Shared space and the perceived safety of older adults

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Abstract

Introduction There has been a rise in the application of shared space in the Netherlands. This resulted in an overall decrease in the number of accidents, but it paradoxically also received criticism for an increasing feeling of unsafety of elderly pedestrians. This research will explore the feelings of safety of older adults in these shared space situations, as there has only been little academic research into the effect of shared space on pedestrians, especially the vulnerable groups in society. The aim of the research was to figure out what the experiences of elderly people are in regard to shared spaces. **Method** The research was conducted in both urban and more rural environments. Ten walk along interviews up to saturation level were done as a qualitative method to gain more insight in the perspective of the participants. **Results** Three key themes came forward; Aesthetics, infrastructure and safety, and interaction with other road users. Elderly people indicated that generally, as more traffic was present in the shared space, the shared space was perceived as less safe. In some cases, elderly people even stated that they purposely avoided shared spaces on busy hours. **Conclusion** For the future, we must account for the presence of elderly people in shared spaces. Not all traffic situations are suitable for implementing shared space, as it would be too busy for vulnerable people to be in. This research added to the knowledge on the perceptions of elderly people on shared spaces. Future recommendations regarding the implementation of shared spaces are that vulnerable groups should be consulted to make sure shared spaces remain accessible to everyone.

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1. Introduction

1.1 Background

What is shared space?

Shared space is an overarching term for many different situations and implementations in traffic. There are some key characteristics that define what a shared space is. In essence, shared spaces regulate traffic by removing traditional road characteristics such as road signage, lines on the road and elevated sidewalks. Originally, a clear set of traffic laws would regulate traffic. In the new shared space situations, traffic would instead be left to a more natural and instinctive set of rules, determined by the interaction between the different road users (Hammond & Musselwhite, 2013).

The implementation of shared spaces meant a move away from separating different parts of the road for different road users and towards a space in which everyone partly uses the same traffic area. The shared spaces are no longer seen as a place to serve as a road for vehicles. Rather, the spaces were seen as a public domain in which pedestrians should be able to move more freely (Kaparias et al., 2015).

History of shared space

When we look at the shift towards the use of shared spaces in the Netherlands, it is important to acknowledge the increasing feeling of dissatisfaction with the streets and the public domain (Hamilton-Baillie, 2008). People felt increasingly unhappy and unsafe in the public domain. This is the result of motorised vehicles dominating the streets as there is an increasing amount of people that possess cars. As a result of this increasing presence of cars, the overall quality of life decreases as the environment, economy and general health suffer negative effects. Shared space is one of the responses in traffic planning for a solution to this public domain power struggle. The implementation of shared spaces meant a reclamation of the public space for pedestrians (Karndacharuk et al., 2014).

The idea for the usage of roads for more than traffic is based on the findings of the Buchanan Report. This is the first mention of so called 'environmental areas'. Instead of solely focussing on traffic, Buchanan saw roads as a possibility to create a positive environment for pedestrians. According to the Buchanan report, roads should not only provide infrastructure for travel through an area, but the street itself could become the destination and enable pedestrians to recreate in the road environment itself. (Besley, 2010; Karndacharuk, 2013b; 2014; MoT, 1963)

One of the earliest examples of shared space following the ideas of the Buchanan Report was the *woonerf* in the Netherlands. These areas, first introduced in the 1960s, tried to decrease the speed in residential areas and through this, improve the space for pedestrians and playing children (Hamilton-Baillie, 2008). The *woonerf* eventually became a part of the overall set of traffic regulations by the government in the Netherlands in 1976 (Karndacharuk et al., 2016).

The popularity of this shared space approach then decreased and the implementation of shared spaces went down between the 1980s and 2000s. Because the effectiveness of shared space in larger scale situations was not yet proven, people were reluctant to implement it in larger and busier roads. In this period, only small scale experiments were set up in Frisian villages. Then, shared space regained traction with the implementation in Drachten in the early 2000s. A busy intersection later called the *Laweiplein*, suffered from increasing busyness that led to traffic jams and many accidents. The junction was rebuilt and the shared space approach was chosen. This meant the removal of traditional road signage and direct traffic instructions. Instead, it was tested if traffic could improve if the regulation was decreased and traffic flows would be left to a more natural and instinctive set of rules. This was a success overall, as traffic flows did improve and the amount of accidents decreased (Hamilton-Baillie, 2008). Since then, the concept of shared space began to gain popularity throughout the northern Netherlands and eventually the EU. The EU has embraced the concept of shared space and started funding shared space projects ever since 2002 (Kenniscentrum Shared Space, 2013).

After the early day successes of shared space, the local stakeholders in traffic management in the northern Netherlands wanted to explore to what extent shared space could be implemented and what the overall effects would be. Therefore, '*Kenniscentrum Shared Space'* was founded to collect, process and distribute academic knowledge about shared space (Hamilton-Baillie, 2008; Kenniscentrum Shared Space, 2013).

The authorities in the northern Netherlands were enthusiastic about the outcome of the larger shared space implementations and saw this as a reason to keep implementing it. The main arguments in favour of the shared spaces were the decrease in traffic accidents, a better traffic flow and an improved and more accessible public space. Regarding the traffic rules, the success of the projects meant that there may not be a need to strictly regulate every part of the traffic network (Curl et al. 2015; Hamilton-Baillie, 2008).

Shared space nowadays

Kenniscentrum Shared Space was instructed with the research of shared space in the Netherlands. The major stakeholders here are the local governments who are advocates of using shared spaces. Throughout the last decade, much became clear about the implications of shared space and its positive consequences as traffic injuries and deaths decreased. However, there is still uncertainty surrounding the role of elderly people in shared space situations. Not much research has been done regarding older pedestrians, although there are indications that older people might experience shared space in a more negative way when compared to younger road users (Kenniscentrum Shared Space, 2013).

