health benefits for citizens and the city itself. Refaat and Kafafy (2014) show that with the health benefits of walking for citizens, people may have more social contact. Exercise is good for the mind and body. Walking can promote mental and physical health (Refaat & Kafafy, 2014). It could, for example, reduce stress, create stronger bones, and contribute to creativity. In creating a healthy living environment, citizens are encouraged to walk more often and leave their cars behind (Refaat & Kafafy, 2014; Forsyth & Southworth, 2008). Going for a walk enables people to interact with the environment since they have the slowest speed on the street (Chan et al., 2019).

1.2 WALKABILITY

A commonly used definition of walkability is one by Southworth (2005): “The degree to which built environment supports and encourages walking by providing pedestrian comfort and safety, connecting people within a reasonable amount of time and effort, and providing visual interest during the journey through the network”. In choosing a route to a destination, a pedestrian will choose the one they feel most comfortable. If they do not feel at ease somewhere, it is unlikely that they will choose that route again (Anapakula & Eranki, 2021). Tan (2016) identified walking as one of the most influenceable behaviours. It is also named as the most environmentally friendly form of mobility. Walkability is the foundation for a sustainable city; without it, resource conservation is impossible (Southworth, 2005).

Walking is an easy mode of transport to learn and use since it does not require special equipment or anything to buy. The one thing someone could need is shoes, but even some live without them

(Southworth, 2005). In devoting more attention to pedestrians, CROW has listed five reasons why different parties should invest in walking (CROW, 2023):

- Limited use of space and lower-cost infrastructure;
- Mobility, accessibility and road safety;
- Good for the living environment;
- Increases health and wellbeing;
- Benefits the economy.

CROW (2023) stated that the reasons do not come out of thin air but from years of gathering knowledge about walking. Throughout history, walkability has evolved. In the Middle Ages, a city was very walkable in the sense that all the necessities were one to two miles from the main square, but the paths needed to be in better condition. By foot was one of the greatest means of transportation. During industrialisation in the 19th century, there were more forms of transportation, walking, however, remained significant. Many could not afford a car or a horse and carriage. The city was easily walkable, yet not so healthy due to poor air and water quality. Finally, in 1920, the well-walkable city came to an end. Modernisation gave the car priority in the city (Southworth, 2005)

Still to this day, pedestrians do not take up much space compared to other modes of transport, even though they do partake in traffic. A car going 50 km/h takes up 40 times more space than a pedestrian. Figure 3 shows the space occupancy per modality. Walking is a more effortless activity than driving a car. Pedestrians use their senses a lot more. They hear a lot of area noise and anticipate traffic based on that. They can see more because of their lower speed and can more easily scan the environment. Pedestrians are influenced by the weather, harmful gases, and bad smells (CROW, 2023). Walking can be done spontaneously, and someone can choose when to go, where and for how long. However, it will only be done if an attractive walking route is facilitated. This is of great importance. Municipalities should recognise this and facilitate an environment that promotes walking (Dytrt, 2023).

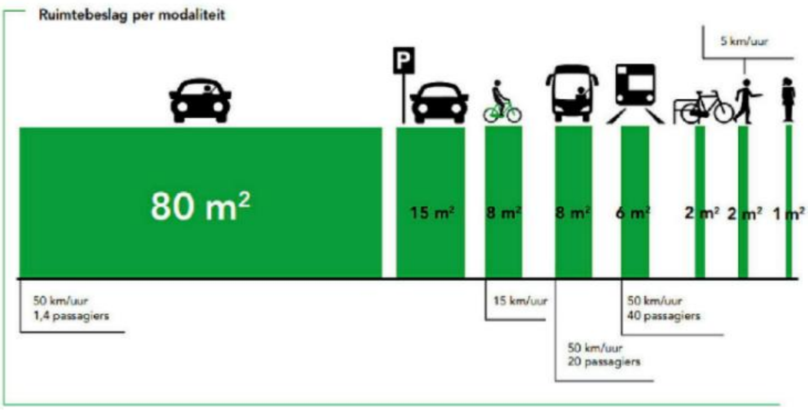

Figure 3 Space occupancy of road users (CROW, 2023)

1.3 PROBLEM STATEMENT

Walking has health, environmental and economic advantages. The walkability of a place can be determined by looking at different environmental characteristics. This includes, for example, the quality of the footpath, feeling socially safe on the street, not being bothered by other traffic, but also the presence of benches along a route or the friendly look of a place (CROW, 2023; Southworth, 2005; van Sluijs, 2022). It summarises the needs and wants of pedestrians and determines their walking experience. If the environmental characteristics are lacking, people tend to walk less or avoid certain places. A walk is more likely to be repeated if the environment is perceived as pleasurable. The amount of effort a route takes, the time available, the attractiveness of the route, and many more things can be influential. The different environmental characteristics come together in a pedestrian needs triangle. Several studies have been done on what layers this triangle should contain, but it often covers five themes (Alfonzo, 2005; van Hagen, 2011). Not only can the environmental characteristics be divided into themes, but they can also be expressed differently within the different walking networks. Commonly used are the base, plus and green network. These can be seen as a hierarchy, with the base being the lowest level and green the highest. At the highest level, the environmental characteristics are consequently considered to be well-highlighted (CROW, 2023).

Where knowledge is lacking, however, is how the environmental characteristics affect pedestrians' time-travel perception. Time is always a factor, knowingly or unknowingly. The time-travel perception is someone's experience of how quickly time goes by while walking from A to B (Gkavra, 2021). As van Hagen (2011) points out, time is seen as a scarcity. People want to do things as quickly as possible, feeling it takes little time. The walking experience of a route may be enhanced by making it enjoyable and feeling brief, thereby reducing the impact on pedestrians' time divisions. However, it remains to be seen whether environmental characteristics can improve a route's walkability and walking experience to the extent that even if it is longer, a pedestrian is willing to take the extra time to take the longer route. Therefore, looking at the link between environmental characteristics and time-travel perception is important to measure what needs to be addressed in making attractive, walkable routes. As Tan (2016) mentions, facilitating an environment that promotes walking helps create a healthy living environment.

Besides the environmental characteristics, individual factors like gender, age, and income also play a part in how a pedestrian experiences the environment and how they judge a route (Da Fonseca et al., 2020; Southworth, 2005). As van Hagen (2011) states, the kind of travel a person does varies depending on how many stimuli a person needs. Some need a lot and others less. While assessing the environmental characteristics, it could differ in how someone experiences a place, possibly influencing a pedestrian's time-travel perception.

1.4 RESEARCH QUESTION AND OBJECTIVE

The link between the environmental characteristics of walkability and its influence on the time-travel perception is the central topic of this research. The objective is to identify which environmental characteristics influence pedestrians' time-travel perception and ensure that pedestrians are positively influenced to keep walking longer. This is done by comparing three different routes and pedestrian experiences. From the aim is the following main question derived:

How do environmental characteristics contribute to enhance the time-travel perception for pedestrians?

The following sub-questions (SQ) are derived from the main question:

SQ1 How do environmental characteristics determine the walking experience of the routes?

SQ2 What is the time-travel perception of the three different walking networks?

SQ3 Which stimuli and environmental characteristics influence the time-travel perception?

1.5 SOCIETAL AND SCIENTIFIC RELEVANCE


Figure 4 Example of forgotten pedestrians (Molster & CROW, 2021)

In addressing the social relevance, it has been noticed that within municipal policy, pedestrians have been forgotten quite a bit over the years or are given the lowest priority. In 2019, the platform Ruimte voor Lopen (space for walking) was set up to help governments, knowledge and educational institutions, and civil society organisations to better understand walking policy and to help solve problems as illustrated in Figure 4. Nevertheless, in most cases, municipalities still outsource their queries in search of the right tools (CROW, 2023). By identifying key environmental characteristics, this research can help in developing the necessary tools.

The scientific relevance of this research relates to the relatively unexplored area of the time-travel perception among pedestrians. Influential scholars like Southworth (2005) and Alfonzo (2005) have conducted numerous studies regarding the impact of environmental characteristics on walkability. Their views on the subject are widely used. There is, however, a gap in understanding how these characteristics influence the time-travel perception while walking. In investigating this link, new insights can be developed into how environmental characteristics can promote walking by positively influencing a pedestrian's time-travel perception. This could lead to more evident approaches for designing walkable streets and encouraging to take the longer route.

1.6 READING GUIDE

This thesis consists of seven chapters. Starting with this chapter, the introduction. Chapter 2 covers the theoretical framework in which the theories used are discussed. This forms the foundation for the rest of the research. This is followed by Chapter 3 Methodology, in which all the methods used are explained in detail. Chapter 4 discusses the Utrecht case study, followed by the results in Chapter 5. Chapter 6, discussion and conclusion, discusses the shortcomings of this research and answers both the sub-questions and central question. Chapter 7 presents the recommendations of this research. Several documents are placed in the appendix for support to which reference is made.

2.0 THEORETICAL FRAMEWORK

The theoretical framework describes the theories and literature used. This chapter delineates the research. The framework first discusses the time-travel perception. This consists of the perception of time and distance, both influenced by different stimuli. Another topic discussed is the three different walking networks: base, plus and greenery. Within these different walking networks, pedestrian needs must be met. To establish the preconditions for those needs in this research, two pedestrian needs triangles are held side by side. The chapter closes with the conceptual framework, which shows the relationship between the different aspects of the theoretical framework.

2.1 TIME-TRAVEL PERCEPTION

We live in a time and age where time runs everyone's lives. It is something we are constantly aware of; it structures our lives. Time is seen as a scarcity, and people want to waste as little of it as possible. Therefore, travelling to and from places should feel as little time-consuming as possible (van Hagen, 2011). The time-travel perception consists of two parts: time and distance. The two can be explained separately but are connected. Figure 5 shows a schematic overview of how the time-travel perception is constructed.

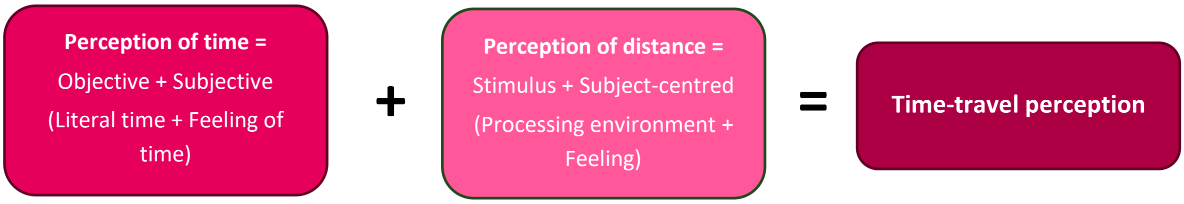

Figure 5 Overview Time-travel Perception

2.1.1 EXPERIENCE OF TIME

Starting with the experience of time. Time can be divided into objective and subjective time. Objective time is the actual seconds on the clock ticking away. Subjective time relates to the personal feeling of time, how someone judges time passing by (Cappon & Banks, 1964). Everyone has their own internal clock that objectively ticks every second but subjectively ticks differently per person (Church, 1984).

Subjective time can be influenced by someone's perception, attention, and memory (Matthews & Meck, 2016). The loss of awareness of subjective time leads to a state of flow, more relaxation, clearer activities, better concentration, and an optimal sense of control. During such a moment, experience, action, and awareness come together and create a moment of loss of perception of time. Stress leads to feeling like time is not passing at the right speed. Getting information on how long is left decreases the feeling of stress (van Hagen, 2011). The distinction between the two is important to know since it is a personal feeling, something someone experiences. Subjective time is, therefore, more difficult to measure.

The study by Gkavra (2021) mentions different variables that influence the subjective experience of time an individual has. Five categories have been determined that later in this research help to build variables to include in the Experiential Walk Method. The five categories are (Gkavra, 2021):

- Stimulus: temporal uncertainty and relevance, duration, and speed and direction of movement;
- Individual state: emotions and temperature (body and outside temperature);
- Individual characteristics: gender, age, personal traits;

- Environment: monotony;
- Activity: effort and rewarding.

Two other aspects of experiencing time are prospective and retrospective time. Prospective time means that someone is aware of the time and attention divided between time and other activities. With retrospective time, the brain draws on memory to estimate the time while not paying attention to it (van Hagen, 2011). Those who are physically more inactive are more likely to overestimate their walking time. The study by Dewulf et al. (2012) questions whether this is because of their inadequate mental map. Their mental map is smaller than those who are active in their area because they interact and experience less. Overestimating the walking time could be even more discouraging, and they could end up wanting to walk less. This creates a vicious cycle that shows the importance of a healthy urban living environment (Dewulf et al., 2012). Similarly, the perception of time wasted is influenced by the necessity to walk at a slower pace than desired. Furthermore, waiting at intersections and walking up stairs or hills have been identified as factors that contribute to a negative perception of time (CROW, 2023).

Previous studies showed that the perceived time while walking could be influenced by external factors like the number of barriers, turns, and intersections. This makes pedestrians feel like a destination is further away. The structure is harder to remember and thus takes more effort. Concerns like safety and getting lost could also influence the route choice and how long it feels. Those who frequently walk perceive routes more often as shorter (Ralph et al., 2020; Staplin & Sadalla, 1981). In the study of Gkavra (2021), busy streets created a shorter estimation for most.

2.1.2 EXPERIENCE OF TRAVEL DISTANCE

Travel distance can also be measured as objective and subjective. The subjective experience of travel distance overlaps with the subjective perception of time. This is because they both refer to personal experience. The objective travel distance is easily available online. The subjective distance within the time-travel perception can be best explained according to the following three factors (Parthasarathi et al., 2013):

1. Stimulus-centred: The cognitive distance of environmental characteristics. How someone processes what they see;
2. Subject-centred: The individual feeling someone has;
3. Stimulus- + subject-centred: Interaction of what someone feels and sees.

These three factors show that the perceived walking distance is, again, influenced by an experience of what is happening while walking, what someone is feeling and seeing.

The time-travel perception combines how someone perceives time and distance, as seen in Figure 5. In walking from A to B, someone walks a certain distance in a certain amount of time. For both, the objective time and distance are available, but the precepted time they felt like they spent walking varies per person.

2.1.3 STIMULUS RESPONS MODEL

To understand the subjective part of the time-travel perception the amount of stimuli a person needs is described. The variation in the time-travel perception depends on the individual experience a pedestrian has. It creates a subjective perception. The environment provides constant stimuli which a pedestrian is not always aware of. As van Hagen (2011) states, around 95% of environmental stimuli are processed unrecognised. Think of sound, temperature, colour, and smell. It is no longer consciously perceived, but it influences how a person feels and behaves. Someone can be in a must or lust state. In a must-state, someone needs little arousal. They are more serious, goal-oriented, and less receptive to environmental stimuli. In a lust state, more stimuli are needed. Someone is in a more spontaneous mood and more receptive to the environment (van Hagen, 2011). The must and lust state can be connected to avoidance and approach behaviour (Temme et al., 2022; van Hagen, 2011):

- Avoidance: All the *negative* behaviour that an environment calls upon, for example, wanting to leave, not wanting to explore, not feeling connected to a place, and not wanting to come back.
- Approach: All the *positive* behaviour that an environment calls upon, for example, feeling excited by the environment, wanting to explore, wanting to stay, feeling connected, and wanting to return.

Approach behaviour can be encouraged by design and adding the right intangible stimuli to the environment (Temme et al., 2022). Each emotional experience can be seen as a combination of pleasure (feeling comfortable/content), arousal (stimulated by the environment) and dominance (sense of control). A strongly stimulating environment can lead to too much stimulus and less pleasure. Van Hagen (2011) divided the number of stimuli:

- Many stimuli + crowded + must: non-congruent → anxiety;
- Many stimuli + crowded + lust: congruent → excitement;
- Few stimuli + quiet + must: congruent → relaxation;
- Few stimuli + quiet + lust: non-congruent → boredom.

To achieve a pleasant experience, the above feelings can be translated into two arches, as seen in Figure 6. Two types of optimal arousal levels can help achieve a pleasant experience. Getting from boredom to excitement, someone needs more arousal. If someone is feeling anxious, then less arousal is needed. This creates two optimal arousal levels.

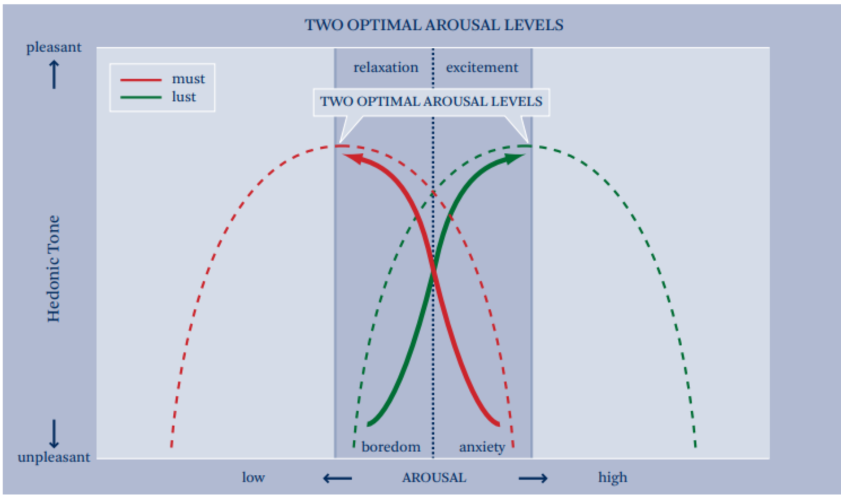

Figure 6 Optimal arousal arches (van Hagen, 2011)

Crowdedness also has a profound impact. When a person perceives a space as too crowded, their demanded space is greater than the available space. Crowding can lead to attention overload. There should be a good balance between boredom, relaxation, excitement, and anxiety. When there are too many stimuli, this balance strikes the wrong way, and a person can have a not-so-good experience. If there are too few, this can also be the case. the amount of desired stimuli can vary from person to person (van Hagen, 2011).

Depending on a person's current mood, it varies how many stimuli a person needs to reach a desired mood. Therefore, it can also differ from person to person what types of stimuli affect the time-travel perception for the better and which for the worse. The theory of stimuli was considered when drafting the survey questions and is reflected in the analysis. How someone experiences a place is strongly related to how that person feels and what stimuli are needed, which is assessed in the Walking Method (Ch. 3).

2.1.4 OVERVIEW VARIABLES

This part of the theoretical framework mentioned different variables that influence a personal experience while walking and, thus, the time-travel perception. These can be divided into internal and external variables. Both are the survey control variables, as seen in Table 1. Appendix 1 shows the connection between the control variables and the survey.

Table 1 Overview control and external variable (CROW, 2023; van Hagen, 2011; Temme et al., 2022; Dewulf et al., 2012; Parthasarathi et al., 2013; Gkavra, 2021)

Control variables	
Internal variables	**External variable**
Baseline emotional state	Weather
Emotional state after the walk	Crowdedness
Gender	Monotony
Age	Smell
Exercise	Traffic volume
Familiarity with the area	Light

To summarize, while walking a pedestrian is influenced by multiple stimuli that create the subjective part of the time-travel perception. If the stimuli are right, this could lead to a pleasant experience. Too many stimuli could have a negative outcome. It varies from person to person which stimuli are the right ones. This depends on the needs of the pedestrian.

2.2 ENVIRONMENTAL CHARACTERITICS

Previous studies established a connection between the walkability of a place and walking behaviour. Improving walkability is associated with enhancing the walking experience of pedestrians, which leads to increased pedestrian activity. Enhancing the appeal of a street can effectively boost pedestrian satisfaction levels and, therefore, their quality of life (Cambra & Moura, 2020; Jung et al., 2016). The walking experience is linked to how pedestrians sensory perceive and interact with the environment, influenced by various stimuli. These interactions shape their experience (Cambra & Moura, 2020).

It varies from person to person how much stimuli a person needs to get to the wanted arousal level (van Hagen, 2011). Similarly, human activity, like walking, is motivated by someone’s needs. These needs can be translated into different characteristics in the environment. A pedestrian benefits greatly from feeling seen on the street. This contributes to feeling socially safe. The behaviour and presence of others, as well as street lighting, can contribute to this. A well-kept environment where the pedestrian has space to walk without feeling unsafe from other traffic. Nuisance traffic can also play a big role. A pedestrian finds a walk more pleasant if there are few intersections with other traffic and they can easily walk on. The road should be clearly marked, and the environment should have an open and clear atmosphere. Too narrow footpaths with many obstacles are also not desirable. Several facilities on the route and enough opportunities to rest can contribute to an enjoyable walk (Alfonzo, 2005; CROW, 2023; Gehl, 2010; Southworth, 2005; van Sluijs, 2022).

In sum, a pedestrian has many different wants and needs that can make or break a walking experience. Based on various studies, a table covering important environmental characteristics for pedestrians has been developed. Appendix 2 shows an overview of the measurable characteristics that respond to a pedestrian's needs.

2.3 PEDESTRIAN NEEDS

All these different needs and characteristics can be divided into different themes and are often seen in a hierarchy. Over eighty years ago, Maslow developed the hierarchy of needs. This theory has been widely used and applied to various themes. In short, Maslow's triangle states that human behaviour is motivated by one's needs. These needs are innate and universal. Up to a certain level, they must be fulfilled. Only when a need is fulfilled does it become a motivation, and will it move to the next level in the hierarchy. Everyone starts with basic needs, and they become increasingly complex (Desmet & Fokkinga, 2020).

