# Conversion of a Typical Street into a Shared Space: Studying Changes in Pedestrian and Cyclist Behaviour in Groningen

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**Bachelor's project**

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## Abstract

This study investigates the impact of converting the northern part of Groningen's Grote Markt into a shared space on pedestrian and cyclist behaviour. Comparing two neighbouring streets, the research addresses the overarching question of how this conversion affects street use. The theoretical framework delves into shared spaces, emphasizing their role in non-verbal negotiations and integrating users. Methodologically, the research uses video recordings and observations to analyse commuter behaviour, highlighting differences in path shapes, mode changes, and daily dynamics between shared and typical streets.

Results reveal significant variations in path shapes, a higher prevalence of pedestrians in shared spaces, and nuanced mode distribution. Daily fluctuations emphasize the dynamic nature of shared spaces influenced by factors like commuter density and market presence. The study suggests reduced adherence to the ‘old’ place for modes within the shared street, emphasizing the impact of loose rules and increased negotiations. Commuters in shared spaces exhibit varied traversal patterns, highlighting the role of ad-hoc nonverbal communication. These findings contribute to evaluating shared spaces in Dutch urban contexts and provide insights into commuter behaviour in environments with rules ambiguous to the commuter.

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# Introduction

## Background

The Grote Markt sits within the centre of the Dutch city of Groningen. The city's main square is surrounded by mostly mixed used buildings, stores and cafes on the street level and housing and office space above it, together with the city hall and the city's largest church, the Martinikerk. Many of Groningen's inhabitants cross or pass the square daily and when food vendors are present several days a week, a broad public from the surrounding area also make use of the square.

The of appearance of the square has changed over time. From cobbled stones to brick and asphalt, back to brick again (as can be seen in figures 1, 2 and 3).


*Figure 1: (A) Postcard depicting the Grote Markt's northern side (1901-1915)*

*Figure 2: (B) Photo taken from the Northwest corner of the Grote Markt in Groningen, facing Southeast. (1931)*

Most of the buildings on the square's northern side were destroyed during the liberation of Groningen in the Second World War. The following reconstruction, the rising popularity of cars (there was a roundabout for a while) and its temporary purpose as a bus station (see figure 3), changed the looks and use of the square (Gemeente Groningen , 2020).


*Figure 3: (C) Photo taken from buildings on the square, depicting (new) north side and bus terminal on the Grote Markt (1968-1972). Taken from approximately the same location as the observation point in this study.*

Due to the municipality's measures of making the city-centre as car free as possible (Gemeente Groningen , 2020), the street typologies of the surrounding streets have also changed. From multiple car lanes to bus terminals, to the partially shared space it is (for now).

Although the square today is mostly used by those on foot and cyclist mostly utilise the streets that surround it, this is changing. Some of the surrounding streets were converted from a typical street to a shared space, changing the way in which people traverse the square. A typical street, in the context of this research is a street with a road surface in the middle and sidewalks, segregating different modes of commuting. This is different from a shared space street. A shared space is a street in which there is no separation between modes of traffic users (e.g. cyclists and pedestrians), leading to overall freer movement of commuters (Batista & Friedrich, 2022). The municipality again changed the street in the period of April-July 2023, as part of phase D of the greater plan to remodel the Grote Markt market square (Gemeente Groningen, 2023). Having been recently converted from a 'typical' Dutch street to a shared space, it might be that not all commuters in this space have yet found their place. This raises the question

whether people will use the new street type as intended or whether they will mostly persist in their old place on the street.

Outcomes of this research have a societal relevance in that it can aid in evaluating the effectiveness (minimising commuter control and integrate commuters socially (Batista & Friedrich, 2022)) of shared spaces, focusing on similar Dutch and/or European urban context. It could also help in re-evaluating their introduction in the first place.

This research could also shed light on common presumptions that come with the introduction of shared spaces as previously done by Methorst, et al., (2007).

Furthermore, with regard to scientific relevance, this research could help gain insight into what behaviour commuters demonstrate when presented with looser rules while commuting. It could do so by acquiring new knowledge regarding commuter interaction and reactions and how resulting behaviours are formed. By doing so, findings of this research can help clarify how to predict such behaviours when using shared space, understand how to act safely in possibly cluttered traffic situations, and finally find solutions to this.

## Research Problem

People move and behave differently when faced with obstacles in their paths. This is especially true for those using shared space street topologies such as on the northern side of the Grote Markt in Groningen. Here, most of the city's main square is designed with pedestrians in mind, whilst also allowing for cyclists to make use of some parts. In the period of April until July of 2023, the street typology of the northern part of the square was changed from a 'normal' street type (meaning a road with sidewalks on both sides) to a shared space street, for cyclists and pedestrians (Gemeente Groningen, 2023) see appendix 1)). This new typology does not make the distinction for a place for cyclists and pedestrians anymore, making the placement of commuters freer and uncontrolled, but also cluttered and chaotic at times.

The aim of this research is to explore how people, more specifically cyclists and pedestrians, react and change their behaviour and movement patterns in a shared space street compared to a street which has a divide between cyclists and pedestrians. This will be explored though the main research question:

*How does the conversion of the northern part of the Grote Markt in Groningen from a street to shared space influence how pedestrians and cyclists use the street?*

Which will be aided by the following sub questions (SQ):

- SQ1: *How do path shapes of commuters differ between shared and typical streets?*
- SQ2: *How does the number of cyclists and pedestrians differ between shared and typical streets?*
- SQ3: *How does the day of the week influence movement behaviour of those in the typical and shared street?*
- SQ4: *To what extent do people stay in their 'old place' on the shared street?*

## Structure

This paper will explore the research and sub questions according to the following structure:

Firstly, this thesis will explore existing literature and theories on shared spaces, and commuter behaviour from different sources, leading to a theoretical framework. This will lead to a conceptual model.

Secondly, the method of research will be explained, motivated, and substantiated. Methods of data collection include (video) observations and will be described along with guidelines on how to proceed when encountering obstacles. Methods of analysis will also be described here. Last for this part, ethics and data management will be discussed, especially with regards to privacy as people were filmed in a public place.

Thirdly, results will be explored, and analysed using statistical testing. Results of this are divided along four sub questions mentioned earlier as a guideline, in order to find differences and similarities between the two street types and to discover general trends. The findings of this research are then compared to those of other sources.

Finally, after a brief summary, conclusions and implications will be made based on the data and results of statistical tests, all through the eye of the theoretical framework that was set up during the exploration of existing literature. This part will also delve into reflection and evaluation of methods and possible improvements of this research or recommendations for further studies. If the findings allow it, policy recommendations may also be made in this section of the paper.