Population Ageing

As the amount of elderly people increases, we must account for this in the street image. It is imperative that the street infrastructure should stimulate elderly people to go outside and not exclude them from the public domain as mobility has a positive impact on their overall quality of life (Bernhoft & Carstensen, 2007). The population of the Netherlands is ageing and thus road infrastructure requires attention to keep enabling elderly to participate in social activities. Especially now that elderly people are expected to age in place, the local environment is of growing importance in preventing loneliness and support healthy ageing by promoting physical activity (van den Berg et al., 2015; Mulero et al., 2018)

Theoretically, elderly people should benefit from an increased access to an improved public domain, as it is beneficial for physical exercise and thus their health and social activity. However, the contrary has been found in previous research, that stated that elderly people actually experience shared spaces more negatively.

1.2 Research Questions

Objective

The objective of this research is to get more insight into the feelings of elderly people during physical activity in shared spaces. The opinions of vulnerable groups in the northern Netherlands are still relatively unknown. It is however important to research the impact of shared spaces on the elderly. The aim of this research is to gain more qualitative understanding of the perceptions of elderly people in shared space situations. These insights could eventually attempt to explain how elderly people perceive the shared spaces.

Research questions

The main research question of this research will be:

"How do elderly people perceive their level of physical activity and feelings of safety as a result of interaction with other road users in areas of shared space?"

This will be answered by figuring out the following sub questions;

- *How do elderly people perceive areas of shared space?*
- *What obstacles do elderly people experience regarding the physical state of the infrastructure of shared spaces?*
- *How do elderly people perceive their level of physical activity in shared spaces?*
- *How do elderly people perceive their feelings of safety in shared spaces?*
- *How do elderly people experience the interaction with other types of traffic in shared spaces?*

1.3 Structure of the paper

This paper will answer these research questions by first stating the theoretical framework this research uses, after which the methods, including data collection and data analysis will be described. Then the results will be stated and discussed in order to conclude with the comments regarding the research questions and recommendations for future implementation of shared spaces in the Netherlands.

2. Theoretical Framework

2.1 The position of elderly people in traffic

Elderly people experience a lesser mobility due to physical impairments related to ageing and have a greater chance on being involved in traffic accidents (Schwanen & Paez, 2010). Elderly people furthermore have a disadvantage in choices of transportation, as they might be unable to physically ride a bike or go by car. This results in a limited movement space in society (Broome et al., 2009). Because their outdoor living space is confined and elderly people are expected to age in place (Morency et al., 2011), feelings of loneliness may arise. These feelings of loneliness in older adults are linked to greater chance of depression. Loneliness has been shown to have a negative effect on both the mental and physical health of older adults (van den Berg et al., 2015; Luanaigh & Lawlor, 2008).

Mobility and health

Walking is a good manner of transport for elderly people as its safe compared to riding a bike or going by car. Even when accounted for the risk of falling, as other types of transport are more prone to accidents happening. The built environment is important in enabling elderly people to participate in outdoor activities. However, as a person gets older, they generally undertake less physical activities than before. This is something of a paradox as elderly people generally have more time due to not working. This is explained by exactly that movement to work that is falling away in everyday life. It is important to research what can drive elderly people to undertake more physical activities, as this improves health by reducing the chance of obesity, diabetes and high blood pressure (Moniruzzaman et al.,2015). Research of Shimada et al. (2010) shows that elderly people experience health benefits even when going outside of their homes around once a week.

Advantages of shared space for elderly people

It has already been shown that the implementation of shared space situations resulted in an overall decrease in traffic accidents. The efficiency of traffic has also been improved (Hamilton-Baillie, 2008). As the interaction between vehicles and pedestrians increases, the amount of incidents decrease.

In the research done by Curl et al. (2015) they tried to show the effect of changing a road to a shared space. This was researched by comparing the situation of people before and after the change. This has been done with quantitative research amongst people aged 65 and older. The outcome of this research was that the situation was improved. The street became more accessible to elderly people and they reported a higher level of activity.

Disadvantages of shared space for elderly people

However, research of Hamilton-Baillie (2008) says that vulnerable groups in society may experience shared spaces as being less safe. Elderly people feel discomfort in sharing the road with other types of transport. As age increases, the feelings of discomfort go up. Elderly people that use a wheelchair or pushchair feel even more discomfort (Kaparias et al., 2012). These feelings of unsafety are the result of elderly people being less able to walk quickly. It is also more difficult to estimate whether or not a gap between traffic can be crossed. Hammond & Musselwhite (2012) stated that the effectiveness of shared space is highly dependent on the feelings of the pedestrians. When they feel they are outnumbered by the motorised vehicles, the advantages of shared spaces become limited.

Research of Bernhoft & Carstensen (2007) showed that elderly pedestrians value elevated sidewalks and clear crossings more when compared to younger pedestrians. In shared space situations, these aspects are no longer there. It is yet to be researched what the implications of these factors are for the experience of shared space by the elderly.

Regarding the implementation of shared space in Drachten, Hans Monderman stated that after the renovations, the amount of accidents was heavily reduced. However, Quimby and Castle (2006) responded to this statement that the amount of accidents had always been low in that specific scenario. Also, the statement Monderman made would be premature as there had only been a limited amount of time passed and such statistics would need several more years to be able to compare.

Also, the situation in Drachten has been changed from an intersection to a roundabout. (Gerlach et al., 2008, in Moody & Melia, 2014)

2.2 Theoretical Framework

The theoretical framework that shared space can be placed in is the concept in traffic science of speed reduction. Within traffic science, many attempts have been made towards slowing down traffic ever since the introduction of motorised vehicles. The aim of this speed reduction was to improve the general safety. Historically, this would be done by specifying the traffic rules with road signage. How much road signage should be used is still debated. Road signs become less clear when there are too many. Too little road signs on the other hand makes the traffic situation complex. Also, the need for road signage differs between different drivers. Local people who know the area require less directions than newly visiting drivers. Despite using the road signs we know today for several decades, there is still little evidence as to what the specific effect is on road safety (Quimby & Castle, 2006).

The theoretical framework that shared space is based on can be divided into external and internal elements. The external elements are the environmental factors outside of the elderly persons control. The internal elements are the personal characteristics of the pedestrians (Kaparias et al., 2012).