Van Sluijs (2022) states that when going for a walk, a pedestrian always has multiple motives. Usually, there is a surpassing main motive (van Sluijs, 2022). A pedestrian's decision to go for a walk can be influenced by if their needs are met. Alfonzo (2005) created five levels of needs based on Maslow's triangle, which offers variables that affect people’s decisions to walk. The idea with the hierarchical layers is that a pedestrian's decision to walk is determined by whether their basic needs are met. If not, the other layers do not matter. Someone can start anywhere within the hierarchy, but still, if their starting needs are not met, the needs above do not matter (Alfonzo, 2005). This hierarchy of five needs layers comes together in the triangle of Figure 7. From the bottom to the top, the five layers can be explained as follows (Alfonzo, 2005):

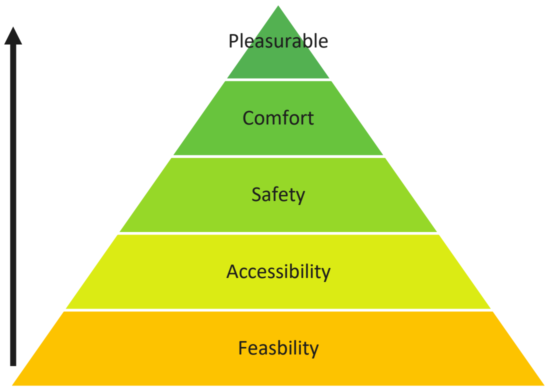

Figure 7 Triangle of Needs (Alfonzo, 2005)

- Feasibility: The practicability or viability of a walking trip. Time plays a crucial role in determining if a trip is feasible. If there is not enough time, other modes of transportation could be chosen, or a trip could not happen at all.
- Accessibility: Affected by the presence (or lack thereof) of for example sidewalks, clearly marked paths, barriers, and commercial use on the route.
- Safety: The personal feeling of being safe on a street by, for example, little litter or no run-down buildings. Especially for a strolling trip, the feeling of safety is important. If someone does not feel safe enough to go for a walk, it will not happen.
- Comfort: The ease, convenience and satisfaction a pedestrian experiences while walking. Factors that make a route stressful influence comfort. For instance, speeding traffic, sidewalk width, weather protection and amenities on the route. Benches, for example, have a positive influence on the comfort of a route.

- Pleasurable: Determined by how enjoyable and interesting an area is. Diversity and complexity within an area create a more pleasurable experience.

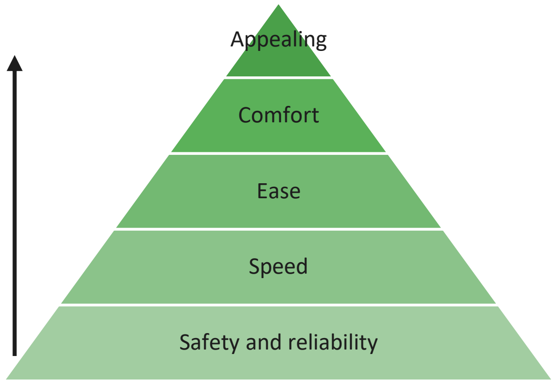

Figure 8 Pedestrian needs triangle van Hagen (van Hagen, 2011)

Maslow's pyramid dates back many years. Alfonzo's pyramid also dates to 2005. Since then, many scientific researchers have worked with it and adapted it to different contexts. Likewise, van Hagen's (2011) customer needs pyramid, as seen in Figure 8. This pyramid provides a hierarchy for how services are perceived. If it is positive, people are more likely to want to stay in a place. It has been widely implemented for various themes, including the pedestrian. The difference with Alfonzo's (2005) theory is the first layers. Van Hagen's pyramid starts with safety because if it is unsafe, people will avoid it. The layer speed refers to the time it takes to travel between the origin and the destination. Depending on the type of walk, it is often preferred to be as short as possible. Ease translates to little hassle, easily knowing where to go and when. Comfort in this triangle means, for example, being sheltered from the weather and having seating areas. Its appeal is determined by architecture, noise, colours, smells and more. Shops and cafes also contribute to the appeal. (van Hagen, 2011; CROW, 2014).

The pyramid has a baseline that illustrates the things that are needed to be able to walk on a street. There are also satisfiers and dissatisfiers. A dissatisfier can be explained as something that can only negatively influence a pedestrian. Otherwise, it is neutral, never positive. The first three layers of the pyramid are connected to this. The satisfiers are things that could positively influence someone and create a better experience. The top two layers are connected to this (van Hagen, 2011; van Sluijs, 2022). With the satisfiers and dissatisfiers, it can be determined if the stimuli during a walk are experienced positively or negatively. A satisfactory experience contributes to the experiential value and a dissatisfactory to the (poor) use value (Temme et al., 2022). Within the walking networks, the environmental characteristics could be related to satisfiers and dissatisfiers. This will be measured during the Experiential Walk Method. If a certain measure made a route satisfactory, dissatisfactory, or had no influence.

In comparing the two pyramids, the difference lies in the starting layers. Alfonzo pays more attention to certain preconditions, while van Hagen argues that these preconditions are already present. Van Hagen states that there already is a place to walk, so it must be safe, or a walk is less likely to happen (2011). That is why his first layer is safety. Alfonzo first looks at whether there is a place to walk, and then the next layers follow. Combining the two is illustrated in Figure 9. The two bottom layers are those of Alfonzo (2005) and then the five layers from van Hagen (2011). In measuring how the environmental characteristics score in a place, the starting layer will be safety since the places being measured in this research are places where it has been established that there is a place to walk. The two bottom layers will be disregarded. Accessibility has also been entangled into speed and ease. Connecting it back to walkability, the pedestrian needs triangle provides a way to determine if the needs of a pedestrian are met. The higher a route scores in the triangle and the environmental characteristics, the more walkable it should be (Tran, 2016).

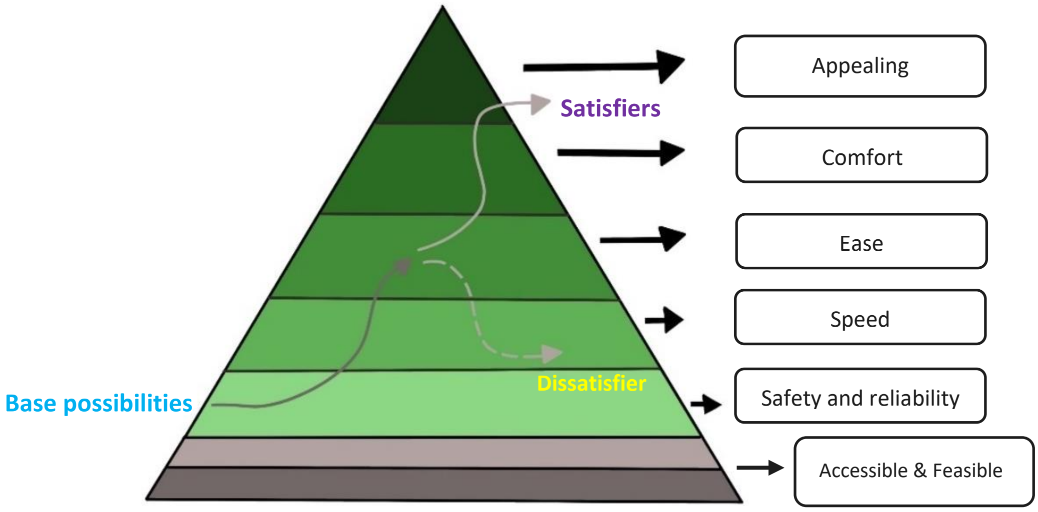

Figure 9 Overview triangle of needs (Alfonzo, 2005; van Hagen, 2011; Temme et al., 2022)

2.4 WALKING NETWORKS

In looking at the different environmental characteristics, three different walking networks are commonly used: base, plus and greenery. The networks are hierarchical, the base being the lowest quality level and the greenery being the highest (van Sluijs, 2022; CROW, 2023). The networks can be explained as follows (CROW, 2023; van Sluijs, 2022):

- Base network: It should be easy, quick, and accessible. It should be available for everyone, and someone should be able to start walking from any location. The highest level of quality is not expected. The base network is usually found in neighbourhoods.
- Plus network: The aim is a higher level of public space, and social safety plays a bigger role. Pedestrians could feel further away from other modes of transport but still have easy access to it. The footpaths are clearer and have more width. The rule of thumb is that when pedestrians with special needs experience a higher level of quality, it is better for everyone.
- Greenery network: It wants to add to a pleasurable walking experience. The connection between different footpaths should be recognizable, and there should be a high quality of greenery and nature in the area. Greenery and water should dominate the environment.

For each network, a route that fits the description has been determined. Their scores of each environmental characteristic will be illustrated later in this research. The chosen routes will be described in Chapter 4, Case Study.

2.5 CONCEPTUAL FRAMEWORK

The conceptual framework is based on the literature and theories mentioned above. Figure 10 illustrates the conceptual model of this research. This research aims to identify which environmental characteristics influence a pedestrian's time-travel perception (blue arrow). They experience the various stimuli in an environment differently, and their influence on the time-travel perception remains to be investigated (pink arrow).

Thus, the analysis considers the interaction between the time-travel perception and different environmental characteristics and stimuli. These connections will be analysed later in this research using the Experiential Walk Method.

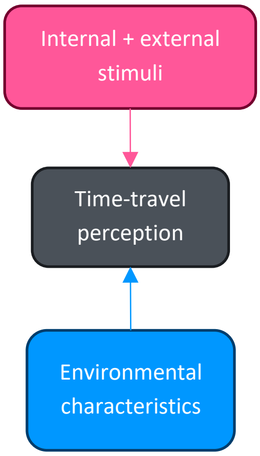

Figure 10 Conceptual framework

3.0 METHODOLOGY

This chapter provides insights into the methods used to answer the central question: *How do environmental characteristics contribute to enhance the time-travel perception for pedestrians?* Each method will be illustrated. How data was collected will be explained from beginning to end and how it was analysed. The chapter closes by clarifying the validity and reliability of the used methods.

3.1 GENERAL RESEARCH DESIGN

To start with, hypotheses were established for the sub-questions based on the theoretical framework. These were needed for the data analysis. A hypothesis shows the expectations of the results within this research. The chosen research method tests this hypothesis (Streefkerk, 2022). The hypotheses are stated in Table 2.

Table 2 Hypothesis per sub-question

Sub-question	**Hypothesis**
SQ1 How do environmental characteristics determine the walking experience of the routes?	The better the environmental characteristics score, the better the walking experience.
SQ2 What is the time-travel perception of the three different walking networks?	The difference in time-travel perception is determined by the quality of walking network.
SQ3 Which stimuli and environmental characteristics influence the time-travel perception?	Positively scoring stimuli and environmental characteristics lead to a positive time-travel perception.

This empirical research used mixed methods. This means qualitative and quantitative methods were used. The results were illustrated through words and numbers. Qualitative research provided an opportunity to ask open-ended questions about why and how. It can address human behaviours such as perception and attitude (Tenny et al., 2017). Quantitative research explains a phenomenon by collecting numerical data and statistically analysing it and its relations. It explains, predicts, and controls a phenomenon (Kandel, 2020). Qualitative and quantitative research supported each other well. The qualitative side helped in understanding the data and figures obtained from the quantitative part (Tenny et al., 2017). The use of both also assisted in answering the various sub-questions. Figure 11 shows the overview of the research design. The top layer illustrates the various stages and below which parts of the research it covers.

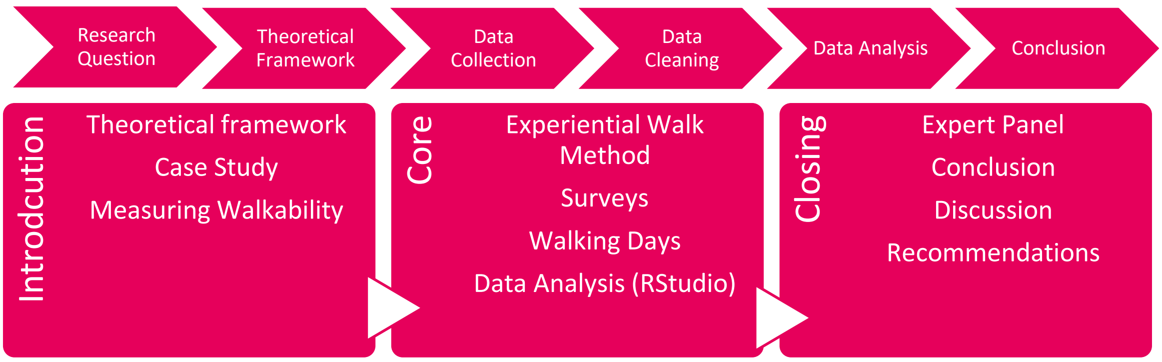

Figure 11 Overview research design

A case study was set up to assess the three routes used in the walk method. This was needed to collect the right data. The use of a case study can be described as an in-depth understanding of a phenomenon in more detail and looking at what is common among several cases or, in this case, three different routes (Hay, 2016). To be able to study a single unit to generalise it across a larger set (Tenny et al., 2017). This part provided qualitative data (results in text form). The chosen case study is the city of Utrecht because of its central location and familiarity with the researcher. Three routes were selected, which are detailed in Chapter 4.

Before measuring the time-travel perception, the objective walkability of the three chosen routes could be determined. A framework based on pedestrian needs was used to identify the three routes of the three different walking networks and their walkability. Appendix 2 shows this table in its completeness, and Table 3 shows a schematic representation. The overall goal of this framework was to assess the three chosen routes of the three different walking networks with the set criteria of each layer in the triangle. The better it scored, the more walkable a route *should* be. By establishing this, survey questions were connected to discover which environmental characteristics influence the time-travel perception (Appendix 3). What route belongs to which network was predetermined. Chapter 4 Case Study illustrates the outcome of the assessment of the three routes.

Table 3 Schematic overview measuring time-travel perception

	Route
Safety *Speed* *Ease* *Comfort* *Appealing*	Criteria (Grading - - to + +)

The Y-axis of Table 3 refers to the five layers of pedestrian needs. The X-axis is the grading of a route. The first three layers of the Y-axis correspond with dissatisfiers. If the criteria score badly, then a route is experienced as dissatisfying. The last two layers function as satisfiers. If a characteristic scores well, then it could influence the walkability of a place positively. These characteristics are part of the walking networks, but the last two layers are more critical in achieving a higher level of public space.

3.2 DATA COLLECTION

The data collection consisted of two parts: objectively measuring the walkability of the three predetermined routes and field research. For the latter, inspiration was taken from The Experiential Walk Method (Piga et al., 2021). From this section, qualitative data emerged primarily through the use of surveys. The results were discussed using statistics with text in support. The theoretical framework used secondary scientific literature and formed the foundation of this research. Each step of the data collection will be discussed.

3.2.1 THE EXPERIENTIAL WALK METHOD

For the participatory part, the Experiential Walk Method by Piga et al. (2021) was used. The idea behind it is to explore the individual walking experience of the environment. Within Piga's study, four steps were used (Piga et al., 2021):

1. Instinctive walk: "A direct experience and observation, they simply have to feel the surrounding environment while walking" (Piga et al., 2021). A participant walks a predetermined route with a focus on the path and surroundings, with no distractions like headphones or a phone. After the first walk, the participant must reflect and organise their thoughts.
2. Rational walk: The goal is to figure out the relation between the experience they just had and the different place conditions. A participant walks the route again and is encouraged to take notes, pictures or whatever they prefer.
3. Data collection: Register the main elements that were characterized during the walk. The participant can do this while walking the rational walk, or afterwards.
4. Metaphorical walk: The goal is to recall the walks and highlight the in-motion ambiences. While using the preferred method, participants should create a route that gives them the feeling they had while walking.

Adjustments were made to make this method fit this research's scope and time frame. In the study of Piga et al. (2021), a route was walked two times. Within this research, this had been changed into walking three different routes once. This remained as the instinctive walk, so walking a predetermined route and focusing on the path and the surroundings. The second step, the rational walk, was done via surveys to make the best use of time. The questions within the survey created the relation between the experience they just had and the different conditions (environmental characteristics). The third step, registering characteristics, was predetermined in this research. The theoretical framework shows the environmental characteristics that were assessed with the walks and survey. The last step was also intertwined in the survey by determining at the start and after each walk the emotional state someone was in and if it had changed. By having a participant walk the three routes once, fewer people were needed to reach the minimum of n=30 per route.

The goal of this data collection method was to measure the walking experience of three different routes. It made it possible to compare the newly collected data to the walkability assessment. Highlighting the survey questions that had a different outcome than the objective assessment of each route. Each experience was also related to the experienced time and measured time.

3.2.2 THE SURVEYS

Surveys are questionnaires that you administer to various people to collect data about the research topic. To make a valid survey that encompasses the problem of this research, the questions used need to have a clear relation to it (Benders, 2023). The surveys were available in both Dutch and English. The questions used were derived from the Goudappel Questionnaire Library, which was set up by experts from the company. These experts checked and evaluated the survey for this research. Most of the survey had statement questions with a scale from one (completely disagree) to ten (completely agree), also known as a Likert scale. This is used to examine opinions, attitudes, or behaviours. Extreme responses are response anchors. The middle option is the neutral response (Bhandari, 2022). It had been checked that each question leaned the same way, all positively. The surveys after each walk consisted of the same set of questions which were conducted the same way each time to ensure reliability. With the surveys, the first questions were to gather basic personal information about a participant and their current emotional state. These were filled in before the walks while singing the consent forms. In total, twenty-five questions were asked about their walking experience. During the walking experiment, each participant filled in their own survey, except for participant number, time and date, and walked route. The full survey can be found in Appendix 4.

In each survey, a consent form was included, which informed participants that they could stop participating at any time without having to give a reason. This had been told verbally and was part of the consent forms. The consent forms also mentioned that the participant had been informed about the aim of the research, the possible risks, that data was to be handled anonymously, and that participation was voluntary. The full consent form can be found in Appendix 4.

3.2.3 WALKING DAYS

This part explains the walking method from beginning to end. A week was organised in early April 2024 with different time slots available each day. There was room for three participants per time slot. The explanation below is written with all three slots filled in a time frame. Table 4 on the next page shows an overview of the steps during the walk method.

Figure 12 Set-up Walking Days

Each walk started at the meeting point Malieblad Utrecht, shown in Figure 12. I, the researcher, was waiting here to welcome and accommodate the participants. Before they arrived, I filled in on each survey their participant number, time and date, and the order in which they would walk the routes. Once the participants arrived the walking session started with the hello talk (Appendix 5.1), consent form and first survey. Each participant received instructions and a first route. Once done, they started their first walk. A timer was started to collect everyone's actual walking time. While walking a route, the participant was to have as little distraction as possible, so no use of phones or listening to music. In case of emergency, a participant could use their phone. This was all mentioned before the first walk.

Once they had circled back to the meeting point, I stopped the timer and provided them with the survey. After, they were given a new route to walk, and I started the timer again. Back at the meeting point, they filled out their second survey. Then they started their third walk, and I started the timer again. Following this, they completed the final survey and there was room for questions. In total, each participant walked three routes and filled out four surveys. Table 5 shows the route distribution for three participants. Fifteen minutes after the end, the next group started to prevent overlap if a group took longer. On weekdays, between sessions two and three, a 45-minute break was planned. During the weekend this was left out and the first timeslot started thirty minutes later. Appendix 6 shows the maps used for the three routes.

Table 4 Overview walking method

Step	Explanation	Time
Introduction	Hello talk, explaining the routes, surveys and filling out the first survey	**15 minutes**
First walk	Instinctive walk A	**15 minutes**
First survey	Rational walk but in surveys	**7 minutes**
Second walk	Instinctive walk B	**10 minutes**
Second survey	Rational walk but in the survey	**7 minutes**
Third walk	Instinctive walk C	**10 minutes**
Third survey	Rational walk but in the survey	**7 minutes**
Goodbye talk	Goodbye talk, last questions, small talk	**15 minutes**
Total time: 1 hour and 25 min. (+/- 1,5h)		

Table 5 Distribution Routes

Route	Estimated walking time	Round 1	Round 2	Round 3
A	15	P1	P3	P2
B	10	P2	P1	P3
C	9	P3	P2	P1

The weather each day was also noted, as this was incorporated into the survey and could have a significant impact on the results. It was a sunny week except for two days of rain. Table 6 shows the weather for each walking day.

Table 6 Weather during the Walking Days – April 2024, n.d.)

Date	Max. temp. in °C	Precipitation in mm	Wind speed in m/s	Wind direction	Sun Hours
April 8th 2024	19.1	1.0	3	SE	3.6
April 9th 2024	14.8	3.9	6	S	2.4
April 11th 2024	14.8	0.4	4	SW	0.0
April 12th 2024	20.0	0.0	5	SW	7.5
April 13th 2024	23.1	0.0	4	SW	8.8
April 14th 2024	14.7	0.0	3	W	7.1

REQUIREMENTS

Inclusion and exclusion criteria were determined to enable participants to participate in the walking method. The included ages lie between 18-67. With this, a broad group of people was involved to ensure that it was representative of not one specific group but generalisable to a broad context. The only requirement is that a person can walk freely.

- Included: ages 18-67, male/female/x, able to walk freely
- Excluded: ages under eighteen and above 67, not able to walk freely

A participant needed to be available for a maximum of two hours between 8:30 am and 6:00 pm. A participant could pick a day and time frame. Three slots were available per time frame. After each session, 15 minutes of extra time was planned in case some sessions took longer. Not all slots had to be filled to get to n=30 (a requirement for a normal distribution with statistical analysis). However, many days and slots were provided so participants had a bigger chance of fitting it into their schedule. Wednesday, 10/04/2024 was missing from the sign-up sheet. This is because the UU scheduled a mandatory return day on that day. This week was still the best option for organising the walking week. People were able to sign up via Google Forms. Through an extension of the forms, a limit of three per timeslot was set. Each participant received a small gift as a thank you for participating.

