# Individual safety perceptions of elderly people walking in Amsterdam

Exploring the diversity in safety perceptions of elderly residents
and its influence on walking in the city

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# Abstract

Walking is important for elderly people as it allows for community interaction, access to resources, and helps maintain mobility and good health. Previous research found that barriers in public space and individual factors, such as reduced mobility, influence safety perceptions of elderly when walking and can eventually affect their willingness of walking. While the municipality of Amsterdam monitors the safety perception of residents, few insights are provided on how elderly perceive their safety while walking and how different determinants are of influence. This research explores individual safety perceptions of elderly and their influence on walking by combining a policy document analysis, semi-structured interviews and Q-methodology. The interviews and Q-methodology were conducted with 14 elderly residents living in three city districts in Amsterdam. Two shared perspectives on safety perception were found, with one emphasizing the importance of respectful behavior from traffic users and the other highlighting good sidewalks that are not slippery. Next to this, sidewalk barriers, traffic speed, and public lighting were important aspects. One interesting finding was the strong negative influence of the behavior of cyclists and micromobility users on the safety perceptions of participants. The policy analysis showed different municipal approaches in relation to walking and revealed that limited space for redesign, limited maintenance budgets and a lack of clear policy on micromobility use currently form the greatest barriers to enhancing safe walking among elderly. Findings of this study help to understand the safety perceptions of elderly residents in more detail and can help inform future municipal policy aimed at encouraging walking among this group.



Keywords: safety perception; elderly people; pedestrians; semi-structured interviews; Q-methodology; policy document analysis

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# 1. Introduction

Walking is important in local transportation and research has shown various benefits for physical health, mental health and the environment (Giles-Corti et al., 2016; Pucher et al., 2010). Physical activity has shown to be effective in preventing several chronic diseases (Warburton et al., 2006). The ability to move around is thus key for promoting physical and mental health, especially for elderly as walking plays a large role in productive ageing, allowing them to interact with community members and access resources in the neighborhood (World Health Organization, 2015). Elderly express the desire to live independently for as long as possible and maintaining mobility is considered the best guarantee to do so. Walking is, however, often more challenging for elderly residents due to limited mobility, a limited walking speed and fear of falling (Borst et al., 2009; Wijlhuizen et al., 2007) and these challenges make it harder to cover large distances on foot. Since elderly residents are thus more likely to undertake short trips close to home (Schmöcker et al., 2007), local governments aim to encourage walking among elderly by designing safe and walkable public spaces within the neighborhood, such as places where residents can pass through and sit down, and green spaces such as parks. The aim is for these spaces to be accessible and tailored to the needs of elderly to support walking among this group.

In the city of Amsterdam, the number of people aged 65 and over is expected to increase over the next 20 years, making up 18% of the population in 2050 (Gemeente Amsterdam, 2025a). Public spaces in the city should therefore be designed while considering the needs of elderly residents, now and in the future. The municipality of Amsterdam acknowledges the importance of creating safe and walkable public spaces for elderly and focuses on creating more room for walking in the city. To do this, the municipality adopted guidelines from the World Health Organization (WHO) aimed at creating an age-friendly environment and designing public spaces that take into account the needs of elderly (Gemeente Amsterdam, 2025a). Through implementing these guidelines and municipal policy, elderly residents should be encouraged to walk and feel safer on the street.

Barriers in public spaces and individual factors such as reduced mobility, however, can influence safety perceptions of elderly people and affect their willingness of walking (Aceves-González et al., 2020; Bornioli et al., 2019). Safety perception can be understood as an individual's perception of risk from harm within the environment (Mouratidis, 2019; Syropoulos et al., 2024). Whereas objective safety is generally easy to quantify by multiple indicators, this is not the case for safety perception. Safety perception is influenced by different contextual and individual determinants and requires an in-depth understanding of the thoughts, feelings and beliefs of an individual (Syropoulos et al., 2024). While objective safety and safety perception are usually interpreted separately, combining the quantifications of the two concepts could be used to get a better and more comprehensive understanding of safety while walking. Barriers such as dangerous intersections, high levels of traffic volume and a poor surface quality of sidewalks can foster a sense of unsafety among elderly and can negatively influence safety perceptions (Ritter et al., 2002; Yavuz & Welch, 2010). These safety perceptions can eventually lead to elderly residents changing the route they are taking or even choosing to not go for a walk at all (Hong & Chen, 2014). The extent to which elderly perceive their environment as safe thus has a significant influence on their walking.

The municipality of Amsterdam monitors the safety perceptions of residents every two years as part of their Safety Monitor (Gemeente Amsterdam, 2022). This monitor includes the results of a nation-wide questionnaire conducted by Centraal Bureau voor Statistiek (CBS) and reveals more information about the safety feelings of residents. Using a five-point scale, residents are asked to express how safe they feel in their neighborhood and in general. The results of the latest questionnaire show differences between respondents when categorized by age group, as can be seen in Figure 1 (Centraal Bureau voor Statistiek, 2024). It shows that younger age groups in the Netherlands tend to feel more unsafe when compared to older groups. From the respondents in the age group of 65+, 10% stated to sometimes feel unsafe in the neighborhood and 25% said to sometimes feel unsafe in general.

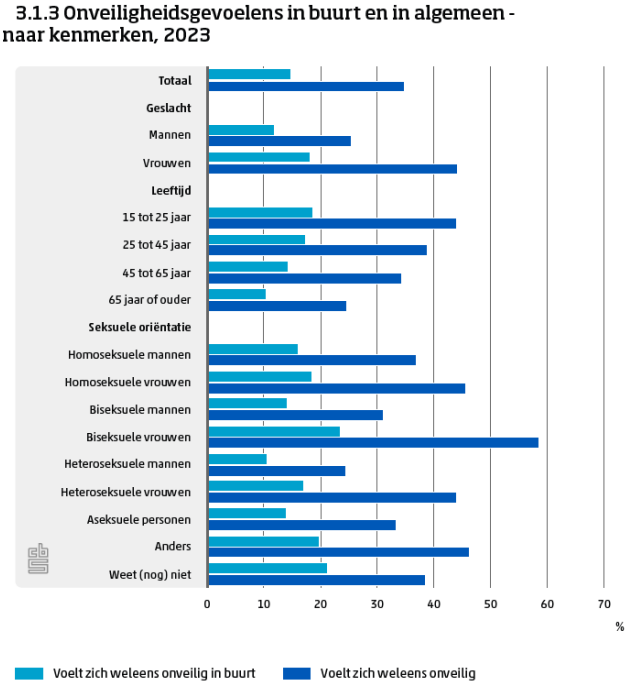


*Figure 1: Unsafety feelings in the neighborhood and in general, divided by gender, age, and sexual orientation, from: (CBS, 2023)*

The municipality of Amsterdam combines the scores given by residents of Amsterdam into a total safety perception score for every district in the city. Although residents are asked about their safety feelings, this is not related specifically to a walking context. The questionnaire results only reveal information about how residents perceive their safety in their neighborhood and in general. Furthermore, the municipality of Amsterdam does not provide the results per age group, so it is not known whether the differences on a national level also apply to the city of Amsterdam. The safety perception scores also do not reveal how different determinants influence residents' perceptions of safety. Previous studies have shown that safety perceptions can differ among age groups when comparing different determinants. Elderly people, for example, tend to have more crime-related safety concerns when compared to other age groups, but are concerned significantly less about familiarity with the place (Zhang & Bandara, 2024). Since there is thus no specific information on safety perceptions of elderly residents related to a specific walking context and the influence of different determinants, further examination is needed to better understand these perceptions and their influence on walking.

### 1.1 Research questions and aim

This research, therefore, aims to explore the individual safety perceptions of elderly residents walking in Amsterdam and focuses on examining the influence of context-specific and individual determinants on these perceptions. This will help get more insight into safety concerns of elderly and the extent to which their safety perceptions influence walking in the city. Studying individual safety perceptions of elderly residents requires a specific research area and for this reason, this study focuses on two city districts in Amsterdam, namely Grachtengordel-West and Dapperbuurt. The choice for city districts is further elaborated on in Chapter 3.1.

In search of an answer to the above-mentioned research aim, the following main research question was formulated:

***"To what extent do individual safety perceptions of elderly residents in Amsterdam influence their walking in the city?"***

To help answer the main research question, this study poses the following secondary research questions:

**SRQ1:** How is walking among elderly residents currently being encouraged in municipal policy and what challenges have been identified?

**SRQ2:** How do built-environment, social, and individual determinants influence the safety perceptions of elderly residents in Amsterdam?

The first secondary research question focuses on examining current municipal policy in relation to walking among elderly and the challenges that have been identified by the municipality of Amsterdam. Relevant policy documents will give more insight into approaches aimed at encouraging walking among this group and which programs and plans are set up by the municipality. This information is important to understand the context in which decisions are made by the municipality, the extent to which safety perception is taken in regard and to reveal what challenges form the greatest barriers to enhancing safe walking among elderly.

Following this, the influence of built-environment, social, and individual determinants on the safety perceptions of elderly residents in Amsterdam will be explored. This will give more insight into the safety concerns of elderly, how different determinants influence their perceptions and whether certain determinants might be assigned more importance than others. It allows for a more in-depth understanding of individual safety perceptions and allows for a better comprehension of how safety perception can impact their walking.

### 1.2 Scientific and societal relevance

This research contributes to knowledge on the topic of safety perceptions of elderly people related to a specific walking context, which is relevant for existing and future municipal policies aimed at creating safe public spaces for this group. This study gives more insight into the importance of context-specific and individual determinants for their safety perception and how these are of influence. It provides more knowledge on how safety perceptions of elderly impact their willingness of walking and can help to inform municipal policy and decision-making. Next to this, it can help develop tools for more in-depth measurement of how safety is perceived and to better align quantifications of objective safety with those of safety perception to create safe places for elderly residents to walk in.

This study can form a starting point for future research, as it explored individual safety perceptions of elderly while walking and aimed to find shared perspectives among the group of participants. This research used a combination of different (semi-)qualitative methods and linked results of semi-structured interviews and Q-methodology to current municipal policy in relation to walking. Future research could build upon the findings of this study, for example by aiming to quantify the results among a larger population or by measuring the safety perceptions of elderly residents over a longer period of time to measure the effectiveness of (future) municipal policy.

### 1.3 Outline

In the following chapters, the underlying theoretical concepts and research design for this study are presented and discussed. Chapter 2 presents the theoretical background and discusses the concept of safety perception and how built-environmental, social, and individual determinants influence the perception of elderly walking. Following this, the research design is introduced in chapter 3, consisting of the research paradigm and data collection and analysis methods. Chapter 4 presents the results of this study. In Chapter 5, these results are discussed in a broader context together with this study's limitations and recommendations for policy makers and future research. Chapter 6 concludes the findings of this study.

# 2. Theory

This chapter presents the theoretical background of this study. It introduces the concept of safety perception, how safety is perceived by elderly people and discusses the different determinants that influence safety perception. This is then all brought together in a conceptual framework which can be found at the end of the chapter.

### 2.1 Safety perception and its influence on walking decisions

Perception refers to various cognitive processes, such as attention, sensation, and memory, in which sensory information is organized and understood (Lumen Learning, n.d.). These processes help people to interpret their environment and involve both bottom-up and top-down processing. Bottom-up processing refers to the fact that perceptions are built from sensory input from the environment (Katsuki & Constantinidis, 2014). Pedestrians pass through and interact with public spaces surrounding them, which include many aspects of the physical environment and also other people that are on the street. They collect information from their environment and this influences how they perceive their surroundings. Top-down processing refers to the influence of people's knowledge, experiences and thoughts on their interpretation of sensory information (Katsuki & Constantinidis, 2014). Perception can be understood as the process of giving structure, stability and meaning to collected information, which is influenced by people's beliefs, values, attitudes and needs (Ou, 2017). People constantly collect information from their environment and its interpretation thus affects how they see and interact with the spaces surrounding them.

Safety perception, specifically, focuses on interpreting sensory information that is related to one's safety and can be understood as an individual's perception of risk to harm within the environment (Mouratidis, 2019; Syropoulos et al., 2024). This harm can come from deliberate acts of people, such as criminal offences or attacks (Hessami, 2004; Jore, 2017), but also from non-intentional events such as human or technical failure in traffic systems (Basu et al., 2022b). Safety perception is about the probability and possibility of becoming a victim to these events. Depending on the individual and the context, this safety perception might be completely altered, either in a positive or negative way. A lack of proper public lighting, drivers not complying with traffic regulations and previous negative experiences can lead to safety concerns for pedestrians while walking on the street and can negatively influence safety perceptions (Aceves-González et al., 2020; Park & Garcia, 2020). These safety perceptions can eventually result in pedestrians changing the route they are taking or choosing to not go for a walk at all (Hong & Chen, 2014). Positive safety perceptions, on the other hand, can encourage residents to go for a walk. Safety perceptions thus have a significant influence on walking decisions that are made by pedestrians.

Safety perception is part of a complex decision-making process, in which pedestrians perceive and assess their environment, decide their walking strategy, and adapt it accordingly if necessary. Previous studies that focused on travel behavior established three different levels on which walking decisions can be made, namely a *strategic*, *tactical* and *operational* level (Basu et al., 2022a; Hoogendoorn & Bovy, 2004). These three levels interact with one another and all correspond to decisions that are either made on-street or off-street. The levels of travel decisions are included in the conceptual framework that is presented at the end of this chapter

(see Figure 2). The highest level concerns strategic decisions, which correspond to off-road activities and decisions that are made before the walking trip such as departure time and an agenda of activities (Basu et al., 2022a). The second level, which refers to tactical decision-making, concerns both off-road and on-road decisions (Hoogendoorn & Bovy, 2004). Off-road decisions might regard route choice, which can be influenced by previous knowledge of the road network, though route choice decisions can also be made on-road when certain conditions are encountered while walking. The third and final level concerns operational decisions and corresponds to decisions that are made during the trip. This includes obstacle avoidance, interaction with other pedestrians and road crossing. The present study focuses on how elderly perceive their safety while walking on the street, safety perception is therefore only studied with regard to decisions that are made on the tactical and operational level.

**2.2 Safety perceptions of elderly people**

Since safety perceptions are highly dependent on the individual and their walking context, previous studies focused on safety perceptions of different age groups to see what differences could be identified among a larger population (Lucchesi et al., 2021; Zhang & Bandara, 2024). One group that researchers focused on was elderly people. Elderly adapt in order to get around in a space and modify their walking by limiting distances they travel and by choosing certain paths over others. Elderly often face more walk-related challenges, due to limited mobility, limited walking speed and fear of falling (Borst et al., 2009; Wijlhuizen et al., 2007) and these challenges affect their perception of safety in public space. Therefore, and because of the ageing population, the everyday mobility and safety perceptions of elderly have become an issue of growing interest (Lord et al., 2018). Previous research found that mobility difficulties increase safety concerns among elderly pedestrians and limits them in potentially needing to escape from a difficult or hazardous situation (Park & Garcia, 2020). Elderly people were also found to feel more unsafe regarding crime when compared to other age groups, but were concerned significantly less about familiarity with the place (Zhang & Bandara, 2024). The safety perceptions of elderly are thus different from other age groups and are influenced by multiple determinants that can have a varying effect on how they perceive their surroundings. Furthermore, elderly should not be seen as a homogenous group because of differences in their mobility and safety perceptions, it is therefore important to study differences in perceptions among this group.

Previous studies established that determinants influencing safety perception can be placed into one of three domains, namely the built-environment, social, and individual domain (Park & Garcia, 2020; Van Acker et al., 2010). Safety perception can be understood as a complex interaction of these built-environment, social and individual determinants that coexist in a certain spatial setting (Piroozfar et al., 2019). The three domains of determinants are discussed in the next subchapter and are also presented in the conceptual framework at the end of this chapter (see Figure 2).

## 2.3 Determinants influencing safety perception

### 2.3.1 Built-environment determinants

The built environment is the physical environment in which people live, work, and spend their time. It includes public spaces and streets that together form the skeleton of a city (UN-Habitat, 2018), but also consists of sidewalks, buildings and greenery. When going for a walk, pedestrians come across and interact with different aspects of the built environment. Previous research established that built environment determinants influence the safety perception of pedestrians, including traffic volume, width of sidewalks and traffic intersections (Aceves-González et al., 2020; Ferrer et al., 2015; Van Cauwenberg et al., 2012).

#### *Traffic volume and traffic speed*

Traffic volume is defined as the number of vehicles that pass a certain point on a road within a specified period of time (Borst et al., 2009). Car and vehicle-oriented streets often consist of multiple traffic lanes and allow a higher volume of traffic to pass through. When pedestrians cross these streets, this means there is more interaction between them and the drivers on the road. Previous studies identified traffic volume as an important determinant for safety perception and found that streets with busy traffic was one of the reasons for increased unsafety feelings among elderly pedestrians (Aceves-González et al., 2020; Van Cauwenberg et al., 2012). Heavy traffic, particularly at road crossings, was reported to make elderly residents feel endangered, especially when experiencing declining cognitive and physical ability (Le et al., 2021).

Traffic speed was also found to influence one's safety feelings when walking on the street, with higher speeds generally resulting in more safety concerns among pedestrians (Aceves-González et al., 2020). A high speed of motorists can increase the fear of collisions and can make walking an uncomfortable and fearful experience (Narayanan, 2020). Contrarily, places where traffic maintains a low speed or where speed limits are in place positively influence how safety is perceived (Basu et al., 2023). Measures taken to limit traffic speed, such as the presence of traffic regulators and speed bumps on the road can also help pedestrians to feel more safe (Mfinanga, 2014). Elderly pedestrians were found to prefer walking in streets with slow traffic and proposed speed bumps to slow down traffic (Van Cauwenberg et al., 2012).