External elements

The limited channel capacity theory of perception proposed by Broadbent (1958) states that people involved in traffic can only process a limited amount of information before the entirety gets cluttered. When too much information is presented in a traffic situation, road signs are disregarded since people deem them as irrelevant to the process they are involved in. In situations with an oversupply of traffic regulations, people tend to focus on the ones they perceive as most relevant (Broadbent, 1958 in Quimby & Castle, 2006). This theory describes the basis of why shared space was originally proposed. There was a surplus of traffic signs that were seemingly unnecessary. By decreasing the amount of impulses involved in traffic, people could focus more on the act of driving itself.

Another theory describing the influence of external factors is the arousal theory of attention. This theory describes the problem of drivers of motorised vehicles being distracted by the amount of signage and road markings. Especially in busy crossroads where other types of traffic are involved, the amount of cognitive impulses and level of arousal is increased. This in result leads to distraction from the key task of driving, clutter of the traffic rules and possibly the obstruction of important visual clues in traffic (Wallace, 2003 in Quimby & Castle, 2006). Both distraction from traffic and clutter in the traffic regulation are useful in the conceptual model for shared space appreciation.

Internal elements

In contrast to the previous theories, Hammond and Musselwhite (2013) propose that the actions of individuals highly influence the way shared space is experienced. Within the socio-cognitive psychological theory they describe how the decrease in traffic accidents may result from individual choices instead of the environmental changes. This theory states that the amount of traffic accidents decreases in the shared space situations because vulnerable groups in society purposely avoid them. As these groups generally have a higher chance of being involved in a traffic accident, the new situations statistically seem safer. However, the shared spaces could actually be more unsafe and only statistically appear as more safe (Hammond & Musselwhite, 2013).

A part of why shared space should work is based on risk homeostasis theory. This theory states that people constantly review the risk they run and weigh the situation around them. When a situation seems dangerous, people take steps to reduce the risk. This also works the other way, where people dare to take more risks in less dangerous situations. Shared space situations work because the situation is more unclear to drivers, making the situation unpredictable and more dangerous. As a result, people decide to reduce the risk by reducing their speed and look around more. Risk taking behaviour can be used in the conceptual model as it in part explains how elderly people manage their risk taking behaviour. However, this theory is lacking in fully explaining every risk and every reaction, as that is different for individual scenarios (Hammond & Musselwhite, 2013b). Shared space falls in the theory that traffic can be slowed down by changing the psychological setting of traffic.

Research by Dey and Terken (2017) has attempted to find out how the interaction between pedestrians and vehicles works. This pedestrian interaction theory explains that pedestrians walk faster when they pass by in front of a car, also in priority situations. Furthermore, this theory explains that pedestrians respond to the car as a whole and not to what the driver is doing. As soon as a car slows down, pedestrians see this as a sign of priority. Pedestrians are capable of estimating the path of vehicles when they are predictably driving and then just adjust their walking direction so that traffic continues to run smoothly. However, when we apply this to shared space situations, the interactions become more difficult to estimate. Because the situation has been intentionally made unclear, vehicles sometimes make unpredictable movements, which may make this interaction between pedestrians and vehicles more difficult. The concept used in this theory is that the predictability of traffic is a determining factor in pedestrians comfort in using the road. A research that is closely linked to the pedestrian interaction theory is the study by Reid et al. (2009). They quantitatively researched several shared space projects in the UK, after which the most optimal traffic characteristics were described in order for shared spaces to work. Their conclusion was that the recommended amount of cars in shared space areas should be no more than 100 cars per hour. Also, the average speed of the vehicular traffic should not exceed 20mph or 32km/h. These numbers have been contested by other shared space projects that were considered successful, whilst being used by more than 100 cars per hour (Kaparias et al., 2012). This research provides the closest idea to a guideline for whether or not shared spaces can be a success. Furthermore, this confirms the suggestion that the busyness is an important factor in elderly people's perception of shared spaces. Therefore, interaction with other road users is an important part in setting up the conceptual framework.

2.3 Conceptual model

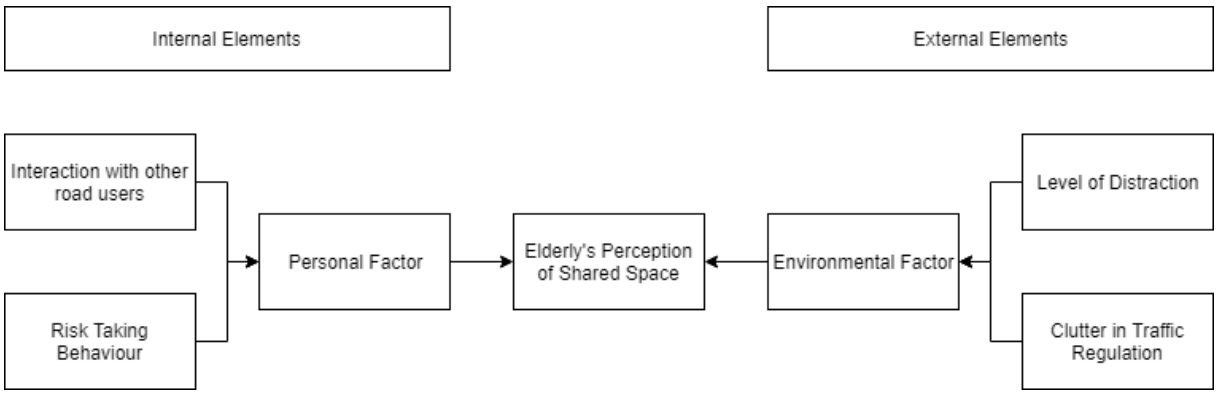

Figure 1: Conceptual model based on the theoretical framework.

3. Methods

3.1 Study design

In order to answer the research questions, a qualitative study design was chosen. Previous studies have already shown that shared spaces improve the safety by reducing the amount of accidents. This research is trying to get a better understanding of the perspective of elderly people in shared space traffic situations. In order to understand these perceptions of elderly pedestrians, we must first understand previous experiences and context from the perspective of the participants. Feelings, emotions and experiences are best described with qualitative research (Hennink et al., 2015).