If someone cancelled, they were offered the opportunity to register in another time slot if there was enough space left. In all safe weather conditions, it continued as normal.

APPROACHING PARTICIPANTS

On March 13th, 2024, the first invitation for participation was sent out. It was sent to Rijkswaterstaat, Goudappel, and other connections in the sector, and it was posted on LinkedIn. On March 18th, 2024, the second group, friends and family, was approached. Appendix 5.2 shows an overview of what the invitations mostly looked like, but they were adapted to who was approached. Sending out invitations was done at two different times, so those who have full-time jobs were part of the first invitation and had the greatest freedom of choice. The second group included more students, who tended to have a somewhat free schedule. While signing up it was stated that each participant would receive two reminders about the walking days. The first reminder was sent on March 27th, 2024, and the second on April 5th, 2024. The layout of these invitations and reminders can be found in Appendix 5.2.

Of the 41 sign-ups, thirty-nine appeared during the walking week. There was also a last-minute entry, bringing the final total to 40 participants. The gender distribution is seen in Figure 13. This shows that over two-thirds of the participants were female.

The average age was around 33 years old. Figure 14 shows the distribution of ages to gender. The average age covers a gap in the different ages of the participants. It can also be seen that there is a clear absence of the age group 40-45 years old. Overwhelmingly, the largest age group is 20-25 years old. The ages are not fairly distributed, and some ages are not present.

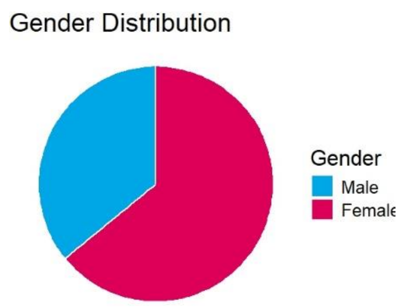

Figure 13 Gender Distribution

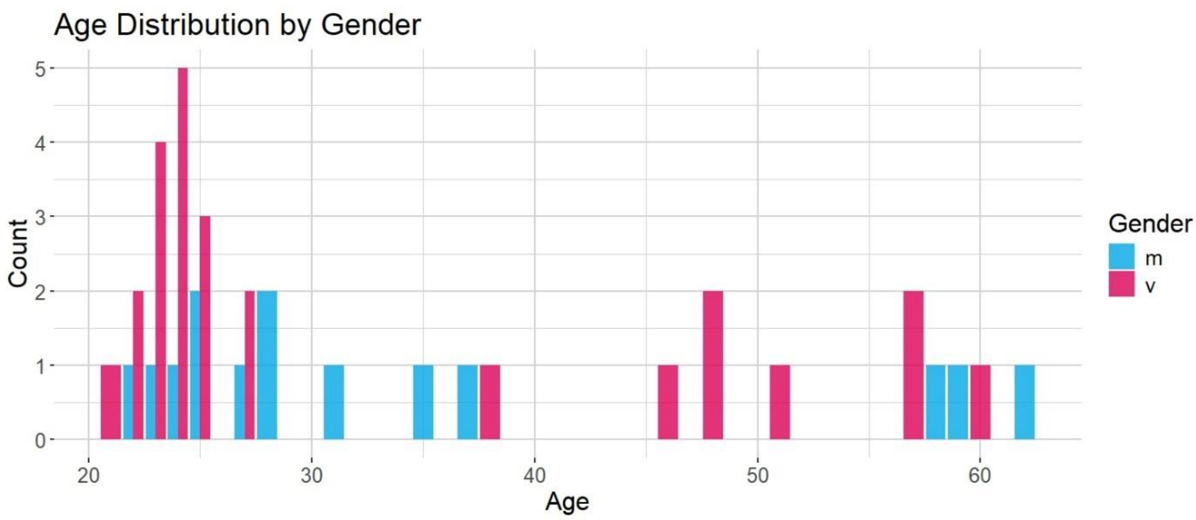

Figure 14 Gender to Age

3.2.4 EXPERT PANEL

The expert panel was held with four urban planners of Goudappel on June 3rd, 2024, and lasted an hour and a half. The panel started with a presentation of the results. This distinguished which results were most important for this session. It briefly outlined again the vision of where this research wanted to go, and there was also room for questions about the presentation of the results.

Then came the discussion part. This was constructed by going off the various significant environmental characteristics of the time-travel perception. The following questions were asked in this regard:

1. How can you implement the significant environmental characteristics in your work?
2. How can you incorporate these results into Goudappel's pedestrian tools?
3. Which environmental characteristic do you think should have priority?
4. Where do you see opportunities or challenges?

It ended with room for the last questions. In the results chapter (Ch. 5), the highlights of this meeting will be discussed. The presentation can be found in Appendix 7.

3.3 DATA ANALYSIS

The data analysis comprised a comprehensive examination of all the collected data from the walking method to link to the objective measurement of walkability and the theoretical framework. The analysis was done using the software RStudio. Each survey question had previously been linked to a connecting environmental characteristic and had been assigned a code (Table 7). After this, an Excel table processed all the survey results. A total of 40 participants completed four surveys each. The participant numbers are indicated on the y-axis of the Excel table, while the codes for the survey questions and responses are indicated on the x-axis. Appendix 8 shows the table with the codes. Due to the size of RStudio's scripts, these have been excluded from the thesis.

Table 7 Coding of data

Theme	**Code**	**Type of variable**
General	gen_	Ordinal and Nominal
Time-travel perception	ttp_	Ordinal and continual
Safety	saf_	Ordinal
Speed	spe_	Ordinal
Ease	eas_	Ordinal
Comfort	com_	Ordinal
Appealing	exp_	Ordinal
Extra	extra_	Qualitative

3.3.1 NORMALIZATION OF DATA AND THE DISTRIBUTION

Before any analysis could be done, the dataset had to be "cleaned up". This involved first checking whether the data was normally distributed. The columns ttp_meas and ttp_min were converted to seconds to form a new column, Time_Difference_sec. This column shows the difference between ttp_meas and ttp_min. From now on, only Time_Difference_sec will be used for the time-travel perception. If a value is negative in this column, it can be said that it is a negative time-travel perception and a participant experienced walking longer than measured. For the positive, the walking experience felt shorter than measured. Based on Time_Difference_sec, a Shapiro-Wilk test was performed, and Q-Q plots were made. These are commonly used methods in checking the normal distribution of data. Furthermore, the interquartile range was calculated to establish limits within the dataset and identify outliers. An analysis was done to see if the dataset became more reliable with or without the outliers. Eventually, these were removed from the dataset, and a new one called clean_data was formed. Appendix 9 shows the analysis of the normality.

The remaining data had to be normalised to be able to compare. The values of each independent variable were transformed to be between 0 and 1. Even non-numeric variables were now usable for the analysis. This created another dataset called new_data which was used to do the rest of the analyses.

3.3.2 GENERAL AND WALKING EXPERIENCE ANALYSIS

The general analysis consisted of creating figures from all questions coded gen_ to illustrate the extracted data, often in the form of a bar chart. For age and gender, no analysis was done due to the small sample size. The walking experience of the three routes could also already be determined. Of each, the average score per column was documented in a bar chart and per theme. A combined analysis of the three routes was also discussed. With text in support, statements could be made about the walking experience. Finally, the scores were held alongside the walkability assessment done by experts.

3.3.3 OTHER ANALYSIS

Time_Difference_sec was primarily the dependent variable, and all other variables were the independent ones. A correlation analysis was performed for every analysis. A scatterplot was created to test for linearity. After a fitting regression analysis was completed, the residuals were plotted. Numerous conclusions were reached using regression and correlation analyses. A corresponding figure, like a bar plot or correlation matrix, was also made, depending on the kind of analysis. When discussing if a result is significant, this means the p-value is smaller than 0.05 ($p<0.05$). This is a commonly used value in statistical analysis. Not every result will be discussed in equal detail. This will depend on the significance and what it generates for the rest of the results.

The two main analysis methods are explained as follows:

- A correlation analysis shows how strongly two or more variables are correlated. These values are between -1 and +1. The closer they are to one of the extremes, the stronger the correlation. For each significant correlation, the r-value (correlation coefficient) and p-value (significance) will be given. A significant positive correlation means that if one variable increases, so will the other. A negative correlation shows that if one variable increases, the other will decrease (Scribbr, 2021).
- A regression analysis shows how variables interact. It can confirm whether one causes a change in another or whether there is a correlation between them. This study mainly involved multiple linear regression analysis ($Y = \alpha + \beta_1X_1 + \beta_2X_2 + u$) (Van Heijst, 2023). The p-value is the most important.

Chapter 5 shows the different results, and the appendix contains all descriptives. When $p<0.05$, it is highlighted in pink to clarify the significance.

3.4 VALIDITY AND RELIABILITY

The validity and reliability of the research show its quality. This is why it is important to reflect on this and justify choices. Reliability represents how consistently the chosen methods were used, whether it was from within the same conditions and principles each time. Validity refers to the accuracy of the measurements. What the research aims to measure is actually measured (Middleton, 2023).

The research took place in Utrecht, where three specific streets within the three main networks were chosen. The reliability of the chosen streets was increased by having the characteristic framework also completed by an expert. However, it can be questioned whether these three routes are representative of other routes in other cities. Also, the walk method was done from the same start and end point each time to increase the reliability of the measurement of the walking times.

The validity and reliability of the survey were ensured by using the Goudappel Question Library, which incorporates years of knowledge and experience. The survey was run through by experts three times to verify it. On March 28, 2024, the walking method was tested by an expert at Goudappel. This revealed minor adjustments in the survey layout and concluded that the walking method would not take two hours but around an hour and a half. This has been changed in Table 3. It also revealed a bigger issue, that one of the three routes would be closed during the walking days. This meant that Route A had to change. A new base route was chosen, passed through the walkability framework, and used during the walking days. That the process had been tested and necessary adjustments had been made increased the reliability of the process.

It was also ensured that each participant received the same information in the same order (standardised research process). Most of the survey questions had a 10-point scale to increase the ease of completion. All data obtained was processed anonymously to increase reliability. Given that the number of participants remained on the low side, the reliability of representativeness could be questioned. The group was sufficiently large for a normal distribution, but no age or gender distinction could be made. Ethics were considered by having each participant sign a consent form before participating. This was to clarify that there was informed consent and that everyone's data would be treated reliably and anonymously.

Several characteristics were dropped in linking the environmental characteristics and survey questions better (more feasible). In three consultation sessions with different experts at Goudappel, the questions for each layer were examined to determine how they could be structured in such a way that as many environmental characteristics as possible were covered, but the questions were reduced to a minimum. Appendix 3 shows what question is connected to which environmental characteristic. The following characteristics were dropped from the survey, namely:

- Minimal detour factor
- Car-free
- Curb with sloping end or no elevation
- Alternation of elevation/no elevation
- Public restroom available
- Landmarks
- Meeting places available
- Presence of a footpath
- (un)uniform and artificial lighting

Of these characteristics, whether they were present or not on a route could be predetermined. Asking a survey question about it was concluded as not necessary since it would have had little to no relevance.

Checking the normal distribution of the data and normalising it increases the reliability and validity of the data analysis. The normal distribution ensures a reliable dataset. The normalisation helped in making it possible to compare the different forms of data. The same steps were used for each analysis between variables to make the process more reliable. A correlation analysis, scatterplot, regression analysis and residuals plot were made of everything. This allowed the distribution of data and results to be checked and compared with each other.

Any research study comes with its limits. Listed below are some that may occur based on the methods chosen:

- The environment was able to introduce variables that greatly influenced the results and were not predetermined.
- Lower attendance than signed up.
- The order of walking the routes could have influenced the responses. Given that it varied from participant to participant which of the three routes was walked first, there was plenty of variation.
- A logistical challenge could have taken place with organising the walking times and that each participant walked the routes, but this was anticipated in advance. Different logistical options were looked at, and the chosen option worked out well.
- With the data collection, measurement errors could occur due to, for example, ambiguously asked questions or confusion when filling in the survey.
- During rush hour, participants may have to wait longer at crossings where pedestrians do not have priority. This should be considered in the analysis when large differences in walking times per route arise.

4.0 CASE STUDY: UTRECHT

To illustrate the walkability framework created in the previous chapter, a case study was selected to study a single unit and generalise it across a larger set (Tenny et al., 2017). It helped to compare the determined environmental characteristics on three different routes of each walking network: base, plus and greenery. These routes were also used for the Experiential Walk Method.

This chapter will first describe the municipality of Utrecht's vision for pedestrians, then focus on the two neighbourhoods where the walking routes run. It closes with the three routes that were used for the field research, as explained in Chapter 3.

4.1 THE CITY OF UTRECHT

The chosen city for the case study is Utrecht. The city had been chosen because of its familiarity, its inviting central location for the participatory component, and most importantly, active engagement in creating a healthy living environment. Their vision emphasises improving the quality of life for all through affordable housing, a green and healthy environment, better accessibility, and neighbourhood care. The municipality recognises that this requires courage, ambition, and cooperation (Municipality Utrecht, n.d.-b).

The municipality created an action plan for pedestrians for the period 2015-2020. Since there has not been a new one. However, an overall mobility plan (including the pedestrian) has been published in 2021. The action plan for pedestrians had two main goals: bettering the pedestrian climate so walking is appealing to more people and improving traffic safety in the city for pedestrians. The municipality sees that walking has many advantages for citizens, the environment and society (People Planet Profit) (Municipality Utrecht, 2015).

In the city of Utrecht, 25-30% of all travel is done on foot. Walking to and from the car or public transport is not included in this number. The municipality argues that priority should be given to facilitating pedestrians, especially around the city centre. Now, for example, there are too many barriers, which rapidly decreases the pedestrian experience (Municipality Utrecht, 2021).

More recently, the municipality of Utrecht published Mobility Plan 2040. The city keeps growing, and the municipality acknowledges that but sees a challenge in providing room for all within the same space. The borders of the city cannot keep moving outwards. To keep the city healthy and accessible, priority is given to clean modes of transportation that take up as little space as possible. Through walking, the growing pressure on mobility should be relieved—less hindrance from traffic and better accessibility with public transport, cycling and walking. The car will always remain usable in Utrecht, but to travel from A to B, the car will no longer be given the fastest or shortest route (Municipality Utrecht, 2021). Utrecht aims to be a '10-minute city' where everyone and everything someone needs is within ten minutes. The municipality aims to travel from A to B via as much green space as possible, as shown in Figure 15 (Municipality Utrecht, n.d.-a).

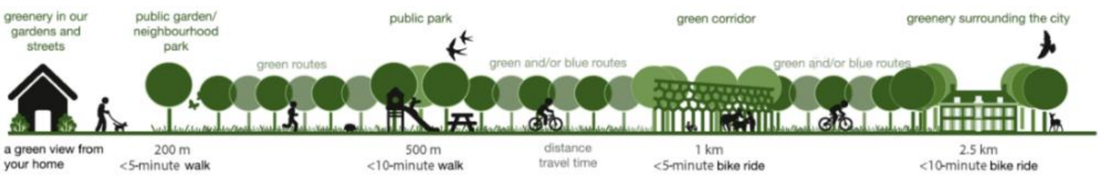

Figure 15 Utrecht 10-minute city (Municipality Utrecht, n.d.-a)

To improve the experience of space in the city, the municipality wants to provide more space for spending time on city streets. They want to do this by placing benches to sit, space to play, more greenery and space where someone can stand still and take in the surroundings. This is especially important in areas marked A-zone. The centre of Utrecht falls under an A-zone, as do the chosen routes (Municipality Utrecht, 2021).

In short, the municipality of Utrecht aims to become a healthy city where pedestrians feel welcome with the implementation of pedestrian-friendly infrastructure. The municipality wants a pleasant public space where everyone feels welcome and by 2040, only clean forms of transport will be used in the ten-minute city. Everything you may need should be achievable within a short time.

4.2 SELECTED DISTRICTS AND NEIGHBOURHOODS

The two selected districts were Binnenstad and Oost, as seen in Figure 16. Within these two districts, two neighbourhoods were also predetermined to be able to focus on three routes within the walking networks. Figure 17 highlights the two neighbourhoods and the three chosen routes within. Each district and associated neighbourhood will be briefly discussed, as well as some environmental characteristics.

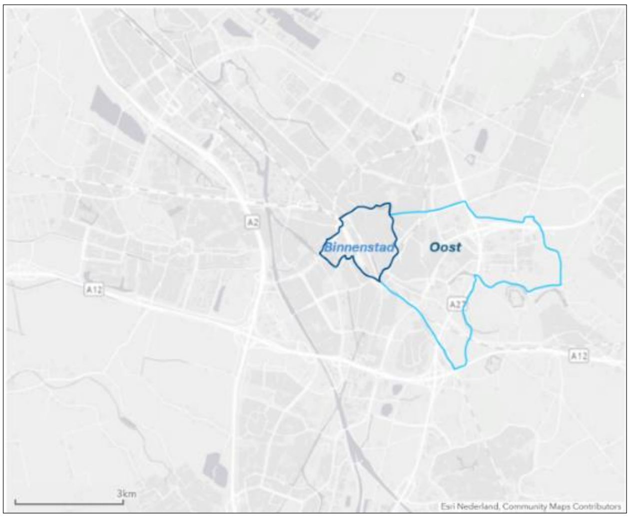

Figure 16 Chosen Districts in Utrecht (ArcGIS Web Application, n.d.)

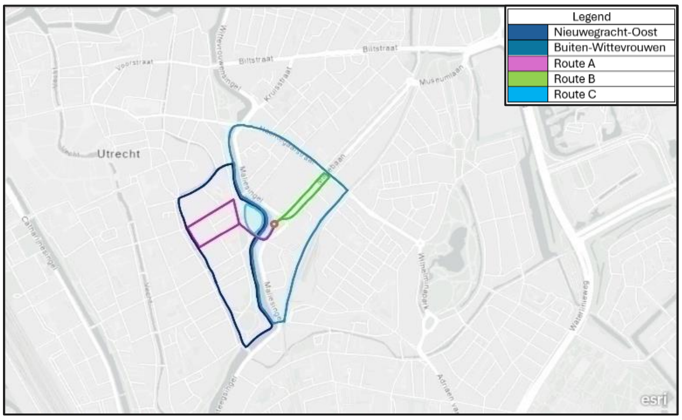

Figure 17 Chosen Neighbourhoods and routes (ArcGIS Web Application, n.d.)

4.2.1 BINNENSTAD

Binnenstad has many historical buildings and special places that define Utrecht. The district consists of eleven different neighbourhoods. Two of the routes run through the neighbourhood of Nieuwegracht-Oost. Nieuwegracht-Oost had a population of 1,140 in 2023. The neighbourhood is 16ha, of which 1ha is water. Park Lepelenburg is part of this neighbourhood. The houses were mostly built around the year 1700. So, the neighbourhood has an older look, just like the rest of the inner city of Utrecht. Four traffic accidents occurred in 2022 (Allecijfers.nl, 2024-a). Over 78% of the neighbourhood has an applied sciences or university degree. The biggest age group is 18-26 with 23,2% (Buurten in Cijfers - Algemeen - Buiten Wittevrouwen, n.d.).

4.2.2 OOST

Oost consists of thirteen different neighbourhoods. Within the case study, only the neighbourhood of Buiten Wittevrouwen is being looked at. One of the chosen routes runs through here. Buiten Wittevrouwen had a total of 4.760 residents in 2023. The neighbourhood is 48ha, of which 1ha is water. It, therefore, borders the canal that runs around the city centre. The houses were mostly built between 1700-1900 and thus have an older appearance. In 2022, twenty-five accidents occurred in the neighbourhood (Allecijfers.nl, 2024-b). Over 70% of the neighbourhood has a degree in applied sciences or a university degree. Mostly, people between 18-26 years old live in Buiten Wittevrouwen with 30,8% (Buurten in Cijfers - Algemeen - Nieuwegracht-Oost, n.d.).

4.2.3 NEIGHBOURHOOD ANALYSIS

For the environmental characteristics, both neighbourhoods are looked at together. Later, each route is highlighted separately, but relevant environmental characteristics are discussed in this section. It is not meant to compare the two, just as a general overview. The characteristics discussed in each neighbourhood correspond with the environmental characteristics of walkability.

Both neighbourhoods have a moderate air quality score. As seen in Figure 18, both also experience quite a lot of traffic noise, especially the streets Maliebaan and Nachtegaalstraat (darker red). The traffic intensity is higher here, which creates much noise. Buiten Wittevrouwen has worse noise quality than Nieuwegracht-Oost. The overall noise is similar to the traffic noise. So, there is more noise pollution in the streets with higher traffic intensity. Park Lepelenburg also provides a small amount of overall noise since many citizens spend time there (Kaarten | Atlas Leefomgeving, n.d.).