#### *Traffic intersections/crossings*

Traffic intersections and crossings can lead to hazardous situations when there are no or few traffic signs, crossings are not clearly marked or when there are issues with pedestrian visibility. These types of intersections and crossings can lead to an increase in safety concerns among elderly pedestrians (Le et al., 2021), and increase concerns about crossing the street in time when experiencing reduced mobility (Leung et al., 2021). A high intersection density, pedestrian crossings with the possibility of turning vehicles and pedestrian crossings at roundabouts were found as factors contributing to unpleasant walking experiences (Ferrer et al., 2015). However, crossings that are supplemented with traffic lights can help to increase safety feelings among elderly while walking (Van Cauwenberg et al., 2012).

### *Number of traffic lanes*

Previous studies found that the number of lanes to cross influences how safety is perceived by pedestrians. The number of traffic lanes is important for how pleasant and safe pedestrians perceive their walking route to be (Ferrer et al., 2015). Large avenues were found to discourage elderly residents to walk and can even become an impediment to walking (Ferrer & Ruiz, 2018). A lower number of traffic lanes positively influences safety perception and pedestrians prefer less space to be reserved for traffic lanes when going for a walk (Aceves-González et al., 2020).

### *Width and surface quality of sidewalk/street*

An adequate sidewalk width enhances safety feelings while walking on the street. Sidewalks with an adequate width, however, can be perceived as narrow and less safe when pedestrians find obstacles on them, such as parked cars, benches or vegetation (Ferrer et al., 2015). Obstacles placed on the sidewalk or footpath increase feelings of being at risk and not being prioritized within traffic (Kelly et al., 2011). Ferrer et al. (2015) found that wide sidewalks can encourage walking and that pedestrians would not choose another route that has narrow sidewalks. Elderly pedestrians prefer sidewalks that are wide enough for people to walk next to each other, when making use of a wheelchair and to keep safe distance from other traffic users (Van Cauwenberg et al., 2012).

Poor sidewalks that are hard or uncomfortable to walk on increase safety concerns among pedestrians and can even lead to them stopping with walking (Ferrer et al., 2015; Leung et al., 2021). These sidewalks can cause hazardous situations for pedestrians, for example when they encounter loose tiles or are forced to walk on the street. Poor sidewalks can also cause pedestrians to take a fall, and this can be especially dangerous for older adults as it can result in severe and long-lasting injuries and health consequences. Uneven and broken pavements can result in negative views on walking and can negatively influence safety perceptions (Pooley et al., 2014). Well-maintained and even sidewalks, however, are considered less hazardous to walk on (Van Cauwenberg et al., 2012).

### *Public lighting*

Public lighting and its coverage on the street and sidewalk influence how safety is perceived while walking. Poor coverage or deficiencies in public lighting were brought up as a factor that negatively influences safety perception when being on the street (Adkins et al., 2019) and can increase the fear of crime (Ferrer et al., 2015). Good illumination of streets and sidewalks, on the other hand, enhances safety feelings and is linked to a positive perception of safety (Landa-Blanco & Ávila, 2020). Importance was also given to public lighting as it helps to identify potential falling hazards during walks at nighttime (Van Cauwenberg et al., 2012). A low visibility of sidewalks and streets makes walking more challenging for elderly pedestrians and can cause them to take a fall (Leung et al., 2021).

### *Pedestrian zones*

Pedestrian zones are areas that are exclusively or primarily reserved for pedestrian use and in which automobile traffic is restricted or prohibited. This means there is little to no interaction between pedestrians and other traffic users in these zones. Pedestrian zones can be seen as more friendly to pedestrians and can therefore create a higher sense of safety when walking on the street. Pedestrians prefer to walk in pedestrian streets when they are present in the area

(Ferrer et al., 2015) and reported a more positive safety perception in environments where motorized traffic is excluded (Basu et al., 2022b).

### 2.3.2 Social determinants

Next to aspects of the built environment, the social context where an individual finds themselves in is also important for how safe they feel while walking. Social determinants influencing safety perception include driver's behavior, presence of other pedestrians on the street, opened shops and businesses and familiarity with the place.

#### *Driver's behavior*

When walking on the street, pedestrians interact to a greater or lesser extent with other traffic users, including drivers of vehicles. Pedestrian safety perception is influenced by the way in which drivers act and behave in traffic and previous research established that driver's behavior is central to discussions about safety perception (Campos Ferreira et al., 2022). Drivers that comply with traffic regulations and interact with pedestrians in a positive way can enhance feelings of safety. A lack of respect from drivers, however, increases safety concerns among pedestrians and can lead to hazardous situations (Aceves-González et al., 2020). Other safety concerns brought up regarded carelessness and recklessness in the behavior of drivers (Zhang & Bandara, 2024) and elderly pedestrians expressed to fear careless drivers (Van Cauwenberg et al., 2012).

#### *Presence of other pedestrians*

Depending on the walking context, the presence of other pedestrians can be perceived either as positive or negative with regard to safety perception. On segregated walkways, in which pedestrians have their own walking space and are separated from other mobility users, presence of other pedestrians is perceived as positive (Bellizzi et al., 2019). On integrated walkways, where pedestrians have to interact with vehicles, too much presence of other pedestrians is not always appreciated since it limits the room for walking on the sidewalk. Previous studies also found that the presence of other pedestrians can also have varying effects on safety perceptions during nighttime. Some studies found that pedestrians tend to avoid walking in abandoned streets and prefer walking alongside streets with other pedestrians (Hidayati et al., 2020; Van Cauwenberg et al., 2012). Park and Garcia (2020) found, on the other hand, that the presence of other pedestrians could raise safety concerns among pedestrians when walking in the dark.

#### *Opened shops and businesses*

Previous research established that shops and businesses on the street can influence how safety is perceived by pedestrians. It was found that open shops and businesses can positively influence safety feelings among pedestrians (Bellizzi et al., 2019; Park & Garcia, 2020). The nearby presence of non-residential uses, such as grocery stores and supermarkets can help encourage elderly to walk to their destinations and makes walking more pleasant (Van Cauwenberg et al., 2012). Closed shops, on the other hand, can lead to safety concerns while walking (Ferrer et al., 2015).

*Familiarity with the place*

Familiarity with the place refers to the extent to which pedestrians are familiar with their walking environment and their knowledge of the place they are passing through. Being familiar with the walking environment can help to better understand and judge the safety situation and identify potential safety risks. Familiarity with the place was found as a determinant influencing how safe pedestrians perceive their surroundings to be (Park & Garcia, 2020). It was found that elderly pedestrians prefer to walk in familiar streets since these streets enhance their feelings of safety (Van Cauwenberg et al., 2012). Pedestrians, however, feel more anxious in unfamiliar areas and expressed safety concerns about potential risks caused by other people (Zhang & Bandara, 2024).

### 2.3.3 Individual determinants

Pedestrian safety perception is not only influenced by the physical and social environment, but also by individual determinants. The individual domain includes determinants such as fear of being hit by motorized vehicles, fear of theft and crime, but also socio-demographic characteristics such as age and gender. Next to this, past walking experiences can significantly influence how safe pedestrians perceive their environment to be.

*Fear of being hit/run over by motorized vehicles*

When walking alongside a busy road or street with many intersections and crossings, pedestrians need to interact to a greater extent with motorized vehicles. This can cause safety concerns when pedestrians experience a fear of being hit or run over. This fear of collision tends to increase when more motorized vehicles are present on the road or when there are issues regarding visibility of pedestrians. Pedestrians who experience a fear of getting hit tend to be more wary towards motorized vehicles (Hidayati et al., 2020). It was found that they prefer to walk on pedestrian-only pathways without sharing with other traffic users as they expressed safety concerns about getting run over (Zhang & Bandara, 2024). Concerns about getting hit also increase among elderly pedestrians when vehicles maintain a high speed (Leung et al., 2021). In the study of King et al. (2012), it was found that the fear of getting hit by motorized vehicles can also increase in a low lighting environment since this decreases the visibility of pedestrians.

*Fear of theft/vandalism*

Previous research found fear of theft or vandalism to be an important determinant of safety perception. It was found that while pedestrians who walked in segregated pathways felt more safe from traffic on the road, they felt more vulnerable to theft compared to pedestrians who walked on more integrated streets (Bellizzi et al., 2019). Public lighting was also reported to influence how pedestrians perceive the risk of theft when walking at night (Landa-Blanco & Ávila, 2020). Creating separated pedestrian-oriented paths, installing surveillance cameras (Bellizzi et al., 2019) and providing adequate public lighting (Landa-Blanco & Ávila, 2020) can help to mitigate fear of theft among pedestrians.

### *Fear of aggression/crime*

A sense of safety from crime can positively influence walking experiences among pedestrians. Particularly at night, crime seems to be a very important deterrent to walking (Ferrer et al., 2015). Pedestrians expressed concerns about crime and becoming a victim to attacks and these concerns can decrease their safety feelings while being on the street (Zhang & Bandara, 2024). Previous studies found that safety from crime can be influenced by multiple factors, such as public lighting, cleanliness but also the presence of other people (Van Cauwenberg et al., 2012). Some studies did not consider crime to be a barrier to walking for pedestrians (Leung et al., 2021).

### *Fear of falling due to slippery pavement*

Pavements can get slippery under certain weather conditions, such as rainy, icy, or snowy weather but also because of mud or leaves lying on the sidewalk. This can make pedestrians more prone to falling onto the pavement and this increases their safety concerns (Van Cauwenberg et al., 2012; Wennberg et al., 2009). Especially for elderly residents falling can be hazardous, as it can result in severe injuries that can affect their mobility. Pedestrians were found to be more likely to avoid walking and stay indoors when there are slippery pavements (Leung et al., 2021). In the same study, participants that have taken a fall before mentioned they do not feel confident enough to walk on slippery and uneven roads.

### *Gender*

Differences in safety perceptions between men and women while walking have been widely studied. Previous research has shown that women have significantly greater safety concerns than men in most situations (Basu et al., 2023; Zhang & Bandara, 2024). They are concerned significantly more about crime-related incidents and reported restricted walking areas since they often need to adapt their route. These safety concerns thus have a great influence on how women use and perceive public spaces and can negatively influence their safety perceptions (Hidayati et al., 2020). Often, women need to prepare themselves before going on a walk and need to take extra precautions when walking alone, such as making sure their location is trackable and carrying personal safety equipment (Zhang & Bandara, 2024). According to Hidayati et al. (2020), perceived safety among women is influenced by spatial configurations and socio-cultural constructs, in combination with individual factors, such as previous experiences.

### *State of mobility (and age)*

Safety perception is also influenced by the state of mobility of elderly pedestrians. Mobility difficulties, such as reduced mobility, make walking challenging for elderly and can make walking feel more hazardous when coming across obstacles placed on sidewalks or when encountering sidewalks that are in poor condition. This can also be challenging when making use of a walking aid, such as a rollator  or stroller, and it was found that pedestrians who make use of a walking aid feel more vulnerable and noticeable (Park & Garcia, 2020). Mobility difficulties can also limit pedestrians in potentially needing to escape from a difficult or hazardous situation. The older pedestrians get, the higher the chance will be they experience reduced physical abilities that make walking more difficult. Their age thus has a significant influence on their state of mobility. Elderly residents expressed concerns about their state of mobility and feared that falling can cause even more complications for their mobility and health (Franco et al., 2015).

### *Previous experiences*

Previous personal experiences are also important when it comes to safety perceptions of pedestrians (Park & Garcia, 2020). Pedestrians might have had past experiences with walking across a certain place or street in which they felt unsafe or with crime or traffic-related incidents or accidents. These experiences can cause more safety concerns when walking on the street and can result in route changes or pedestrians avoiding certain places altogether (Zhang & Bandara, 2024). Differences in safety concerns were found when comparing a group of pedestrians who did not experience any prior traffic incidents with a group that had experienced an incident before. Pedestrians who had experienced a traffic incident before were found to feel less safe while walking (Gkekas et al., 2020).

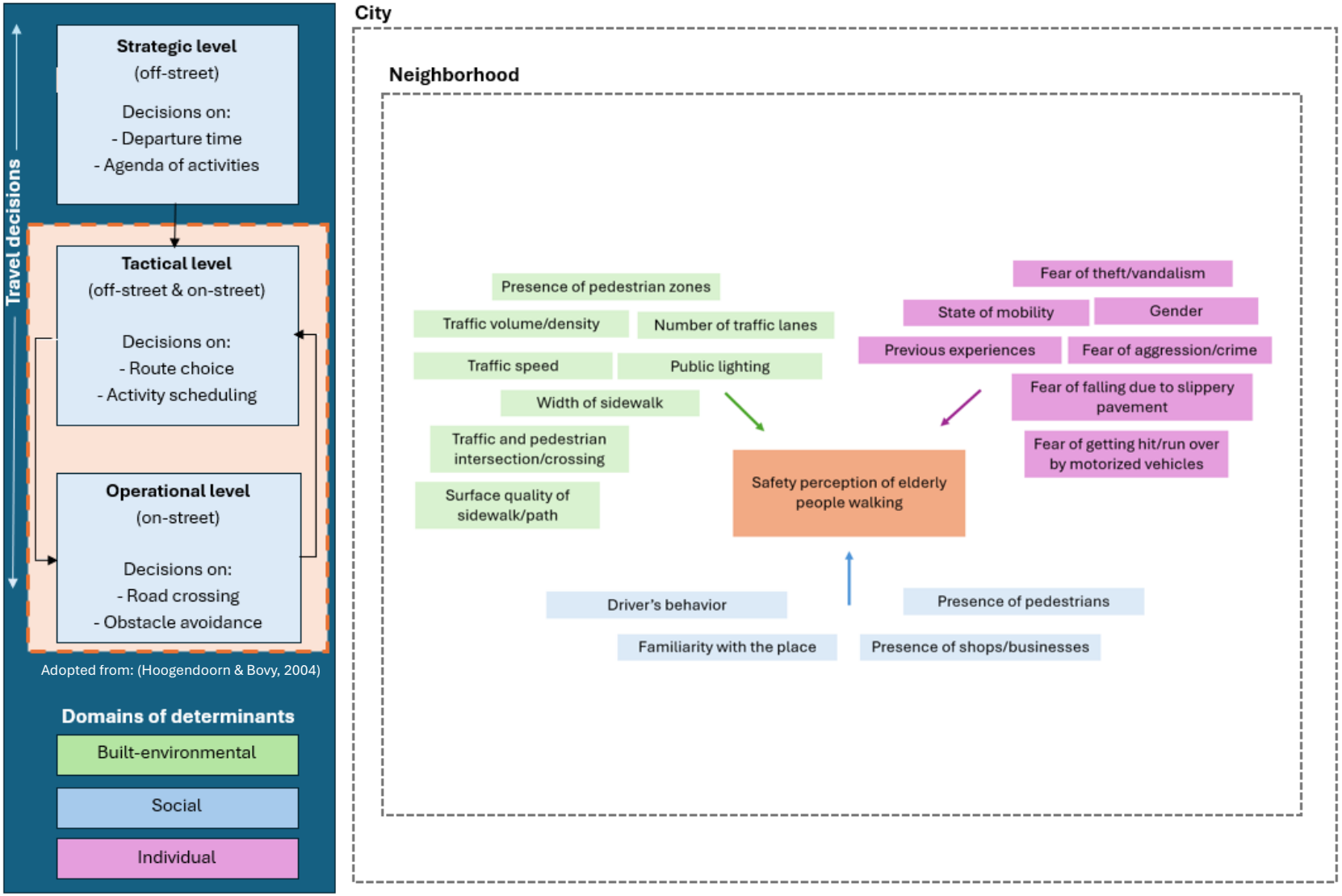


*Figure 2: Conceptual framework including levels of travel decisions and determinants influencing safety perception*

# 3. Methodology

This chapter discusses the research philosophy, research area and methods for data collection and analysis that were used for this study. Firstly, the research paradigm is introduced to give a clear view of the assumptions and values this research was based upon. Following this, the research area is described and the choice for data collection methods is explained. Finally, the approaches for processing and analyzing the data are elaborated on.

## 3.1 Research philosophy and research area

### Research paradigm

An interpretivist paradigm was adopted since it fits this study's nature and its focus on individual safety perceptions of elderly people walking in the city of Amsterdam. This study's topic is subjective in nature and is greatly influenced by personal viewpoints. An interpretivist paradigm helps to better understand the complexity and multitude of viewpoints that individuals might have regarding a specific topic (Turin et al., 2024). Previous studies that focused on safety perceptions of pedestrians used a combination of mostly qualitative data collection methods. Adkins et al. (2019) conducted on-street interviews with pedestrians to study differences in social and physical dimensions of perceived walkability in Tucson, USA. Ferrer et al. (2015) adopted focus groups as a data collection method to study the role of the built environment on short walking trips among adults in Valencia, Spain. In the study of Park and Garcia (2020), a mixed-methods approach was used, combining quality scoring of different urban settings together with an online survey to better understand pedestrian safety perceptions in Alabama, USA. A qualitative approach is more likely to explore opinions, thoughts, and feelings people have on a certain topic (DeJonckheere & Vaughn, 2019). By adopting an interpretivist paradigm and using a (mostly) qualitative approach, this study sought a deeper understanding of how elderly perceive their safety while walking in Amsterdam and the influence of safety perceptions on walking in the city.