The qualitative data collection method that is chosen was the semi-structured walk along interview. During the interviews, the researcher would walk alongside the elderly through shared space situations. By doing a walk along interview it would become easier for elderly people to describe feelings and emotions as they come. Any obstacles in the physical infrastructure elderly people could experience would also be better described while going through or near them.

3.2 Participant selection

Participants for these walk along interviews were originally recruited by contacting nursing homes that provide mostly residential care for elderly people near shared spaces. However, this plan did not work out as the care facilities would be too far from the shared spaces for the elderly people to walk there. Therefore these elderly people would have no experience walking there. Another problem was that some care facilities turned out to be for specialist care for elderly people with limited mobility or other health problems. These elderly people would rarely walk outside which meant another approach had to be chosen. Recruiting participants was eventually done by waiting in the shared space areas and approaching elderly people that would pass by. This would work quite well, as elderly people generally didn't mind being accompanied for an interview. However, there was the problem that there were long intervals before elderly people would pass through.

Inclusion criteria for the participants were that the age of the participants should be 75 years or older and were still able to independently walk outside, with or without the aid of a walker. This choice was made because most elderly people aged 65-75 have only minor mobility impediments. The older the person gets, generally, the more they experience difficulties in walking. For this research it is important to take that vulnerable group into account. By choosing people aged 75 and older, it was more likely that participants experienced shared space differently. The interviews happened both with and without the presence of other elderly people.

Exclusion criteria would be if elderly people rarely went through the shared spaces and were incidentally there at that time. Tourists for example did not have enough experience to share their perceptions about the shared spaces. Their response would generally be neutral and have no use for answering the research questions.

3.3 Data collection

An aspect to take into account whilst doing the interviews is the weather. Walk along interviews are only possible when the weather is not too bad. Weather conditions such as rain or hard wind put the participant in an unnecessary risk. The time of the interview is also essential in order to understand the influence of shared spaces on the elderly. Traffic varies a lot depending on the time of day. It is necessary to take this into account when planning the walk along interviews in order to avoid situations that are too busy or quiet. Another logistic side of walk along interviews as compared to sitting down interviews is that preparations must be taken to be able to make notes, record the audio and conduct the interview at the same time (Carpiano, 2009; Clifford et al., 2010).

The interview guide, as seen in the appendix, was made by first of all deducing key topics in shared space perceptions from the conceptual framework. After these themes were determined, questions were set up per topic in order to be able to answer the related research questions. At first, the plan was to

solely do interviews in Groningen, so some questions originally were focussed on the Groningen specific situation. These were later changed to be able to apply to every separate situation. The interview guide was designed for a semi-structured interview as being in the shared space situation would lead to further questions and leave space for the participant to further elaborate on the specific scenario or aspects they would feel are important.

Eventually, ten walk along interviews were done in shared space sites in Drachten, Damwoude, Hardegarijp, Leeuwarden and Groningen. It was also useful to interview at different sites, as this would bring different insights as traffic situations would be different.

3.4 Ethical considerations

It is important to take the implications of walk along interviews into account. First of all it is important to always ensure the safety of elderly people during the walk along interviews. It is very well possible that the participants experience mobility issues and experience difficulty walking. It is important here that the elderly person decides whether or not something is possible and not to force excessively long walks. The physical condition of the participant must be looked after and should not be placed in potentially dangerous situations.

The participants were first of all be read an informed consent form, in which was stated that the interview was fully anonymous, what the purpose of the research was, that the elderly people did not have to answer questions if they did not want to and that the interview could be stopped at any point in time. As most interviews were held on the street, the informed consent was verbally explained to the participants.

Any personal information was anonymised in the transcripts of the interviews, as street names and could give away the participants general living address.

Regarding the minimization of harm, it would be asked during the interviews whether or not the elderly people were tired or needed to take a rest by sitting somewhere. Furthermore, by avoiding dangerous weather situations, no unnecessary risks were taken (Hennink et al., 2015).

3.5 Data analysis

The data was analysed by making transcriptions of the full interviews and consequently coding them. A part of the codes were deductively set up by using the theoretical framework and other codes resulted inductively as themes coming forward during the coding procedure of the interviews. After categorizing the codes, links were made between codes in order to be able to eventually get an answer for the different research questions.

4. Results

4.1 Participant characteristics

In total, ten interviews were held in the five locations. The ages of the participants ranged from 75 to 87 years old. There were five male and five female participants. Out of the ten participants, four had to use a walker due to medical reasons resulting from varying previous injuries. One participant used a walking cane.

4.2 Three themes

After ten interviews, saturation was reached surrounding the elderly perceptions of shared space. As a result of the analysis of the transcripts from the interviews done during this research, three themes were identified. These themes are aesthetics, infrastructure and safety, and interaction with other road users. These themes will first of all be discussed separately, presenting the main findings on the elderly's opinion within the theme.

Furthermore, situation specific characteristics of shared space are explained. The shared spaces the interviews took place in during this research have the same characteristics that belong to shared spaces. However, there are certain aspects that are specific to the situation and deserve to be explained by itself. This will be done by describing every situation separately and highlighting the experiences of the elderly people that solely apply to that situation.

1. Aesthetics

In all cases, the elderly people stated in the interviews that they preferred the look of the new situation when compared to the previous one or other surrounding, traditional road types. Often, there was a lot more focus on the presence of trees and other green areas in the adapted shared space situation. Another positive aspect the elderly named was the presence of benches and other places you could sit on. The situation was no longer strictly a traffic situation, but could now also be used as a place for recreation.

When asked about the new situation around the station in Leeuwarden, one participant stated:

"Imagine you are a tourist and you arrive by train and you get off at the station, it looks nice."

Another participant agreed and said:

"Yes, this looks nice, but so do those benches there. That is also, and this right here, that edge. A very nice space. But also, you can sit here for a moment, you can sit there for a moment."