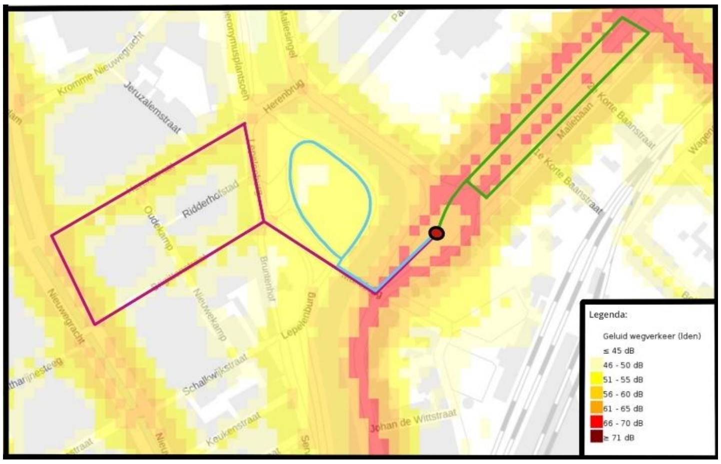

Figure 18 Traffic noise (Kaarten | Atlas Leefomgeving, n.d.)

As for the cooling effect of water and greenery, Nieuwegracht-Oost has an advantage with Park Lepelenburg. At this place, it is around 1.4-2.0 degrees Celsius cooler than in the rest of the neighbourhood, as seen in Figure 19. Buiten Wittevrouwen is somewhat cooler at the northeast and south corners than the rest of the neighbourhood. It has enough water and greenery to provide an overall cooler feeling than other neighbourhoods in Utrecht (Kaarten | Atlas Leefomgeving, n.d.). The urban heat island effect (UHI) is a relevant issue in every city (Figure 20). The UHI shows where heat is retained through petrification and allows temperatures to rise to more extreme levels with many complications (Filho et al., 2021). Comparing it to the cooling map, you can see where the greenery and parks are. At these places, the UHI is less apparent. Both neighbourhoods are overall warm (up to two degrees Celsius) (Kaarten | Atlas Leefomgeving, n.d.).

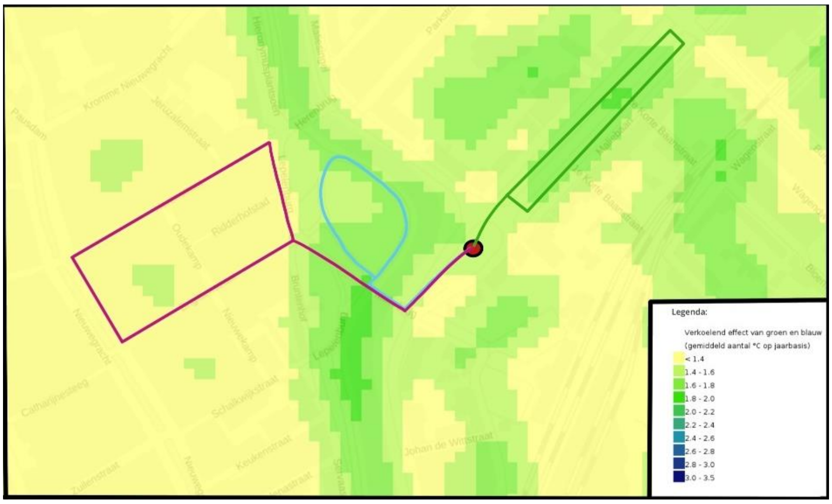

Figure 19 Cooling Effect of Water and Greenery (Kaarten | Atlas Leefomgeving, n.d.)

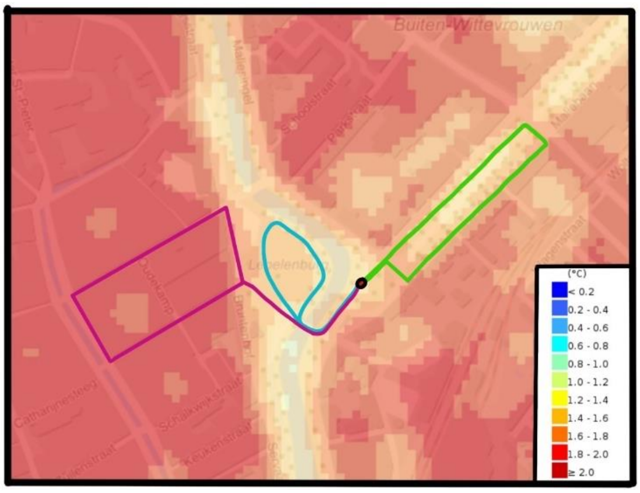

Figure 20 Urban Heat Island Effect (Kaarten | Atlas Leefomgeving, n.d.)

4.3 SELECTED ROUTES

The chosen routes had to have a connecting central point from which to start and end. It also had to be easily accessible within Utrecht. The starting location Malieblad (Figures 21-23) gave the possibility for a route within each walking network. This is how the three routes around Maliebaan and Park Lepelenburg were decided upon. It is centrally located and easily accessible by bus and bicycle.

Each route has been run through the environmental characteristics framework to compare these results with survey answers. The assessment of the routes was done in association with an expert at Goudappel to avoid any biases. The filled-in frameworks can be found in Appendix 10. The exact address of the starting point is Malieblad, 3581 CM Utrecht. In this paragraph, each route will be described and certain features that emerged from the assessment.

Figure 21 Participant starting a walk

Figure 22 Meeting point Malieblad

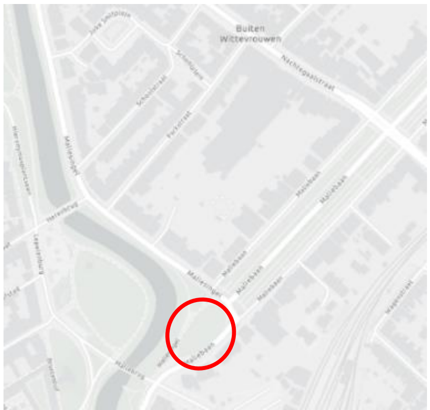

Figure 23 Meeting point Malieblad

ROUTE A – BASE NETWORK

The base network is usually found in neighbourhoods (van Sluijs, 2022). This is also the case in the Herenstraat in Utrecht. Appendix 10 shows the assessment for this street. The sidewalks are narrow and have many barriers, such as parked bikes (Figure 24-26). This already makes it difficult for one pedestrian to move forward, let alone two towards each other or past each other. There is no shelter from the weather or seating options. The street is monotonous, with not a lot of greenery. The estimated walking time is 15 minutes.

Figure 24 Narrow footpath in the Herenstraat

Figure 25 Parked bikes in the Brigittenstraat

Figure 26 Parked bikes on the footpath in the Brigittenstraat

As for the crossing options, Figure 27 shows the unregulated crossings on route A. From Malieblad, someone can walk across the bridge without having to cross the street. After the bridge, it is an unregulated crossing. To follow the route, someone has to cross at their own initiative. There is also an unregulated crossing to get to the Brigittenstraat. At the Nieuwegracht there is no crossing. The pavement continues, but the street is narrow and busy. A pedestrian does have to pay attention before making the turn. While walking back on Lepelenburg, one passes the same crossings as at the beginning.

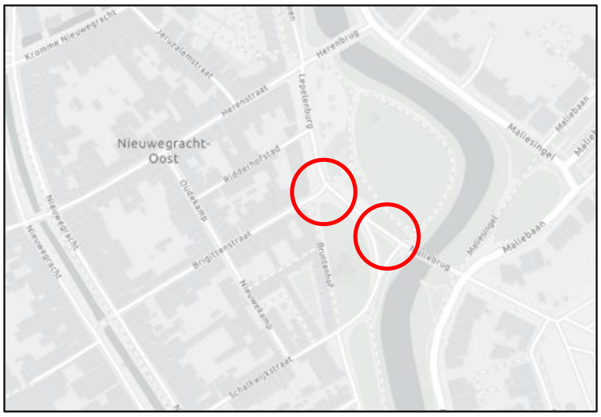

Figure 27 Unregulated crossings

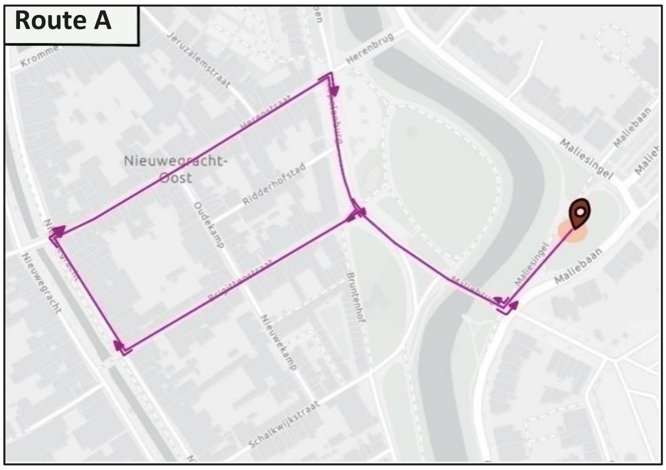

Figure 28 Route A

With this route, one walks past Park Lepelenburg and some office buildings. Once in the residential area, many of the same kinds of houses can be seen. It also goes past the Nieuwegracht, which has a canal running through it and provides a view of the Dom of Utrecht.

Figure 29 Crossing in Herenstraat

Figure 30 Nieuwegracht

Figure 31 Crossing to Lepelenburg Park

ROUTE B – PLUS NETWORK

The Plus network has a higher level of public space with more greenery and clearer footpaths (van Sluijs, 2022). Maliebaan fits in well with this. The Maliebaan is a wide street with different kinds of traffic at different speeds. For the pedestrian, there are two options to walk where the pedestrian is separated from the rest of the traffic, as seen in Figure 32. Two can effortlessly walk side by side on a wide sidewalk. It is, therefore, a more popular walking route. However, the cars driving in the middle have a somewhat higher speed. Maliebaan has some seating options, and the street has a neat appearance. It is monotonous and has limited unobstructed views. The Maliebaan is a busy street for both bicycle and car traffic. For cars, it is one of the roads to the Waterlinieweg (Utrecht Ring Road). The Maliebaan is a wide street with mostly offices on both sides. It is home to, for example, the Rabobank and a childcare centre. At the first intersection, there are streets with stores, cafes, and other facilities on both sides. The Estimated walking time is 10 minutes.

Figure 32 Maliebaan pedestrian path east side

Figure 33 Regulated crossing Maliebaan

Figure 34 Crossing between the two pedestrian paths

In Figure 35, the green circles show the regulated crossings and the red the unregulated ones. One must cross on a non-regulated crossing to get from the starting point to the Maliebaan. Immediately to the right follows a crosswalk (Figure 34). From here it is possible to continue to the intersection, where the pedestrian must wait at the traffic light to cross (Figure 33). Back at the intersection with Malieblad, the pedestrian stands at the same non-regulated crossing they first walked past. There is a crosswalk to cross Maliebaan, but to Malieblad, it is unregulated.

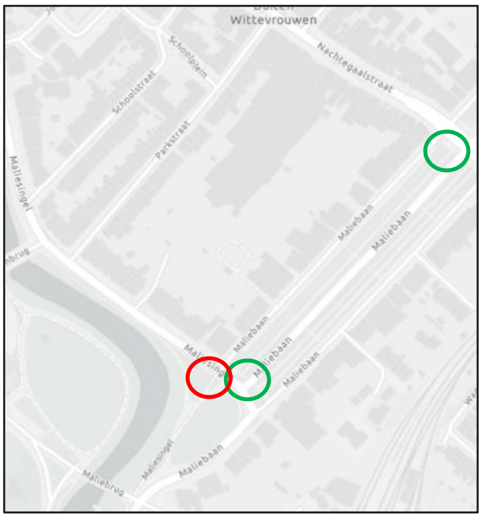

Figure 35 (un)Regulated crossings route B

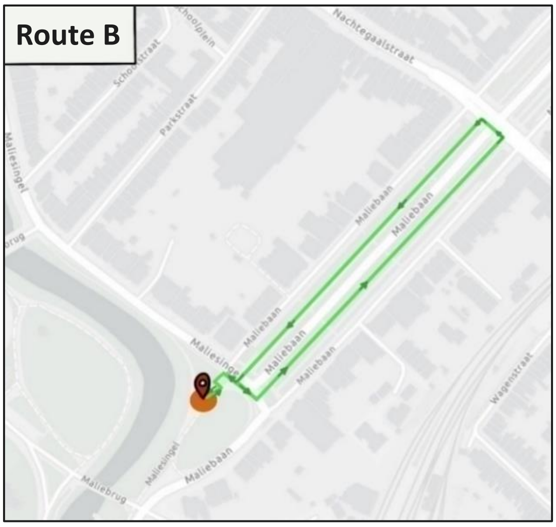

Figure 36 Route B

ROUTE C – GREENERY NETWORK

Dominantly water and greenery are part of the greenery network (van Sluijs, 2022). Park Lepelenburg fits in this quite well. It is separated from other traffic. A pedestrian can do a lap around the park without crossing other traffic. One side of the park connects to a street with cars and cyclists. There is also a lot of parking here given that it is next to the city centre. The park has an open appearance (Figure 38) where someone can easily look from one side to the other. The path's location is clear, as seen in Figure 37. There are plenty of benches, many other pedestrians and a lot to see, such as the canal, a gazebo and, from an angle, even Utrecht's Dom. It is a well-known park where many people meet. The estimated walking time is 9 minutes.

Figure 37 Path Park Lepelenburg

Figure 38 Middle field Park Lepelenburg

Figure 39 Bridge Maliesingel to Park Lepelenburg

With the lap around the park, the pedestrian does not have to cross the street. One can continue via the sidewalk. On the surrounding streets, a lot of bicycle and car traffic passes by. At Malieblad, there is a parking spot for tour buses. This is where many pedestrians come from. Next to the park is the Railway Museum. Because of this, the Maliebaan is also crowded with traffic. The parking lot fills up so quickly that cars soon have to park elsewhere. This is possible next to the park but is often also filled quickly.

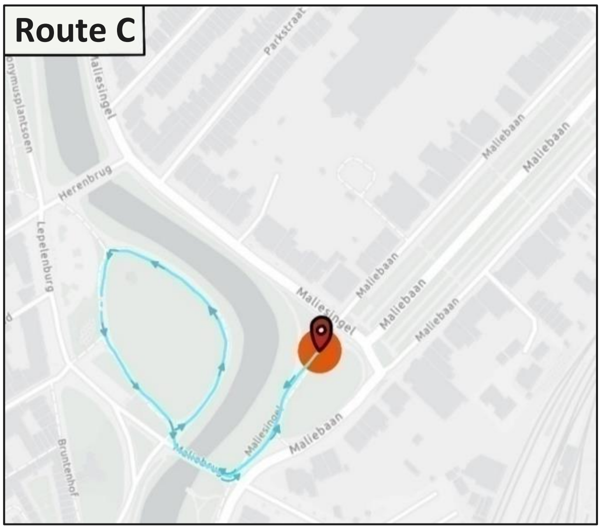

Figure 40 Route C

The case study illustrated the three used routes and their objectively measured walkability. This helps establish the base for measuring the time-travel perception with the field research. Through the data collection method, it was examined whether the environmental characteristics that affect walkability also affect the time-travel perception.

5.0 RESULTS

This chapter discusses the results of the walking method. By first illustrating the scores of the environmental characteristics of each route, a sense of the walking experience is given. This is also held alongside the walkability measurement done earlier. After this, the influence of these environmental characteristics on time-travel perception is examined. Whether any striking results emerge from this. It also looks at the different stimuli and what influence they had during the walk on time-travel perception. The following hypotheses are tested in this chapter:

- The better the environmental characteristics score, the better the walking experience.
- The difference in time-travel perception is determined by the quality of the walking network.
- Positively scoring stimuli and environmental characteristics lead to a positive time-travel perception.

5.1 ENVIRONMENTAL CHARACTERISTIC SCORES

This section discusses the results in terms of the scores for each environmental characteristic for each route and the three routes together. This determines the walking experience of each route. The average scores for each pedestrian needs theme are discussed, and how the routes scored for each characteristic are shown. It is also compared with the walkability measurement. The set hypothesis was: The better the environmental characteristics score, the better the walking experience.

5.1.1 ROUTE A

Route A was the longest route and ran through the base walking network. It had an average score of 7.1. Figure 41 shows the grading of each theme. The route scored best on the theme speed with a 7.6. The highest score was for waiting time, which participants experienced as good (score 8.4). Route A also scored well on its ease of finding the way (score 8.3), the little effort the walk took (score 8.0), and the lack of hindrance from the weather (score 8.1). The route scored the least on its overall ease. It was experienced that the sidewalks were not wide enough (score 4.5) and that there were many obstacles (score 5.6). Participants noted “little footpath to walk on and many obstacles and bikes”. Busyness also received a low score of 5.7, but in this case, that could mean a positive thing. The route was perceived as moderately quiet. Figure 42 shows all the different scores. Participants scored the various characteristics of the route highly while it was part of the base network. In particular, the

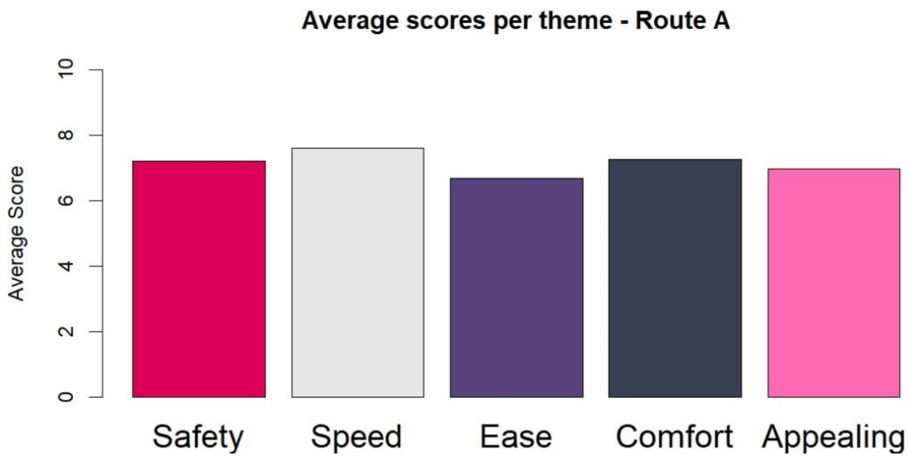

Figure 41 Average score per theme - route A

various satisfiers scored better than expected. Satisfiers can be explained as things that could positively influence someone and create a better experience (van Hagen, 2011; van Sluijs, 2022). Only the absence of benches along the route corresponded to experts' walkability measurements (Appendix 13).

5.1.2 ROUTE B

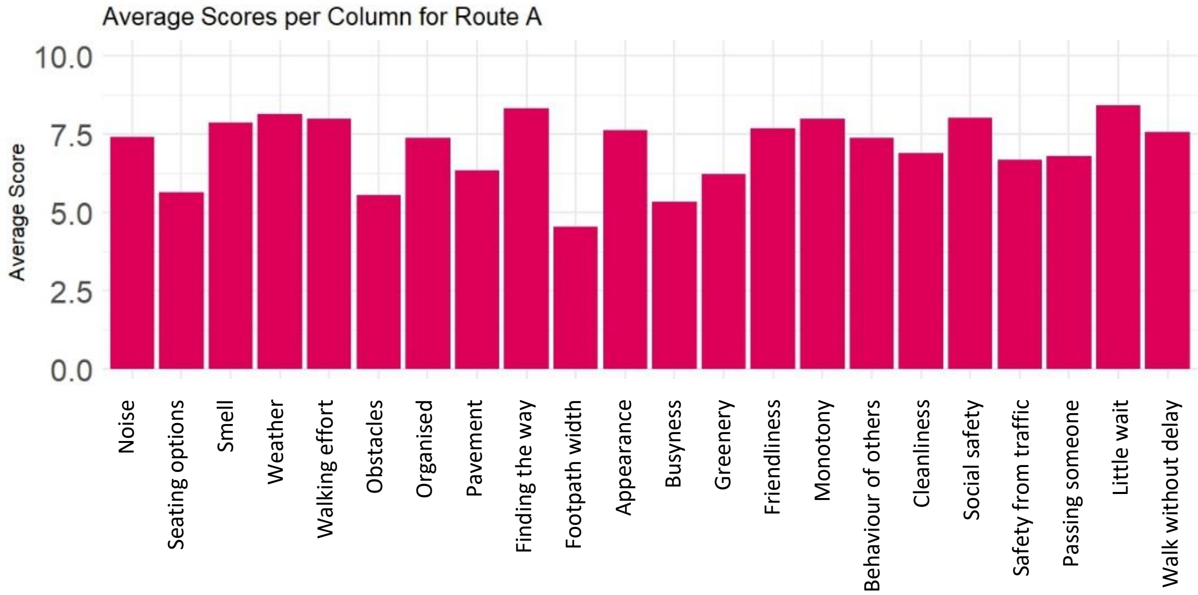

Figure 42 Average score per column - route A

Route B walked through the plus walking network and had an average score of 7.3. Figure 43 shows the scores per theme. The route scored best on ease (score 8.8) and least on appeal (score 5.9). Everything that falls under the theme of ease had a score of +8.0. Finding the way had the highest score with a 9.1. The appeal of route B was expected to be better (Appendix 13) than it was experienced, especially in looking at the friendliness of the route (score 5.8). Route B also scored poorly on hindrance from noise (score 5.3), which corresponds with the measured traffic noise in the case study chapter (Ch. 3.2.3). It was also noted by participants in their surveys that “the route itself is beautiful but too bad about the busy car traffic”. It was also experienced as not very varied (score 4.7). This makes sense since it was a short walk on the same street. Busyness also had a low score. This means that it was experienced as not too busy. Figure 44 shows the scores of all the other variables.