### Research area

This study focused on two city districts in Amsterdam to examine individual safety perceptions of elderly residents and the influence of different determinants. The choice for city districts was based on the results of the latest municipal Safety Monitor that were published in 2024, in which all city districts in Amsterdam were given a safety perception score. To explore the diversity in perceptions, this study focused on one district with a relatively low safety perception score, with the other district having a relatively high score. Eventually, it was decided that the city districts of Grachtengordel-West (with a higher relative score) and Dapperbuurt (with a lower relative score) would be the focus of this study since they fit the above-mentioned criterion. This choice was further substantiated by the fact that elderly residents make up a significant portion of the population in both districts, this being 17,1% in Grachtengordel-West and 15,8% in Dapperbuurt, respectively (Centraal Bureau voor Statistiek, 2025). The city districts are depicted in Figure 3.

Grachtengordel-West forms the western part of the Canal District and is a residential area located in the city center of Amsterdam with a population amounting to 6,630 inhabitants as per December, 2024 (Centraal Bureau voor Statistiek, 2025). Dapperbuurt is the other residential

area, located just outside of the city center and part of Amsterdam-Oost. In December 2024, Dapperbuurt had 10,130 inhabitants (Centraal Bureau voor Statistiek, 2025).

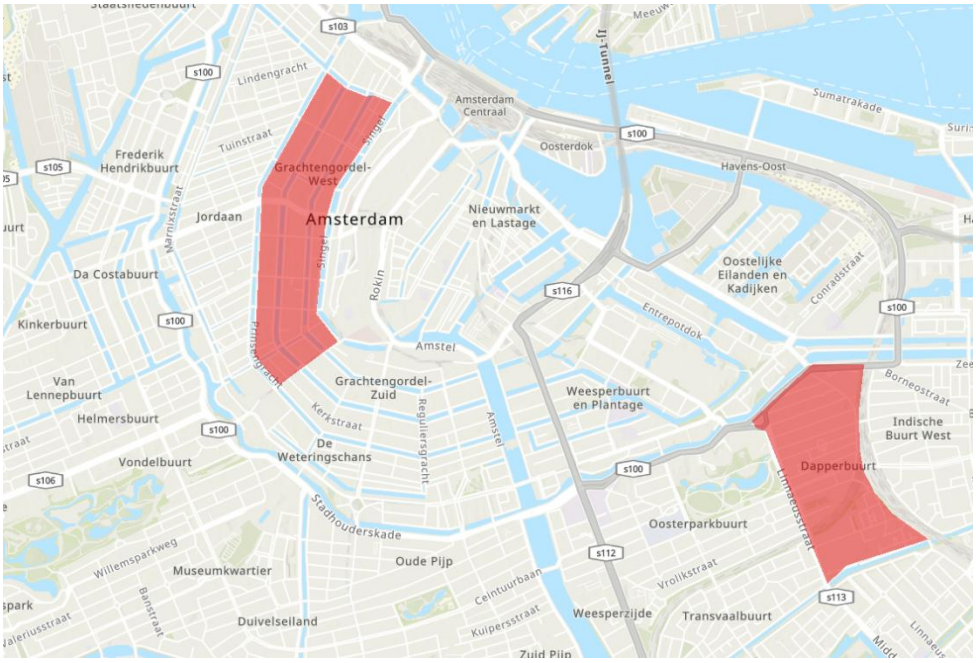


*Figure 3: The city districts of Grachtengordel-West (left) and Dapperbuurt (right), from: (ArcGIS, n.d.)*

## 3.2 Data collection methods

This present study used a mix of (mostly) qualitative data collection methods to explore the individual safety perceptions of elderly people walking in Amsterdam. The selection of data collection methods was based on what was most sensible and pragmatic for this research. A policy document analysis was undertaken to get a clear overview of municipal policy in relation to walking among elderly and the context in which decisions are made. Semi-structured interviews and Q-methodology were found best suited to get more in-depth information on the safety perceptions of elderly participants within a specific walking context.

### 3.2.1 Policy document analysis

A policy document analysis was done to explore current municipal policies and approaches in relation to walking among elderly residents and to identify challenges that have been mentioned by the municipality. Reviewing these policy documents in a systematic way helped to provide more context and supplemented the other data collection methods used.

Different criteria were used to find municipal policy documents that were relevant for the analysis. Firstly, documents needed to specifically focus on elderly people in Amsterdam and strategies and approaches related to walking among this group. Documents that did not include elderly residents, a walking context or that had a focus that was too broad were excluded from this study or were used only for context when considered to be relevant. Secondly, documents that were published in the past, but that did not have a clear link to this present moment were not used for analysis. Whether there was still a link to the present depends on the specific policy, but for this research a publication date of more than 15 years before this study was taken as a cut-off point. This means that the publication date had to be within the period of 2010 up till 2025. Relevant documents were mainly found through the website of the municipality and the

research database *OpenResearch Amsterdam* since these are the main places for publication and contain most policy documents. One document was extracted from the website of *GGD Amsterdam* and concerned a document that was set up by a collaborative effort between the municipality, GGD Amsterdam and other parties. On the website of the municipality, documents are organized by policy theme which was helpful in selecting documents that were suitable for analysis. Documents were selected and analyzed up until the point that enough relevant data for this study was collected.

In total, ten policy documents were analyzed to obtain more information on municipal policy and approaches in relation to walking among elderly. These included mobility and health plans, programs specifically focused on productive ageing and implementation plans related to mobility and public space. The policy documents used for analysis can be found in Table 1.

*Table 1: Policy documents used for the analysis*

| Year | Document | Source |
|---|---|---|
| 2013 | Amsterdam Mobility Plan 2030 (*MobiliteitsAanpak Amsterdam 2030)* | Website of municipality<br>Gemeente Amsterdam (2013) |
| 2019 | Agenda Low-car city Amsterdam (*Agenda Amsterdam Autoluw)* | OpenResearch Amsterdam<br>Gemeente Amsterdam (2019) |
| 2021 | Amsterdam, safe and livable – 30 km/h in the city (*Amsterdam veilig en leefbaar – 30 km/u in de stad)* | Website of municipality<br>Gemeente Amsterdam (2021a) |
| 2021 | Amsterdam Health policy 2021-2025 *(Amsterdamse nota gezondheidsbeleid 2021-2025)* | OpenResearch Amsterdam<br>Gemeente Amsterdam (2021b) |
| 2023 | Amsterdam Makes Room *(Amsterdam Maakt Ruimte)* | OpenResearch Amsterdam<br>Gemeente Amsterdam (2023a) |
| 2023 | Room for pedestrians (*Ruimte voor de voetganger)* | Website of municipality<br>Gemeente Amsterdam (2023b) |
| 2024 | Program Productive Ageing 2023 – 2026 (*Vitaal ouder worden – Programmaplan 2023 – 2026)* | GGD Amsterdam<br>Gemeente Amsterdam (2024b) |
| 2024 | Traffic safety - Implementation plan 2024 (*Uitvoeringsprogramma 2024 – Verkeersveiligheid*) | Website of municipality<br>Gemeente Amsterdam (2024a) |
| 2025 | Traffic safety – Implementation plan 2025 (*Uitvoeringsprogramma 2025 – Verkeersveiligheid)* | Website of municipality<br>Gemeente Amsterdam (2025b) |
| 2025 | Program Elderly in Amsterdam 2024 - 2029 *(Programma Ouderen in Amsterdam 2024 – 2029)* | OpenResearch Amsterdam<br>Gemeente Amsterdam (2025a) |

The selected policy documents were imported to the qualitative data analysis software *Atlas.ti* to help identify themes and patterns across the data (Atlas.ti, n.d.). Policy documents were read in a thorough way and relevant data was highlighted. Open coding was used to assign labels to sections of the document to help highlight relevant parts of the text. After finishing open coding, the different codes were used to better interpret the data and to identify overarching themes within policy.

### 3.2.2 Interviews

As a second data collection method, semi-structured interviews were conducted with a total of 14 elderly residents in Amsterdam. The interviews were conducted within the research area and focused on the individual safety perceptions of elderly walking in the city districts of Grachtengordel-West and Dapperbuurt. Participants needed to be 65 years or older and had to be a resident in one of the two districts. Preferably, they had been living in the district for multiple years in order for them to have sufficient walking experience in the area. Participants were approached through purposeful sampling via elderly associations, neighborhood groups, activity centers and other relevant organizations and key figures in the area. Next to this, flyers and brochures were distributed in neighborhood centers and churches. Snowball sampling was also employed, which allowed participants to recommend other people that fitted the research scope and would be willing to participate. Due to difficulties with finding participants, the research area was slightly extended and one resident was included that lives in Jordaan, a city district right next to Grachtengordel-West. An overview of the participants can be found in Table 2. The interviews were conducted while sitting down and were audio-recorded with a recording device. The interviews lasted 30 to 45 minutes.

*Table 2: Participants of the semi-structured interviews*

| Code participant | Gender | Age | District | Years living in district |
|---|---|---|---|---|
| P1 | Male | 75-80 | Grachtengordel-West | 25 |
| P2 | Female | 80-85 | Grachtengordel-West | 15 |
| P3 | Male | 85-90 | Grachtengordel-West | 30 |
| P4 | Female | 80-85 | Grachtengordel-West | 30 |
| P5 | Male | 70-75 | Grachtengordel-West | 50 |
| P6 | Female | 80-85 | Grachtengordel-West | 6 |
| P7 | Male | 75-80 | Grachtengordel-West | 43 |
| P8 | Female | 75-80 | Grachtengordel-West | 23 |
| P9 | Male | 75-80 | Grachtengordel-West | 23 |
| P10 | Female | 70-75 | Jordaan | 5 |
| P11 | Female | 75-80 | Dapperbuurt | 1 |
| P12 | Female | 70-75 | Dapperbuurt | 1 |
| P13 | Male | 70-75 | Dapperbuurt | 46 |
| P14 | Female | 70-75 | Dapperbuurt | 33 |

Data saturation is often used as a justification for the number of interviews to conduct in qualitative research (Vasileiou et al., 2018), and previous research recommended to use a minimum of 12 interviews to reach this point of data saturation (Braun & Clarke, 2016; Guest et al., 2006). The number of interviews that are needed should however depend on the specific

study at hand. The total of 14 interviews provided enough relevant data to answer the research questions of this study and explore the diversity in safety perceptions. Due to the limited time that was set out for this research and difficulties with finding participants, this number could not be enlarged. It should be noted that the sample used within this study is not statistically representative for a larger population of elderly residents in Amsterdam.

To conduct the interviews in a proper and professional manner, a specific procedure from TU Delft was followed in which ethical approval had to be obtained. This procedure ensured that research ethics were effectively incorporated into this research and that potential risks for participants were minimized. A checklist for potential risks, a data management plan and an Informed Consent Form were included in the submission for the ethics committee (HREC). Only after getting approval from the committee, neighborhood gand activities centers were contacted and visited to find participants for the interviews. Before the interviews started, participants were given time to read the Informed Consent Form and were asked to sign this as a form of agreement. At any time, they were allowed to opt out of certain questions or withdraw from this research if this was wished for.

The interviews consisted of a set of questions about residents' walking experiences, their safety perception while walking and how different built-environment, social, and individual determinants influence their safety perception. The interviews started with a couple of questions to encourage participants to share about their walking experiences in their district of residence. Following this, more in-depth questions were asked to better understand their safety perception, to identify places they did or did not feel safe in, and to see how these places might affect their walking in the city district. Q-methodology was employed as another method during the interviews to identify shared perspectives among participants. This method is further elaborated on in Chapter 3.3.3. After finishing the Q-methodology, participants were asked a couple of questions to close off the interviews and were given the opportunity to comment on their answers. An interview guide was used to give guidance to the semi-structured interviews and included open questions while also leaving room for unplanned follow-up questions. The full set of questions included in the interview guide can be found in Appendix A.

After completing the interviews, audio recordings were manually transcribed to start the analysis. The audio recordings, transcripts, and other relevant data, such as personal data given by participants during the interviews, were labeled and stored in different folders to keep a clear overview and for safety reasons. Transcripts were imported to Atlas.ti, where they were thoroughly read. Open coding was used to mark relevant sections of data within the transcripts and to get a first overview of relevant passages in the text. The built-environment, social, and individual determinants that were derived from literature were used for coding, but other codes were assigned as well to the interview transcripts. The transcripts were then thoroughly read another time to see if any relevant information was not marked yet. Finally, the interview transcripts were grouped according to city district to get more insight into walking experiences and safety perceptions per district.

### 3.3.3 Q-methodology

Q-methodology was used to get a better understanding of the similarities and differences between residents' viewpoints on safety perception and set out to find portions of shared meaning (factors) within the data that were provided by participants. Q-methodology can be used to study subjective phenomena by adopting a combination of qualitative and quantitative approaches (Churruca et al., 2021). Participants were asked to rank order a set of pre-selected statements derived from literature onto a grid with a prearranged number of columns, and that followed a normal distribution. The statements were ranked according to their relative importance and through placing them onto the grid participants were forced to only choose a couple of statements they found most or least important for their safety perception. The final distribution of statements formed their viewpoint on safety perception while walking.

The Q-methodology started with selecting the statements (the *Q-set*) that would be presented to participants to help them articulate their own viewpoint. Statements are usually written in the form of opinions or beliefs on the topic at hand, and the number can range from 20 to over 250 statements, but also Q-sorts with lesser statements were used in the past (Millar et al., 2022). For this study, a set of 16 statements was presented to participants during the interviews since this was more pragmatic and considered the limited time that was set out for the interviews. The built-environment, social, and individual determinants from literature formed the basis for the Q-set statements and the statements were printed onto physical cards. Not all determinants that were listed in Chapter 2.3 were used for the Q-set, because of the limited number of statements used and the fact that some determinants, such as previous experiences, were better fitted as part of the interview questions to get more in-depth information. For every determinant, it was decided whether it was best to include it within the Q-set or to include it within the interview questions. Table 3 shows the statements that were used for the Q-set, both in Dutch and English. The physical cards where the propositions were printed on can be found in Appendix B.

*Table 3: The Q-set statements*

| Name determinant | Statement (in Dutch) | Statement (in English) |
|---|---|---|
| **Built environment** | | |
| **Traffic volume**<br><br>(Aceves-González et al., 2020); (Le et al., 2021); (Van Cauwenberg et al., 2012) | "Weinig verkeer op straat" | "Not much traffic on the road" |
| **Traffic speed**<br><br>(Aceves-González et al., 2020); (Basu et al., 2023); (Mfinanga, 2014); (Narayanan, 2020) | "Een lage verkeerssnelheid" | "A low traffic speed" |
| **Traffic intersections/crossings**<br><br>(Ferrer et al., 2015); (Le et al., 2021); (Leung et al., 2021); (Van Cauwenberg et al., 2012) | "Weinig (kruis-)punten waar ik gedwongen word over te steken" | "Few intersections or places where I am forced to cross the street" |
| **Number of traffic lanes**<br><br>(Aceves-González et al., 2020); (Ferrer & Ruiz, 2018); (Ferrer et al., 2015) | "Weinig verkeersbanen op de weg" | "Few traffic lanes on the road" |
| **Width of sidewalk**<br><br>(Ferrer et al., 2015); (Kelly et al., 2011); (Van Cauwenberg et al., 2012) | "Een stoep die breed genoeg is" | "A sidewalk that is wide enough" |
| **Surface quality of sidewalk/path**<br><br>(Ferrer et al., 2015); Leung et al. (2021); (Pooley et al., 2014); (Van Cauwenberg et al., 2012) | "Een goede staat van de straat/stoep" | "A good condition of the sidewalk/street" |
| **Public lighting**<br><br>(Adkins et al., 2019); (Ferrer et al., 2015); (Landa-Blanco & Ávila, 2020); (Leung et al., 2021); (Park & Garcia, 2020); (Van Cauwenberg et al., 2012) | "Voldoende straatverlichting" | "Sufficient public lighting" |
| **Presence of pedestrian zones**<br><br>(Ferrer & Ruiz, 2018); (Basu et al., 2022b) | "Voldoende aangewezen zones voor voetgangers" | "Sufficient pedestrian zones" |

| **Social** | | |
|---|---|---|
| **Driver's behavior**<br><br>(Aceves-González et al., 2020); (Campos Ferreira et al., 2022); (Van Cauwenberg et al., 2012); (Zhang & Bandara, 2024) | "Respectvol gedrag van bestuurders" | "Respectful behavior of drivers" |
| **Presence of other pedestrians**<br><br>(Bellizzi et al., 2019); (Park & Garcia, 2020); (Van Cauwenberg et al., 2012) | "Voldoende mensen lopen op straat" | "Sufficient people are walking on the street" |
| **Opened shops and businesses**<br><br>(Bellizzi et al., 2019); (Ferrer et al., 2015); (Park & Garcia, 2020); (Van Cauwenberg et al., 2012) | "Winkels in de straat zijn open" | "Shops/businesses on the street are opened" |
| **Familiarity with the route/place**<br><br>(Park & Garcia, 2020); (Van Cauwenberg et al., 2012); (Zhang & Bandara, 2024) | "Een bekende plek om te lopen" | "A familiar place to walk in" |
| **Individual** | | |
| **Fear of being hit/run over by motorized vehicles**<br><br>(Hidayati et al., 2020); (King et al., 2012); (Leung et al., 2021); (Zhang & Bandara, 2024) | "Ik ben niet bang voor een aanrijding met auto's/voertuigen" | "I feel safe from getting hit by motorized vehicles" |
| **Fear of theft/vandalism**<br><br>(Bellizzi et al., 2019); (Landa-Blanco & Ávila, 2020); | "Ik ben niet bang voor diefstal/vandalisme" | "I feel safe from theft/vandalism" |
| **Fear of aggression/crime**<br><br>(Ferrer et al., 2015); (Leung et al., 2021; Zhang & Bandara, 2024); (Van Cauwenberg et al., 2012) | "Ik ben niet bang voor misdaad/agressie op straat" | "I feel safe from crime/aggression on the street" |
| **Fear of falling due to slippery pavement**<br><br>(Leung et al., 2021); (Van Cauwenberg et al., 2012); (Wennberg et al., 2009) | "Ik ben niet bang om te vallen door een gladde stoep" | "I feel safe from falling due to a slippery pavement" |

During the interviews, participants were presented with the physical cards and were given instructions on how to distribute the statements onto the grid. This exercise is called a *Q-sort*. They were given time to read the statements and to reflect on them. They were then asked to rank order the statements according to their relative importance on the grid. The Q-sort grid that was used can be seen in Figure 4 and was printed on an A1 poster board. It followed a normal distribution and had a scale running from least important (-3) to most important (3). These scores were placed at the outermost columns of the grid. Participants are more likely to have a strong opinion about only a few of the statements (Millar et al., 2022), therefore the outermost columns contained the smallest number of spaces for the statement cards. Since participants might complain about the normal distribution of cards wanting to put as many cards in the outermost columns (Webler et al., 2009), it was emphasized during the interviews that one of the goals of Q-methodology is to prioritize the statements and rank them according to their relative importance. Only the placement of cards onto the different columns mattered; statements that were placed onto different rows did not differ in importance.