## Theoretical Framework

While shared spaces and the behaviour that accompanies them are well studied (Ewing, 2001) (Batista & Friedrich, 2022) (Karndacharuk, 2013), even within the surroundings of Groningen (Methorst, et al., 2007), no research has yet been done about whether commuters still adopt their 'old' place on the street when traversing a shared space in Groningen's city centre.

In a 'typical' Dutch street pedestrians and other flows of traffic are separated, most commonly by a sidewalk. A shared space however still allows for multiple commuting modes (cycling, walking etc.), while not having a clear spatial distinction for where these modes have their place in the space. Since no indicated lanes or markings are present, normal traffic rules are not always followed. Some of the terms that are very important for this research are related to how a shared space is an untypical type of street and how this makes people behave differently. Some important definitions:

- *Typical street*: A street with a road surface in the middle and sidewalks on one or two sides, allowing for segregation of commuter modes and travel directions.
- *Shared space street:* A street where there is no spatial distinction of sidewalk and road, allowing for mixing of commuters of different modes and directions.
- *Path shape*: The shape of the path a commuter takes through the street. This can have one or multiple directions and for this research is categorised in five shapes (see figure 8).
- *'Old' place:* As the shared space has no distinction between sidewalks and road surface, the 'old' place refers to the part of the street where the sidewalks used to be before the conversion into a shared space.
- *Movement Behaviour:* The overall way in which commuters move spatially, consisting of their location in the street, direction, mode, and the shape of the path a commuter traverses the street with.

### Shared Space

Essential to this research is the concept of a shared space. The term 'shared space' has become more common since the 2000s and shared space streets are not an uncommon sight in urban centres anymore (Kaparias, 2013). According to Batista & Friedrich (2022), shared space is meant to improve the urban quality of streets via integrating users. Shared spaces encourage users of the space to socially integrate between travel modes and move based on negotiating as mentioned by Ben Hamilton-Baillie (2008). This negotiating is non-verbal and comes in the

shape of people adapting their movement based on the movement and behaviour of others they encounter in the shared space (Karndacharuk, 2013).

While they have grown in popularity, concerns with the introductions of shared spaces also exist, especially when the shared space in question seeks to integrate motor vehicles and pedestrians (Kaparias, 2013). This is also claimed by Methorst, et al. (2007), whose findings indicate that while car speeds are slower overall, commuters in the shared space do not always feel safe and have to be constantly aware of their surroundings as rules and place on the roads are looser. It is mentioned that children and elderly especially cannot utilise this space by themselves, as they often lack the overview (Methorst, et al., 2007). This uncertainty in what to expect in a shared space, among other things, is an important factor that shapes travel behaviour.

## Travel / Movement Behaviour

Travel behaviour in shared spaces, or how one behaves when commuting in shared space is well studied and while decision making of individuals in traffic is hard to simulate, shared space concepts depend on core behavioural patterns of commuters (Rinke, et al., 2017), even though this is not universal as shared spaces can differ in their design and therefore again influence commuter behaviour differently. Factors that determine travel behaviour vary as it often context based, with local and cultural differences playing large roles in establishing travel behaviour (Batista & Friedrich, 2022).

The built environment does influence commuting behaviour (Thao & Ohnmacht, 2020). The built environment's effect on people's travel behaviour is studied in works of Ewing and Cervero (2001), where reasons for travel were investigated and how factors such as population density, public transport quality and availability of different travels modes influenced commuters and how these shaped commuter patterns.

## Commuter Patterns and Paths

Commuter patterns are the paths commuters take. If all drawn together, they can show the most likely path an individual will follow when traversing the space in question. These can be made across a city, using several modes or in a single street, as is the case in this study. The behaviour a commuter shows whilst commuting any street, be it nonverbal, verbal or otherwise influences the behaviour of others in the space, which in turn influences the paths they themselves and other commuters take. In the case of a shared space, as mentioned before, no spatial distinction is present, leading to the fact that behaviour of other commuters plays a larger part in shaping

the behaviour and thus the paths an individual may take when compared to a ‘typical’ street where the different modes have their given place on the street.