2. Infrastructure and feelings of safety

The alterations that have been made to the infrastructure were also experienced mostly positively by the interviewed elderly people. The organization of the street environment actually helped the elderly in their movement across shared spaces. Most of the interviewed elderly people were walking with tools to aid them such as walkers or walking canes, as they are no longer able to fully independently walk. For most elderly people, this was the result of previous health problems. These people stated that the biggest problem while walking was getting up and down the elevated sidewalks. Sometimes ramps would be lacking and they had to push the walker up the sidewalk, which results in an increased risk and more instability. This was no longer a problem in the shared space situation, as all terrain is now on the same elevation level. A participant that uses the aid of a walker stated:

"I like it here, I think the pavement is pretty reasonable. Because I happened to have been away for a week to Enkhuizen, but then it's really paving from the Middle Ages. And especially if you walk with such a thing."

Although most of the traffic signs were removed in the new situations, the elderly people still generally found the traffic rules to be clear enough. Therefore, the elderly people did not feel more unsafe in the shared space situation due to unclarity. Most of the problems related to moving through a shared space

were also simply solved by having patience. One of the outcomes of the interviews was that elderly people were no longer worrying about traffic situations. They said during the interviews that they now had a lot of time and never had to rush anywhere to make certain appointments. Instead, walking outside is now something that the elderly enjoy more and is recreational instead of purely functional. The elderly people seemed to appreciate it more, as mobility was not taken for granted. The participants mentioned the advantages of walking for their general health, and tried to keep walking as much as possible. In the new situation, the elderly people on average had to wait longer before they could cross the street, but they did not see this as problematic, as patience and clear communication about where they were heading would keep the traffic from being too chaotic. One participant explained this as following:

"You just have to be clear in what you do. And look, a car that turns right also has to blink. If I go somewhere I have to indicate it, I do this or that."

There were however situations in which the elderly people felt more unsafe. Situations that were brought up the most were parts of the road where pedestrians had to share the road with cyclists. The elderly people stated that the cyclists would ride with three people next to each other, which left little room for the elderly to walk in. As a participant stated:

"Yes, sometimes I see them coming with three people side by side. Then I sometimes have to yell: hey, I'm here too!".

The difference in speed would sometimes be intimidating to the elderly and lead to increased feelings of unsafety. A development that increases the speed differences even more is the upcoming presence of the electrical bicycle. The participants found that especially older people on these electrical bikes were sometimes unable to fully control it. One participant thought that the government should give these people courses to learn how to handle the increased speeds, as he stated the following:

"Yes I think, they have to give courses for that. Because especially old people on an electric bicycle, they don't know how to stop. Because they have one setting, extremely hard."

3. Interaction with other road users

As stated prior, most of the negative interactions elderly people experienced were with cyclists. On the other hand, cars were found to be less unsafe. This was mainly due to the clear presence of the cars. The behaviour of the cars could often be predicted well, as they were less likely to make unexpected movements. However, this was the case with cyclists. Due to the manoeuvrability of cyclists, they can move around more freely in traffic situations, making it more difficult for the elderly to oversee the situation. The elderly people were also aware of the difficult situations the cars could be in. As a participant stated this on the situation near the train station in Leeuwarden.

"But imagine, in the morning when the trains arrive, than you can't move anywhere. That is pure irritation. Because let's admit, most drivers just don't have a lot of patience. But the stream of pedestrians that comes through here is infinite. That goes on all morning."

In addition, there is still hardly any overlap in shared spaces between the places where the elderly walk and where the cars drive. The situations of interaction therefore mainly stemmed from crossing the road. The designated pedestrian crossing that were still available in or near the shared spaces were therefore appreciated by the elderly people, as one participant described:

"But you see, this is essential. Those pedestrian crossings. And those bicycle crossings too."

On the other hand, the shared spaces are often arranged so that pedestrians and cyclists use the same part of the road. The clearest example of this was a situation in which a large stretch of the main road was lacking a separate sidewalk. The elderly people had to walk in a designated area for both pedestrians and cyclists. The cyclists could also come from both sides, which led to increased discomfort while walking.

In general, the shared space situations were not experienced as very negative during the interviews. This was partly due to the time frame in which the interviews were done. These were held at quieter moments during the day, in order to avoid unnecessarily busy and dangerous situations with the elderly. In the interviews, the elderly did indicate that they specifically avoid these busy moments. One participant indicated that she had to go to a different store at the weekends than the one in the shopping mall, because it is not possible for her to be in shared space. There would be too much traffic for her to move there safely:

"Yes always on Friday yes. Because Saturday is very busy in the mall.

4.3 Situation specific outcomes

Damwoude

Regarding the situation in Damwoude, the elderly people interviewed were the most negative when compared to the other situations. What mainly emerged here is that the shared space situation is in the busiest road in the village. This main road still has a high traffic capacity, which means that many motorized vehicles pass through it at busy times. This caused chaotic situations at the crossing points, according to the elderly. Due to the lack of traffic rules, cars here hardly knew what to do. Chaotic situations arose in particular at the intersection closest to the shopping centre. An older person described that the intersection is reminiscent of a roundabout, but it actually legally doesn't count as one. The older person often saw that cars crossed the intersection both to the left and to the right of the pole. When there was a lot of traffic, there were traffic jams in the middle of the intersection. A participant that happened to know the other situation in Damwoude stated:

"What strikes me most is the pedestrian crossing and that crosswalk. That is clearly different here than in Damwoude. People hardly dare to cross the square because you just have to cross a very large stretch. And if you have difficulty walking, or you are a little unsure on the bike .."

Drachten

The situation investigated in Drachten is the intersection between the Torenstraat and the Drift. This is a partial shared space situation as there are pedestrian crossings on the road that lead to and from the shopping area. The situation is in a busy shopping street with occasional traffic. This situation was received mostly positively, although there were some critical notes. For the most part, the elderly were pretty accustomed to the shared space situation as Drachten was one of the early towns to implement it in the street image. The specific situation that was researched was characterized by major differences in the busyness of the road. At certain times, the road would be empty while other times, traffic jams would occur as trucks had to move into the shopping area. The presence of the pedestrian crossings was notable as in the busy situations, pedestrians and cyclists would go around just to use the crossing.

One participant described the busyness of the intersection as follows:

"As you can see here. Sometimes it goes on in rapid succession. And only once in a while they have to stop driving."