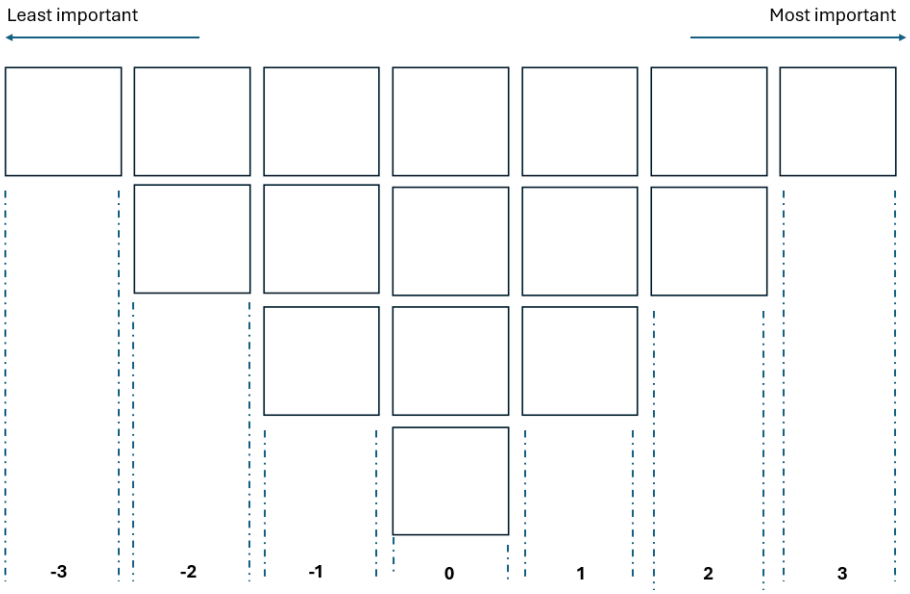


*Figure 4: The Q-sort grid*

Participants could ask for clarification on how to perform the Q-sort or on the definition of statements. Apart from giving clarification if this was asked for, no other input was given to prevent from influencing participants in any way. Participants were allowed to move around cards at any time, up until the point they decided that their distribution of statements was final. After finishing the Q-sort, they were asked a couple of follow-up questions in a short post-sorting interview since this could reveal hidden information about the Q-sort that is relevant for factor analysis and interpretation (Webler et al., 2009). Participants were asked to elaborate on their distribution of cards, especially regarding the statements they placed in the outermost columns and what might be missing in the Q-set. Finally, they were given time to make additional comments on their Q-sorts is this was wished for.

**Analysis of Q-methodology**

Using the specialized Q-methodology software *KenQ* (Banasick, 2023), all individual Q-sorts were then collected and analyzed to determine the extent to which participants distributed statements similarly and whether viewpoints were shared among the group. Each individual Q-sort was first compared to all other sorts and this resulted in a correlation matrix which showed similarities and differences between the Q-sorts. The higher the correlation score, the more similar participants had distributed the Q-set statements onto the grid. Low correlation scores indicated few similarities between participants' viewpoints, whereas negative scores indicated that statements were distributed in a reverse order. The correlation matrix showed a first glimpse of shared viewpoints on safety perception as it forms the site from which the factors are born (Watts & Stenner, 2012). Following this, factor extraction and rotation were used as multivariate data reduction techniques. Factor extraction summarized all individual Q-sorts into a few factors that are represented by participants. Factor rotation was then used to minimize the number of factors that are needed to explain the study data.

*Factor extraction*

Factor extraction was performed by using Principal Component Analysis (PCA). This works by creating new components (factors) from a larger set of measured variables, with the goal of maximizing the study variance that the extracted factors account for (Jolliffe & Cadima, 2016). This technique thus aims to keep as much statistical information from the dataset as possible and in this study, the Q-sorts of participants formed the set of variables. PCA started with searching for a first, shared pattern in the study data which became the first factor that revealed information on a shared viewpoint held among participants. The first factor accounted for most of the study variance, with each subsequent factor steadily decreasing in size. After factor 1 was found, it was extracted from the correlation matrix and this resulted in the loss of a significant portion of shared meaning in the data. The factor extraction continued by searching for any further portions of shared meaning in the residual correlation matrix. Through PCA, a total of eight factors were extracted from the dataset and the factor loadings of the individual Q-sorts for each factor were shown. The end product of the factor extraction process was a table of factor loadings that indicated the correlation of each individual Q-sort with each of the extracted factors. This table can be found in Appendix B. Each factor has an ideal Q-sort (called *composite Q-sort* or *factor array)* and this represents the view of a participant that would 100% correlate with that specific factor. The higher the factor loading, the more similar a participant's Q-sort is to the composite Q-sort of that factor. Similarly to the correlation matrix, the factor loadings can be high, low, or negative indicating various levels of correlation between participants' Q-sorts and the factor's composite Q-sort.

Together with the factor loadings, the eigenvalues (EVs) and explained variance scores were given for each of the factors. A factor's EV is calculated by summing the squared unrotated factor loadings of all individual Q-sorts on that factor and is a measure for the statistical strength of a factor (Watts & Stenner, 2012). A factor's variance, the extent to which it accounts for meaning in the dataset, can then be derived from its EV using the following equation (Brown, 1980):

$$Variance\ Factor\ N = 100\ x\ (EV : no.of\ Qsorts\ in\ the\ study)$$

Before moving on to factor rotation, a decision had to be made regarding the number of factors to keep for rotation. Previous studies established a couple of criteria that can be used as a guidance for this decision, although the number of factors should always depend on the study at hand and should be decided within its context (Watts & Stenner, 2012). Using the factors' EVs, the Kaiser-Guttman criterion was used and a Scree-Test was employed. Next to this, the significance of factor loadings was studied and the four dimensions used by Webler et al. (2009) were considered. The results of this decision-making process can be found in Appendix B. After careful consideration of these criteria and the study context, a two-factor solution was chosen.

*Factor rotation*

Varimax rotation was then used for the two factors that were kept for rotation and this technique positioned the factors in such a way that they accounted for the maximum amount of study variance (Watts & Stenner, 2012). Similarly to the end product of factor extraction, varimax rotation resulted in a table of factor loadings but now these loadings were rotated. The factor loadings were different after rotation than before, since varimax rotation set out to increase a Q-sort's loading on only one factor, while trying to decrease its factor loading on the other factor. Table 4 shows the rotated factor loadings for all individual Q-sorts in the study and how strongly each sort is correlated to each factor's composite Q-sort.

*Table 4: Factor loadings and district of residence for participants' Q-sorts*

| Participant | Factor loading F1 | Factor loading F2 | City district |
|---|---|---|---|
| P2 | 0.8897X | -0.0972 | Grachtengordel-West |
| P9 | 0.8707X | -0.0225 | Grachtengordel-West |
| P8 | 0.861X | 0.2446 | Grachtengordel-West |
| P13 | 0.7738X | 0.3283 | Grachtengordel-West |
| P4 | 0.7447X | 0.214 | Grachtengordel-West |
| P5 | 0.7261X | 0.2342 | Grachtengordel-West |
| P10 | 0.724X | 0.2246 | Grachtengordel-West |
| P7 | 0.6793X | 0.1884 | Jordaan |
| P1 | 0.3704 | -0.0658 | Grachtengordel-West |
| P12 | 0.087 | 0.7868X | Dapperbuurt |
| P14 | 0.0923 | 0.7288X | Dapperbuurt |
| P6 | 0.4873 | 0.5595 | Grachtengordel-West |
| P11 | 0.2025 | 0.5371X | Dapperbuurt |
| P3 | 0.0612 | -0.4944X | Dapperbuurt |

The composite Q-sorts of both factors were then constructed via a weighted averaging of all individual Q-sorts that loaded significantly on that specific factor (Watts & Stenner, 2012). A decision had to be made on which Q-sorts to use to construct the composite Q-sorts, this process is called *flagging*. Only the sorts that were considered to load significantly on one of the two factors at $p<0.05$ were flagged. The equation used for deciding on the number of factors (see Appendix B) showed that a factor loading, in this study, can be considered significant at $p<0.05$ if it is 0.49 or greater. Table 4 shows the flagged Q-sorts for factor 1 (marked in blue) and for factor 2 (marked in orange). One Q-sort (P1) was not flagged for either of the factors since its factor loadings cannot be considered significant, with one other (P6) not being flagged since it loaded quite highly on both factors. This Q-sort was considered a confounder and was therefore left out of constructing the composite Q-sorts. Interestingly, one of the sorts (P3) had a significant

negative factor loading, which indicated that this ranking of statements was reversed to some extent.

After flagging the participants' Q-sorts that loaded significantly, KenQ produced Tables 5 and 6 containing the Q-set statements, Z-scores, and ranks. For each statement, the corresponding Z-score and rank for both factors can be found. The Z-score is a measure for how far a statement is placed from the middle of the grid. A Z-score of +3.0 is three standard deviations above the middle point of the distribution, which means a statement is placed at the far right of the grid (Webler et al., 2009). The rank is based on the Z-score and shows how the statements were ranked for that factor in order from most important (1) to least important (16). The Z-scores were used to find consensus statements (statements that were similarly placed) and distinguishing statements (statements that were placed significantly differently) when comparing the two factors. In total, eight distinguishing statements were found, seven with significance at $p<0.01$ and one statement with significance at $p<0.05$. These statements are highlighted in purple in Table 5 and can also be found in Table 6.

*Table 5: Q-set statements and their corresponding Z-scores and ranks*

| Statement | Z-score F1 | Rank F1 | Z-score F2 | Rank F2 |
|---|---|---|---|---|
| Respectful behavior of drivers** | 1.72 | 1 | 0.57 | 3 |
| A good condition of the sidewalk/street | 1.68 | 2 | 1.60 | 2 |
| Sufficient public lighting** | 1.13 | 3 | 0.17 | 7 |
| A low traffic speed** | 0.94 | 4 | -0.82 | 13 |
| A sidewalk that is wide enough* | 0.62 | 5 | -0.03 | 8 |
| I feel safe from getting hit by cars/motorized vehicles** | 0.24 | 6 | -1,12 | 15 |
| Shops/businesses on the street are opened | 0.17 | 7 | -0.07 | 9 |
| Sufficient pedestrian zones | 0,15 | 8 | 0.33 | 5 |
| Not much traffic on the road | -0,44 | 9 | -0.76 | 12 |
| Sufficient people are walking on the street** | -0,47 | 10 | 0.49 | 4 |
| I feel safe from theft/vandalism | -0,51 | 11 | -0.17 | 10 |
| I feel safe from crime/aggression on the street | -0,64 | 12 | -0.59 | 11 |
| I feel safe from falling due to a slippery pavement** | -0,81 | 13 | 2.45 | 1 |
| A familiar place to walk in | -0,99 | 14 | -1.00 | 14 |
| Few intersections where I am forced to cross the street** | -1,34 | 15 | 0.30 | 6 |
| Few traffic lanes on the road | -1,44 | 16 | -1.33 | 16 |

(*) Significance at $p<0.05$, (**) Significance at $p<0.01$

*Table 6: Distinguishing statements for Factor 1 and Factor 2*

| Statement | Z-score F1 | Z-score F2 | Difference in Z-score | Comp. Q-sort F1 | Comp. Q-sort F2 |
|---|---|---|---|---|---|
| I feel safe from falling due to a slippery pavement** | -0.81 | 2.45 | 3.26 | -1 | 3 |
| A low traffic speed** | 0.94 | -0.82 | 1.76 | 1 | -1 |
| Few intersections where I am forced to cross the street** | -1,34 | 0.30 | 1.64 | -2 | 1 |
| I feel safe from getting hit/run over by motorized vehicles** | 0.24 | -1.12 | 1,36 | 1 | -2 |
| Respectful behavior of drivers** | 1.72 | 0.57 | 1.15 | 3 | 2 |
| Sufficient people are walking on the street** | -0.48 | 0.49 | 0.97 | 0 | 1 |
| Sufficient public lighting** | 1.13 | 0.17 | 0.96 | 2 | 0 |
| A sidewalk that is wide enough* | 0.62 | -0.03 | 0.65 | 1 | 0 |

(*) Significance at p<0.05, (**) Significance at p<0.01

Table 6 shows the eight statements that are distinguishing for both factors and that were ranked significantly differently. Next to the Z-scores and the difference between factors, the placement of these statements in the composite Q-sorts can also be found. The statement "*I feel safe from falling due to a slippery pavement"* has the largest difference in Z-scores between the two factors. This factor was placed in the -1 column in the composite Q-sort for Factor 1, but in the +3 column in the composite Q-sort for Factor 2. Each of the subsequent statements have smaller differences in Z-scores but were also ranked significantly differently. The Z-scores and ranks that are shown in Table 5 were used by KenQ to create the composite Q-sorts of the two factors, which can be found in Chapter 4.1.

In Table 7, the relationship can be seen between both factors. Since the correlation value is less than 0.399, the relationship level can be considered low (Schober et al., 2018). Preferably, the correlation score is low which means there are more distinguishing statements (Webler et al., 2009). The low relationship level between the two factors is reflected in the number of distinguishing statements that were found.

*Table 7: Correlation value between factors*

| | Factor 1 | Factor 2 |
|---|---|---|
| Factor 1 | 1 | 0.2619 |
| Factor 2 | 0.2619 | 1 |

The composite reliability for each of the factors is also above average (0.8). A high reliability above the average indicates the analysis is consistent and reliable. Table 8 shows that the number of defining variables is eight for Factor 1, and four for Factor 2. This means that eight participants represent Factor 1, whereas Factor 2 is represented by four participants. The higher the number of participants representing a certain factor, the higher the reliability score will be.

*Table 8: Statistical characteristics for rotated factors*

| | Factor 1 | Factor 2 |
|---|---|---|
| Number of defining variables | 8 | 4 |
| Average Relative Coefficient | 0.8 | 0.8 |
| Composite Reliability | 0.970 | 0.941 |

In Table 9, the participants who loaded significantly onto the two factors can be found. The number of participants that represents the two factors is equal to the number of defining variables shown in Table 8. Table 9 also shows the city district of residence of the participants. Factor 1 is mainly represented by participants living in Grachtengordel-West (6 p.), but also by one participant in both Jordaan and Dapperbuurt. Factor 2 is represented by three participants living in Dapperbuurt and one living in Grachtengordel-West.

*Table 9: Participants representing the rotated factors*

| Factor | Participant | City district |
|---|---|---|
| **Factor 1** | P2 | Grachtengordel-West |
| | P9 | Grachtengordel-West |
| | P8 | Jordaan |
| | P13 | Dapperbuurt |
| | P4 | Grachtengordel-West |
| | P5 | Grachtengordel-West |
| | P10 | Grachtengordel-West |
| | P7 | Grachtengordel-West |
| **Factor 2** | P12 | Dapperbuurt |
| | P14 | Dapperbuurt |
| | P11 | Dapperbuurt |
| | P3 | Grachtengordel-West |

Through factor extraction and rotation two factors were found that represent viewpoints that are shared among participants on safety perception while walking. For each factor, a composite Q-sort with distinguishing and consensus statements was constructed that represents that factor's viewpoint. This information was then used for the interpretation of factors, which can be found in Chapter 4.

# 4. Results

In this chapter, the results of the data collection methods are presented. Firstly, the shared perspectives (factors) on safety perception that were derived from the Q-methodology are described. Following this, the determinants discussed during the interviews and Q-methodology are presented according to their relative importance and together with the outcomes of the policy document analysis.