## Conceptual Model

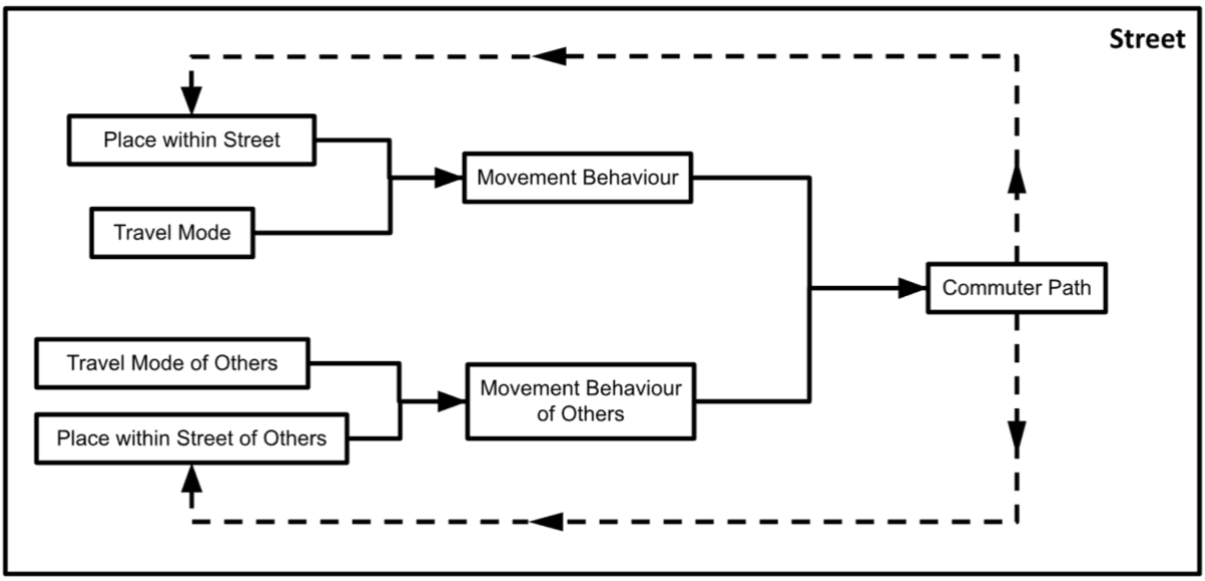


*Figure 4: Conceptual model.*

# Methodology

## Data Collection: Location, Timepoints

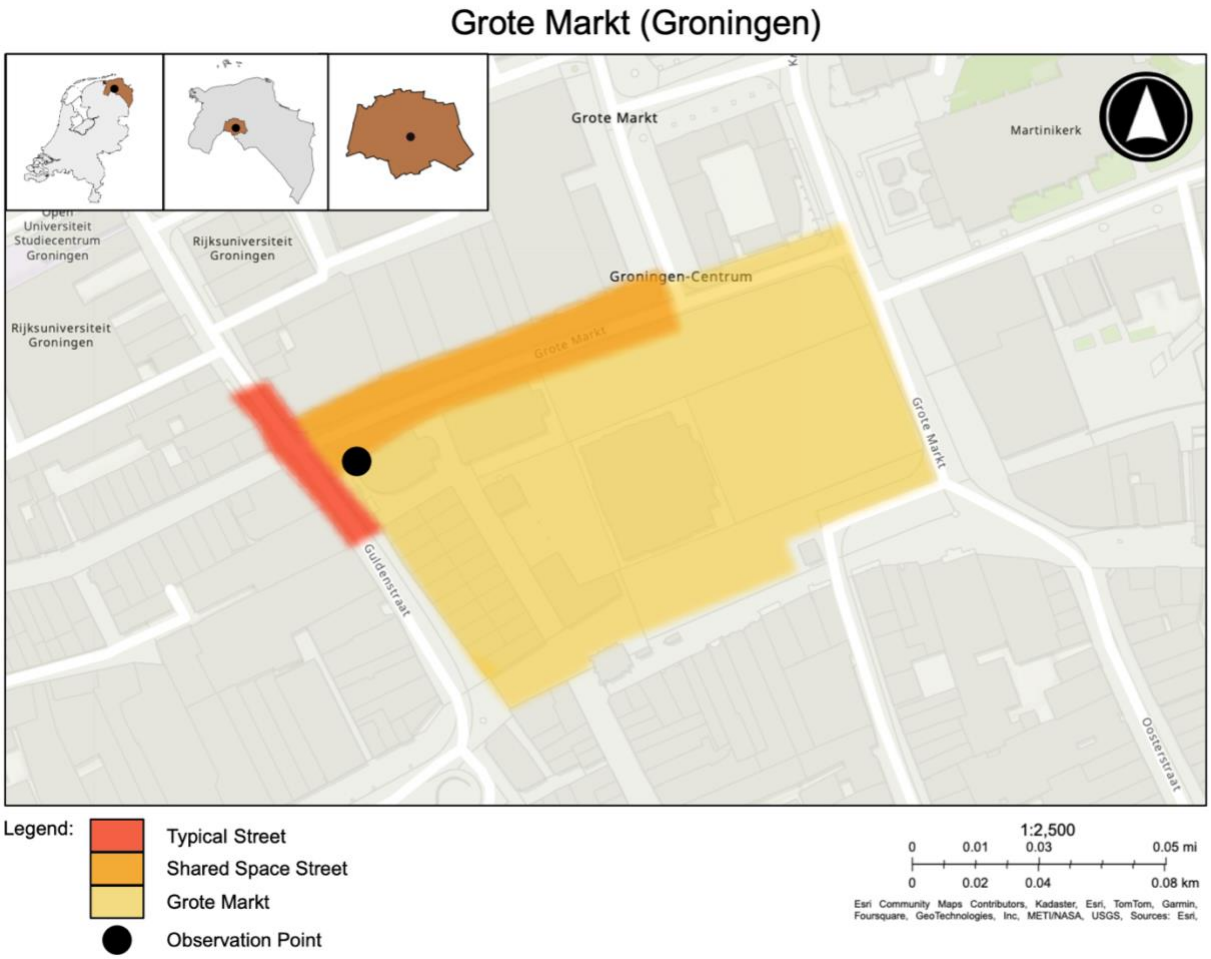


*Figure 5: Location of two streets along the Grote Markt (yellow) that will be compared. The shared space is shown in orange and the 'typical' street is shown in red. The black dot represents the observation point one floor above street level.*

Data collection was undertaken by video recordings on two sites along the northwest corner of the Grote Markt in Groningen (figure 5). Street A is a typical street(red), and street B is shared space street (orange) allowing for comparison between two different street types. These two streets were chosen based on their proximity to each other, their similarity in size and their location within Groningen's city centre. This to ensure sufficient numbers of commuters to be analysed and for overview.

Commuters on both streets were analysed based on their movement behaviour. The focus of this research will be on cyclists and pedestrian commuters.

## Video Data Collection

The data was collected in 15-minute-long sessions on several days of the week, two on weekdays (Monday and Wednesday) and one on Saturday. This to include days with more

commuter traffic as to investigate the influence of the presence of the local farmer's market on movement behaviour of pedestrians and cyclists.

Commuters were observed form the first floor of a building at the chosen location. (see figure 5). From here, commuters were observed and recorded with a handheld camera. These recordings serve as the main source of data, as commuters could be counted, logged, and processed with greater accuracy. Video material was recorded in the following frames: (see figure 6 and 7).

*Figure 6: (D) Image of the typical street and indications of limits of observation area (hard red line) and sidewalk borders (red dotted line). Note, the white building on the corner is also visible on the postcard from 1901-1915 (see figure 1)*


*Figure 7: (E) Image of the shared space street and indications of limits of observation area (hard red line) and old sidewalk borders (dotted red line). Image shows buildings on the northside of the Grote Markt.*

After collecting the videos, the material was viewed, slowed down, or paused if necessary, and all commuters on the videos were counted and categorised based on their transport mode, shape of their commuter path and whether commuters still assumed their 'old' place on the street (see figure 8). This was done according to the following observation checklist:

| Observation checklist | | | | | |
|---|---|---|---|---|---|
| Street type | Shared Space | 'Typical' Street | | | |
| Transport mode | Pedestrian | Cyclist | | | |
| Change of mode | Yes | No | | | |
| Shape of Commuter Path | Straight | Diagonally | Across | Meandering | Curving |
| Mostly old place on the street | Yes | No | | | |

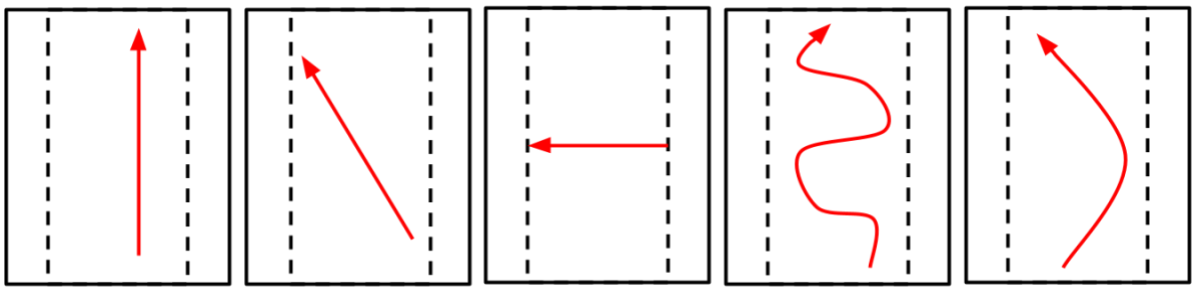

*Figure 8: Shape of commuter paths, from left to right Straight, Diagonally, Across, Meandering, Curving. (Observation area is marked in black lines, and (old) sidewalk borders in dotted lines)*

The observations resulted in a dataset that contains counts of several aspects of movement behaviour for the recorded commuters (see appendix 2). The data consists of observations from two groups, one from the 'typical' street and one from the shared space street. By using the

data collection instruments described above (observation checklist and figure 8), commuters' behaviour on the north-western corner Grote Markt could be thoroughly explored and documented.