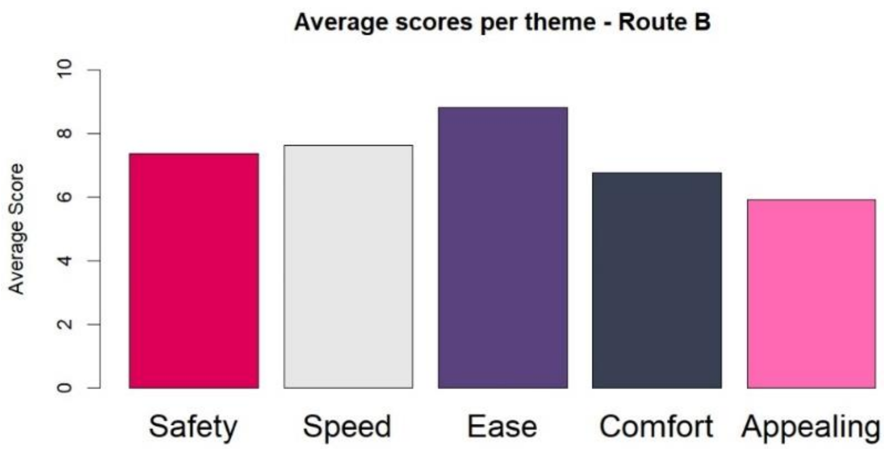

Figure 43 Average score per theme - route B

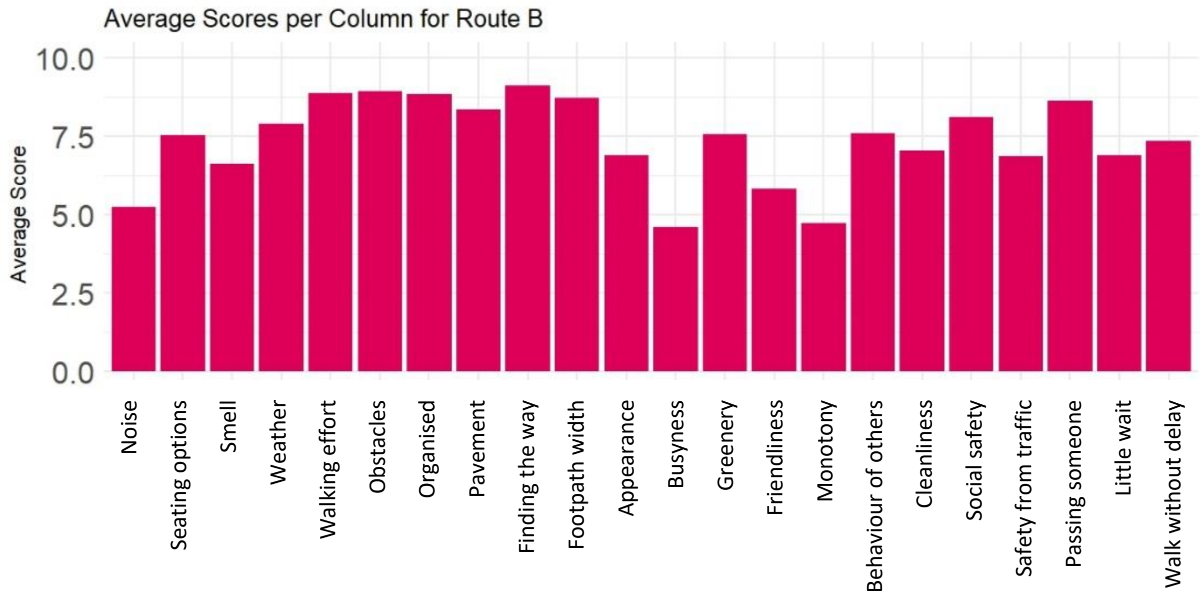

Figure 44 Average score per column - route B

5.1.3 ROUTE C

The final route walked through the greenery network. This route had an average score of 8.5. Many themes scored 7.9 and up, as seen in Figure 45. Speed and ease both have average scores above 9.0. Speed had the best score overall, with a 9.0. Waiting time got an average score of 9.7. The route was a circle without any crossings, so this high of a score makes sense. The route was experienced as well organised, took little effort, and scored well on greenery. The latter is in line with the measurement in the case study chapter (Ch. 3.2.3). It was experienced as not too busy. In terms of route variation, route C scored poorly with a 6.8, which comes as no surprise considering it was a small loop around the park. Figure 46 shows all the scores. While scores were high, there was also criticism. For example, many participants mentioned that the urinal was very foul-smelling and some experienced inconvenience due to the presence of homeless people in the park.

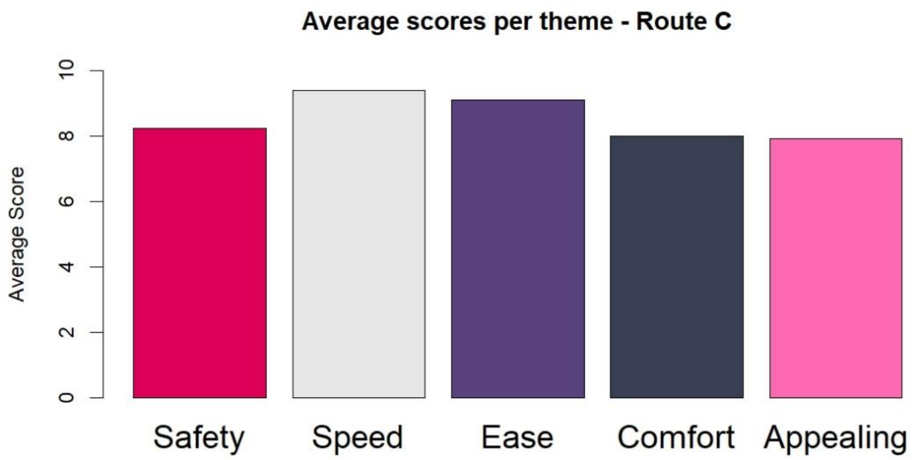

Figure 45 Average score per theme - route C

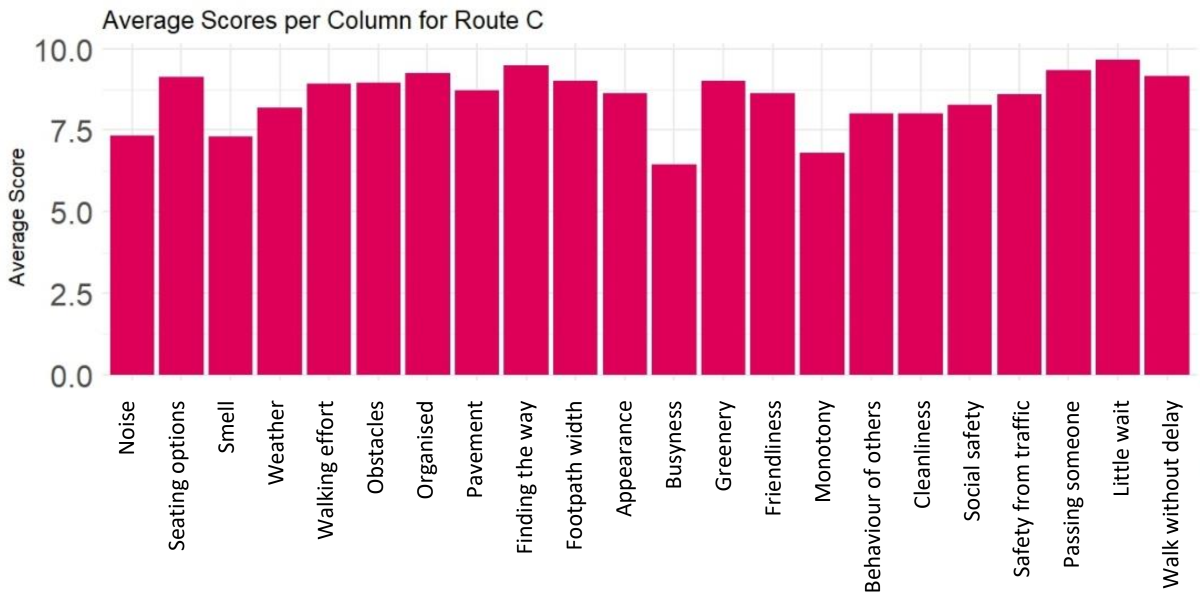

Figure 46 Average score per column - route C

5.1.4 THE THREE ROUTES COMBINED

It can be concluded that, overall, the three routes scored well in terms of environmental characteristics and their walking experience. The order in which the three routes scored is consistent with the expected walkability of each. Route C came out best and route A worst. Even though routes A and B have a close score. Figure 47 shows all the scores of the three routes combined. This way, the difference per theme and route can be compared. A few things stand out. Route C mostly has the highest score except for the experienced hindrance due to noise, variation of the route and hindrance due to smell. Route A has a higher score with these. Comparing the average score of the width of the pedestrian path, route A has a way lower score than the other two. Also, for the obstacles, route A scores are way lower. With variation and hindrance due to noise, route B has an average lower score than the other two routes.

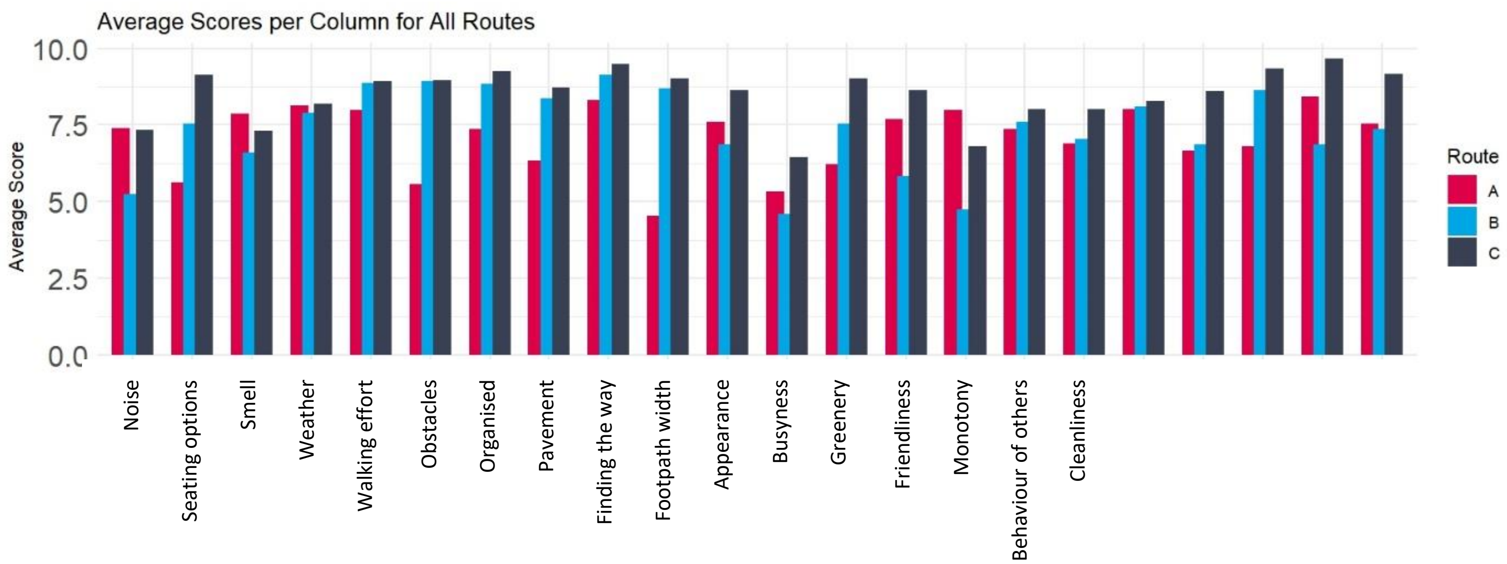

Figure 47 Averages of all the routes

Figure 48 shows the distribution of different pedestrian needs themes within the average scores of each route. For route A, the score is most influenced by speed, with 21.3%. Comfort and safety come after this with both 20.2%. For route B, ease contributes the most to the average score, with 24.1%. The least is the appeal of the route, with 16.2%. The average score of route C is mainly explained by speed (22%) and ease (21.4%). The distribution of the three routes are relatively equivalent with each percentage heading towards 20%, which makes sense since all the routes scored well on average. These percentages and scores show an overview of the differences, but the routes were positively experienced.

Figure 48 Distribution of the different themes

To conclude, the walking experience of the three routes is consistent with the hypothesis set. The three routes differ in the degree of walking experience and become increasingly better. However, even the 'worst' route still scored better than expected. Overall, the walkability of the three routes is scored as good.

5.2 TIME-TRAVEL PERCEPTION

The time-travel perception is described as walking a certain distance in a certain amount of time. For both, the objective time and distance are available, but the precepted time they felt like they spent walking varies per person (Gkavra, 2021). The hypothesis tested in this chapter is: The difference in time-travel perception is determined by the quality of the walking network. The walking time was measured for each participant, and they were asked to guess it. This created a time difference (i.e. time-travel perception). A positive value of time difference means that someone overestimated the walking time compared to the measured time. A negative time difference means someone underestimated the walking time compared to the measured time. Appendix 11 shows the descriptives of the analyses done.

The average walking time of route A was 777.51 seconds (around 12 minutes). The average overestimation was 134 seconds. This is an overestimate of 17%. The average underestimate was 140.7 seconds, giving a percentage of 18%. Route A has the smallest difference in time-travel perception of the three routes. Figure 49 shows the time difference per participant. Participant 4 stands out with an underestimation of more than 10 minutes. It is almost equally divided between the under- and overestimation of the walking times.

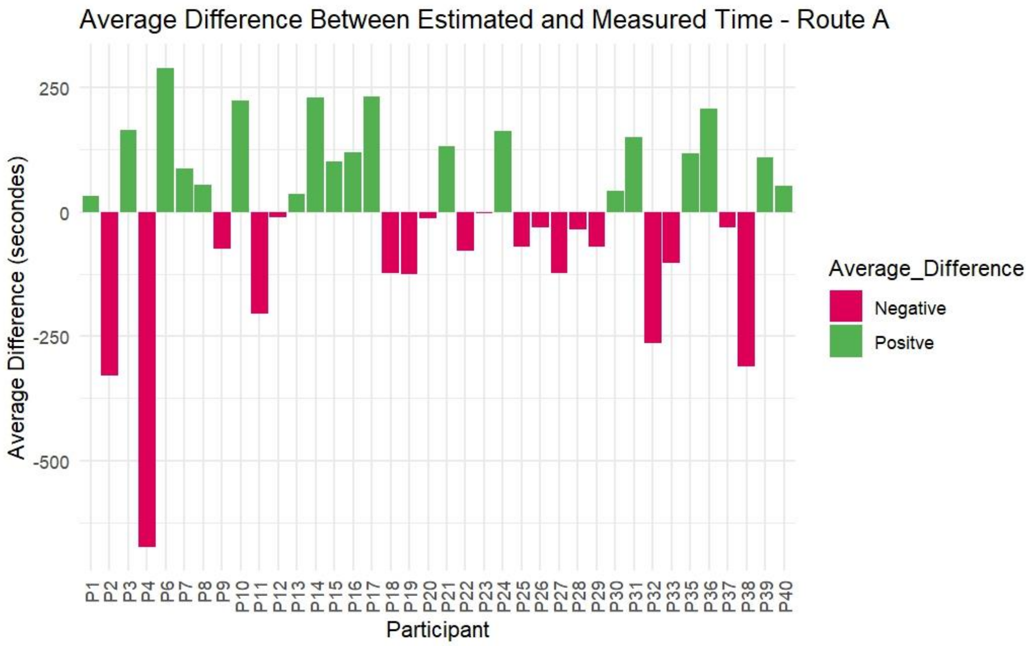

Figure 49 Average time difference - route A

Route B had an average measured walking time of 455.2 seconds (around 7.5 minutes). The average overestimate was 155.93 seconds and thus an overestimate of 34%. The average underestimate was closer to the measured time, with a difference of 55.72 seconds on average (12%). As Figure 50 shows, only fifteen participants estimated walking shorter than measured. Five participants believed that they walked for more than five minutes longer than measured.

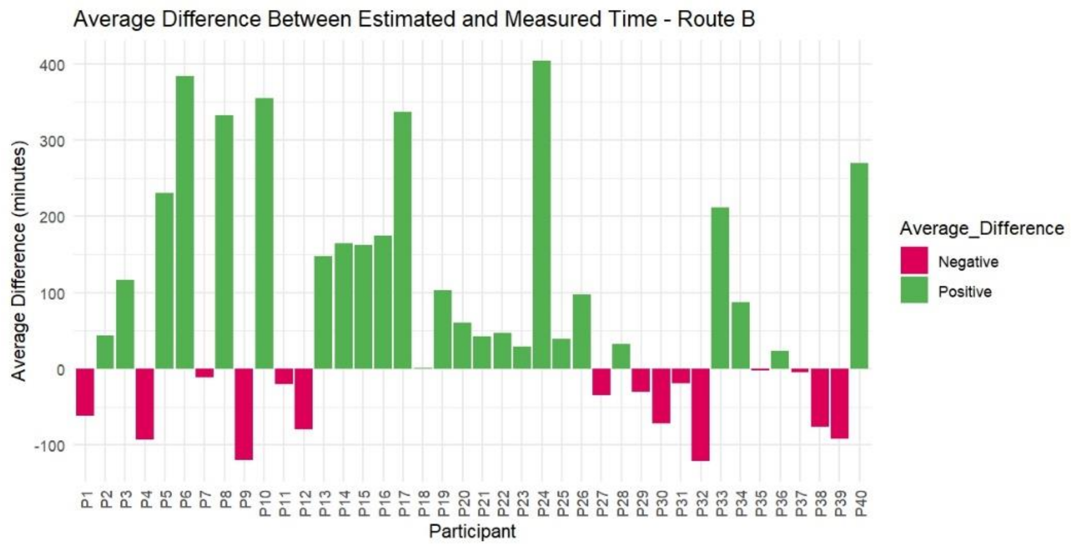

Figure 50 Average time difference - route B

The average measured walking time of route C was 414.1 seconds (around 7 minutes). The average overestimate was 108.21 seconds, an overestimate of as much as 26%. The average underestimate was not too different, averaging 92.4 seconds, or as much as 22%. Figure 51 shows the difference per participant. It is noticeable that Participant 11 has no bar, meaning they guessed the walking time to be the same as that measured. More than half of the participants overestimated the walking time. Here too, the difference between the under- and overestimation of walking times is almost evenly divided.

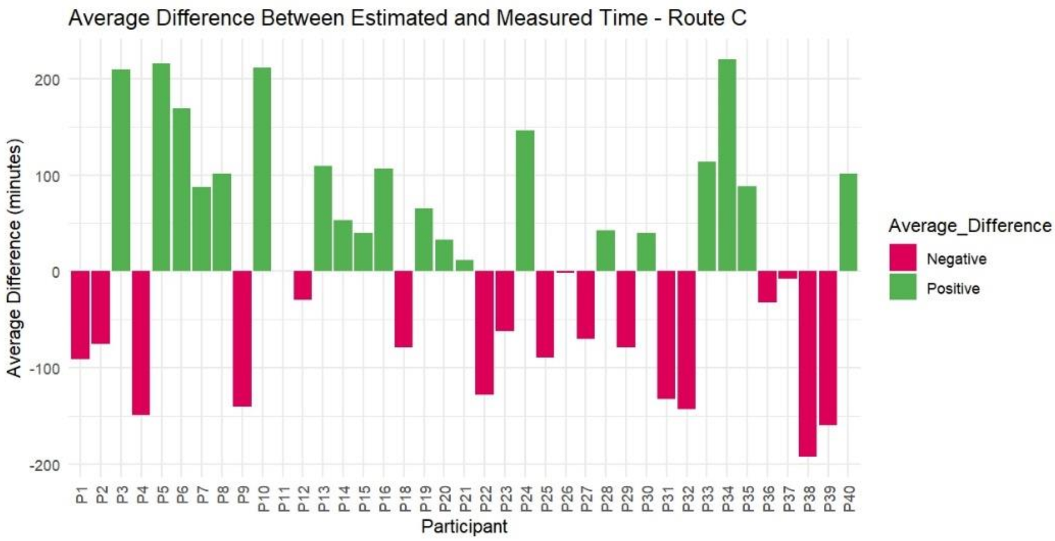

Figure 51 Average time difference - route C

In comparing the three routes, it emerged that for 19 of the 40 participants, route A most often had the most positive time-travel perception. This could still be an overestimation of walking time, but a smaller one than for the other routes. It is less than half, but still the most frequent. Although route A had the greatest positive effect on the time-travel perception, it also had the most barriers. This contradicts the study by Ralph et al. (2020), who found that the number of turns and barriers had a negative effect on the time-travel perception. On the other hand, Route B was the most overestimated route for 23 of the 40 participants. Route C had a slightly more positive influence on the time-travel perception. For 16 out of 40 participants, this was the most underestimated route. Overall, route A had the most frequent positive influence on time-travel perception for most participants.

There is a clear correlation between the measured and estimated time. They have a strong positive effect on each other ($r=0.683$, $p<0.001$) with an explanatory variance of up to 46.6%. This means that as one increases in value, the other will also. The regression analysis also shows a clear significant positive relationship ($p<0.001$).

Another vital part of the time-travel perception is whether it felt like time was passing quickly. However, no significant impact on the time-travel perception emerged. Also, the feeling of time did not have a significant impact on route A. For route B, a friendly appearance did appear to have a significant impact ($p=0.04$) and for route C, the monotony of the route ($p=0.04$). Thus, these factors may promote or worsen the feeling of whether time passes quickly. The time-travel perception was examined for each route, but it is also interesting how it differed per time slot. The largest total miss estimations happened on April 11th at 13:30h. Figure 52 shows that route B often resulted in an overestimation in time-travel perception for each day. For routes A and C, this is slightly more varied.