## 4.1 Factors

Below, the composite Q-sorts of the two factors can be found that represent the perspectives that are shared among participants of this study, see Figure 5 and 6. These composite Q-sorts contain the consensus and distinguishing statements for that specific factor. Each factor was given a name to capture the essence of the shared perspective on safety perception while walking. Next to this, a short overview of relevant statistical and demographic information is given followed by a description of that factor's perspective.

**Factor 1: Behavior of other traffic users is key to feeling safe**

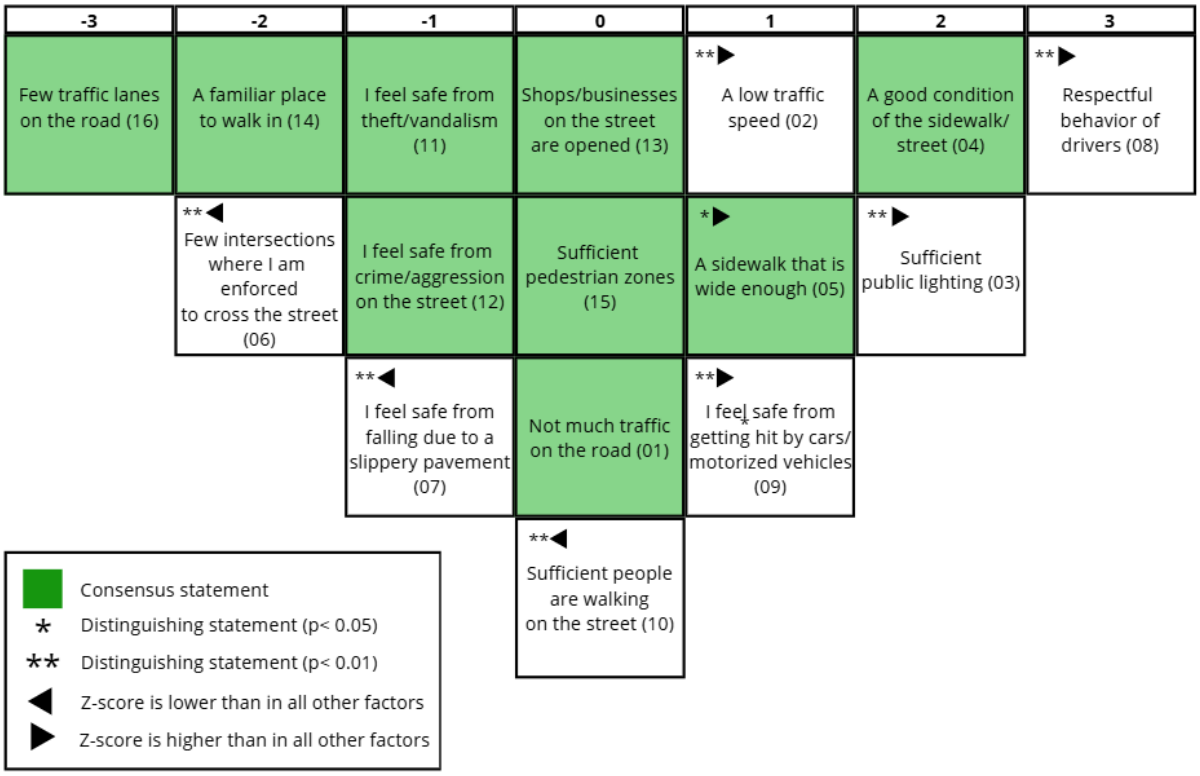


*Figure 5: Composite Q-sort for Factor 1*

Factor 1 is represented by eight participants and accounts for 39% of the study variance. Six participants are a resident of Grachtengordel-West, one of Jordaan and one of Dapperbuurt. Four are male and four are female.

In this perspective, respectful behavior of traffic users is very important for how safety is perceived and strongly influences how walking is experienced (08: +3). Although some drivers do not comply with traffic regulations, most are considered respectful since they take into account pedestrians and stop for them to cross the street. This behavior strongly enhances feelings of

safety while walking. In this account, cyclists and micromobility users are, however, seen as dangerous and cause strong negative feelings. Multiple participants expressed to have had various negative experiences with these traffic users and this mainly concerns cyclists and fatbike users who make use of the sidewalks, forcing pedestrians to get out of their way. This can be especially challenging and dangerous for elderly residents since they are physically more vulnerable and are more likely to experience reduced mobility.

In this account, traffic speed is also considered important for safety perception (02: +1). Participants mentioned that drivers often respect speed limits, but they say this is different for cyclists and micromobility users who often maintain a very high speed. This increases their fear of getting hit or run over (09: +1) and they must always pay close attention to traffic situations to make sure they can safely walk and cross the street. Participants do not necessarily feel less safe when they are forced to cross the street, for example because of road work (06: -2), nor does the number of traffic lanes strongly influence their safety perception (16: -3).

This group also stresses the importance of a good state of sidewalks (04: +2), though participants reported to regularly come across sidewalks in poor condition. Participants also mentioned that public lighting can greatly enhance safety feelings while walking (03: +2) but mainly because sufficient lighting can help spot irregularly paved sidewalks. Deficiencies in street lighting, on the other hand, can cause dangerous situations at night when irregularly paved sidewalks and loose tiles are not clearly visible. Although poor sidewalks and slippery pavements can cause participants to take a fall, falling onto the sidewalk or street is less of a safety concern (07: -1). They also do not feel particularly bothered by the possibility of theft or crime happening on the street (11: -1, 12: -1), but they do stress the importance of staying alert.

**Factor 2: Good sidewalks are needed that are not slippery**

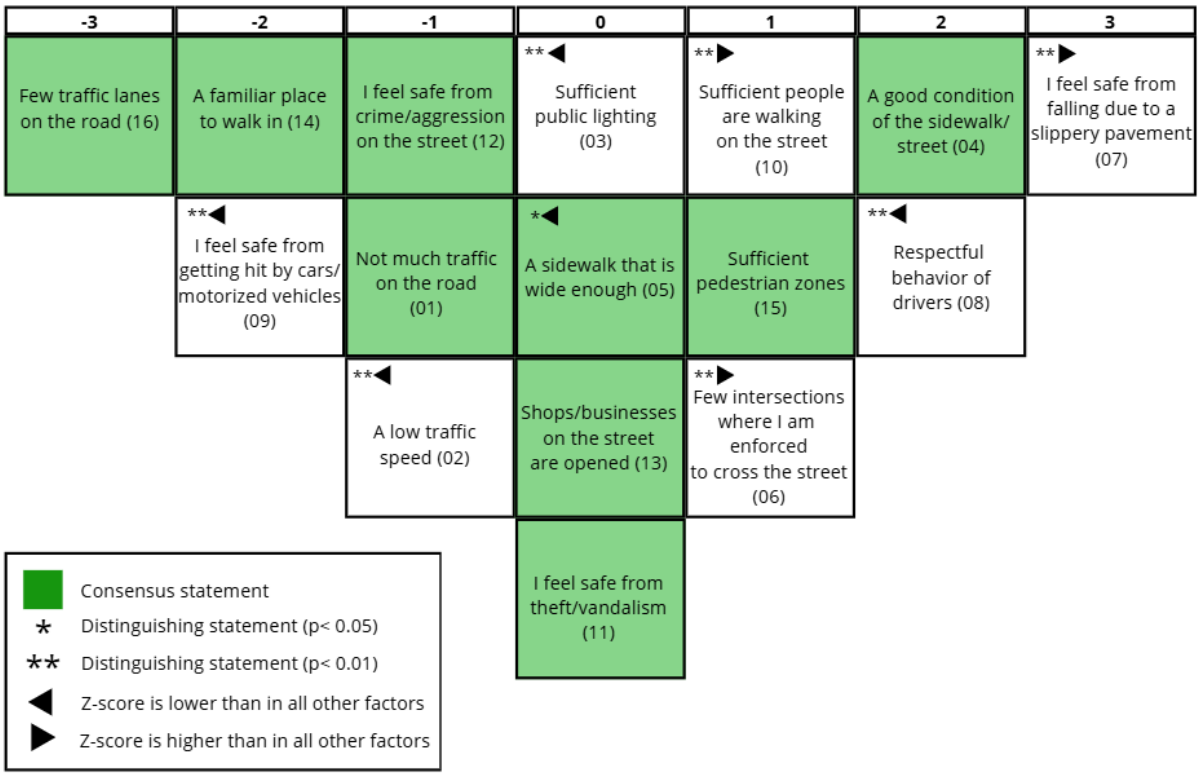


*Figure 6: Composite Q-sort for Factor 2*

Factor 2 is represented by four participants and accounts for 17% of the study variance. Three participants are a resident of Dapperbuurt and one participant is living in Grachtengordel-West. Three are female, one is male.

This perspective highlights the importance of feeling safe from falling onto the sidewalk or street (07: +3). Places where sidewalks are slippery are seen as the biggest threat to feeling safe and make participants afraid of falling. Falling can have serious health consequences for elderly residents, especially when they are already experiencing mobility issues. This group found that sidewalks are often in bad condition and commented that sloping surfaces and loose tiles make walking very challenging. They also found that maintenance work on sidewalks is often not done well and this leaves residents with uneven or broken surfaces to walk on. It is important for them to constantly pay attention while walking to prevent them from taking a fall.

Other pedestrians walking on the street can also positively contribute to safety perception and can make walking more comfortable (10: +1), especially during nighttime. Crime or theft are, however, not seen as a great threat to feeling safe when walking (12: -1,11: 0). Participants did stress that the possibility of crime and theft happening should always be kept in mind. Staying alert in traffic is also important, especially when crossing the street. A fewer number of intersections to cross the street can enhance safety feelings of participants (06: +1), as does the presence of pedestrian zones (15: +1).

The number of traffic lanes does not particularly influence safety feelings (16: -3), nor does the extent to which participants are familiar with the area influence their safety perception (14: -2). In this account, respectful behavior of drivers and other traffic users was also seen as important (08: +2). Some residents reported to have had negative experiences with cyclists and micromobility users, though they do not necessarily feel afraid of getting hit in traffic (09: -2).

## 4.2 Most important determinants for safety perception while walking

In this subchapter, the built-environment, social, and individual determinants are discussed according to their relative importance for the safety perception of interviewed residents. This chapter combines the results of the semi-structured interviews and Q-methodology together with the outcomes of the policy document analysis.

**Sidewalk condition**

During the interviews, almost all participants emphasized the importance of a good sidewalk condition for their safety perception, though they expressed their concerns about the current state that sidewalks are in. They stated to regularly come across loose tiles, sloping surfaces and irregularly paved sidewalks. One resident mentioned: "*… all sidewalks are not flat, they are sloping towards the street. This makes walking on the sidewalk difficult. Sidewalks are also irregularly paved which causes you to trip … walking is quite challenging because you have to constantly pay attention*." (woman, 80-85, Grachtengordel-West, P2). A poor condition of sidewalks negatively influences safety perception and makes walking more challenging, especially for participants with reduced mobility since they need to move around loose tiles or are forced to leave the sidewalk. One resident found poor sidewalks to be the biggest threat to walking safely in the city center: *"… the streets are paved poorly, they are not flattened in the right way, and these are all things that make the streets unwalkable. And this I consider to be the biggest safety threat in the city center."* (man, 70-75, Grachtengordel-West, P5). Interviewed residents also discussed the maintenance of sidewalks and mentioned that this is often not done well, leaving them with sidewalks that are irregularly paved. Complaints about maintenance work were expressed by residents of all three city districts.

The importance of a good sidewalk condition was also reflected in the Q-methodology results. While the two factors represent different perspectives held among participants, a good sidewalk state can be found on the right side of the composite Q-sorts of both factors (see Figure 5 and 6, statement 04). For both factors it was placed in the +2 column, indicating a high relative importance compared to all other statements. This was also reflected in the Z-scores and ranks as can be seen in Table 5. The Z-score of the corresponding statement was 1.68 for Factor 1 and 1.60 for Factor 2. Based on these scores, a good sidewalk condition was ranked the second most important determinant for both factors and since the corresponding statement was similarly ranked it was found as a consensus statement.

That interviewed residents said to come across irregularly paved sidewalks, loose tiles and sloping surfaces is not surprising, since issues regarding the condition of sidewalks were also discussed in municipal policy. Over the last couple of years, the municipality has seen an increase in frequency and intensity of the use of sidewalks and streets by pedestrians and this increases the need for maintenance (Gemeente Amsterdam, 2025b). Municipal policy is aimed at keeping these spaces safe, functional and in good condition, so that elderly residents and other pedestrians can continue to make use of them (Gemeente Amsterdam, 2023a). The analysis of policy documents showed, however, that redesign and maintenance can only be done when really necessary due to available municipal budgets being limited. This means that in some places, the safety and walkability cannot be improved on the short term leaving pedestrians with sidewalks and streets that are not in great condition (Gemeente Amsterdam, 2024a).

***Respectful behavior of traffic users***

Participants mentioned that respectful behavior of traffic users strongly influences their safety perception. Some found the behavior of traffic users to have changed over time and pointed out how people nowadays mostly focus on themselves. One resident mentioned: "*I never feel unsafe when walking on the street, but what I do find unsafe is that traffic users do not really pay close attention to me when I walk and want to cross the street. I look both ways and a cyclist passes just in front of me. People do not really comply with traffic regulations.*" (woman, 80-85, Grachtengordel-West, P6). Some interviewed residents also said that people on the street go stand in the middle of sidewalks, not paying attention to the fact that they are blocking the sidewalk. Another resident (woman, 70-75, Dapperbuurt, P14) commented that people using their phones while walking bump into other pedestrians, and this can be dangerous for elderly since they are physically more vulnerable.

Participants differentiated between multiple types of traffic users when discussing their safety perception. They were predominantly positive about car and vehicle drivers and in most cases they feel respected by them. One resident mentioned: "*Drivers are very respectful. I make use of a walking stick and almost all cars stop whenever I want to cross the street. It surprises me that they do this very gently.*" (woman, 80-85, Grachtengordel-West, P2). Most car and vehicle drivers comply with traffic regulations and stop for residents to cross the street, and this increases their safety feelings while walking.

In contrast to their opinions on drivers' behavior, they expressed strong negative feelings about the behavior of cyclists and micromobility users. During the interviews, nine participants expressed to have had negative walking experiences related to these users and their behavior. They mentioned to feel very unsafe and threatened because of cyclists, e-bikes and fatbikes and found their behavior to be an important issue for their safety. Interviewed residents stated that cyclists and micromobility users (mainly fatbike users) do not comply with traffic regulations and often maintain a very high speed which causes them to not feel respected and comfortable walking on the sidewalk. Multiple residents said to even feel forced to walk on the street when cyclists and micromobility users make use of the sidewalk and mentioned that fatbikes, in particular, are very hard to notice since they do not make a lot of noise. Participants living in Dapperbuurt pointed out that while the sidewalks in shopping streets are more spacious, the room for walking decreases when cyclists and fatbikes make use of them as well.

The composite Q-sorts of the two factors highlight the importance of the behavior of traffic users, as the corresponding statement is placed on the right side of the grid (see Figure 5 and 6, statement 08). For Factor 1, it was found as the most important determinant for safety perception and the corresponding statement was placed in the outermost right column. This statement got the highest Z-score (1.72) and rank for Factor 1 (see Table 5). For Factor 2, it was also ranked relatively high (3$^{rd}$) with a Z-score of 0.57 but was ranked significantly lower than for Factor 1 (see Table 6). During the post-sorting interviews, the behavior of cyclists and micromobility users was brought up most when asking participants whether something was missing from the Q-set statements. The statement used in the Q-set regarded respectful behavior of drivers. Multiple residents pointed out that an additional statement should have been added which focused on the behavior of cyclists and micromobility users specifically.

The analysis of policy documents showed that the municipality noticed recent increases in use of different forms of bicycles and micromobility and mainly expressed its concerns about the age, speed and behavior of fatbike users in traffic (Gemeente Amsterdam, 2024a). The municipality wants to set out regulations for maximum speed, parking and enforcement for these traffic users in future policy, but this is dependent on national policy. Currently, a national plan *(Toelatingskader Lichte Elektrische Voertuigen)* is being developed that sets out regulations for the use of micromobility and differentiates between types of vehicles that are either allowed or not allowed to be used in the Netherlands. This national plan should also allow for municipalities to make adjustments to regulations and consider them in the local context (Gemeente Amsterdam, 2024a).

**Fear of falling due to a slippery pavement**

Multiple interviewed residents stated that feeling safe from falling positively influences their safety perception, but expressed concerns about falling since it could result in serious health consequences. Some mentioned they fell once or multiple times in the past and this resulted in reduced mobility. Two interviewed residents who experience reduced mobility and had fallen before mentioned that their current state of mobility makes them feel more vulnerable to breaking something when they take a fall again. One resident mentioned: *"Well, if the sidewalk is slippery, I try my best to work around it, but if I take a fall then I will break something. I will not leave my house if there is not really a good reason to do so, in case the sidewalks are slippery. However, it is also the case that there are not that many cold winters anymore. But this remains very important to me, because the slipperiness of pavements is not something I can change myself."* (woman, 70-75, Dapperbuurt, P14).

The importance of feeling safe from falling was also reflected in the Q-methodology results, especially when looking at Factor 2. The Z-score of the corresponding statement for Factor 2 was the highest overall score (2.41, see Table 5) and indicated that all representing participants placed this statement on the right side of the grid. Interestingly, there is a significant difference in placement when comparing the two factors. Whereas this statement was found most important for Factor 2, it was placed on the left side of the composite Q-sort for Factor 1 (see Figure 5 and 6). This is the statement that distinguishes most strongly between both factors, with a Z-score of 2.45 for Factor 2 (ranked first) and a Z-score of -0.81 (ranked 13$^{th}$) for Factor 1 (see Table 5 and 6).