This exploration gave an overall idea of the movement behaviour of commuters in the two streets on the north-western side of the Grote Markt. It provided an understanding on the change in movement behaviour of commuters that comes with the conversion of the street to a shared space street.

## Supplementary Observations

In addition to video collection supplementary observations were also performed These observations serve as extra information and shows information that does not fit inside of the categories that are logged with the observation checklist. These observations serve to confirm general first impressions made while recording the video material. The supplementary observations are of a more subjective nature to confirm aspects such as general commuter characteristics. This included things such as cyclists often moving in small groups within the shared space, a behaviour not accounted for in the checklist. Occurrences of peculiar behaviours seen in the video material, and other observations that are of influence within later discussion and conclusions are also noted through these observations.

## Ethics

The commuters who were filmed did not know that they were the subject of this research. It does not mean however, that their privacy will be at risk.

Aside from the notes that were taken according to the observation checklist, no further efforts were or will be made to identify or recognise the commuters on camera.

With transparency in mind, the researcher filming made clear that he/she is associated with the Rijksuniversiteit Groningen by wearing clothes with a visible logo of the university. If at any time during recording the researcher was approached with questions regarding privacy of those on video, an explanation would be provided that is similar to that what is mentioned above. The researcher could add that it is not illegal to film public spaces such as squares and the people in them. If this proves to be insufficient to the individual who asked, the researcher could offer to delete the recording and start again at another point in time. This in order to safeguard the researcher's wellbeing. A possibility of such a situation did exist and brings with it the risk of delaying the data gathering and with that, the rest of the research.

Following data collection, the video recordings, and files of gathered data were stored on a private, secured digital cloud folder. The privacy of those recognisable on video was protected by obscuring faces in any images and figures that were used later. Next to this, apart from some still images that are used as examples and figures in this project, the videos will be deleted after final analysis (at latest 26/1/2024).

This way, only the anonymised stills are kept after the research, protecting the privacy of those captured on film by the camera. These measures were meant to minimise the risk of the video material being used for anything else than the research.

## Data Analysis and Statistics

The data gathered from the video recordings was analysed according to the observation checklist, resulting in a dataset (see appendix 2), with factors that determine the commuter's movement behaviour as shown in the observation checklist. The collected data was imported into a dataset. Variables were expressed in 'observed counts' (N). Descriptive statistics were performed in order to establish the frequency of different shape patterns observed and the number of cyclists and pedestrians, as well as the other factors from the observation checklist. In order to identify patterns in people's overall behaviour on typical street and shared space streets, the multiple Chi-Square test was used. This test allows for comparison of multiple categories across multiple groups, resulting in a value to indicate whether a significant difference is actually present. This can be used to answer all four sub questions. Data was analysed using the statistical tests from Microsoft Excel (Version 16.81), as it has a built-in function for this particular statistical test and the data was stored in this programme already, avoiding having to transfer data to a different testing software. A p value of $< 0.05$ was defined as statistically significant.

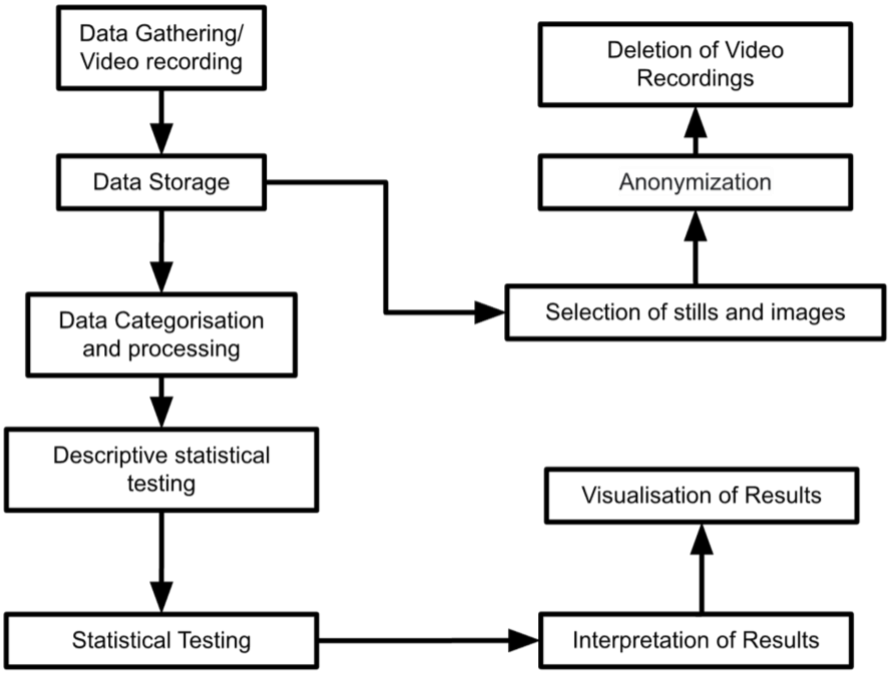


*Figure 9: Data Analysis Scheme*

## Results

Video recordings were made between 23/10/2023 and 11/11/2023. After viewing the recordings and observing the commuters according to the observation checklist, a total of 2948 commuters were witnessed traversing the two streets along the north-western corner of the Grote Markt in Groningen. Of these, 1587 were observed on the shared space street, and 1361 on the typical street, all in six total windows of 15 minutes recorded between 14:30 and 16:30 in the afternoon. From these observations the following data came as a result (for the full dataset, see appendix 2).

### Path Shapes in Typical and Shared Space streets.

From the data gathered during the observations, it shows that some path shapes are more prevalent than others (see figure 10). Overall, it showed that the 'straight' path shape was the most common overall. The distribution shows that in both street types, most commuters move in a direction parallel to direction/orientation of the street itself ('straight' path type (figure 8)), with 32,26 percent of the commuters in the typical street and 59,86 percent of all commuters in the shared street moving along the length of the street. When looking at the other path shapes in the distribution, it shows that most values are different between the shared space street and the typical street, with the 'diagonally' path being the second most observed in the shared space street, while the 'across' path is the second most observed in the typical street. It is remarkable here that the data shows that 'across' is more prevalent in the typical street type than in the shared street type, since, as hypothesized earlier, the expectation was that commuters in the typical street were expected to more follow the 'straight' path, along the direction of the street itself. A possible explanation for this could be that there is a perpendicular street present in the middle of the recorded typical street. The 'meandering' path (where the commuter makes two or more turns, visible in figure 8) was the path that was least observed in both street types, suggesting that commuters rarely adjust their course more than once.