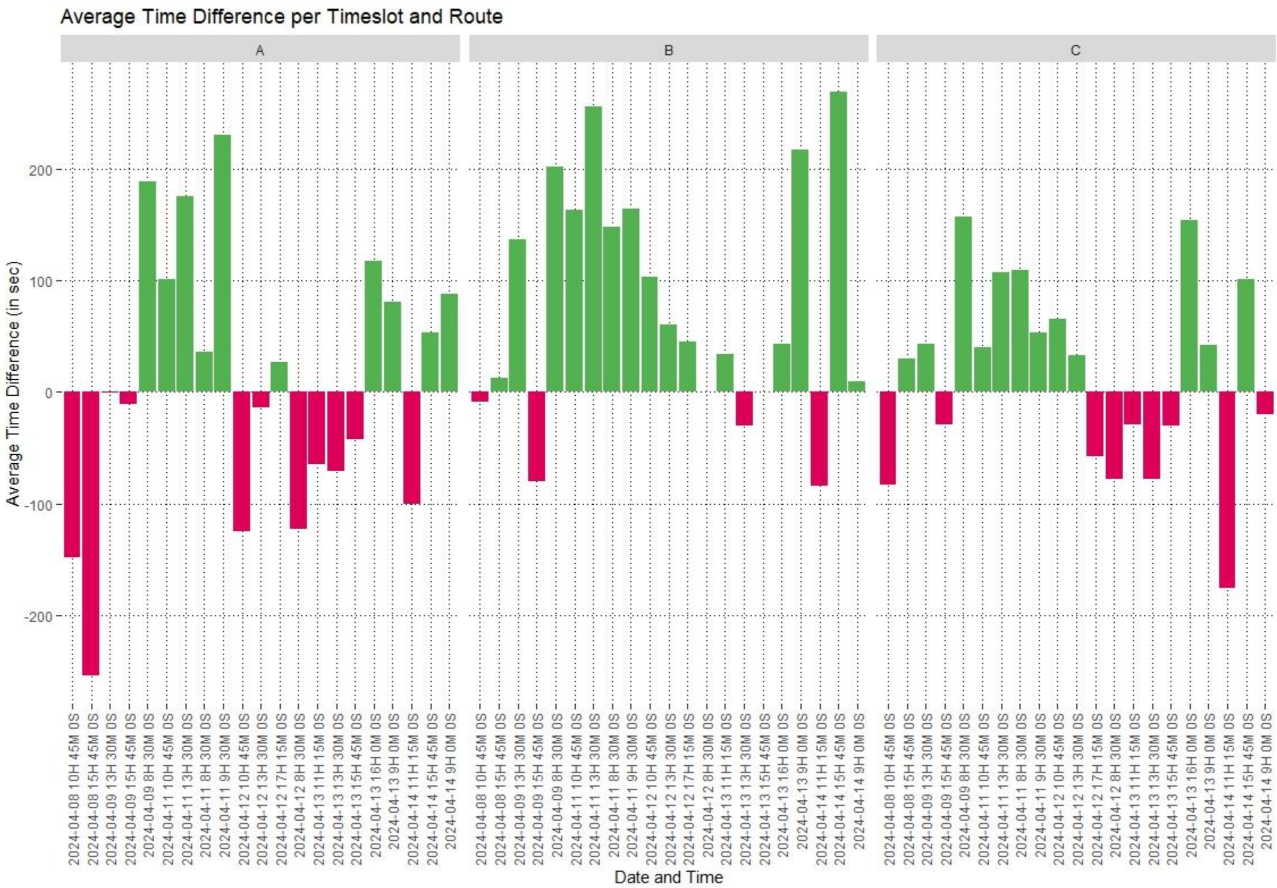

Figure 52 Time-travel perception per timeslot and route

It can be concluded that there is a clear relationship between measured and estimated time. However, this is not determined by whether time while walking felt like it was passing quickly. Friendliness and monotony for routes B and C did contribute to that feeling. Nevertheless, the networks' overall quality did not significantly influence the time-travel perception. The hypothesis can be rejected. The quality of the walking networks does not determine the time-travel perception.

5.3 ENVIRONMENTAL CHARACTERISTICS AND TIME-TRAVEL PERCEPTION

Having identified the walking experience and time-travel perception of the three routes, it was now possible to see how they coincided. This involved looking at the influence of different environmental characteristics on the time-travel perception. The hypothesis was as follows: Positively scoring stimuli and environmental characteristics lead to a positive time-travel perception. Appendix 12 shows the descriptives of each analysis done.

5.3.1 ENVIRONMENTAL CHARACTERISTICS AND THEIR INFLUENCE ON THE TIME-TRAVEL PERCEPTION

A total of twenty-one different questions, in which different environmental characteristics were linked, were assessed to determine what significantly affects the time-travel perception of the three routes. Appendix 3 shows which characteristic is connected to which survey question.

In looking at the three routes together and determining whether the time-travel perception can be positive or negative, the following characteristics have a significant medium positive correlation with the time-travel perception: the feeling of personal safety (r=0.4, p=0.01), a short waiting time (r=0.3, p=0.02), no monotonous route (r=0.3, p=0.04), being able to easily find your way (r=0.3, p=0.03). A negative time-travel perception significantly correlates with friendliness (r=0.3, p=0.02), amount of greenery (r=0.3, p=0.02) and busyness (r=0.3, p=0.04). These all have a medium positive correlation contributing to a negative time-travel perception. Figures 53 and 54 show the correlation matrixes.

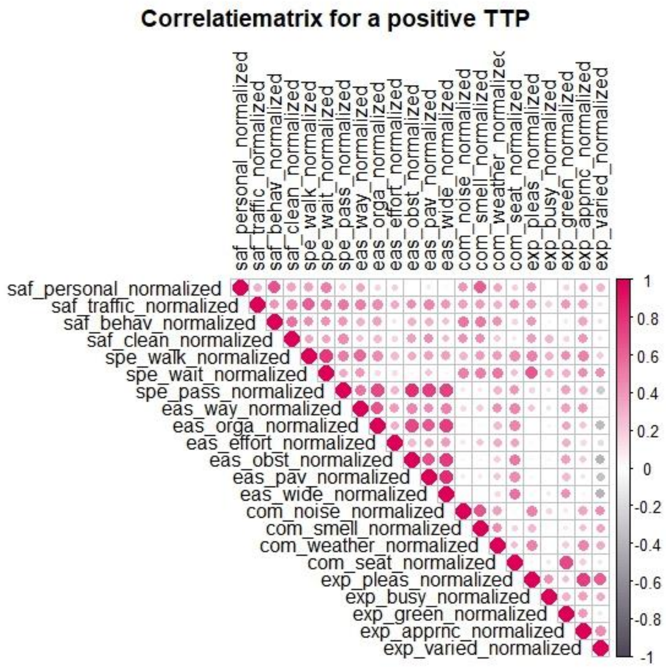

Figure 53 Correlation matrix positive time-travel perception

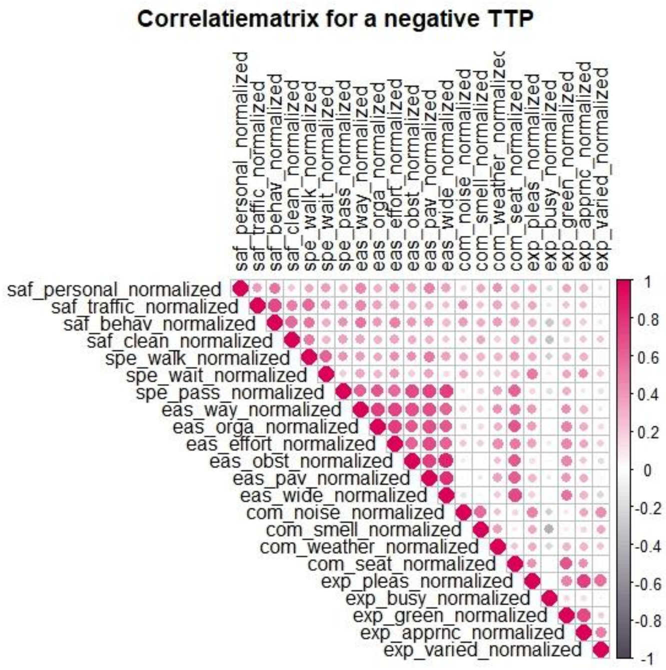

Figure 54 Correlation matrix negative time-travel perception

A positive correlation between characteristics works as follows. For example, for the feeling of personal safety and a varied route, people will give the feeling of safety a higher rating if the route is also varied. This then could result in a more positive time-travel perception. For a negative correlation, one will increase, and another will decrease. If the score on the annoyance of traffic increases, the score of green will decrease. In other words, the more inconvenience from traffic, the worse the greenery is perceived and the greater the negative time-travel perception could be. The regression analysis shows whether the time-travel perception is strongly influenced.

From the regression analysis emerges that for a positive time-travel perception, the ease of finding the way is influential (p=0.01), meaning having plenty of signposting, visible street names and wayfinding are influential. The easier the route is to find, the more positive the time-travel perception is rated. For a negative time-travel perception, busyness is influential (p=0.007). A busy environment can induce a negative time-travel perception ($p<0.05$).

Without distinguishing between a positive and negative time-travel perception, a moderate positive correlation between a sense of personal safety and time-travel perception (r=0.33, p=0.045) was found for Route A. Personal safety translates to having (in)direct eyes on the street, an average number of pedestrians in the area, protection for pedestrians and facade transparency. The ease of finding the way (r=0.33, p=0.04) also had a moderate positive relationship between the time-travel perception and route A, meaning having visible street names and signposting. Routes B and C have no significant correlations with the time-travel perception. The regression analysis shows that only route C, being able to walk easily without delays, significantly affects the time-travel perception (p=0.03). There are no variables of significant influence for the other two routes in this analysis.

Each route was part of a different walking network: base, plus and greenery. For this part, the routes were looked at separately per the pedestrian triangle theme. The correlation analysis shows no statistically significant correlation for all three routes. The matrixes in Appendix 15 show several strength correlations, but a larger sample is needed to extract significance. Even though there are no relevant correlations, some variables influence the time-travel perception. Starting with route A, the number of seating options on the route significantly negatively influences the time-travel perception (p=0.03). This means that the absence of seats can make you feel like you are walking longer. The presence of greenery positively influences the time-travel perception (p=0.03). Also, the versatility of a route makes it feel like walking takes a shorter time (p=0.009). Route B positively influences the time-travel perception for the ease of passing someone on the route (p=0.04). This indicates there is enough space for two pedestrians to walk side by side. Additionally, finding one's way easily (p=0.02) and a wide enough footpath (p=0.02) also have a positive influence. The presence of visible street names, adequate signposting and wayfinding, and a footpath width of 180–200cm (minimum) with a minimum constriction of no more than 90cm are also beneficial. The lack of friendliness of the route has a negative effect in this case (p=0.03). The absence of approachable places like restaurants and schools created an overestimation of walking time. Still, for route C, no characteristic had a significant influence.

5.3.2 ENVIRONMENTAL CHARACTERISTIC SCORES AND THE TIME-TRAVEL PERCEPTION

Different significant environmental characteristics affecting the time-travel perception were determined. This section looks at how these relate to the scores discussed in Ch. 5.1. A high score for an environment characteristic may not mean it was also significant for time-travel perception. Each score had a share within the corresponding pedestrian needs triangle theme and the average of each route. This section illustrates this and compares it with the different significant characteristics of the time-travel perception. Appendix 13 shows an overview of the differences between the measurement of walkability and the walking experience.

The monotony of the route was significant for route A. Participants also scored it with an average of 7.9. The monotony of the route has a positive influence on the time-travel perception. However, it explains only a tiny part of the average appeal score, as seen in Figure 55. Participants experienced the route as diverse, translating into their time-travel perception, but other characteristics were more influential in scoring the route. Seating options had a low score of 5.6 and negatively influenced the time-travel perception. However, this did not stand out in the average comfort score, with a share of only 6%. The other characteristics were more influential in scoring the route. Greenery positively influenced the time-travel perception for route A but had an average score of only 6.2. The little greenery present had an impact, but more greenery could lead to an even better time-travel perception. It also has one of the larger shares within the theme appeal of 24%.

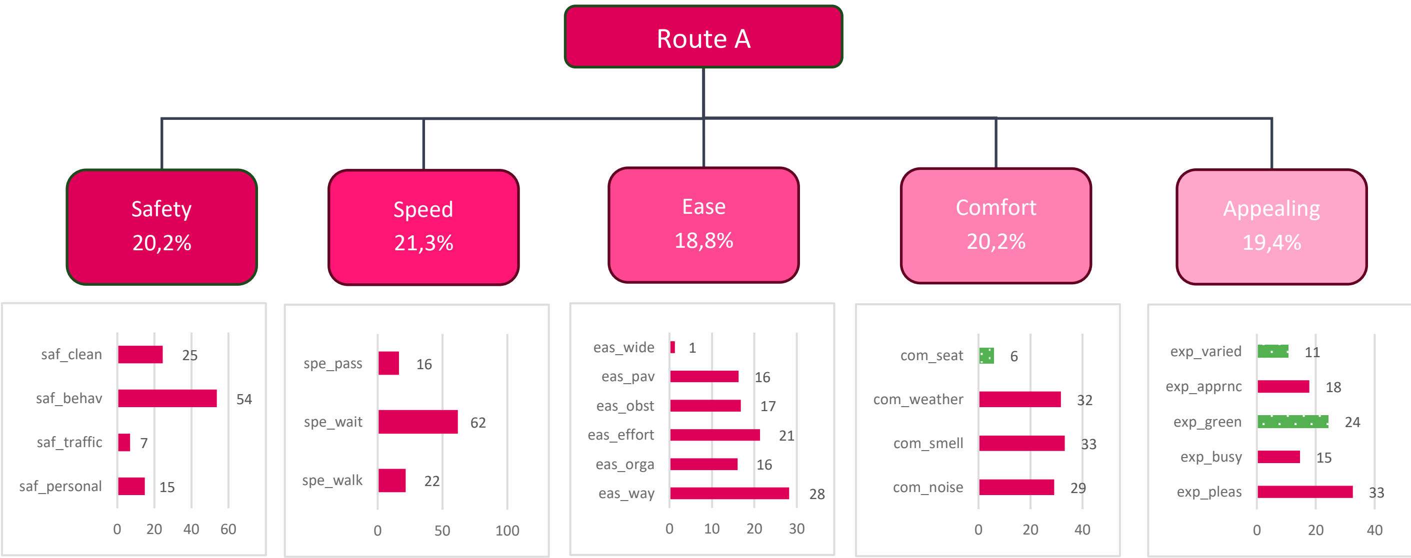

Figure 55 Environmental characteristic shares (%) within each pedestrian triangle theme – Route A. It shows how the average score of the route and by theme are made up. A green bar shows a significant influence on time-travel perception.

The ease of finding the way had a positive influence on the time-travel perception of route B. The average score was also 9.1, so participants experienced enough ease in finding their way, positively influencing their time-travel perception. Even though it is significant, ease of finding the way has only a 2% share within the ease theme, as seen in Figure 56. Other variables were more determining in scoring the characteristics of the route. The route's friendliness negatively influenced the time-travel perception of this route and an average score of 5.8. It was experienced as not having too many amenities, negatively influencing the perception of time. Consequently, its share within the theme of appeal is 28%, one of the larger shares. In scoring route B, this was enough to influence the theme average. Being able to pass someone had a positive influence on the time-travel perception for route B, with an average score of 8.6. Participants experienced it as easy to do, making it feel like time went by faster. Within the theme, it explained 24% of the theme score. Other variables within the theme stood out more in scoring the route. The footpath width had the same positive influence on the time-travel perception. With it being experienced as wide enough, it makes sense that it was easier to pass someone. However, this only had a small share of 9% within the ease theme. Mostly, the pleasantness

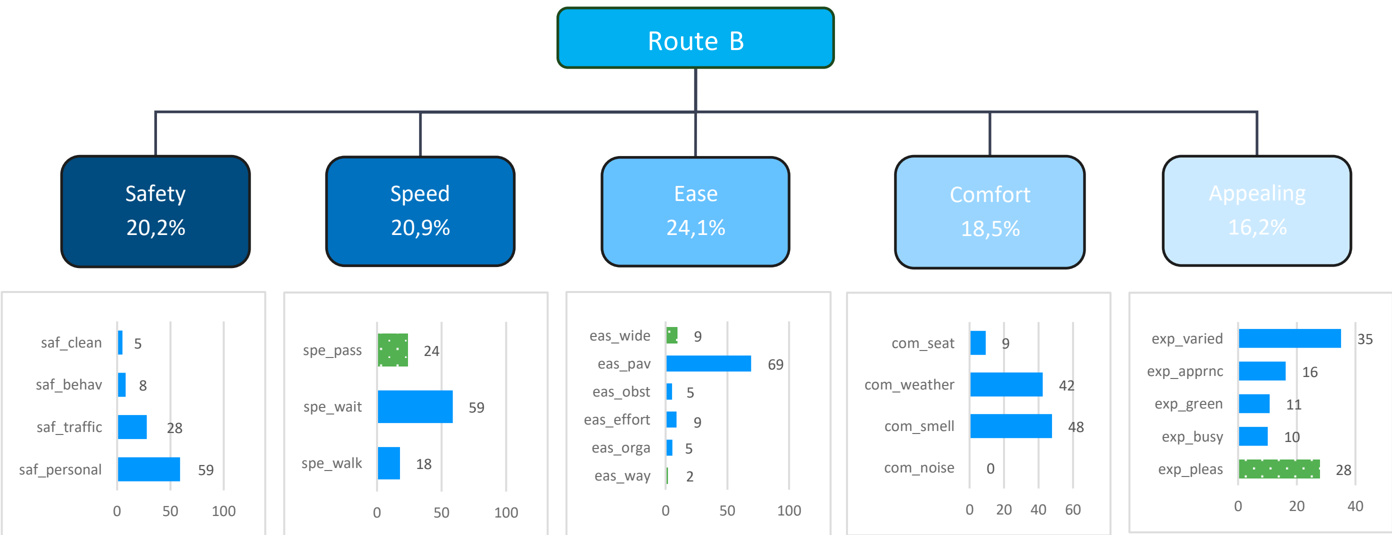

Figure 56 Environmental characteristic shares (%) within each pedestrian triangle theme – Route B. It shows how the average score of the route and by theme are made up. A green bar shows a significant influence on time-travel perception.

of the pavement was influential in scoring ease. These can improve the time-travel perception, but other variables are more influential for the walking experience.

Walking without any delays was the only significant influence on the time-travel perception for route C. It had an average score of 9.1, which means participants felt like they could walk without delays. Since the route was a circle, this makes sense. Walking without any delays had a 31% share within the speed theme, as seen in Figure 57. This is not the largest share within the theme, but it still makes up a large part of the average ease score.

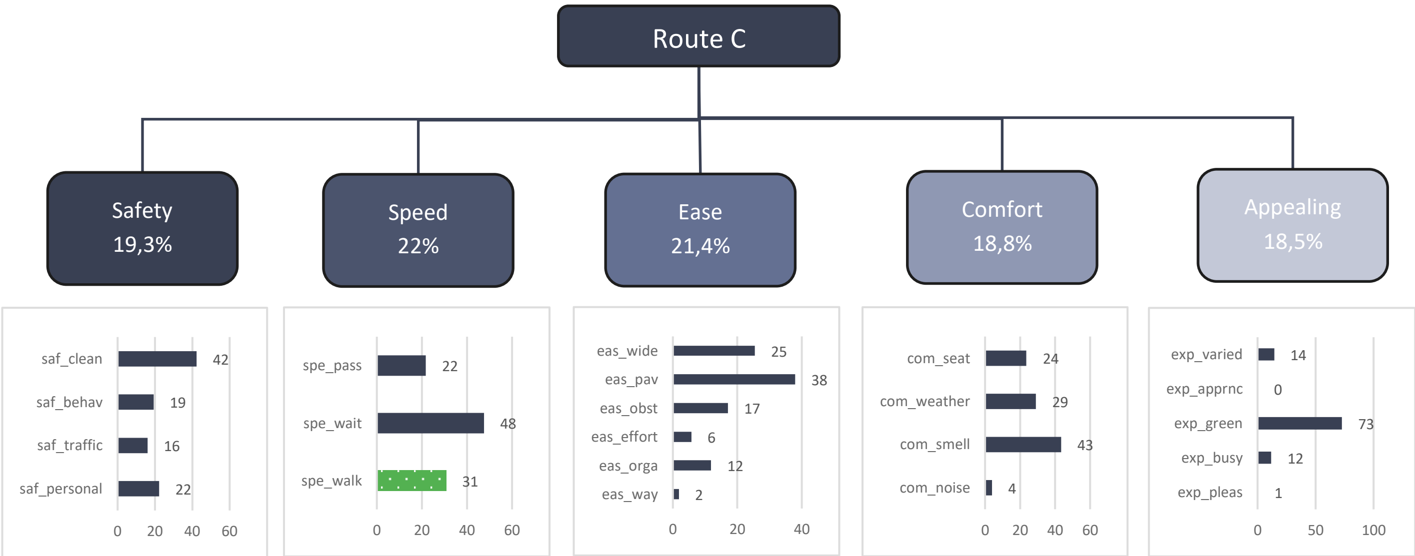

Figure 57 Environmental characteristic shares (%) within each pedestrian triangle theme – route C. It shows how the average score of the route and by theme are made up. A green bar shows a significant influence on time-travel perception.