The policy document analysis showed that the municipality also identified falling as a serious threat to the health of elderly. To decrease the number of falling incidents among elderly and raise more awareness of the risks of falling, the municipality organizes fall prevention courses (Gemeente Amsterdam, 2024b). So far, the fall prevention courses resulted in a decrease of 40% in falling incidents among participating residents and the aim is to extend the courses to places all over the city. Two interviewed residents mentioned following these courses, although it is not known whether other participants were also aware of these courses.

**Sufficient public lighting**

Five participants living in Grachtengordel-West emphasized the importance of public lighting for their safety perception. They did not mention having any fears regarding crime or theft but rather discussed this determinant in combination with the sidewalk condition. One resident said: "*I find public lighting important, mainly because I want to clearly see the sidewalk on which I am walking. Sidewalks do not always have a smooth surface, so I find this important for my safety.*" (man, 85-90, Grachtengordel-West, P3). The combination of irregularly paved sidewalks and

deficiencies in lighting causes some residents to feel more vulnerable and alert when walking on the street. Another resident commented: "*Some light poles are placed too far from each other, and there are no light poles placed on bridges. If you are crossing a bridge, and the sidewalk is in poor condition, you have to be careful.*" (man, 70-75, Grachtengordel-West, P5). Interviewed residents living in Dapperbuurt did not specifically comment on the influence of public lighting during the interview questions or Q-sort.

The Q-methodology results showed that public lighting was assigned a high relative importance for Factor 1 (see Figure 5, statement 03). The corresponding statement was placed within the +2 column of the grid, ranking third most important with a Z-score of 1.13 (see Table 5). For Factor 2 it was placed in the 0 column (see Figure 6) and was ranked seventh most important with a Z-score of 0.17. It was found as a distinguishing statement for both factors with significance at $p<0.01$.

The analyzed policy documents did not provide specific information on public lighting and its link to safety perceptions of pedestrians. Information on municipal approaches and guidelines for public lighting can be found in other policy plans such as the *Policy Plan Public Lighting (2017)* and the *Policy Plan Puccini Method (2018)*.

**Adequate width of sidewalks (sidewalk barriers)**
Most interviewed residents found that an adequate sidewalk width positively influences their safety perception and stated this determinant plays a large role in feeling safe and comfortable while walking. Most did not have any issues with the current width of sidewalks in their districts and found that sidewalks offer enough room to walk. They were concerned, however, about barriers that are placed on sidewalks, such as parked cars and bicycles, trash bags, and terraces of restaurants, and which limit the room for walking. To pass these obstacles, they are often forced to leave the sidewalk and walk on the street and this causes safety concerns especially for participants who are experiencing mobility issues. One resident said: "*I always try to walk on the sidewalks, but if cars are parked in the middle of the sidewalk, then I am forced to walk on the street.*" (woman, 80-85, Grachtengordel-West, P6). In almost all cases, barriers or obstacles placed on the sidewalk negatively influence safety perception while walking on the street.

Interviewed residents living in Dapperbuurt discussed differences in sidewalk width between shopping streets, such as Eerste van Swindenstraat and Javastraat, and other streets in the city district. The shopping streets have wide sidewalks which was regarded as positive and residents said this width could serve as an example for sidewalks in other places. Other streets in the district often have smaller sidewalks and offer less room for walking. Interviewed residents commented that while coming across obstacles on the sidewalk, there is often still enough space for them to walk. In Grachtengordel-West and Jordaan, however, obstacles force participants to leave the sidewalk.

The results of the Q-methodology reveal that participants assigned some importance to an adequate sidewalk width when looking at the composite Q-sorts of both factors (see Figure 5 and 6, statement 05). The corresponding statement is found in the +1 column for Factor 1 and in the 0 column for Factor 2. It was ranked fifth most important for Factor 1 with a Z-score of 0.62 and ranked eighth most important for Factor 2 with a Z-score of -0.03. It was found as a distinguishing statement with significance at $p<0.05$.

The policy document analysis showed that the municipality also identified sidewalk obstacles as a deterrent to walking, causing sidewalks to not be fully utilized (Gemeente Amsterdam, 2019). The aim is to create more space on sidewalks to ensure there is enough room, also when

making use of a wheelchair, rollator, or stroller. Through the launch of the program *Room for pedestrians*, the municipality set out regulations for a minimum sidewalk width and differentiated between new, redesigned and existing physical environments (Gemeente Amsterdam, 2025b). For new and redesigned physical environments, the aim is to create sidewalks with a minimum width of 2.00 meters and for existing environments this minimum width should be 1.80 meters. The width should be adjusted to the number of people making use of the sidewalk and might need to be increased in crowded places. Creating more room is challenging in existing environments since there is often less room to reserve for pedestrians. In future projects, the municipality wants to place as little physical objects as possible on sidewalks, only when this is really necessary. Alternative parking locations for bicycles and cars are also sought to free up more space on sidewalks and to alleviate pressure from the built environment, though the municipality did not report yet on whether these parking locations have been found.

**Traffic speed**

Five participants stressed the importance of traffic speed for their safety perception. They mentioned that most car and vehicle drivers stick to the speed limit and comply with traffic regulations. One participant mentioned: "*I do think a low traffic speed is important, because that is what I take into account the most, the speed of other traffic users, cyclists, fatbikes, skaters and cars.*" (man, 70-75, Grachtengordel-West, P1). One resident in Dapperbuurt (woman, 70-75, Dapperbuurt, P12) found traffic speed to be least important because traffic users simply do not comply with the speed limit. This resident also spoke about the enforcement of the 30 km/h speed limit, saying that traffic users are not complying with the speed limit because there is no active enforcement by the municipality.

The Q-methodology results showed the corresponding statement as a distinguishing statement for the two factors with significance at $p<0.01$, see Table 6. It was placed on the right side of the grid (+1 column) for Factor 1, but on the left side (-1 column) within the composite Q-sort of Factor 2 (see Figure 5 and 6, statement 02). It was ranked as fourth most important statement for Factor 1 with a Z-score of 0.94, but was only ranked 13th for Factor 2 with a Z-score of -0.82.

In 2023, the municipality of Amsterdam implemented a speed limit of 30 km/h applying to most roads in the city, especially in areas with a high urban density and where pedestrians, cyclists and cars all make use of the public space. The policy document analysis showed that this measure was implemented to decrease the number of traffic incidents and to decrease the severity of accidents. In 2024, 80% of all roads in the city had this speed limit (Gemeente Amsterdam, 2025b). For the policy document analysis, reports on the effects of this measure were not analyzed. In 2025, the municipality published the *Project Report 30 km/h in the city,* in which they shared in more detail the effects this speed limit has had since its implementation in 2023.

**Pedestrian zones**

For some participants, pedestrian zones can positively contribute to their walking experiences and safety perception. It is important, however, that for pedestrian zones to make a positive contribution these are respected by other traffic users. Some participants mentioned that there are no pedestrian zones in their city district. One resident said: "*Sufficient pedestrian zones, that does not apply to this city district. I walk on the sidewalk, cross the square or I accidentally walk*

*on the street, because I cannot walk on the sidewalk. There are no pedestrian zones."* (woman, 70-75, Grachtengordel-West, P10). Participants living in Dapperbuurt consider the Oosterpark as a designated pedestrian zone. They commented, however, that cyclists consider the park to be a place to cycle through which leaves less space for them to walk.

The statement "Sufficient pedestrian zones" can be found in the middle column in the composite Q-sort of Factor 1 and in the +1 column for Factor 2 (see Figure 5 and 6, statement 15). It was ranked eighth most important for Factor 1 (Z-score of 0.15) and fifth most important for Factor 2 (Z-score of 0.33). It was found as a consensus statement for both factors.

The policy document analysis did not show municipal policy and approaches focused on creating zones that are reserved exclusively for pedestrians but showed a focus on zones that prioritize pedestrians. When public spaces are redesigned, the municipality reassesses the situation and strives to prioritize pedestrians where possible (Gemeente Amsterdam, 2019). In the *Agenda Low-car city Amsterdam (2019),* the municipality discussed a couple of places where a low-car zone can be found and mentioned wanting to further prioritize pedestrians in the future.

**Shops and businesses that are opened**

Most interviewed residents did not feel strongly about the importance of opened shops and businesses for feeling safe when going for a walk. A couple of residents did not find this determinant important at all, others did not specifically speak on its importance. Some mentioned that open shops and businesses make walking more comfortable during the day, but that this is not the case at night since most shops and businesses are closed. One resident said: *"This I am not afraid of, but I also do not think that social surveillance should come from shops on the streets."* (woman, 80-85, Grachtengordel-West, P6). A resident living in Dapperbuurt mentioned that opened shops and businesses make them feel more comfortable, but closed shops do not stop them from walking.

Interestingly, the results of the interviews are not fully reflected in the outcomes of the Q-methodology. The Q-methodology results showed that participants did assign some importance to this determinant. The outcomes showed that the corresponding statement was placed in the middle column of the composite Q-sorts of both factors, indicating a higher relative importance compared to quite some of the other statements (see Figure 5 and 6, statement 13). For Factor 1, this statement has a Z-score of 0.17 and was ranked seventh most important. For Factor 2, this statement has a Z-score of -0.07 and was ranked ninth (see Table 5 and 6).

Opened shops and businesses were not specifically mentioned in municipal policy that are in relation to walking. The policy document analysis showed no specific comments from the municipality on the importance and influence of opened shops and businesses on pedestrian safety or safety perception.

**Presence of other pedestrians**

Opinions differed when discussing the presence of other pedestrians on the street and its influence on safety perception. Some participants mentioned that this is not important to them, stating that the presence of other pedestrians does not positively or negatively influence their feelings of safety. Others found this determinant to be of a greater importance and preferred to walk in places where other people are on the street as well. A resident of Dapperbuurt said to avoid walking from the train station at night because of a lack of people on the street and a fear

of theft: *"... it is quiet, and there are few people on the street. I think I am mostly worried about younger men, because they will probably take something from me, such as my bag. I feel more vulnerable."* (woman, 70-75, Dapperbuurt, P14).

The statement belonging to this determinant ("Sufficient people are walking on the street") was found as a distinguishing statement for both factors with a significance at $p<0.01$. For Factor 2, it was ranked fourth most important with a Z-score of 0.49. For Factor 1, it was ranked ninth most important with a Z-score of -0.46, indicating a lower relative importance when compared to Factor 2 (see Table 5 and 6, statement 10).

The policy document analysis did not show any specific comments on the presence of other pedestrians or its influence on how safety is perceived.

**Places where pedestrians are forced to cross the street**

Participants also differed in opinions on intersections or places where they are forced to cross the street. A couple of participants found this determinant important for their safety perception, stating they would prefer fewer intersections to cross and that these places make walking unpleasant. Some commented that they have to cross the street mainly because of road work and that this determinant, therefore, only temporarily influences their safety perception. One resident living in Dapperbuurt did not find this determinant to be important: *"Few intersections where I am forced to cross the street, where I cannot walk further on the sidewalk? I do not find that important. They are working on the road, but I just have to pay attention myself."* (woman, 70-75, Dapperbuurt, P14). Other residents commented that they feel indifferent towards this determinant or that it does not apply to their city district.

The Q-methodology results showed the corresponding statement as distinguishing for both factors with significance at $p<0.01$. It was ranked sixth most important for Factor 2 and placed in the +1 column, but only ranked second to last ($15^{th}$) for Factor 1 and placed in the -2 column of its composite Q-sort.

The analyzed policy documents showed that the municipality wants to pay more attention to places where pedestrians cross the street and stated that currently, pedestrian crossings are not always safe as severe traffic accidents and incidents still occur at these crossings. The municipality strives to create more designated pedestrian crossings and wants to increase the visibility of pedestrians. Guidelines for pedestrian crossings have been updated and for every redesign project elevated pedestrian crossings will be considered to enhance visibility. The policy document analysis did not show the extent to which changes to crossings have been made by the municipality.

**Traffic volume**

Some participants mentioned they prefer walking in smaller and quieter streets with less traffic, while others felt indifferent towards the traffic volume, stating that it does not have a great influence on their safety feelings. One resident living in Dapperbuurt did not find traffic volume to be important, stating that people should adjust themselves to the amount of traffic. This resident said: *"A low traffic volume, I find that to be impossible, it is not something with which you can argue. You have to accept the situation as it is, so I do not find this determinant to be important."* (woman, 70-75, Dapperbuurt, P14).

The results of the Q-methodology showed that participants did not assign much importance to this determinant. In the composite Q-sort of Factor 1 it can be found in the 0 column, for Factor

2 in the -1 column. The statement "Not much traffic on the road" was ranked ninth for Factor 1 with a Z-score of -0.44 and 12th for Factor 2 with a Z-score of -0.76 (see Table 5). It was found as a consensus statement for both factors.

The analysis of policy documents showed that together with the implementation of the speed limit of 30 km/h, the municipality introduced a new category of roads called *GOW30*. This type of roads allows for a relatively high traffic volume to pass through but also aims to be safe and livable for other traffic users. The municipality wants to prioritize pedestrians as much as possible but wants to make sure traffic can still pass through these streets.

**Fear of theft/vandalism**

Participants did not feel strongly about the importance of fear of theft or vandalism for their safety perception. Multiple participants stated that they feel safe from theft or vandalism and do not experience any related fear when walking on the street. One resident said: *"I am not afraid of theft or vandalism. I am not afraid, but I do keep it in mind, but it is not that important to me."* (woman, 70-75, Dapperbuurt, P12). Some residents did mention that staying alert is important and that, in some situations, it is necessary to constantly pay attention to not get robbed. One resident living in Dapperbuurt reported that there was something stolen from them and that this still influenced their walking experiences. Other residents did not think previous theft-related incidents influence their safety perception.

The outcomes of the Q-methodology reflect what participants mentioned during the interviews. The corresponding statement was found in the -1 column for Factor 1 and in the 0 column for Factor 2. It was ranked 11th most important for Factor 1 with a Z-score of -0.51 and 10th most important for Factor 2 with a Z-score of -0.17 (see Table 5).

The policy document analysis did not show any specific comments by the municipality on fear of theft or vandalism and its influence on safety perceptions of pedestrians.

**Fear of crime/aggression**

Similarly to the fear of theft or vandalism, participants did not feel strongly about the importance of fear of aggression or crime. Multiple participants said that they do not experience any fear of aggression or crime when being on the street and that they feel safe regarding this aspect. One resident mentioned: *"I am not afraid of aggression or crime, because incidents can happen anywhere. They can take place across the street, they can happen here. If I walked back from the train station at night, I would take a different route, so I do take it into account. But I am not afraid."* (woman, 80-85, Grachtengordel-West, P6). One resident of Jordaan did mention that because of their reduced mobility they would be more vulnerable to aggression and crime on the street.

The Q-methodology results reflected the answers given during the interviews. Fear of crime or aggression was ranked 12th most important for Factor 1 and 11th most important for Factor 2. In the composite Q-sort of both factors it was found in the -1 column.

Similarly to the fear of theft or vandalism, the policy document analysis did not show any specific comments by the municipality on fear of crime or aggression and its influence on safety perception of pedestrians.

**Familiarity with the place**
Although some interviewed residents were more familiar with their city district than others, most mentioned that this determinant does not strongly influence their walking experiences and does not feel important to them. A couple of residents mentioned that an unfamiliar place would not be a problem for them since they can use their phones to find out more about the area. One resident living in Dapperbuurt (woman, 70-75, Dapperbuurt, P14) said familiarity with the place is not important to them, since there will always be places that you need to familiarize yourself with.

The results of the interviews were reflected in the outcomes of the Q-methodology. The statement "A familiar place to walk in" was ranked 14$^{th}$ for both factors, indicating a low relative importance compared to other statements in the Q-set (see Table 5). In the composite Q-sorts of the two factors it was found in the -2 column. Familiarity with the place was not specifically mentioned in municipal policy.

**Number of traffic lanes**
Interviewed residents did not consider the number of traffic lanes to be important for their safety perception. Some residents were indifferent about this determinant, others found it to be unimportant since it does not apply to their city district. Especially in Grachtengordel-West, interviewed residents commented that roads are not divided into multiple traffic lanes. One resident said: *"A low number of traffic lanes, that actually does not apply to Grachtengordel-West. There are few roads with a lot of traffic lanes."* (man, 75-80, Grachtengordel-West, P10). Residents in Dapperbuurt did not specifically comment on the importance of this determinant.

Q-methodology showed that this determinant was found to be least important, ranking 16$^{th}$ for both Factor 1 and Factor 2, with a Z-score of -1.44 for Factor 1 and -1.33 for Factor 2 (see Table 5). Therefore, it was also found in the -3 column for both factors (see Figure 5 and 6). The municipality did not specifically comment on the number of traffic lanes in policy and its relation to how safety is perceived.

# 5. Discussion

This study set out with the aim to explore the diversity in individual safety perceptions of elderly walking in Amsterdam and investigate the influence of these perceptions on walking in the city. Through a thorough analysis of municipal policy documents, current policy and approaches in relation to walking among elderly were explored and related challenges mentioned by the municipality were identified. Semi-structured interviews were conducted with elderly participants in the city districts of Grachtengordel-West, Jordaan and Dapperbuurt to gain a better understanding of their safety perceptions and how built-environmental, social and individual determinants are of influence. Q-methodology was used as a method to find shared viewpoints on safety perception among participants.