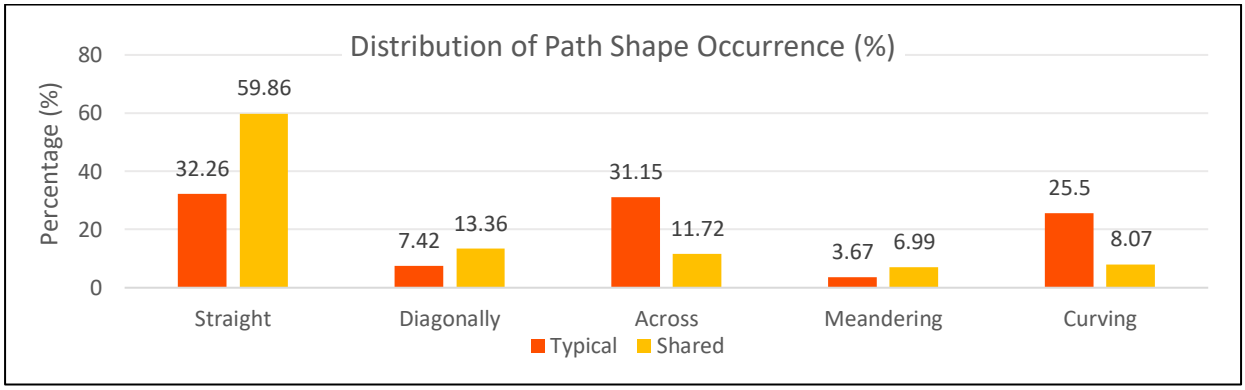


*Figure 10: Distribution of Path Shape Occurrence (%)*

In order to find that there actually is a significant difference, a chi squared test was performed on the data with path shapes. The data shows that there is a significant difference in shape paths between commuters in the typical street and commuters in the shared space street as analysed by the chi squared test, $p < 0.05$ (see figure 11). This means that within the available data, there is indeed a significant difference in what path shape commuters move in between the shared space street and typical street.

| **Chi² test Path Shape** | | | | | | |
|---|---|---|---|---|---|---|
| Observed | | | | Expected | | P-value |
| Categories | Shared | Typical | total | | | 1,17499E-91 |
| Straight | 950 | 439 | 1389 | 747,74 | 641,26 | |
| Diagonally | 212 | 101 | 313 | 168,50 | 144,50 | |
| Across | 186 | 424 | 610 | 328,38 | 281,62 | |
| Meandering | 111 | 50 | 161 | 86,67 | 74,33 | |
| Curving | 128 | 347 | 475 | 255,71 | 219,29 | |
| total | 1587 | 1361 | 2948 | | | |

*Figure 11: Chi-square test on path shape between Typical and Shared Space Street.*

## Commuter Mode Choice in Typical and Shared Space Streets

The data shows that on average, there are more pedestrians than cyclists on both street types, for all days of recording. This does not mean however that the ratio of cyclists to pedestrians is the same between the two studied street types, as can be seen in figure 12. This chart shows that in the typical street the amounts of cyclists are higher than in the shared space street. It also shows that the number of cyclists and pedestrians are closer in the typical street than in the shared space street, partly due to that pedestrian numbers are higher in the shared space street. To investigate whether there was a significance difference between the two groups another Chi-Square test was performed. The test showed that there was indeed a significant difference between the numbers of pedestrians and cyclists between the two street types (shown by a $p < 0,05$). This implies that there is indeed a difference in what mode commuters mostly use per street type, even though being on foot is more common for both.

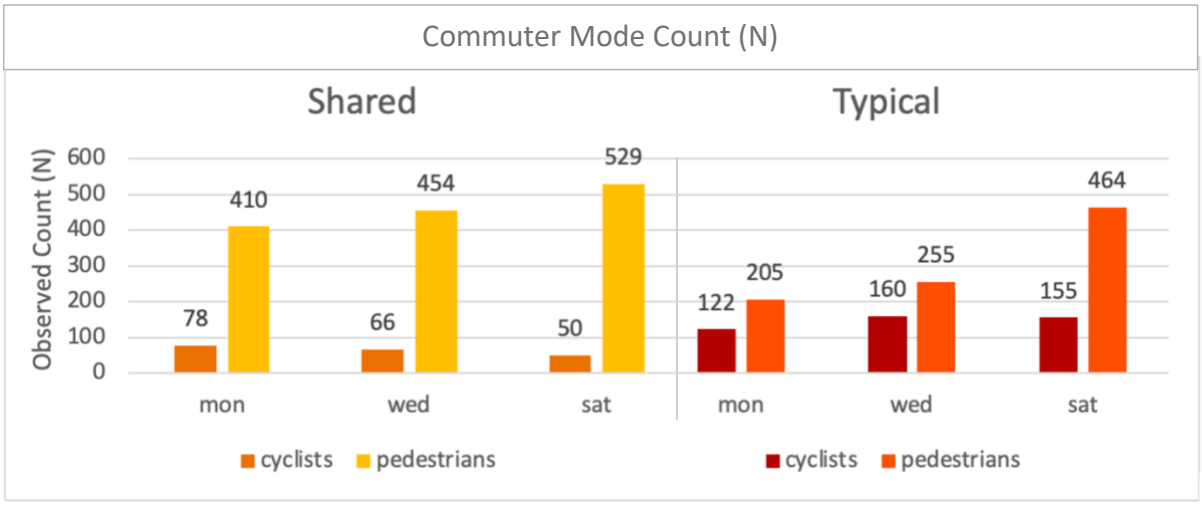


*Figure 12: Commuter Mode Count (N)*

## Day of the Week and Movement Behaviour in Typical and Shared Space Street.

The graph: *Commuter Mode Count* (figure 12) does not only show that Saturday has higher numbers of commuters, the difference between the amounts of pedestrians and cyclists also increases. Multiple Chi-Square tests were done to test for the presence of significant differences between the days of the week. For the shared space street all factors of the observation checklist turned to have significant difference in numbers between days of the week, with the exception for mode change, which not showed significant different values throughout the week (see figure 13). For the typical street, there was also no significant difference in how many commuters moved within their 'Old' place in the street between days of the week (figure 13).

| | Significant difference between days of the week? (p<0,05) | |
|---|---|---|
| | Shared | Typical |
| Mode frequency | Yes | yes |
| Mode change | no | no |
| Standstill | yes | yes |
| Path shape | yes | yes |
| Old place in the street | yes | no |

*Figure 13: Overview of Chi-Square test results*

The results of these tests imply that there is no significant difference between the days of the week when it comes to how often commuters change their mode, inferring that, within the data, higher commuter numbers have little effect on whether commuters change their mode while commuting. They also infer that there are significant differences between the days of the week

when looking at occurrences of path shapes, people standing still and what mode commuters use. This suggests that the day of the week indeed does influence what path shape commuters use, how often commuters stand still while traversing the street and how frequent a mode is on that day. It shows that while the 'straight' path is most common throughout the week it fluctuates between the days, more than the other path shapes do in their recorded frequency (figure 14).