In looking at the three routes together, the environmental characteristics busyness and ease of finding the way had a significant influence on the time-travel perception. Busyness varied in terms of score and had a negative influence on the time-travel perception. It differed by time slot and weather conditions how busy each route was perceived. The ease of finding the way scored overall high, meaning finding the way on all walks was not too difficult. It also has a positive influence on the time-travel perception.

Each route has several significant environmental characteristics that affect the time-travel perception. The figures accompanying this section showed the different shares and that the largest shareholder has no significant influence on the time-travel perception. These shares show where areas of improvement lie in the walking experience. Those that impact the time-travel perception will enhance a pedestrian's perception of time. However, the themes with the highest shares highlight the emphasis on improving the walking experience.

5.3.3 STIMULUS AND THE TIME-TRAVEL PERCEPTION

During a walk, the person's emotional state varies from person to person. Some want more stimuli to get to a higher arousal level, while others need less (van Hagen, 2011). This section distinguishes between the stated internal and external stimuli and their connection to the time-travel perception. Appendix 14 shows the descriptives of the analyses done in this chapter.

Different theories in the theoretical framework identified several stimuli that may affect the time-travel perception and someone's walking experience. Figure 58 shows these (gender and age excluded) and how they correlate with the time-travel perception. Immediately, it can be concluded that stronger correlations hang between certain variables. This will be discussed for each variable. Starting with how many times a week participants walk more than fifteen minutes. Dewulf et al. (2012) suggested that those who are more active are better at estimating their walking time. This may result in wanting to walk longer. Overestimating walking times can lead to a negative time-travel perception and thus not wanting to continue walking. Figure 59 shows that in this research, the largest group walks 1 to 3 times a week for more than fifteen minutes and a small percentage only do so less than once a week. However, the analyses showed no significant outcomes (p=0.6, p=0.4). How many times a week someone walks does not influence the perception of time.

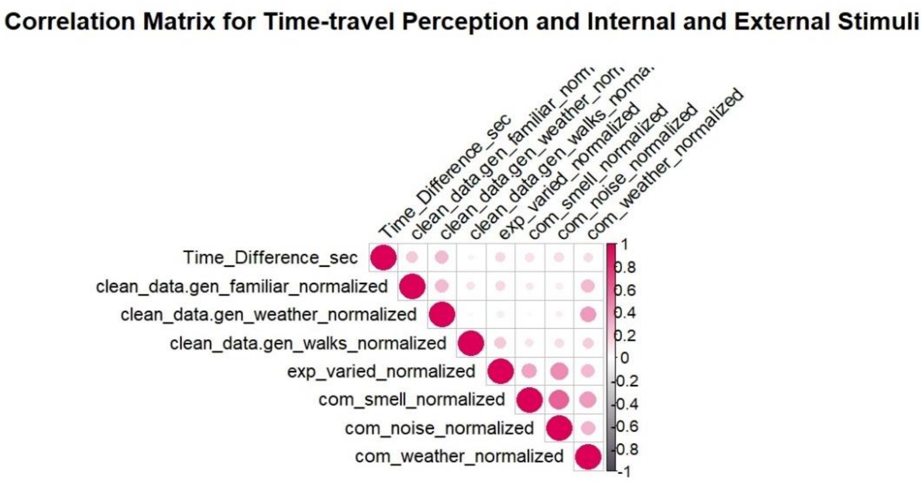

Figure 58 Correlation internal and external stimuli

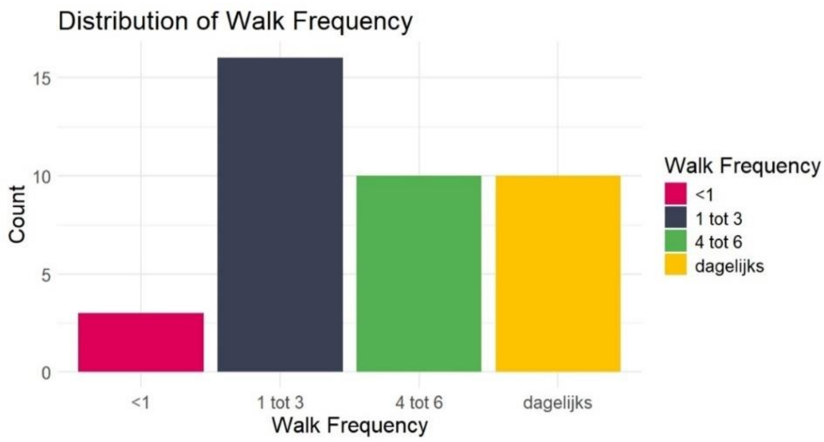

Figure 59 Walk Frequency of Participants

Following on from Dewulf et al.'s (2012) observation, a clearer mental map of the area gives a better sense of time, too. Pedestrians may be better able to estimate how long a particular stretch of walking will take, resulting in being able to continue for longer. From this came the question of familiarity with the environment. Participants were more familiar with the environment, as seen in Figure 60. Scores 7 and 10 contained the largest group. Also, four participants gave a score of 2 and were not that familiar with the environment. The analysis also showed a weak to medium positive effect between familiarity with the area and the time-travel perception (r=0.2, p=0.025). The more familiar the participants were with the environment, the better their time-travel perception was. The regression analysis revealed the same. If someone is familiar with the area, the positive influence can be as high as 73.1 seconds, as seen in Figure 61.

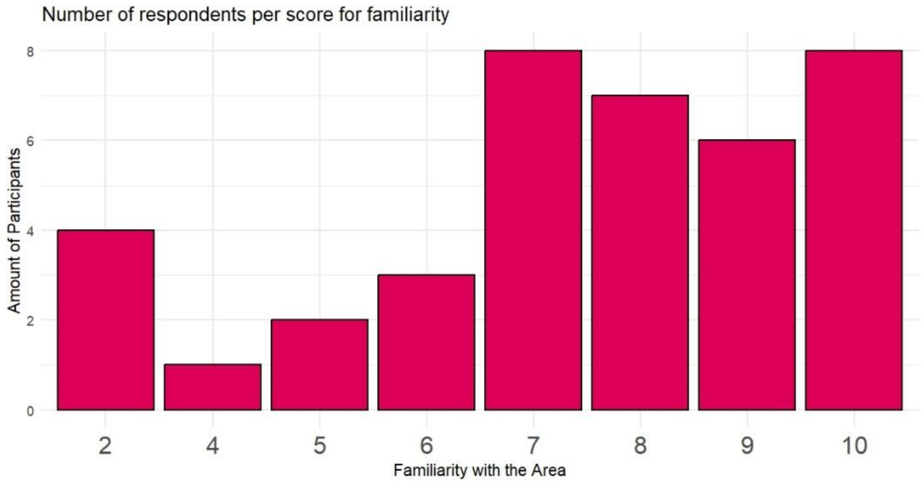

Figure 60 Familiarity Scores

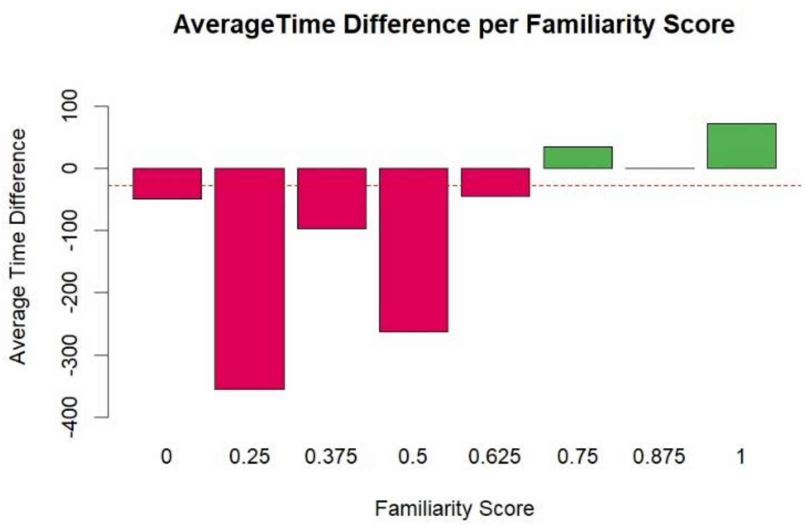

Figure 61 Average time-travel perception per familiarity score

When it comes to the overall experience of the weather, it was accommodating during the walking days. On average, the weather was good, as the participants also perceived. As Table 6 in the methodology has shown, the weather was nice on April 8, 12 and 13. Figure 62 shows the participants' ratings, and that the afternoon of April 14 was also perceived as pleasant weather. The average score was above 5, and the weather was perceived as good throughout the week. Therefore, the weather had a weak to moderate positive significant effect on the time-travel perception (r=0.3, p=0.003). Those who came for a walk on a nice day had a more positive time-travel perception. The difference between nice and bad weather could differ by as much as 142.97 seconds (p=0.01).

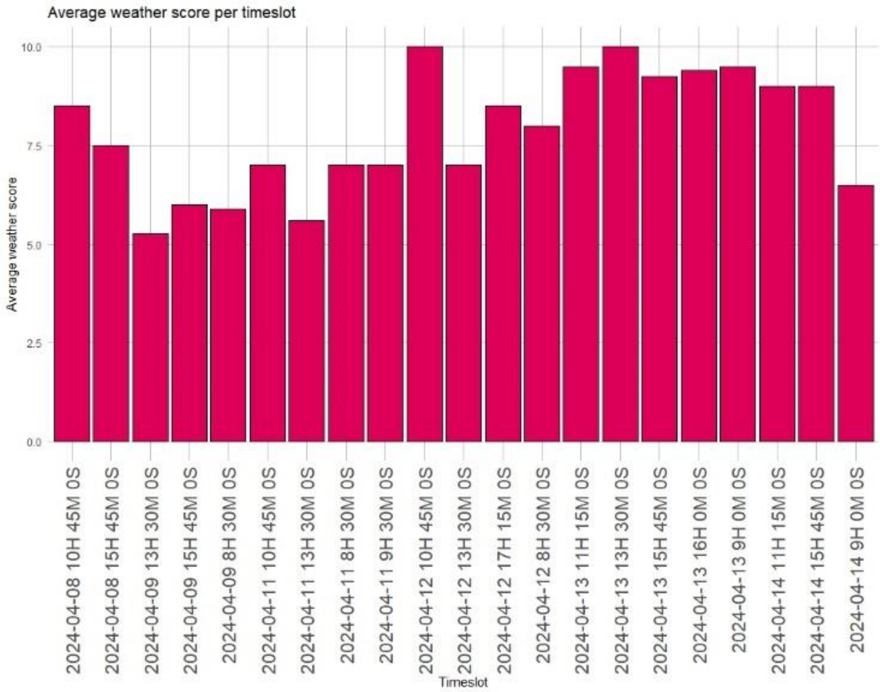

Figure 62 Average weather score per timeslot

As stated by van Hagen (2011), people are not aware of the different kinds of stimuli but are certainly still influenced by them. In this case, the route's monotony and hindrance from smell, noise, and weather during the walk. The results show that on all three routes (A, B, and C), no significant relationship was found between the variables and the time-travel perception ($p>0.05$). Some weak correlations emerged, but these, too, were not significant. These weak correlations might grow into significant relationships if the sample size increases. Monotony did, however, stand out during the expert panel. Even though there was no significance, ideas emerged that route A scored so well because of the large number of turns compared to other routes. Curves were seen as a possible solution to counteract monotony. Overall, it can be concluded that none of the variables discussed makes the walk appear faster or slower.

Busyness is a variable that can make or break a person's mood. If it is too busy, attention overload can set in. It is important to have the right amount of busyness stimuli to keep someone in the desired state (good balance between boredom, relaxation, excitement, and anxiety) (van Hagen, 2011). As mentioned, busyness significantly negatively influences the time-travel perception of all routes ($p=0.007$). This differs from the outcome of the study by Gkavra (2021), in which busyness has a positive influence. Figures 63 show the average perceived busyness per time slot and route. Interestingly, route C was mostly perceived as the busiest. Busyness was a variable that stood out during the expert panel because it differs per person in how busy a place is desired to be (van Hagen, 2011). Responding to this, therefore, remains challenging.

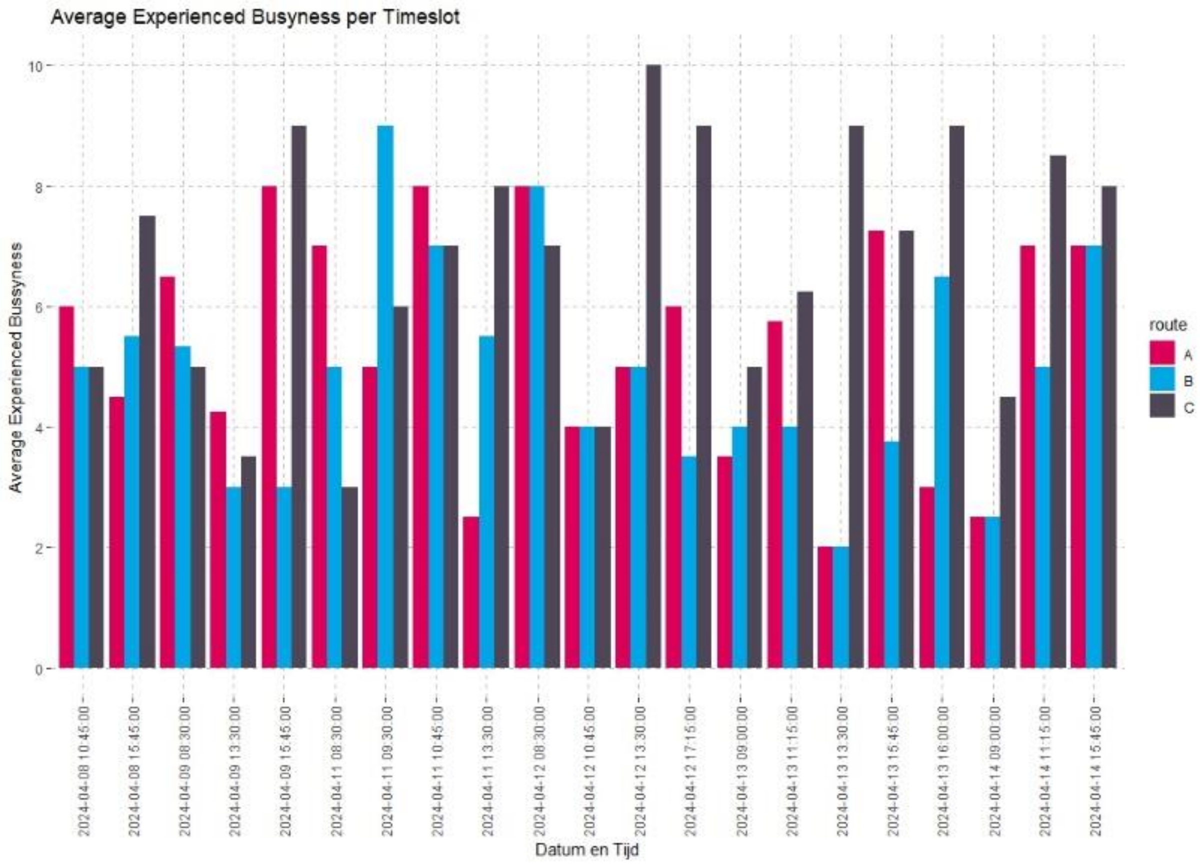

Figure 63 Average busyness per timeslot

All participants were asked how they felt at the start of the walks. For the vast majority, this resulted in a score of 8, so rather good. No scores lower than 4 were given either, as seen in Figure 64. The baseline level of a person's emotional state is important in determining whether a person is in a must state (low arousal and goal-oriented state) or lust state (more stimuli and more receptive to the environment). The higher the emotional state score, the more a person might be in a lust state (van Hage, 2011).

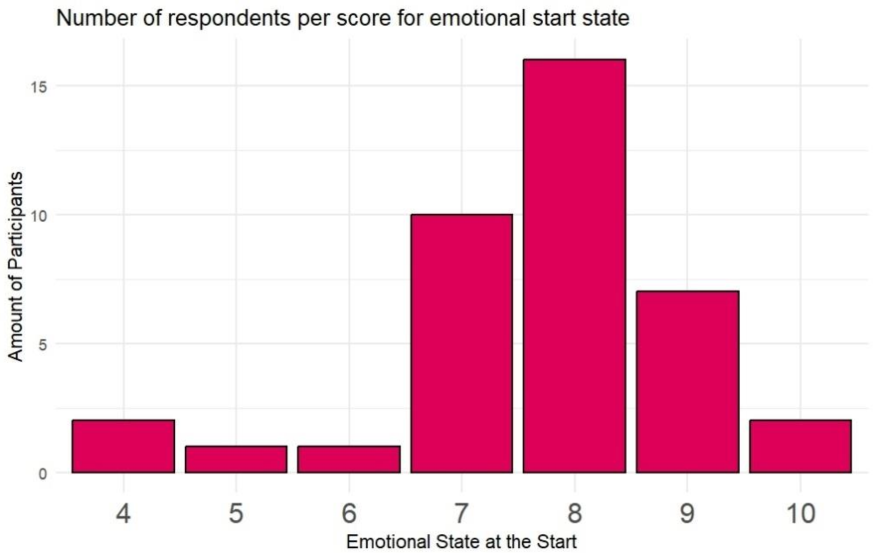

Figure 64 Emotional Start State

After each walk, they were also asked again how each participant felt at that moment. For routes A and B, no significant changes emerged between the start emotional state and after the walk. Route C did have a weak positive correlation (r=0.3, p=0.04). This means that after walking route C, the emotional state improved slightly. No significant link emerged from the regression analysis for all three routes. The emotional state and time-travel perception also had no significance. Figure 65 shows the change in emotional state after walking each route. The black dot shows the beginning emotional state. It varied whether participants felt better or worse after having walked a route. Some experienced great improvement and others felt no change. It mainly shows that there was a change between the start emotional state of the walking process and after each walk.

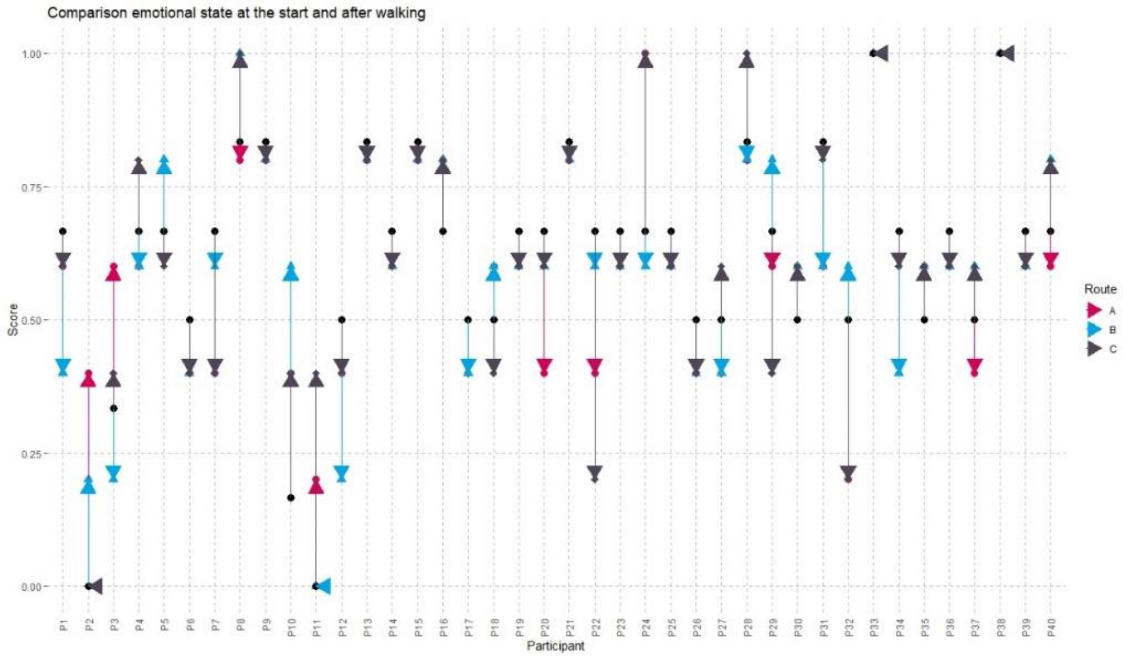

Figure 65 Changes in emotional state

How someone feels before and after the walk can influence how they look at the surroundings. Table 8 shows the significant correlations (p<0.05) between the different variables and the emotional state. The full correlation matrixes for all routes can be found in Appendix 15.

Table 8 Significant correlations with emotional state

Route A	Route B	Route C
- The feeling of personal safety (r=-3)	- The feeling of personal safety (r=-0.4)	- Walk requires little effort (r=-0.4)
- Cleanliness of the route (r=-0.4)	- Little interference of traffic (r=-0.3)	- Little hindrance due to noise (r=-0.4)
- Scenery well-organised (r=-0.3)	- Behaviour of people is pleasant (r=-0.5)	- Busyness (r=0.4)
- Pavement is pleasant (r=-0.4)	- Easily able to keep walking (r=-0.2)	- Inviting appearance (r=-0.3)
- Little hindrance due to smell (r=-0.5)	- Little hindrance due to noise (r=-0.4)	
- Little hindrance due to weather (r=-0.4)		
- Pleasantness (r=-0.4)		
- Busyness (r=0.4)		
- Variation (r=-0.4)		

Several environmental characteristics also had a significant influence on emotional state. For route A, this came down to the amount of obstacles (p=0.02). This was not a surprise, considering this route was also rated as having too many obstacles. For route B, significant influence emerged from the behaviour of others (p=0.046). Perceived busyness influenced emotional state when walking route C (p=0.02). Among all three routes, the explanatory variance of the models was high. For route A, it was 82%; for routes B and C, it was 64%. This means that the emotional state can explain a large part of the scoring of the route. However, the sample size should be bigger for this. In its current state, the model is not significant.