This chapter discusses how the findings of this study can be interpreted in a broader context and help answer the research questions. Next to this, some limitations are highlighted which are needed for a clear interpretation of the results and some recommendations for future research are formulated. Finally, a couple of recommendations are given for policy makers.

### 5.1 Interpretation of study findings

Results of this study highlight the importance of good sidewalks, respectful behavior of traffic users and having enough room to walk for the safety perception of elderly residents. Fear of falling due to a slippery pavement, public lighting and traffic speed are also important aspects. Q-methodology revealed two shared perspectives on safety perception while walking, with one account emphasizing the importance of the behavior of other traffic users and the other highlighting good sidewalks that are not slippery. The analysis of policy documents showed that municipal policies also focus on the sidewalk condition, creating more room for walking and the behavior of cyclists and micromobility users, but that limited maintenance budgets, limited space for redesign and a lack of clear policy and regulations on micromobility use currently form the greatest barriers to enhancing pedestrian safety in the city.

A good state of the sidewalk can greatly enhance safety feelings, though most participants expressed concerns about the condition sidewalks are currently in. Their safety perception is negatively influenced by loose tiles, sloping surfaces and obstacles that are placed on sidewalks, such as parked cars, trash bags, and terraces of restaurants. These results are consistent with previous studies that found that poor sidewalks and obstacles can raise safety concerns among pedestrians and can even become a deterrent to walking (Ferrer et al., 2015; Van Cauwenberg et al., 2012). An interesting finding from this study is that sufficient public lighting was considered important but mainly because it helps to clearly see irregularly paved sidewalks in the dark and prevents participants from taking a fall onto the street or sidewalk. Only a few participants discussed public lighting in combination with fear of crime, and this is in contrast to other studies that found public lighting to be most associated with this determinant (Park & Garcia, 2020; Zhang & Bandara, 2024). In the study of Van Cauwenberg et al. (2012), however, sufficient public lighting was found to help identify potential falling hazards at night. Participants of this study found sidewalks in their city districts to be of an adequate width, but obstacles limit the room for walking and can cause safety concerns when residents are forced to walk on the street. This finding aligns with results of previous research that showed that obstacles on sidewalks negatively influence safety feelings of pedestrians (Kelly et al., 2011).

Another important finding is the strong influence of the behavior of other traffic users on safety perception. Findings show that most car and vehicle drivers were considered respectful and sensible because they comply with traffic regulations and drive at the allowed speed. Respectful drivers enhance safety feelings of participants while walking, although some drivers were seen as acting careless or reckless and this negatively influences their safety perception. Prior research also found that drivers who show carelessness and recklessness in their behavior can increase safety concerns (Aceves-González et al., 2020; Van Cauwenberg et al., 2012). In contrast to their opinions on drivers' behavior, participants expressed strong negative feelings about the behavior of cyclists and micromobility users, such as fatbike users and experienced various instances in which these traffic users did not pay attention to them and forced them out of the way. Residents with reduced mobility raised safety concerns about the behavior of these users since they are physically more vulnerable. Previous studies also showed that cyclists can negatively influence pedestrian safety perception when acting careless in traffic (Van Cauwenberg et al., 2012; Zhang & Bandara, 2024) or when they cycle through pedestrian areas (Wennberg et al., 2009). Although fewer studies have focused on the behavior of micromobility users and its influence on safety perception, some studies have argued that the use of micromobility forms can negatively influence how safe and comfortable pedestrians are feeling on the street (Hassanpour & Bigazzi, 2025; Sucha et al., 2023; Tzouras et al., 2025).

An interesting finding is that participants of this study assigned greater importance to most built environment determinants than to social and individual determinants. They did not particularly feel afraid of crime, theft or vandalism nor did they assign great importance to determinants such as opened shops and businesses or familiarity with the place. This was reflected in their ranking of statements during the Q-sorts. These findings are in contrast to prior research that emphasized the importance of fear of crime and other social and individual determinants for safety perception (Adkins et al., 2019; Zhang & Bandara, 2024). The theoretical framework used in this study also underlined the importance of the built environment, social and individual domain of determinants and through the use of this framework it was assumed that each domain was more or less of equal importance for safety perception. Results of this study suggest, however, that more importance might need to be given to built environment determinants. The differences in findings might be partially explained by the fact that most participants live in their city districts for many years, which increases their familiarity with the place and their knowledge on where and when it is safe to walk. Most interviewed residents that experienced crime or theft related incidents in the past did not think these incidents currently affect their safety perception, but they did stress it is important to keep potential crime and theft-related incidents in mind. They did not mention to feel afraid of crime of theft but rather expressed an alertness regarding crime and theft potentially happening.

Furthermore, all participants expressed to generally feel safe while walking in their city districts and stressed that in most situations they are not concerned about their safety. Although some pointed out places where they prefer not to walk, most said that these places do not strongly or negatively influence their safety feelings. Most participants mentioned to feel the need to always stay alert but that they do not necessarily feel unsafe from crime, theft or getting hit by motorized vehicles. They said it is important to constantly pay attention to potential hazards, but that they do not see these as major concerns for their safety.

The most important individual determinant for safety perception was fear of falling due to a slippery pavement. Pavements can get slippery due to a variety of weather conditions, mud or leaves on the sidewalk and this increases safety concerns for participants. This finding supports results from previous studies that showed that slippery pavements can raise safety concerns among elderly pedestrians (Van Cauwenberg et al., 2012). Feeling safe from falling can greatly enhance safety feelings, though participants expressed concerns about falling since it can result in severe and long-lasting injuries and health consequences. Some participants that have fallen before and experienced reduced mobility were afraid that falling again would even further impact their mobility. This finding aligns with previous research that found that elderly pedestrians who have taken a fall before are fearful of falling again and this fear can become a deterrent to walking (Franco et al., 2015; Leung et al., 2021).

The policy document analysis showed that the municipality aims to create a safe and functional walking environment for elderly and that policy focused on limiting traffic speed and fall prevention have proven successful in enhancing pedestrian safety. There are, however, certain challenges that form barriers to further enhancement of safe walking amongst elderly. The municipality wants to improve the sidewalk condition and keep sidewalks well-maintained, but limited budgets only allow for this when it is really necessary. Sidewalk guidelines have also been recently updated to create more room for walking, this is however challenging due to limited space for redesign and obstacles such as parked cars and bicycles that need to be relocated. The municipality also expressed concerns about micromobility users and their behavior, but formulating clear and effective policy is challenging since no clear decisions have yet been made on a national level and municipal policy should be in line with national policy.

For the results of the Q-methodology, it must be noted that participants ranked the statements according to their relative importance. Statements that were placed in the left columns of the grid should, therefore, not be considered as unimportant for the safety perception of participants or within the composite Q-sorts, but rather as less important in comparison to all other statements. The interpretation of how statements are distributed is also mentioned in previous studies that focused on doing Q-methodological research (Watts & Stenner, 2012; Webler et al., 2009). It must also be noted that the distribution of statements is not fixed to participants, since they may have varying opinions in different contexts or their opinions and beliefs might change over time. It is therefore important to understand that the results from the Q-methodology showed their viewpoint on safety perception while walking at that specific moment of time.

### 5.2 Study limitations

To study the individual safety perceptions of elderly residents in Amsterdam, the city districts of Grachtengordel-West, Dapperbuurt and Jordaan were chosen as the main focus of this research. Residents of these districts were asked to participate in semi-structured interviews and complete a Q-sort to study similarities and differences in perspectives on safety perception while walking. It should be noted, however, that this study was not designed in a way to formulate any conclusions on the extent to which the perspectives found and results from the interviews are representative of all elderly residents in these city districts. The goal was not to quantify the results for a larger population in the city of Amsterdam, but rather to explore the diversity in individual safety perceptions and the influence of different determinants on safety perception. The viewpoints found in this study might therefore not be commonly held among other residents in the city and it is thus important to stay cautious when generalizing the results.

Caution must also be used when interpreting the results of the Q-methodology, because participants might have been unfamiliar with this method and might have experienced it as a lengthy process. While the Q-sort was designed in such a way to limit the length of the exercise, participants might have experienced some form of cognitive fatigue during the process. It is possible, therefore, that some participants might have completed their Q-sort without giving it too much thought. Another thing that should be taken into account is that the quality of this methodology strongly depends on the statements that are used and how these are formulated. While various discussions took place to ensure a good formulation of statements, the exact wording may not have entirely matched with participants' views or their own wording. After completing the Q-sort, a post-sorting interview was conducted with participants to give them the opportunity to elaborate on their distribution of statements and to reflect on what statements might be missing. Despite conducting these post-sorting interviews, it must be considered that the completed Q-sorts might not fully represent participants' perspectives on safety perception as the used statements were based on pre-selected determinants from literature.

In some cases, participants asked for clarification on the statements that were used for the Q-set. For example, the statement "Few places where I am forced to cross the street" was first interpreted by some participants as places where pedestrians are allowed to cross the street, rather than places where they have to cross the street. Some participants were also slightly confused about the formulation of a couple of statements in Dutch, particularly the ones that started with "I feel safe from..". The Dutch equivalents of these statements were formulated in negation, which caused confusion when these statements were placed on the left side of the Q-sort grid. Some participants needed clarification to properly understand where to place these statements onto the poster board. Although more information on the statements was provided when asked for by participants, this might have influenced their distribution of statements onto the grid.

Some limitations must also be highlighted regarding the recruitment of participants, as the sampling techniques that were used (purposeful and snowball sampling) came with some constraints. Purposeful sampling was used to select participants who provide useful information for this research. This sampling technique, however, also has its drawbacks as it limits the generalizability of the findings since participants are selected based on certain characteristics chosen by the researcher. There is also a risk of underrepresenting participants that have less prominent viewpoints. Snowball sampling can also lead to differences in representation of groups, causing some groups to be the main focus and other groups to be underrepresented or excluded. This technique allows participants to recommend other people with relevancy for this study, these recommendations are however based on social connections. This can lead to individuals within the participant group having similar characteristics and

perspectives, which limits the diversity of the sample and to exclusion of individuals that are not directly linked to participants of this study.

Due to limited time and resources for this project and difficulties with finding participants, the sample size used in this study could not be enlarged. A larger sample size could have revealed additional shared viewpoints, other important determinants for safety perception and might have further substantiated or contradicted findings of this study. The goal was to conduct a total of 20 interviews, from which 10 interviews would be conducted in both Grachtengordel-West and Dapperbuurt. To find participants, neighborhood groups and associations were contacted, activity centers for elderly were visited and flyers and brochures were distributed in neighborhood centers, on the street and on markets. Eventually, only 14 participants were interviewed and these included nine residents from Grachtengordel-West, one in Jordaan and four in Dapperbuurt.

Initially, it was planned to include a short walk-along part in the interviews which was led by the participant and would be accompanied by the researcher. During the short walk-along interview, the participants would take the researcher to a few places that they perceived as safe or less safe, so that they could further elaborate on their safety perception. Because of time constraints and potential mobility difficulties, it was decided not to do this. An alternative was found in using Google Maps so that participants could digitally “show” the researcher around in these places, but again, due to time constraints this was not done and only questions about these places were asked during the interviews.

### 5.3 Recommendations for future research

This study gives more insight into the diversity in individual safety perceptions and walking experiences of elderly, but was not specifically designed to quantify the viewpoints found on safety perception. Future research could use a larger and more representative sample to formulate conclusions on the extent to which viewpoints are shared among a larger population. Researchers could, for example, broaden the scope of this research by including more city districts in Amsterdam and increase the sample size for interviews and Q-methodology to understand safety perception more in detail. The number of statements used in the Q-set could also be increased in upcoming studies to potentially reveal additional shared viewpoints and to get a more nuanced understanding of how safety is perceived by elderly residents. Results of such studies could be used to better inform municipal policy and can help to align the quantifications of objective safety and safety perception. Next to conducting research in Amsterdam, future studies could focus on other walking contexts to see what differences can be found in different places, and for example across countries.

A relevant approach for upcoming studies could also be to include a (digital) walk-along interview to get more information on places where participants feel safe or less safe when walking. Walk-along interviews can reveal additional information as they combine the observations of participants with interview questions (Mou et al., 2024), and previous research established benefits of this type of interviews, such as gaining nonverbalized information about participants' interactions with their surroundings (Hand et al., 2018).

This study highlights the importance of the behavior of other traffic users and reveals a strong negative influence of cyclists and micromobility users on safety perception. Whereas the influence of cyclist behavior on safety perceptions of pedestrians has been widely studied, fewer studies have focused on the influence of micromobility users. Further examination of the behavior of these traffic users is needed to better understand how this influences safety perceptions of residents while walking. Even fewer studies have focused specifically on how micromobility users influence the safety perception and walking experiences of elderly residents, so this would be a relevant topic for future research as well. Studying the influence of micromobility users can help reveal the types of traffic users that cause most safety concerns and show the places where conflicts between pedestrians and micromobility users take place.

Future investigations could also focus on how to best align quantifications of objective safety with those of safety perception and this could be focused on the city of Amsterdam. The municipality measures objective safety by collecting information regarding different indicators, such as crime rates and the number of traffic incidents. This study showed that measurements of safety perception by the municipality do not provide detailed information on how different determinants are of influence. Future studies could further build upon the findings of this study and look into ways in which measurements of objective safety and safety perception can be combined to get a more comprehensive understanding of the safety of elderly in the city.

In this research, the safety perceptions of elderly residents walking in Amsterdam were explored for a brief period of time. As previously discussed, the viewpoints found are not fixed to participants as perceptions might change over time and can be different in other contexts. It would therefore be relevant to study safety perceptions of elderly residents for a longer period of time to see what changes might occur. It would be interesting to use Q-methodology to do this, as only few studies have used this method to examine changes over time in viewpoints of participants because there are few guidelines on how to analyze Q-sorts completed by the same participants at different times (Akhtar-Danesh et al., 2023; Morea, 2022). Longitudinal studies that combine Q-sorts over time could help to reveal any changes in importance that is assigned to specific determinants and could help measure the impact of municipal policy and approaches in relation to walking among elderly.

### 5.4 Recommendations for policy makers

Based on the findings of this study, a couple of recommendations were formulated that can help policy makers to enhance positive safety perceptions among elderly and encourage walking among this group. These recommendations can be found below.

**Improving the sidewalks in poorest condition should be prioritized**

Participants expressed concerns about the current state of sidewalks and how maintenance work is done, and mentioned that uneven sidewalks negatively influence their safety perception while walking. Coming across poor sidewalks makes walking a more challenging and fearful experience and this can even become a deterrent to walking. Improving the sidewalk condition and keeping sidewalks well-maintained should thus be prioritized for elderly to feel safe and comfortable when walking. It should be kept in mind that while the state of sidewalks needs to be improved, municipal budgets for maintenance are limited, which means that this can only take place when it is really necessary. The way forward could be to prioritize improving the sidewalks that are in poorest condition and that are located in neighborhoods with many elderly residents. This could be done by creating a list of sidewalks that are in poor condition and that pose the biggest threats to the safety of elderly. It is important to include elderly residents in this process to identify sidewalks that most strongly affect their safety perceptions and to ensure sidewalks meet their needs after being improved. Importance should also be given to maintenance work, so sidewalks do not need to be improved again on the short term and to ensure a safe walking environment for elderly. Residents also reported to not always feel safe when walking during nighttime, because of the combination of deficiencies in public lighting and the poor condition of sidewalks. Public lighting should therefore also be regularly checked to see if there are any deficiencies that need to be fixed.

**Prevent sidewalk pavements from getting slippery and extend fall prevention courses**

Participants mentioned to feel afraid of falling onto the sidewalk or street due to sidewalks being slippery and in poor condition. Pavements can get slippery because of a variety of weather conditions, mud or leaves and this can cause pedestrians to take a fall. Falling can result in severe health and mobility issues and can even pose a bigger threat to residents that are already experiencing mobility issues. It is therefore important that extra attention is paid to both the slipperiness of the pavement and raising awareness among elderly of the risks of falling. Especially during wintertime and extreme weather conditions, the pavement should be regularly checked to see if precautions should be taken to prevent sidewalks and streets from getting slippery. Some sidewalks and streets might be more prone to getting slippery during icy or snowy weather, other sidewalks might be placed alongside a line of trees where fallen leaves might create a falling hazard. Investigating which sidewalks are more likely to get slippery might help to reduce the safety concerns that are experienced. Another good option would be to study the main walking routes of elderly residents and to discuss the places in which they feel most afraid of falling.

Since 2022, the municipality has been organizing fall prevention courses for elderly residents to raise more awareness of the risks of falling. These prevention courses have proven to be successful and have resulted in a considerable decrease in falling incidents among elderly. Two participants of this study mentioned taking part in a fall prevention course to learn about the risks of falling, although it is not known whether other participants were aware of these courses. The fall prevention courses should be further extended to reach an even bigger group of elderly residents and extra attention should be paid to make sure these courses are well-communicated towards elderly.