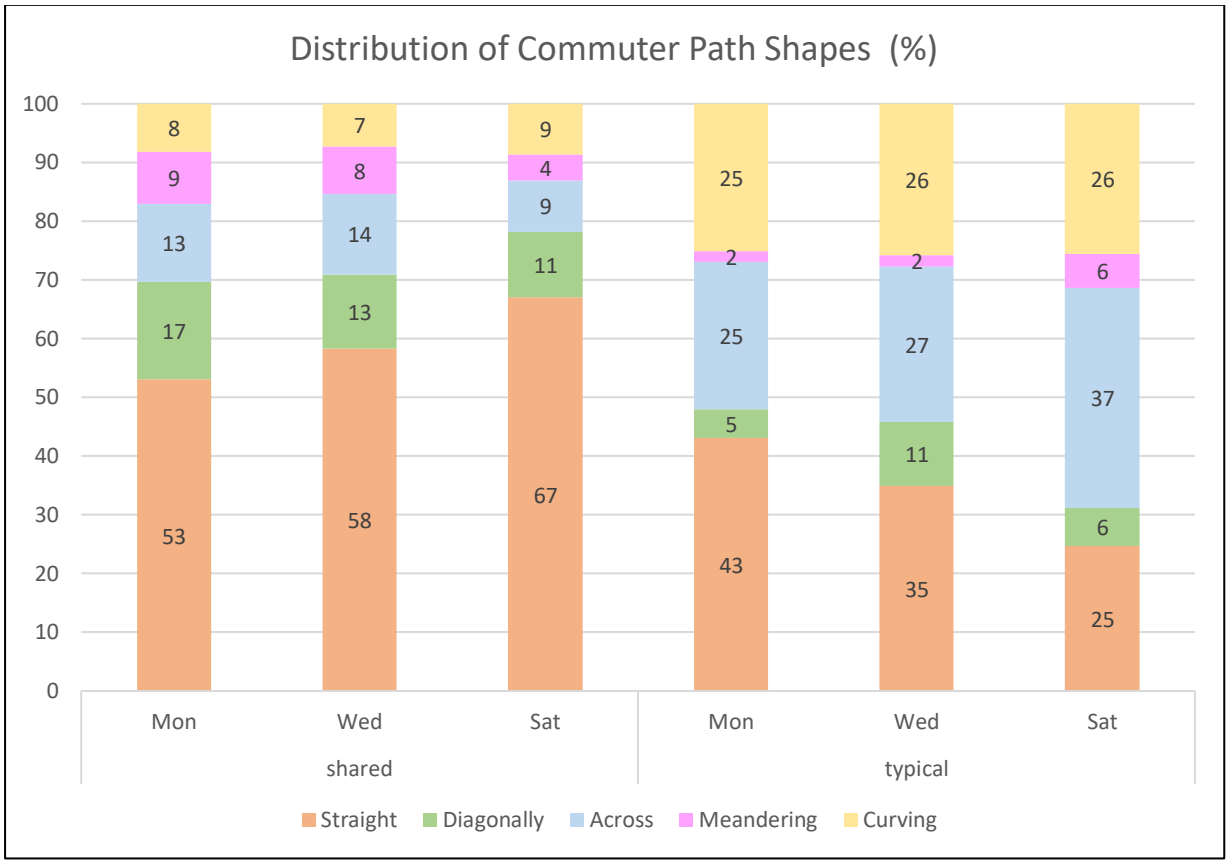


*Figure 14: Distribution of Commuter Path Shapes*

## Adherence to "Old" Place in the Street

To investigate the fourth sub question; *To what extent do people stay in their 'old place' on the shared street?* another Chi-Square test was conducted. The resulting p-value of this test indicates that within the data, there is a statistically significant difference between the two street types when looking at whether commuters stayed in their 'old place' or not ($p < 0,05$). Individual commuters in the typical street show that they adhere more closely to their assigned place on the street than commuters on the shared space street. This is also supported by figure 10, where the 'straight' path is the most frequent. The supplementary observations can shed some light on this. As people move more along the direction of the street, the speed difference between modes becomes more apparent, this causes (together with traffic rules that are in place) people to walk on the sidewalks and cyclists to use the street surface, in their 'Old' place in the street more so than in the shared space street.

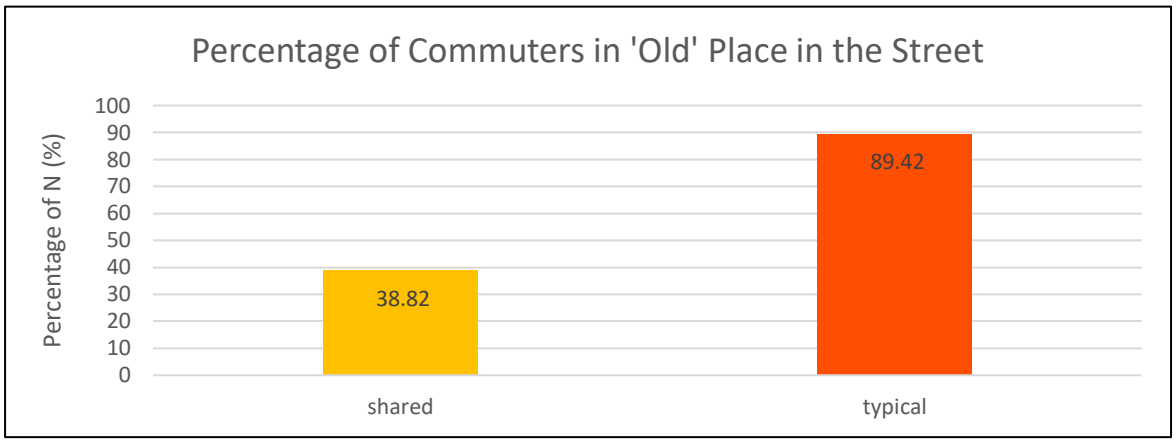


*Figure 15: Percentage of Commuters in 'Old' Place in the Street*

## Supplementary Observations

Some observations were also made with that did not fit within the observation checklist.