Hardegarijp/Leeuwarden

The shared space situation in Hardegarijp was described positively by the elderly. In comparison with other situations in the north of the Netherlands, there were hardly any negative points mentioned. The main positive point that emerged here is that it was a huge improvement for the elderly compared to the previous situation. Before the shared space, a busy road ran through Hardegarijp that led a lot of traffic through the village. With the arrival of the Centrale As in Friesland, Hardegarijp also got a relief from the traffic pressure, since the majority of motorized traffic could now be guided along the Centrale As alongside the village. In the current situation, the elderly indicated that they hardly saw any cars in the shared space sections.

After the interviews in Hardegarijp the interview moved to Leeuwarden with the elderly to view the renewed station area. The contrast between the two areas was large. Where Hardegarijp was characterized by the tranquillity that was created with the diversion of the cars, Leeuwarden was another, busier experience. The elderly people stated that there was a lot of unclarity about the traffic rules in the situation. As it was a station area, many people were waiting to pick people up from the arriving trains. However, as there were no designated parking areas, people would just park anywhere they could. Also, as the lines on the road were removed, car drivers would turn around in the middle of the road if they saw the possibility. The elderly people described the situation as chaotic and unclear. Crossing the street was experienced as unsafe, unless they went across the designated pedestrian crossing.

One participant described the interaction between the busses and cyclists;
"It is every once in a while that there is almost someone hit by a bus there at the station. That the buses, because they also have to pass by and they have to go there in the direction of the bus station. But that crosses with the cyclists. Of course thousands of cyclists pass by. So those bus drivers do not know in advance where to look."

Groningen

The situation in Groningen was characterized by a very specific problem within the third theme of interaction with other road users which was much less prevalent in the other situations; the interaction with cyclists. During the observation it became clear that the shared space situation resulted in much less motorized traffic than before. However, it appears that this is not sufficient to make the situation clear and safe for pedestrians. The enormous flow of cyclists and the lack of crossing places caused unclear situations for the elderly. The shared space situation in the Brugstraat is the largest shared space area in terms of area and traffic for this study. From the interviews with the elderly it became clear that the largest obstacle was crossing the street at busy moments. There would be such a great flow of students on bicycles that there was no opportunity to cross in the gaps. The elderly people were unable to quickly move through the situation and because of the lack of designated crossings, they often had to wait long times.

Regarding the interaction with the cyclists one participant mentioned:

"Nowadays they have the stewards that move the bikes, but in the beginning they were all over the place. There was no sense of direction and everyone went everywhere. There were a lot of near accidents in the first month."

5. Discussion

This research sought out to find an answer to the research question;

"How do elderly people perceive their level of physical activity and feelings of safety as a result of interaction with other road users in areas of shared space?"

The answer to this question is multi-faceted. First of all, elderly people appreciate the physical activity in shared spaces. The overall aesthetics are improved and the accessibility is better due to the lack of elevation differences. However, the elderly people can experience an increased feeling of unsafety in shared space situations. This is the result of some shared spaces still being dominated by other types of transport, both motorised vehicles as well as cyclists. In response to the limited channel capacity theory by Broadbent (1958) and the arousal theory of attention, we can state that the amount of clutter in traffic regulations indeed went down. There might not be a need for the amount of road signage in the traditional street image. However, there are certain elements that the elderly people were missing, such as the lines on the road or the presence of pedestrian crossings. Removal of these elements actually increased the uncertainty in the traffic situation.

Regarding the risk homeostasis theory, the outcome of the research indicated that there were no clear indications that elderly people changed their risk taking behaviour. However, when compared to the research by Dey and Terken (2017) there are indeed similarities. The pedestrian interaction theory applies strongly as the interaction between pedestrians, cyclists and car drivers determined how the traffic situation was perceived, both positively and negatively.

These findings are an important part in understanding the perceptions of a group of vulnerable road users, the elderly. The findings can be used to critically look at future shared space designs and account for an increasing presence of elderly people.

The most important and most frequently mentioned interaction was with cyclists. The elderly generally had fewer problems with the presence of the cars, as they were paying enough attention. The elderly could often get eye contact with the car drivers, so it was clear which movements both parties would make. The elderly did indicate that they sometimes needed patience to cross the road, since there were fewer or even no pedestrian crossings.

5.1 A new model

In response to the previously stated theoretical framework, we can state that regarding the effectiveness of shared space, it is mostly dependant on internal elements. Human interaction seemed to lead to the biggest changes in traffic behaviour. The environmental determinism perspective is not complete as it lacks explanatory power in shared space behaviour. Furthermore, the environmental changes made in the shared space areas positively increased the participants perception of the environment.

The level and type of interaction between different road users appeared to result from two traffic characteristics, the type of traffic and the busyness. First of all, the experiences of interaction with motorised vehicles were different from interactions with predominantly bicycle traffic. Secondly, in response to the research by Reid et al. (2009), there is indeed a maximum traffic capacity for shared space to effectively work. In high volume traffic, the elderly people felt they were in a disadvantage in using the road. When other types of traffic outnumbered the pedestrians, the effectiveness of shared space decreased.

The elderly participants did feel generally safe walking through the shared spaces. The indications from the existing literature that elderly people might feel more unsafe are therefore not applicable here. The new shared space situations instead led to an increased feeling of safety when compared to the previous situation, as the participants stated that they largely preferred the new situation more.