**Barriers on sidewalks should be minimized to create more room for walking**
Barriers on sidewalks, such as parked cars, bicycles and trash bags limit the room for walking for pedestrians. They can even force pedestrians to walk on the street, which results in an increase in safety concerns. Participants found sidewalks in their city districts to be of an adequate width, but obstacles placed on them decreases this width. The width of sidewalks should be maximized where possible and the municipality has set out guidelines for sidewalks in new and redesigned environments and in existing environments. At the same time, it should be prevented that obstacles decrease the actual walkable width. The municipality aims to free up more space on sidewalks by finding alternative parking locations for bicycles and cars and this search might be most needed in areas where sidewalks are relatively small, such as Grachtengordel-West. Participants also mentioned coming across different forms of micromobility that were parked on sidewalks and this requires clear policy and active enforcement to prevent these traffic users from blocking the walking route. In places where elderly residents raise safety concerns due to trash bags, placement of trash containers should be considered or placing trash bags on the street should only be allowed on certain days of the week.

**Extra attention should be paid to the behavior of cyclists and micromobility users**
An important finding is that the behavior of cyclists and micromobility users negatively influences the safety perception of participants. The municipality also expressed concerns about the behavior of these traffic users, and particularly about fatbike users, since these are often very young and not familiar with traffic regulations. Since the room for walking on sidewalks is limited, cyclists and micromobility users should be discouraged to make use of and park on sidewalks. Clear policy and regulations are needed to enhance safety feelings among pedestrians, this is however challenging since there is no clear policy on micromobility use on a national level. Policies that have been implemented by other cities and regions can be used as an example for managing cycling and micromobility and could provide useful information on different approaches that can be taken. The city of Vienna, Austria could be used as such an example since its local authorities formulated regulations for micromobility use on a local scale. Local authorities decided that micromobility users had to comply with the same rules as cyclists, enforcing them to stick to the traffic rules and speed limits, and prohibiting riding on sidewalks (POLIS, 2023). More recently, additional regulations were formulated which restrict areas where micromobility forms can be used and parked, and which prohibit parking on sidewalks. Policies that have been implemented in other cities can help to formulate approaches on how to manage cyclist and micromobility use in the city.

# 6. Conclusion

The ability to move around allows elderly residents to connect with community members, access resources in their neighborhood and helps maintain good physical and mental health. While walking, elderly collect sensory information from the environment and together with their thoughts, beliefs and opinions, this influences how safe they perceive their surroundings to be. Barriers to walking, however, can negatively influence safety perceptions of elderly and can eventually affect their willingness of walking in the city.

This study focused on exploring the diversity in individual safety perceptions of elderly residents in Amsterdam and its influence on walking in the city. It sought to find an answer to the following main research question: *"To what extent do individual safety perceptions of elderly residents in Amsterdam influence their walking in the city?"* By combining a policy document analysis, semi-structured interviews, and Q-methodology, municipal policy in relation to walking among elderly were explored and safety perceptions of elderly participants in the city districts of Grachtengordel-West, Dapperbuurt and Jordaan were examined. This study showed that the safety perceptions of elderly residents are influenced by multiple determinants, such as the sidewalk condition, behavior of traffic users and reduced mobility, and revealed challenges mentioned by the municipality, including limited maintenance budgets, limited space for redesign and a lack of clear policy and regulations on micromobility use.

Findings of this study show that the sidewalk condition, room for walking and behavior of other traffic users are the most important determinants for safety perception. Traffic speed, fear of falling due to a slippery pavement and public lighting were also found as important aspects. Next to this, two shared perspectives on safety perception were found, with one account emphasizing the importance of the behavior of other traffic users and the other highlighting good sidewalks that are not slippery.

This study also showed that participants assigned more importance to most built environment determinants than to social and individual determinants. Determinants such as the sidewalk condition and sidewalk width, public lighting and traffic speed were given more importance than fear of crime or theft, open shops, and familiarity with the place. Most participants also mentioned that their past experiences with crime and theft-related incidents do not affect their safety perception.

This research found that participants generally feel safe while walking but do keep potential safety hazards in mind, such as crime and theft related incidents. They did not think there are specific places in their city districts that strongly or negatively influence their perceptions nor did they avoid walking in certain places. Some preferred walking in certain streets over others and most said to not walk late at night. Findings of this study show that safety perceptions of elderly participants can lead to them changing their walking route, but that their current perceptions do not stop them from walking. It is important, however, to use caution when interpreting the results since no conclusions can be formulated on the extent to which these results are representative for a larger population.

Most safety concerns expressed by interviewed residents were also mentioned in municipal policy, including concerns about the current state of sidewalks, room for walking and behavior of cyclists and micromobility users. In recent years, municipal policy and approaches focused on limiting speed of vehicles and fall prevention have proven successful in enhancing safe walking among elderly. Limited maintenance budgets, limited space for redesign and a lack of

clear policy on micromobility use, however, currently form the greatest barriers to further enhance positive safety perceptions.

The way forward for policy makers could be to prioritize improving and maintaining sidewalks that are in poorest condition and in areas with many elderly residents, extend fall prevention courses to other areas in the city and minimize the obstacles that are placed on sidewalks to create more room for walking. Next to this, extra attention should be paid to keep pavements from getting slippery and clear policy and regulations are needed for micromobility use in the city.

This study set out to explore the individual safety perceptions of elderly residents in Amsterdam and gave more insight into their walking experiences. It showed multiple approaches that can be used to understand safety perceptions in more detail and revealed more information about safety concerns of elderly. A comprehensive understanding of safety perceptions is crucial for supporting walking among elderly and future studies could build upon these findings by using a larger and more representative sample, including a (digital) walk-along interview and by investigating changes in safety perceptions over time.

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# Appendix A

This interview guide was used to provide structure to the interviews that were conducted as part of this research. Next to asking participants questions that were formulated in this guide, unplanned follow-up questions were asked if considered to be relevant. Below, the interview guide can be found both in English and Dutch.

**English version**

***Introduction***

- Introduction and explaining research
- Explanation about consent, privacy, data management and asking permission to record
- Participants must sign Informed Consent Forms before starting the interview

***Beginning of interview***

- How would you describe this city district?
- How do you experience walking in this city district?
    - Could you explain a bit more about your experience?
- When/at what moments do you go for a walk?
    - When you are going for a walk, where are you going?
    - If participants do not go for a walk, why is this the case?

***Safety perception while walking***

- Do you feel safe while walking in this district? Why (not)?
- In which places do you (not) feel safe? Why (not)?
    - In what way do these places affect your walking in the city district?
- Are there places that you avoid when walking because you do not feel safe?
- Are you experiencing any difficulties with mobility? Does this affect your feelings of safety while walking?
- Did you have any previous experiences in which you did not feel safe or something happened (an accident/incident)?
    - If yes, how does this affect your walking in the city district?

**Q-Method**

- Present different physical cards with statements regarding built-environment, social and individual determinants (16 statements in total)
    - Are there any pictures / cards that stand out to you? Why is this the case?
    - Is there anything missing that is relevant to you in order to feel safe?
- Ask interviewee to rank order the different pictures / cards
    - Ask interviewee to further elaborate on their distribution of statements (especially on the statements they placed in the outermost columns)

***Other questions***

- Is there anything you do / measures you take that make you feel safer while walking?
- What would you need to feel safer while walking in this city district?

- Personal details of interviewee (age, gender, how many years have they been a resident?)

***Closing out***

- Time for questions or suggestions from the interviewee
- Thanking the interviewee for their time and participation

**Dutch version**

***Introductie***

- Introductie en uitleg onderzoek
- Uitleg over toestemming, privacy, data management en toestemming vragen voor opnemen audio
- Toestemmingsformulieren moeten zijn ondertekend voor de start van het interview

***Begin interview***

- Hoe zou u deze wijk beschrijven?
- Hoe ervaart u het lopen in deze wijk?
    - Kunt u verder toelichten hoe u lopen in de wijk ervaart?
- Wanneer loopt u in de wijk? Op welke momenten loopt u in de wijk?
    - Als u gaat lopen, waar loopt u dan heen? Waar gaat u naartoe?
      Vragen naar de reden voor het lopen (boodschappen doen, etc)
    - Als ze niet lopen in de wijk, waarom is dit het geval?

***Veiligheidsbeleving tijdens het lopen***

- Voelt u zich veilig tijdens het lopen in de wijk? Waarom (niet)?
- Op welke plekken voelt u zich (niet) veilig? Waarom (niet)?
    - Op welke manier beïnvloeden deze plekken uw lopen in de wijk?
      *Gebruik van foto's van de wijk / Google Maps voor deze plekken*
- Zijn er bepaalde plekken die u vermijdt tijdens het lopen omdat u zich niet veilig voelt?
- Heeft u ergens last van bij het lopen? Ervaart u moeilijkheden/problemen tijdens het lopen?
    - Op welke manier beïnvloedt dit uw gevoel van veiligheid tijdens het lopen?
- Heeft u eerdere ervaringen gehad waarin u zich niet veilig voelde of waarin er iets is gebeurd (een ongeluk of incident)?
    - Zo ja, op welke manier beïnvloedt dit uw lopen in de wijk?

**Q-Method**

- Presenteer de verschillende statement kaartjes met ruimtelijke en sociale factoren (16 statements in totaal) en uitleg van de Q-sort opdracht.
    - Zijn er bepaalde kaartjes die er voor u uitspringen? Waarom is dit zo?
    - Mist u iets binnen deze groep van kaartjes dat u voor uw veiligheidsbeleving belangrijk vindt?

- Vraag de deelnemer om de kaartjes te ordenen / ranken.
    - Vraag de deelnemer om de ordening/ranking verder toe te lichten (vooral bij de statements die ze in de buitenste kolommen hebben geplaatst en dus het minst/meest belangrijk vinden).
- Neem een foto van de Q-sort opdracht.

***Andere vragen en persoonlijke informatie***

- Is er iets wat u doet / maatregelen die u neemt om u veilig te laten voelen tijdens het lopen?
- Wat heeft u nodig om u veiliger te voelen tijdens het lopen?
- Wat zou ervoor zorgen dat u vaker gaat lopen in de wijk?
- Persoonlijke informatie (leeftijd, geslacht, hoeveel jaar ze wonen in de wijk).

***Afsluiting***

- Tijd voor vragen/suggesties van de deelnemer
- De deelnemer bedanken voor zijn/haar tijd en deelname

# Appendix B

**Conducting Q-methodology**

Below, the physical cards where the propositions were printed on can be found.


*Figure B1: Physical cards used during the Q-sort*

**Analysis of Q-methodology**

The following table was created by KenQ and shows the eight factors that were initially extracted from the dataset through Principal Component Analysis (PCA):

*Table B1: The eight factors initially extracted through PCA*

| | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 |
|---|---|---|---|---|---|---|---|---|
| Eigenvalues | 5.9689 | 1.7884 | 1.5053 | 1.4175 | 1.0995 | 0.6738 | 0.5766 | 0.2986 |
| Explained Variance | 43 | 13 | 11 | 10 | 8 | 5 | 4 | 2 |
| Cumulative Explained Variance | 43 | 56 | 67 | 77 | 85 | 90 | 94 | 96 |

The following table with factor loadings was also given after PCA was performed and was used to decide how many Q-sorts loaded significantly on the extracted factors (marked in red).

*Table B2: Unrotated factor loadings of factors initially extracted*

| Particip. | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 |
|---|---|---|---|---|---|---|---|---|
| P1 | 0.3195 | -0.1986 | 0.593 | 0.3587 | -0.2127 | 0.2856 | 0.4894 | -0.0355 |
| P2 | 0.7901 | -0.4206 | -0.2104 | -0.0387 | -0.1885 | 0.1554 | 0.0306 | -0.0873 |
| P3 | -0.1267 | -0.4818 | -0.3249 | 0.076 | 0.6004 | 0.5091 | -0.079 | 0.0516 |
| P4 | 0.771 | -0.0777 | -0.2611 | -0.2313 | 0.1398 | -0.3047 | 0.2468 | 0.0138 |
| P5 | 0.7612 | -0.0521 | 0.1507 | -0.5322 | 0.0524 | 0.0582 | 0.0386 | 0.14 |
| P6 | 0.6601 | 0.3386 | 0.0983 | -0.0858 | 0.5246 | -0.0896 | 0.2454 | 0.1435 |
| P7 | 0.7007 | -0.0772 | -0.3528 | 0.5494 | -0.0428 | -0.0855 | 0.0402 | -0.1444 |
| P8 | 0.8903 | -0.0925 | -0.198 | 0.0463 | 0.1854 | -0.0969 | -0.01 | -0.1485 |
| P9 | 0.8001 | -0.3442 | 0.274 | 0.1289 | 0.0317 | -0.1487 | -0.2951 | -0.1105 |
| P10 | 0.7556 | -0.0603 | 0.4971 | 0.0274 | -0.0688 | 0.098 | -0.3053 | 0.1659 |
| P11 | 0.3874 | 0.4235 | -0.2294 | 0.7121 | -0.0287 | -0.0076 | -0.0724 | 0.2842 |
| P12 | 0.3729 | 0.6982 | 0.4011 | 0.0353 | 0.3151 | 0.1408 | -0.1236 | -0.2543 |
| P13 | 0.8404 | 0.0176 | -0.1458 | -0.2233 | -0.3779 | 0.1434 | -0.0669 | 0.1041 |
| P14 | 0.3562 | 0.6424 | -0.4274 | -0.2407 | -0.2753 | 0.3403 | 0.0163 | -0.0883 |

*Deciding on the number of factors*

Through factor rotation the number of factors that was used to explain the study variance was minimized. Before moving onto this step, a decision had to be made on the number of factors to keep for rotation. There is no set number of factors that is best for factor rotation. Previous studies established a couple of criteria that can be used as a guidance for this decision, although the number of factors should always depend on the study at hand and should be decided within its context.

Using the factors' EVs, the Kaiser-Guttman criterion was employed to determine the number of factors to use for factor rotation. Following this criterion, factors with EVs of less than 1.00 were not considered for further analysis. This is often considered as the minimum EV needed, since factors with lower EVs account for less study variance than a single Q-sort (Watts & Stenner, 2012). It is also widely accepted by the factor analytic community as a tool to use for making this decision. After applying this criterion, only five factors remained. These can be seen in Table B3.

*Table B3: Number of extracted factors after applying the Kaiser-Guttmann criterion*

| | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 |
|---|---|---|---|---|---|
| Eigenvalues | 5,9689 | 1,7884 | 1,5053 | 1,4175 | 1,0995 |
| Explained Variance | 43 | 13 | 11 | 10 | 8 |
| Cumulative Explained Variance | 43 | 56 | 67 | 77 | 85 |

The Kaiser-Guttman criterion can, however, result in an overly large number of factors (Wilson & Cooper, 2008). Therefore, some other criteria were used as well to decide on the number of factors to keep for rotation. A Scree Test was employed and involved the plotting of the factors' EVs on a line graph. The number of factors to extract was indicated by the point at which the line

changed slope. The line graph is shown in Figure B2 and shows a slope change after Factor 2, indicating that only two factors should be kept for rotation.

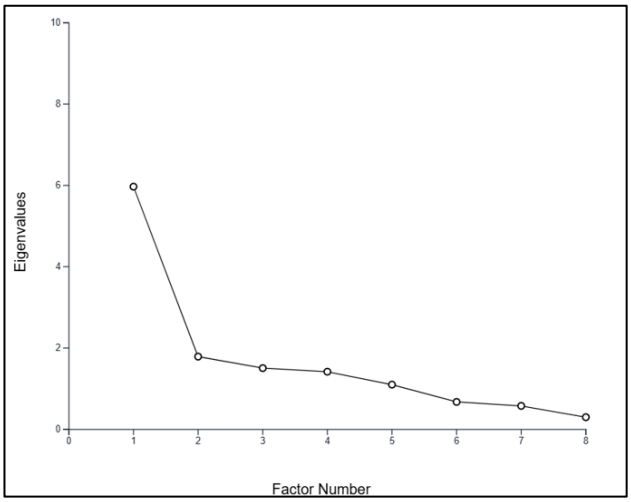


*Figure B2: Scree plot test*

Another method used was to accept only those factors that have two or more Q-sorts with significant loadings following extraction. Whether a Q-sort loading is significant at the $p<0.05$ level can be decided by using the following equation (Brown, 1980):

$$Significant\ factor\ loading = 1.96 * (1 : \sqrt{no.of\ items\ in\ Qset})$$

Following this equation, loading Q-sorts would only be significant if their factor loading score equals at least 0.49. The factor loadings are presented in Appendix B. If this criterion is used for the five factors that were presented in Table B3, all factors should be kept for further analysis since they have two or more significant loadings. Factor 1 has most significant factor loadings, with a total of nine. The four dimensions as described by Webler et al. (2009) were also considered to decide on how many factors to use for rotation.

*Table B4: Four dimensions to decide on the number of factors for rotation, adopted from: (Webler et al., 2009)*

| Dimension | Explanation |
|---|---|
| Simplicity | Fewer factors are better, since it makes the viewpoints easier to understand and interpret. However, this should not result in a loss of important or interesting information in differences in viewpoints. |
| Clarity | Each sorter should preferably only load highly on one factor. The number of people who load on multiple factors (confounders) or who do not load on any factor (non-loaders) should be minimized. |
| Distinctness | Low correlations between factors are better, since this means viewpoints are more distinguishing |
| Stability | Certain people tend to cluster together, even when using a different number of factors for your results. A good set of factors will preserve as many of these clusters as possible. |

The different dimensions mentioned above were also used as guidance, but they do not point to one objectively correct answer on how many factors to keep for further analysis. Watts & Stenner (2012) stress the importance of the researcher's knowledge and trying out different factors before any final decisions can be made. After careful consideration of the above-mentioned criteria and looking at the different factors that were extracted, it was decided to keep only two factors for rotation (F1 and F2).