It was noticed that cyclists matched their speed to pedestrian when traversing through the shared space street, not doing so in the typical street. Cyclists in the shared street also seemed to make use of openings between the larger number of pedestrians in the shared space street, and when found, would go through in small clusters of three or more. It was also noticed that people who change their mode are most often alone and surrounding by those from the other mode.

## Conclusion and Discussion

The main difference between a shared space and a typical street is the lack of clearly assigned places for different types of commuters, in this case pedestrians and cyclists. Due to the lack of a clear sidewalk on the shared street typology, commuters can, and are allowed to walk outside of their ‘old’ place. This study investigates the impact of converting the northern part of Groningen's Grote Markt from a street to a shared space on pedestrian and cyclist behaviour. A comparative analysis was conducted on two adjacent streets of different types within the city centre. This study showed a significant difference in how often commuters moved in their ‘old’ place when comparing the shared and the typical street types. With 89% of the typical street commuters being in their respective assigned place in the street, compared to only 38% of commuters moving within where these places would be in the shared street. As Batista and Friedrich (2022) mention, shared space seeks to enhance the role of the pedestrian in the street, which could translate to a larger percentage of commuters in such a street consisting of pedestrians, who then also utilise a larger part of the space then they would in a typical street. By observing commuters and recording data based on five criteria, key trends emerged.

In this study, pedestrians were more prevalent in the shared street compared to the typical street. The frequency of path shapes significantly differed between street types, indicating distinct movement patterns. Interestingly, mode changes on the streets were infrequent, with individuals often anticipating the presence of slower pedestrians before entering the shared space.

When cyclists traversed the shared space, they tended to move in groups, capitalizing on openings created by others while negotiating through pedestrians—a testament to the utilization of non-verbal communication. Significant differences were also noted between different days of the week for various factors, emphasizing the dynamic nature of commuter behaviour.

Commuters in the shared street exhibited a reduced likelihood of walking in their "old" place, influenced by the lack of clear rules, higher foot traffic, and increased negotiations. This resulted in a more varied traversal of the space, deviating from straight lines along the street's direction. The findings suggested the establishment of a balance through ad-hoc nonverbal communication, leading to constant changes in travel behaviour, particularly as commuter numbers increased.

As expected, this study showed a difference between the shape of path commuters take on shared spaces compared to typical streets since rules are looser and boundaries are less or not defined. An explanation for this is that commuters have no or a less clear idea of how and where they can encounter others in a shared space compared to a typical street (Batista & Friedrich, 2022). This leading to commuters constantly negotiating non-verbally and adapting their movement behaviour, shaping different paths (Karndacharuk ,2013)

In both the shared space street and the typical street pedestrians were present in larger numbers than cyclists. However, in the typical street the proportion of cyclists compared to pedestrians was larger. Mode change (changing from walking to cycling or vice versa), however, was very rare for both. Out of a total of 2948 commuters only 40 (1,36%) were observed changing their mode. For mode change there did not seem to a be a significant difference in numbers when comparing different days of the week, both for the shared and the typical street. This implies that higher commuter density does not have a mayor effect on mode change when already traversing the space/street in question. Also, when looking at differences between days of the week, the data does not suggest there is a significant disparity in the frequency of mode changes between the shared space street and the typical street. This could be supported by works of Karndacharuk (2013), as it would be an example of nonverbal negotiation between commuters based on the behaviour of others in the street and, that commuters change their mode in anticipation of entering a different street type and the corresponding behaviour of other commuters. Those that do change their mode were often alone and changed their mode in reaction to the mode of those immediately around them. E.g. a cyclist steps down in order to blend in better at the same speed as the pedestrians that surround him/her.
Findings of Ben Hamilton-Baillie (2008) would contrast this notion, suggesting that as while traversing a shared space is a process of negotiation, it is ad-hoc and commuters do not change their commuter behaviour in anticipation of entering the shared space, and only react to behaviour of those immediately around them. Evidence of this thinking can be found in that most cyclists entering the shared space were spotted driving in small groups when traversing the shared street, suggesting that seeing another commuter cycle in the same openings between pedestrians would influence those on a bicycle already to follow them in their approximate path.

Next to comparing whether the street types themselves showed differences in behaviour of commuters, observations were done on different days of the week in order to see a possible

difference in commuter behaviour patterns between them. For most of the observed factors there turned out to be a significant difference between days of the week. A possible explanation for this could be that some days were busier than others and higher commuter density lead do differences in commuting behaviour, as non-verbal negotiating became more frequent. A trend that also shows is that with increased commuter numbers, the number of cyclists among them are smaller. A difference between the shared and typical street was found when looking at where commuters went within the street. As it showed that, there was a significant difference in whether commuters walked/cycled in their 'old' place in the street between the days of the week. A difference that was not present between the observations of the typical street. This might imply that having assigned zones within a street leads to less negotiation between commuters and that travel behaviour is mostly based on nonverbally negotiating with other commuters but also on set general traffic rules. This would make the typical space less ad-hoc as Ben Hamilton-Baillie (2008) put it, as travel modes are spatially segregated and (most) traffic moves in only two directions.

## Reflections

Batista & Friedrich (2022) and Trifunović (2021) utilized tracking and mapping software to map out the exact paths of traffic in their case studies, to so study the patterns of commuters. This resulted in gaining more insight in not only where the most likely paths of pedestrians, cyclists and automobiles were, but also their shape and the speed at which these paths were navigated. In the case of the northern side of the Grote Markt, insights such as this can explore whether people behave significantly different within a shared space in Groningen compared to a 'typical' Dutch street. The utilisation of such software would have been ideal in the case of this study. However, due to the limited timeframe of this research, the choice was made to instead observe commuter paths and divide these in categories based on their shape and general placing. With this method, significant insight in where commuters place themselves and how they behave in this shared street could still be gained.

Weather and time of year can have their effect on the total number of commuters in the street as well. In this study, weather and time of year were not included. However, since enough commuters were observed during observations for analysis, this was not an issue. The chosen typical street, with a side street leading to frequent crossings, did however pose a challenge in data interpretation. This issue could be mitigated by relocating the observed area north or south along the street to ensure a more representative sample.

## Implications

The findings of this study provide an indication of what behaviour commuters exhibit when encountering a shared space. The insights in common aspects of this behaviour may aid in understanding how shared spaces in similar Dutch and European urban contexts are utilized by cyclists and pedestrians.

## Recommendations

For future research the following recommendations can be made:

- Relative speed should be incorporated the checklist, assessing how commuters adapt their traveling speed when interacting with others.
- Logging interactions between commuters and noting whether their intended path shape is maintained or altered by encounters could provide valuable insights in commuter behaviour and (non-verbal) negotiations.
- Weather and time of year can have their effect on the total number of commuters in the street. In a larger study could be included as a factor of influence on commuter behaviour.
- The researcher(s) should be aware of side streets and crossings when choosing the typical street(s) for observation, with regards to data skewness.
- The use of tracking and mapping software is advisable as it is more accurate for studying the patterns and behaviours of commuters.