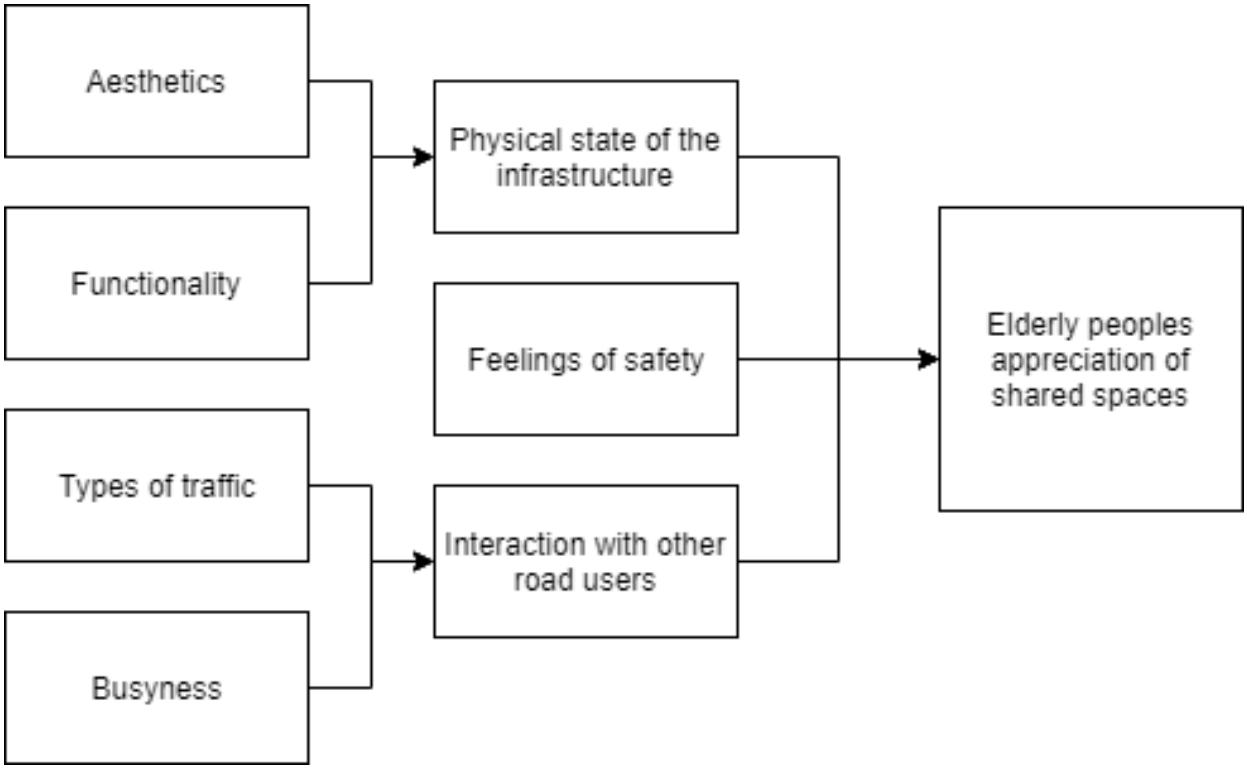

Figure 2: Conceptual model based on the key themes that came forward in the existing literature and later adapted to the outcome of the data analysis of the interviews.

5.2 Strengths and limitations

A problem encountered in this study is the selection bias. I had expected in advance that care homes in the neighbourhood of shared spaces would be willing to cooperate with the research. However, this turned out to be different as none of the care homes were available. Therefore the main way of recruiting for participants was standing in or near the shared spaces and ask people. An important implication is that almost all people who have been interviewed were already in shared spaces, or near them. It is quite possible that a group of people who consciously avoid shared spaces were not reached and are missing from this research.

Overall, shared space is a good way to improve a traffic situation as it has been proven to be effective in reducing the amount of overall accidents. But we must acknowledge its shortcomings and pay attention to the position of vulnerable groups in it. We need to make sure that the implementation of shared spaces doesn't mean that some people are excluded from the public space. Instead it must stimulate especially these people to go outside as its good for their general health and social life. The elderly people stated that they would very much appreciate a dedicated space for pedestrians, or at least keep the designated spaces in order to cross the road. The majority of their problems would be solved and shared spaces can be inclusive instead of exclusive.

This research added to the knowledge about elderly people in traffic situations in the northern Netherlands. The research gave more qualitative insight about the elderly people's perception of safety in relation to other types of traffic and their physical activity in shared space situations. Future recommendations in shared space designs are to make sure that the presence of other types of vehicles can be rerouted via other roads. Furthermore, shared space situations can and should have designated pedestrian crossings in busy areas. It is important for the elderly people to be able to stick to safe crossing areas in which they still have priority.

5.3 Further research and recommendations

For future research, it is necessary to fill a few gaps in current knowledge. More quantitative research is needed on whether the elderly and other vulnerable groups deliberately avoid shared spaces and as such reduce the number of traffic accidents. Furthermore, it is necessary to investigate how the elderly experience shared spaces from the cyclists' point of view. During the investigation it became clear that many elderly people are still capable of cycling. Because people experience the situation differently from the bicycle, this could lead to new and different insights. Future studies could also focus on the differences between the shared spaces in the Netherlands. The shared spaces are experienced differently and are not all equally successful. For the future, it is necessary to look at what makes shared spaces successful and what does not. In particular the volume of traffic before and after the new situation must be examined in order to determine the maximum volume of traffic per situation.

It should be taken into account that the findings within the Netherlands may not apply to other areas of the world. Due to the high amount of cyclists in Dutch traffic, people are more used to sharing areas of the road. In countries where this is much less common, research could lead to different outcomes.

The implementation of shared spaces should be more in consultation with vulnerable groups to ensure their needs are taken into account and as such are not excluded from the public domain. In addition, it is important to realize that shared spaces cannot be used everywhere. in situations with large volumes of traffic, it sometimes proved difficult for the elderly person to cross the road. the natural course of traffic cannot solve everything here, so that people fall back to traditional road characteristics. It turned out that cyclists cross the pedestrian area in busy situations because they feel unsafe when sharing the road with cars. Certainly with the rise of the electric bicycle this results in large speed differences. the elderly did not feel safe in sharing the road with the cyclists. It is therefore sometimes not possible to remove all lines and crosswalks.

5.4 Conclusion

In conclusion, this research contributed to the understanding of elderly people’s perception about shared spaces. Three themes were identified regarding the elderly people’s perception of shared space. These themes were aesthetics of the area, the physical state of the infrastructure and the interaction with other road users.

The research showed that the interaction with other road users, especially cyclists determined whether or not a shared space was perceived as safe. In busy situations, crossing the street would be the most challenging for the elderly. It became clear that in these shared spaces, the pedestrians had to share the road mostly with cyclists, as vehicular traffic would still have a fixed position. Interaction with this vehicular traffic would mostly be while crossing the street. The shared spaces were an improved surrounding aesthetically when compared to the previous situations.