From the different stimuli analysed, it can be concluded that familiarity with the environment and weather affects the time-travel perception. Ten of the 40 participants had a positive time-travel perception for each route. This group had an average familiarity score of 7.5 and gave the weather an average of 7.6. Thirteen participants had a negative time-travel perception for all routes. Consequently, their familiarity score was, on average, a whole point lower (6.5), and the weather also received a lower score with a 7. This again shows that the better the weather and the more familiar the area is, the more positive the time-travel perception was in this research. It often varied per route, depending on whether someone had a positive or negative time-travel perception. As for the emotional state, many different variables had a significant correlation with the three routes. The amount of obstacles had a significant influence on route A. The behaviour of others appeared to be of significant influence on route B and the busyness on route C.

In summary, several environmental characteristics and stimuli certainly influence the time-travel perception, but not all. The hypothesis can be rejected. Positively scoring environmental characteristics and stimuli do not necessarily lead to a positive time-travel perception.

5.4 OVERVIEW OF THE RESULTS

This chapter contained many different analyses from which several significant environmental characteristics emerged for the time-travel perception. Figure 66 shows an overview of the different significant environmental characteristics and their influence. It distinguishes per walking network but also includes two variables affecting the time-travel perception of all three routes. Furthermore, the figure includes the significant stimuli from the environment, weather and familiarity.

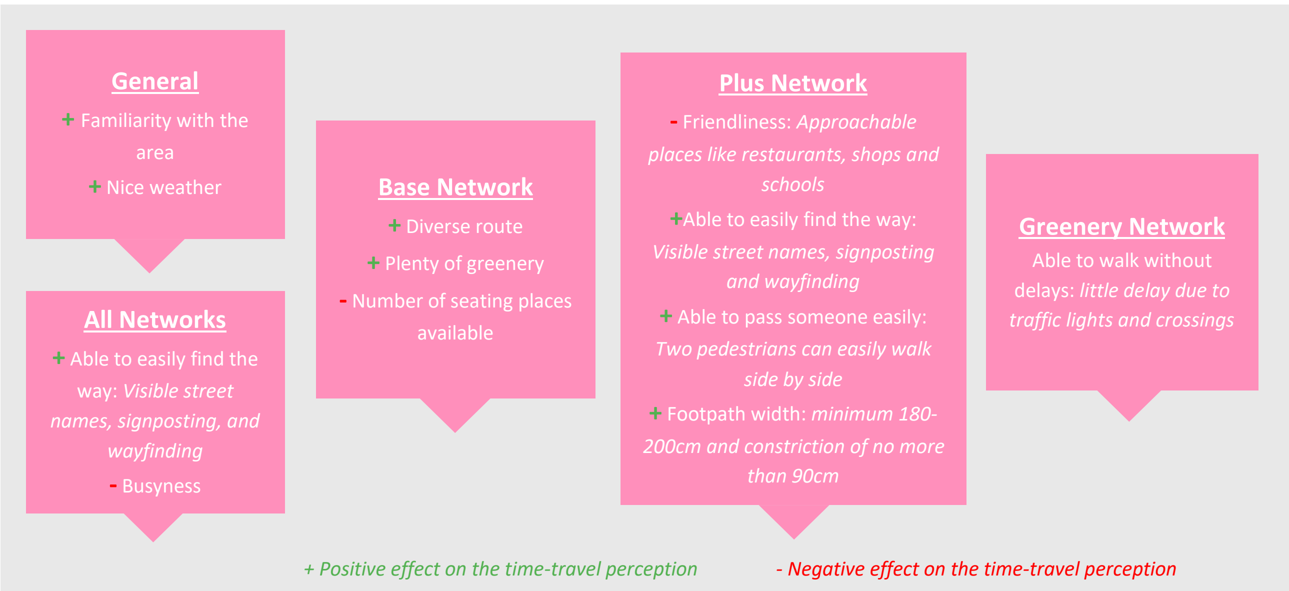

Figure 66 Overview significant characteristics per network

6.0 DISCUSSION AND CONCLUSION

This chapter presents the discussion and conclusion of this research. The discussion addresses the various limitations of the research concerning the method, case study and data analysis. The conclusion will first discuss the sub-questions and answer the central question of this research: *How do environmental characteristics contribute to enhance the time-travel perception for pedestrians?*

6.1 DISCUSSION

6.1.1 METHOD

This research focused on measuring which environmental characteristics affect the time-travel perception. The method for this was to do statistical analysis based on survey results. This research made this measurable, but choices were made to make it appropriate for this research framework. For instance, some environmental characteristics were excluded from the case study. To make the survey workable, characteristics were also merged to achieve an optimal number of questions. In this, well-considered choices were made in consultation with experts. As a result, the measurement of the environmental characteristics differed from the theories used in the theoretical framework, but it was still substantial enough to conclude.

The chosen method can be seen as reliable and replicable. It is also based on the method of Piga et al. (2021). Again, adjustments were made to make it fit into this research, but this is substantiated and explained in methodology and thus replicable. The walking method was also tested and checked by experts within the internship company to increase reliability. As it turned out, the average walking session only lasted around an hour. The entire process took much less time than planned. It was decided not to change anything about the start times as the participants had chosen a start time well in advance. The time between sessions increased, but this did not cause any problems. Despite concerns about longer walking times during rush hour, the results showed no unusual outcomes, possibly due to mostly avoiding evening rush hour. The last group started walking at 15:45, indicating it was the beginning of rush hour.

Before the walking days were conducted, it was predicted that the order of routes walked could be influential. If several participants came at the same time, everyone got a different order. Nevertheless, the order ABC was still the most common. Therefore, no statement can be made as to whether this had any influence. The other sequences were too infrequent. It is also assumed that the routes were followed correctly. It is not possible to ascertain whether this was indeed the case.

During the walking days, a small logistical challenge did emerge. Malieblad was filled with building materials. The routes were not restricted, but there was sometimes more noise as a result. This could be seen as a newly introduced variable by the environment, but the results showed no strange outcomes on noise from the environment. Furthermore, the environment did not introduce any other unexpected variables. The walking method recruitment process was successful, with well-planned recruitment and identifying potential issues. Participants expressed positive feedback about the process and participation.

6.1.2 CASE STUDY

The environmental characteristics tested impact the Utrecht case study, making it generalisable for similar urban areas. All three routes scored well, but this could differ in another location. The case study area in this research was near the attractive centre of Utrecht. The surveys also showed that people perceived all three routes as pleasant. Route A was expected to get the worst score. This was true, but it still scored +7 and had the best time-travel perception. The section along the park could also influence route A’s score. Participants had to walk past this section to access the streets of the base network. The route was scored as a whole, so it might be higher than if the part along the park was not part of it. Each route ran through an urban environment with beautiful old buildings and significant greenery, making each route a positive walking experience. Different results might emerge if the research area were to move to a more sterile environment. Nevertheless, the results of this research are certainly helpful in making statements about the influence on the time-travel perception.

6.1.3 DATA ANALYSIS

The one area where the method became somewhat debatable is the size and consistency of the sample. A sample size of 40 was still sufficiently large to meet the standard criterion of n=30 for normal distribution. Outliers had to be removed, which made the group smaller. Nevertheless, limitations emerged while conducting the statistical analyses. The group was too small for some of the analyses, so another approach had to be chosen. This was especially the case regarding the breakdown of what positively or negatively impacted the time-travel perception. In this, a general statement was finally chosen. The sample was too small for those analyses to break down. Fortunately, this was not the case for every analysis, and where it was, it was mentioned. The sample is also questionable because the vast majority came from Utrecht and were more familiar with the area. The results show that this had a significant impact on the results. This research focused on a specific group, so the results cannot be generalised to everyone. The average age was on the lower side, and some groups were under-represented. This may have influenced the scores for the environmental characteristics.

There are many theories about the emotional state and what influences it. In the survey set-up, this ended up being minimally reflected. More on this would offer more profound insights into how to respond to participants' different arousal levels—knowing when they are experiencing stress or starting to feel better. In the end, it was still possible to draw the desired conclusions, but a larger sample and more survey questions on the topic would further enhance reliability.

6.2 CONCLUSION

This research investigated how different environmental characteristics affect pedestrians' walking experience and time-travel perception. This was done by having participants walk three routes, each representing a different walking network (base, plus and green), and after each route, they were asked to complete surveys. All this is to answer the following main question: *How do environmental characteristics contribute to enhance the time-travel perception for pedestrians?*

6.2.1 HOW DO ENVIRONMENTAL CHARACTERISTICS DETERMINE THE WALKING EXPERIENCE OF THE ROUTES?

This research utilised three routes that were situated within distinct walking networks: base (A), plus (B) and greenery (C). These are hierarchical in structure. The lowest expected quality is at the base network, while the highest is at the greenery network (CROW, 2023; van Sluijs, 2022). To determine the walking experience, participants scored each environmental characteristic for each route. The results indicated that route C exhibited the highest mean score. This is also the network where the highest quality was expected by experts and theory (CROW, 2023; van Sluijs, 2022). Therefore, these findings are consistent with one another. The main point of concern was that participants experienced route C as quite monotonous. The route was a circle around an open park, which connects with that it was experienced as monotony. Routes A and B were close to one another regarding average scores, but route B came out better. Route B, however, was found to be lacking in terms of monotony, friendliness and noise levels. The route comprised a round trip down the same street, with pedestrians separated from other traffic. However, the traffic intensity remained high throughout. Therefore, the monotony and level of noise are consistent with this assessment. The theme ease scored well. Walking on a path designated for pedestrians was experienced as satisfactory. Route A was expected to have the lowest degree of walkability, being the base network (CROW, 2023; van Sluijs, 2022), and this is how the participants perceived it. Nevertheless, the score was still relatively high. The amount of obstacles present on the route's narrow footpaths scored low. Likewise, a low score went to the seating options. It is, therefore, understandable that pedestrians experienced this as unpleasant.

The walking experience is determined by the high and low-scoring environmental characteristics, creating, in this case, an average of +7 for each route. High-scoring characteristics positively influence the walking experience, while low-scoring characteristics show areas for improvement.

6.2.2 WHAT IS THE TIME-TRAVEL PERCEPTION OF THE THREE DIFFERENT WALKING NETWORKS?

The time-travel perception is described as walking a certain distance in a certain amount of time. The objective time and distance are available for both, but the time a pedestrian feels like they spend walking varies per person (Gkavra, 2021). Time-travel perception can be divided into positive (overestimation) and negative (underestimation) perceptions based on the difference between the measured and estimated walking times. Route A had the lowest mean scores for the environmental characteristics but had the smallest difference between under and overestimated walking times. Out of the three routes, route A was most often perceived as having the most positive time-travel perception. This contradicts other studies which found that the route with the most obstacles and turns, such as route A, would lead to the greatest overestimation of time (Ralph et al., 2020). Route C was similar to route A regarding time-travel perception but came out lower. Route B had the greatest difference between the under and overestimation of walking time and had most often a negative time-travel perception out of the three routes.

In this research, the networks' environmental characteristics scores cannot explain the differences between the three walking networks and their time-travel perception. However, each type of network's time-travel perception differs significantly.

6.2.3 WHICH STIMULI AND ENVIRONMENTAL CHARACTERISTICS INFLUENCE THE TIME-TRAVEL PERCEPTION?

Of all the environmental characteristics and various stimuli, several emerged that significantly influence the time-travel perception of each route. The time-travel perception of route A, the base network, is positively influenced by the monotony of the route, as was the case in the study of Gkavra (2021). Another influence was the amount of greenery. If the route is experienced as varied and enough greenery is present, the time-travel perception has a greater underestimation. A negative influence is the amount of seating options along the route. The lack of seating options makes the time feel like it is passing more slowly, resulting in an overestimation. For route B, the plus network, lack of friendliness (approachable places) negatively influences the time-travel perception, meaning it feels like time goes by more slowly. A positive influence comes from finding the way easily (signposting and wayfinding (Southworth, 2005)), passing someone easily, and the footpath's width (minimum 180-200cm (CROW, 2023)). Route C, the green network, was influenced by being able to walk on without delay (due to traffic lights and crossings (CROW, 2023)). In addition to characteristics influencing each route separately, two characteristics influenced them universally. Finding one's way easily contributes positively to the time-travel perception, and busyness on the route influences it negatively.

A pedestrian is also influenced by various stimuli while evaluating the environmental characteristics, both consciously and unconsciously. As van Hagen (2011) stated, 95% of these occur without the pedestrian realising it. This research also measured a variety of stimuli to determine whether they affected the time-travel perception. Familiarity with the area and the weather emerged as influential factors. The more familiar a person was with the area, the more positive the time-travel perception was. The same was true of the weather. On a sunny day, the time-travel perception was more positive.

6.2.4 HOW DO ENVIRONMENTAL CHARACTERISTICS CONTRIBUTE TO ENHANCE THE TIME-TRAVEL PERCEPTION FOR PEDESTRIANS?

Not all environmental characteristics contribute to enhance the time-travel perception for pedestrians. The scores of the walking experience of a route are not a prerequisite for determining the time-travel perception of pedestrians. The environmental characteristics with the largest shares in each route's mean scores differed from the significant environmental characteristics for time-travel perception. Both have different goals and focus points but simultaneously contribute to creating a better walking environment for pedestrians.

Nevertheless, this research found that the following environmental characteristics positively contributed to enhancing the time-travel perception for pedestrians: the ability to find the way easily, diverse routes, plenty of greenery, the ability to pass someone easily, and footpath width. In addition, a few environmental characteristics negatively contributed to the time-travel perception: busyness, lack of seating options, and no friendly appearance. The characteristics with a negative influence indicate areas that require improvement or avoidance. The characteristics that exert a positive influence should be emphasised to enhance the time-travel perception further.

By improving pedestrians' time-travel perception through significant environmental characteristics, new steps can be taken to create pedestrian-friendly places where pedestrians are influenced so that it is attractive to continue walking longer. This will contribute to developing a healthy living environment where walking plays a central role.

7.0 RECOMMENDATIONS

Based on the outcomes of this research, multiple recommendations are given. These include looking at what this research was unable to address and how this fits into a follow-up study. A recommendation is also made for the area of the case study used and consultancy Goudappel.

7.1 RECOMMENDATION TO URBAN PLANNERS

In seeking guidance on how to develop policies for pedestrians further, this research offers several insights for different parties with the identification of key environmental characteristics for the time-travel perception. Clear recommendations emerged from the expert panel as well.

Significant environmental characteristics should be implemented in the vision for pedestrians and how to respond to their needs. Of the various walking networks, existing characteristics can influence walkability and the walking experience. The characteristics that influence the time-travel perception fit well into such a vision. This includes the following:

- The base network should incorporate enough variety and greenery to respond positively to the time-travel perception. Adequate seating options along a route should also be considered, as their absence negatively affects the time-travel perception.
- Central to the plus network should be that the footpath is wide enough. CROW states a minimum of 180-200cm (2023). Other aspects should be that pedestrians can easily pass each other and can easily find their way around. This will have a positive influence on time-travel perception. The plus network should have a pleasant feel with amenities appropriate to the location. When it does not, it negatively affects the time-travel perception.
- In the greenery network, pedestrians should be able to walk through without delay. Few to no intersections with other traffic and enough space for pedestrians are essential here.
- For all walking networks, it should be easy to find one's way by, for example, clear signage and various orientation options to positively influence the time-travel perception. The amount of people in an area should be able to be dispersed to counteract locations that are too busy, as this negatively affects the time-travel perception.

In short, there are many different points of attention to enhancing a pedestrian's time-travel perception. It is recommended that urban planners take into account environmental characteristics that are relevant to the time-travel perception in places where active mobility is lacking, while revitalising existing neighbourhoods and their pedestrian networks, in creating new neighbourhoods and new pedestrian networks, providing access to and from public transport, and promoting active mobility.

Ideas for visualising the significant environmental characteristics to help various parties influence pedestrians towards improving their time-travel perception also emerged in response to the expert panel’s findings. Goudappel's Looptool (Walking tool) should implement the characteristics. This tool indicates the walkability of a place. The underlying theory is the one of van Hagen (2011), as used in this research. Significant environmental characteristics can be included as weighting factors to the corresponding layer. This tool will then measure walkability and consider responding to the time-travel perception as well. Experimenting with the time-travel perception in various route planning software is also possible. A pedestrian should be given the option to choose the fastest route or the "nicer" route. A disadvantage, however, is that the walking times are included, and people are quickly tempted to take the fastest route. There should be a way to respond to pedestrians' needs and influence them to choose a route that positively influences their time-travel perception. That people do not realise they are walking a few minutes longer because it does not feel that way. The results of this research provide good initial guidance.

7.2 ACCESSIBILITY IN FUTURE STUDIES

This research focused on the knowledge gap of the time-travel perception of pedestrians and which environmental characteristics are of influence. Concluded from this research is a set of characteristics that could enhance the time-travel perception. However, these results only focused on a specific group of relatively young and active people from Utrecht. In follow-up studies, a more extensive and diverse population is essential for better and more significant results. Also, participation in the walking days was only allowed if you were able to walk freely. This research offered an overview, but since walking is not an easy task for all, it is recommended that additional groups are examined as well. The amount of effort a walk takes, or the ease of it, is influential in how someone experiences a route (Alfonzo, 2005). Those who cannot walk easily could perceive these kinds of topics differently. Therefore, it is recommended that this research be conducted for people with disabilities and older people, which was also concluded during the expert panel.

People with disabilities have different perceptions of when a street is pleasant and other needs. It is also essential to consider how to make a walkable and pleasant walking area for them. In the study of Gamache et al. (2018), different studies about accessible design features of pedestrian infrastructure were discussed. This study concluded that there is a clear knowledge gap here. Specific solutions exist but have not been tested enough among people with disabilities. This thesis can help create even more tools to develop guidelines that are also sufficient for people with disabilities. A sufficient amount of interviews and tests should be conducted with the target group. It is necessary to engage not only with an urban planner and the target group but also, for example, with rehabilitation professionals, as mentioned by Gamache et al. (2018).

The second group that needs extra attention is older people. They are more fragile on the streets due to reduced motor skills. Some also walk with a walker or cane, making sufficient footpath width important. This gives them other needs for what makes a street pleasant to walk on. Their perception of time may offer different outcomes on which environmental characteristics affect their time-travel perception. Gaglione et al. (2022) show that walkability for older people has some initial research. However, these results are difficult to replicate. Gaglione et al. (2022) looked at what needs to be implemented on a micro-level to make streets more walkable for older people. This thesis can build on this by incorporating the significant characteristics into their results. Based on this, more interviews should be held with older people to see if this improves their quality of life.

Including these groups in what environmental characteristics affect their time-travel perception will create a more complete overview. The goal is to have an inclusive overview with measures to implement for the three walking networks to positively influence the time-travel perception and more effective design for walkable streets.

7.3 CASE STUDY SETTING

The case study took place around the historic centre of Utrecht, which was perceived as a pleasant environment to walk in. Based on the significant environmental characteristics, adjustments to routes are advised. Even though there were no significant environmental characteristics on route C, removing the urinal at the park's edge is still recommended as it caused many complaints. Given that another public toilet has also been placed in the park, the curl appears redundant. Route A has limited seating areas due to narrow streets and traffic passage routes, negatively impacting the time-travel perception. The width of the footpath is also problematic, creating unsafe situations for pedestrians. The footpath should be obstacle-free and maintain a positive atmosphere to improve safety. Route B experiences noise pollution, but a redesign of Maliebaan in the coming years will address this by making the route more versatile and car-free (Municipality of Utrecht, n.d.). This would increase pedestrians' time-travel perception, as the current friendliness of the route negatively influences the time-travel perception. On average, these three routes scored well, yet several points of attention emerged for Utrecht specifically. In improving these, not only will the walkability and walking experience of the routes improve, but the time-travel perception of pedestrians will also be positively influenced.

Ultimately, it is recommended that future studies look at a broader range of routes to address the time-travel perception positively in more places. It is recommended that the same research design should be applied to different types of neighbourhoods. This allows for a comparison between areas in which environmental characteristics significantly influence the time-travel perception. A more streamlined plan can then be made that applies to a broader range of places. In doing so, it is suitable for the reliability of the results if it is a location that all participants are unfamiliar with. This research showed that familiarity with the area affects the time-travel perception. Providing an unbiased measurement of which environmental characteristics are influential may have a significant impact if everyone is unfamiliar with the environment.

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APPENDIX

Appendix 1 Overview Control Variables

Appendix 2 Overview Environmental Characteristics

Appendix 3 Survey Questions and the Connected Characteristics

Appendix 4 Survey (English Version)

Appendix 5 Walking Days Information

Appendix 6 Maps of the Routes

Appendix 7 Expert Panel Presentation

Appendix 8 Coding of Data

Appendix 9 Normal Distribution of the Data

Appendix 10 Walkability of the Routes

Appendix 11 Descriptives Time-travel Perception

Appendix 12 Descriptives Environmental Characteristics and Time-travel Perception

Appendix 13 Differences Measurement of Walkability and Walking Experience

Appendix 14 Descriptives Internal and External Variables

Appendix 15 Correlation Matrixes