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## Literature


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## Photographs

Photo A: Eisveld Bosch, S.,1905-1915. [Postcard] *Groningen. Noordzijde Groote Markt.* Groningen: Groninger Archieven.

Photo B: Lubbers-Timmer, Ans & Johann, 1931. [Photograph] *Stadhuis en Goudkantoor noordzijde, rechts de Waag.* Groningen: Groninger Archieven.

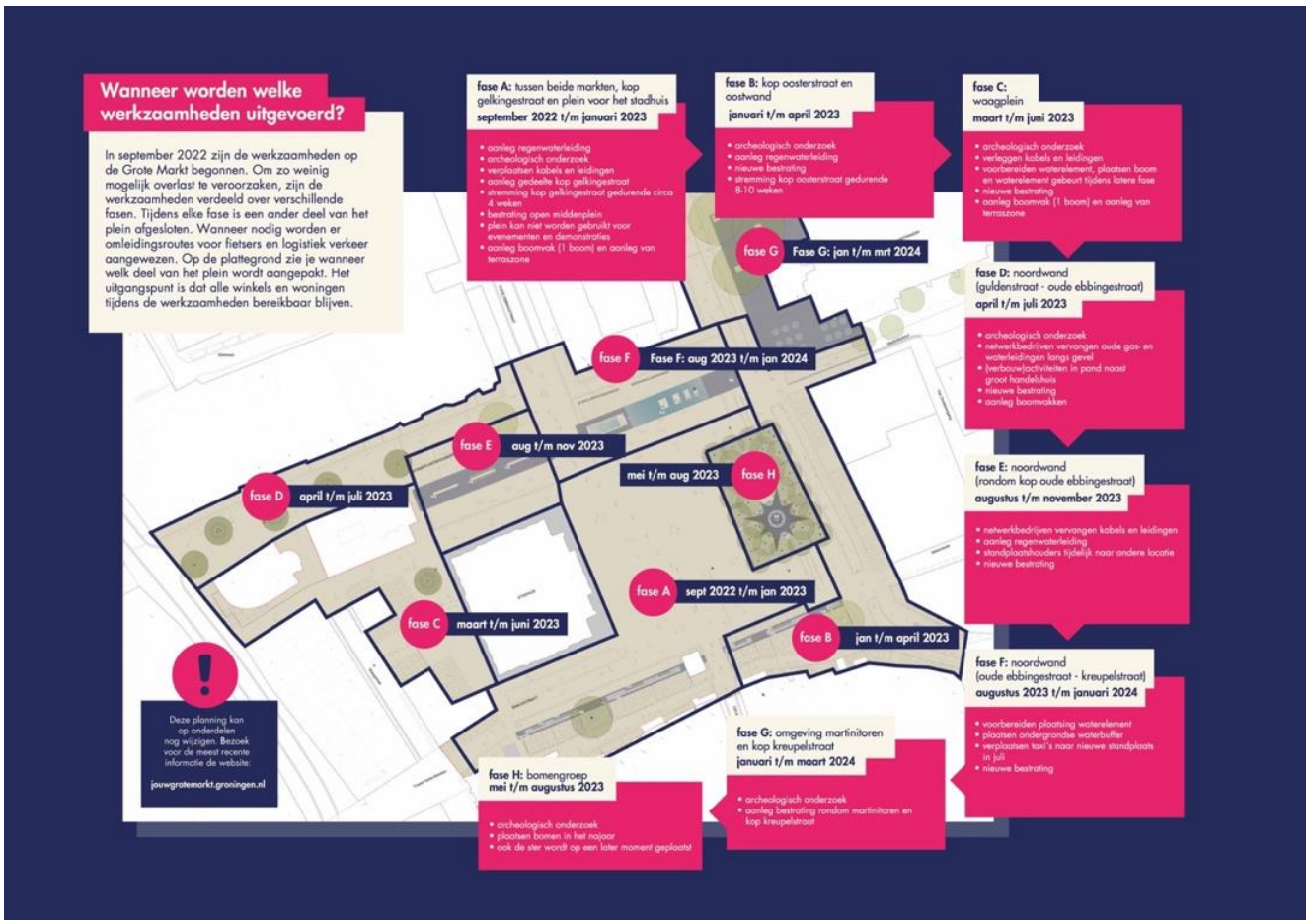
Photo C: Persfotobureau D. van der Veen, 1968-1972. [Photograph] *Groningen (stad): Grote Markt noordzijde : busstation.* Groningen: Groninger Archieven.

Photo D: du Marchie Sarvaas, G. J., 2023. [Photograph] *image of typical street.* Groningen

Photo E: du Marchie Sarvaas, G.J., 2023. [Photograph] *image of shared space street.* Groningen

# Appendices:

## Appendix 1: Municipality Plans for the Grote Markt



## Appendix 2: Data from Observations:

| | Shared street | | | Total shared | Typical Street | | | Total typical | Overall Total |
|---|---|---|---|---|---|---|---|---|---|
| Video | 1 | 2 | 3 | | 4 | 5 | 6 | | |
| Date (2023) | 23/10 | 25/10 | 28/10 | | 06/11 | 08/11 | 11/11 | | |
| Time window | 14:30-14:45 | 14:30-14:45 | 16:15-16:30 | | 15:10-15:25 | 14:35-14:50 | 16:09-16:24 | | |
| Observed Count (N) | | | | | | | | | |
| Cyclists | 78 | 66 | 50 | 194 | 122 | 160 | 155 | 437 | 631 |
| Pedestrians | 410 | 454 | 529 | 1393 | 205 | 255 | 464 | 924 | 2317 |
| Mode change | 7 | 1 | 4 | 12 | 4 | 12 | 13 | 29 | 41 |
| Standstill | 23 | 39 | 45 | 107 | 1 | 15 | 28 | 44 | 151 |
| Straight | 259 | 303 | 388 | 950 | 141 | 145 | 153 | 439 | 1389 |
| Diagonally | 81 | 66 | 65 | 212 | 16 | 45 | 40 | 101 | 313 |
| Across | 65 | 71 | 50 | 186 | 82 | 110 | 232 | 424 | 610 |
| Meandering | 43 | 42 | 26 | 111 | 6 | 8 | 36 | 50 | 161 |
| Curving | 40 | 38 | 50 | 128 | 82 | 107 | 158 | 347 | 475 |
| ‘Old’ place in the street | 238 | 166 | 212 | 616 | 289 | 364 | 564 | 1217 | 1833 |
| Total Commuters Video | 488 | 520 | 579 | 1587 | 327 | 415 | 619 | 1361 | 2948 |