The contribution made to the current knowledge about the position of a vulnerable group in the northern Netherlands in this relatively new traffic situation. The outcome of the research suggests that elderly people in the future could benefit from the accessibility of shared spaces, if close attention is paid to the amount and types of traffic that goes through it.

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Appendix I – Interview guide

General questions

1. What is your age?

2. Can you tell something about yourself?

3. What do you do on a normal day?
   → Do you meet anyone?
   → How often do you take a walk outside?

4. How often do you walk?
   → Where to?
   → What distances?

5. Do you use other types of transport?
   → Did you previously use other types of transport?
   → Why not anymore?

Questions to answer the research question:
How does the built environment affect the mobility of the elderly in shared spaces?

1. How does this space compare to the previous streets we walked through?
   →Do you experience walking here differently?

2. Do you feel like the traffic rules are clear enough in this shared space situation?
   → Why not? or What makes them work?

3. What are your thoughts on the surroundings? The levelled street, the lack of road signage?
   → What aspects have a positive effect on your walking?
   → What aspects have a negative effect on your walking?

4. Where do you prefer to walk? In a 'traditional' street type or in a shared space like this?
   → Why is that?
   → What are the advantages of one compared to the other?

Questions to answer the research question:
What are the obstacles that elderly people experience during physical activity in shared space?

1. What difficulties do you experience while walking?
   → Are they time specific?
   → How could they be solved do you think?

2. Do you feel like you have enough time to cross the street?
   → Does it make you feel unsafe?

3. What are your thoughts on the clarity of the traffic rules?

4. How far can you normally walk?

5. Does it get more difficult to walk as you age?
   → Why is that? Can you give examples?

Questions to answer the research question:

What circumstances affect the feelings of safety of elderly people in shared spaces?

1. What times of day do you prefer walking here?
   → Does it get too busy?
   → When is it too busy?

2. Does the weather influence your decision to walk here?
   → When do you avoid walking outside?
   → When compared to other streets, how do you feel about walking here in wet or even icy conditions?

3. How do you experience walking here when it is dark outside?
   → Is the lighting good enough?

Questions to answer the research question:

How do elderly people experience the interaction with other types of traffic in shared spaces?

1. How do you experience the interaction between you and other types of traffic?
   → Do you feel safe moving through this shared space?
   → Is the situation clear enough for you to oversee and move through?

2. Have you ever had negative interactions with other types of traffic?
   → Do you feel like bicycles are going too fast?

3. Do you feel like you have enough space for walking in this shared space?

4. Are you comfortable sharing the road with other types of transport?
   → Why is that? or Why not?

5. What do you prefer, a road where every user has its own designated space, or a shared space?

Closing questions

1. What do you think about the recent changes made regarding traffic?
   → Does it impact you that the availability of public transport in the city centre is decreasing?
   → How do you feel about the amount of shared spaces increasing?

2. How important is it to you to be able to independently walk?
   → Has this changed since losing the ability to drive/ride your bicycle?

3. How do you foresee your future walking?

→ How long will you be able to keep walking?

Appendix II – Code Book

Code	Type	Description	Example from data
Perception	Deductive	Apply when general opinion on shared space is mentioned	*"The way it is now. You don't want to change that."*
Physical state of the infrastructure	Deductive	Use for discussion of the physical infrastructure of the shared space.	*"I like it here, I think the pavement is pretty reasonable."*
Feelings of safety	Deductive	A code for the effect of shared space on the perception of safety in the walks of the elderly participants.	*"Well I think it's a weird intersection, but if you stay on this side then it's safe. If you cross over on the other side it is dangerous."*
Interaction with other road users	Deductive	Use for any interaction with other road users is mentioned.	*"Yes, because they are afraid that the cars will hit them, they cycle on the sidewalk."*
Weather	Deductive	When the influence of weather on walking is discussed	*"Well if the weather is good yes, I will take a walk quicker."*
Time of day	Deductive	When the time of the walk is mentioned	*"But imagine, in the morning when the trains arrive, than you can't move anywhere. That is pure irritation."*
Aesthetics	Deductive	When the participant mentions how the shared space looks.	*"Yes it is nice here yes. I think it looks nice."*
Other types of transport	Deductive	A code describing the use of other types of transport by the participant.	*"Not for years. I had a stroke about four years ago. So driving a car ended immediately."*
Clarity of the traffic rules.	Deductive	For the overall perception on the clarity of traffic rules in the shared space area.	*"To me the traffic rules are clear enough. To some people not, especially cyclists."*

Code	Type	Description	Example from data
Preference for traditional road characteristics	Inductive	When the participant mentions traditional road characteristics that they feel are lacking or indispensable.	*"I think the pedestrian crossing is essential here."*
Purpose of the walk	Inductive	Use for when participant mentions destination or purpose of the walk.	*"Once a week. I always go to the mall."*
Space on the path	Inductive	A code for mentions of the amount of available space for pedestrians.	*"Yes sometimes I see them coming with three people side by side. Then I sometimes have to yell: hey, I'm here too!"*
Speed of other road users	Inductive	The mentions of speed differences between pedestrians and other types of traffic.	*"Because especially old people on an electric bicycle, they don't know how to stop. Because they have one setting, extremely hard."*
Avoiding shared space	Inductive	When the elderly people purposely avoid the shared spaces and take different routes or don't go at all.	*"Yes always on Friday yes. Because Saturday is very busy in the mall."*
Busyness	Inductive	A code describing the traffic intensity of the road.	*"It is never really busy. This is for destination traffic only."*
Top-down planning	Inductive	Use for when participant feels the traffic planning is being implemented in a top-down fashion, without the consult of the local people.	*"And there came a work of art, but it appears to be an invention of some professor. And then it is that. Then everyone says, why don't they turn it into a roundabout? No, that professor knows better."*
Patience	Inductive	When the participant mentions the necessity of patience in the shared space situation.	*"No, the older you get, the less you worry about certain things."*
Health benefits	Inductive	Use for when the health benefits of walking for the elderly person are discussed.	*"Yes, because otherwise everything will rust."*