Sustainable street space allocation and the use of it in European cities: A Berlin and Groningen comparison

Groningen and Berlin, Author (2024)

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Abstract

The global transport sector is responsible for 24% of global CO2 emissions. A third of this comes from all road users. Reasons for the emission are the street space allocation and street use. Therefore, this paper tries to find out more about the overall sustainability of streets leading to their city centre in Berlin and Groningen. By counting the street use and looking at the street space allocation, we can find out how sustainable streets are and see if they are sustainable for the foreseeable future. This paper concludes that both cities contain a high level of sustainable mobility. With Berlin focusing primarily on public transport and Groningen on Active mobility. However, differences can be found between the West and East in Berlin. The West is predominantly car-dependent while the east has more on-street public transport available. Groningen forms an example for Berlin when it comes to promoting active mobility and forming a more sustainable street space allocation. This makes promoting active mobility by street space allocation and policies in city centres the best way to achieve sustainable street use.

Keywords: Street Space Allocation, Sustainability, Street use, Comparison, Transportation

Content

1. Introduction

The world calls for a more sustainable transportation sector, as the existing transport accounts for a fourth of the global greenhouse gas emissions (Ritchie, 2020). Three-fourths of this comes from road users with passenger cars providing almost a third of the overall emissions of road users. After this insight, the search for a decrease in emissions was launched worldwide. Sustainable transportation planning has become increasingly popular worldwide (Costa Valenca, Moura and Morais de Sa, 2021). The main reason for this is the transport sector's impact on global emissions.

Therefore, this study researches the street space allocation and street use of city centre access streets. These factors influence sustainability and transport sector emissions (Karahasanovic *et al.*, 2020). Changing the street space allocation from the contemporary practice of privatised motor vehicles to public transport and active mobility, would cause cities to be more sustainable in a polluting sector like mobility (Berg Van den and Langen De, 2015). This can help people experience better air quality and contribute to measures against climate change.

Berlin and Groningen provide case studies for this bachelor's thesis. During this research, the focus will be on the extent to which existing street space allocation in both cities contributes to contemporary sustainable mobility. Sustainable mobility in this project is defined by using transport modes with no to low greenhouse emissions.

In this research, a sustainable street allocation has an allocation where green transportation modes like public transport, walking and cycling are prioritised over less sustainable transport modes like cars. These street allocations are of significance towards more sustainable mobility. The space allocation attracts certain types of modes and determines how the streets are distributed (Gössling, Schröder and Freytag, 2015). Therefore, sustainable street space allocation allows streets to be used more efficiently in terms of space use which opens opportunities for more green street use. Instead of space consumers like cars (Nello-Deakin, 2019).

To find these differences, Mobility is counted and street space allocation is visualised by cross-sections in both cities. This is done in cooperation with the STONIE program of the University of Groningen. The research will primarily focus on so-called city centre access streets. These streets experience sufficient amounts of traffic connecting housing with the amenities in the centre. The research will show how the cities differ from each other and in what way they could improve on the subject of sustainable mobility. Groningen is considered to already consist of a more prominent bike use, suggesting a sustainable street space allocation. However, streets that provide access to city centres can still both be used by cars and active mobility. Groningen can gain an insight into how these streets are primarily used and look into making these streets more attractive to active mobility. Berlin can gain insights into their street space allocation and the use of these streets compared to a city that has experience with active mobility (Gemeente Groningen, 2022). An insight into street space allocation and the use of streets shows that streets are not only constructed for more sustainable travel modes. But can also show if they are used like it. This could give further insight into sustainable street use not only in Berlin and Groningen but in cities worldwide.

2. Research Problem

This research aims to find out whether or not Groningen and Berlin have a sustainable street space allocation concerning the level of sustainability in their existing street use. Researching access streets flowing into the city centre. Following this, the Research question and sub-questions were constructed:

How do Berlin and Groningen compare on sustainable street space allocation and their use in city centre access streets?

- Sub-question 1: What is sustainable street space allocation?
- Sub-question 2: How do the cities compare on actual street use?
- Sub-question 3: How do the cities compare on street space allocation?
- Sub-question 4: What can the cities learn from each other regarding sustainable street use/allocation?

These sub-questions help answer the main research question. The first two sub-questions will give an understanding of the way the city allocated their city centre access streets and if this is allocated sustainably. The answer to the third and fourth sub-questions provides an overview of which modes are being used and if this fits the level of sustainability of the first two sub-questions.

3. Theoretical Framework

In a world with a need for more sustainable mobility, contemporary street space allocation worldwide has proven to be more focused on private motorised vehicles like cars (Gössling, Schröder and Freytag, 2015; Gössling, 2020; Guzman et al., 2021; Attard, Guzman and Oviedo, 2023; Sasidharan *et al.*, 2023). In the transport sector in Australia, private transport is accountable for 88% of the total transport emissions (Stanley, Hensher and Loader, 2011). Even some existing policies on street space allocation prioritise cars over sustainable transportation with prior knowledge about the effect it has (Xianbo et al., 2020). Therefore, it remains a big part of the existing planning for street space allocation in places with a high population density like Valetta (Malta), Bogota (Colombia) and Freetown (Sierra Leone)(Attard, Guzman and Oviedo, 2023). In these places, private motorised vehicles can have a destructive effect on the city due to the space that is lost to them (Guzman et al., 2021). This is mainly because the costs of changing the street space allocation towards a more sustainable space are relatively high (Currie, Sarvi and Young, 2007).

However, there has been an increase in sustainable transport and public transport (Currie, Sarvi and Young, 2007). Implementing more attraction for sustainable transportation modes like cycling, walking and public transport would decrease the amount of emitted greenhouse gasses. These transport modes do not have a significant emission per person compared to privatised motor vehicles. Therefore, the use of bicycles in the urban setting is increasing (Gössling, 2020). This has also been the case in Dutch cities and Copenhagen (Nello-Deakin and Brömmelstroet, 2021). In these cities cycling is already an important transport mode, and this causes transport to be more sustainable.

Other factors influence street use. Transport policies are implemented to achieve more sustainable transportation. These are often effective in the transition from privatised vehicles to active mobility (Möser and Bamberg, 2008). Especially when it comes to promoting active mobility (Yang et al., 2010; Scheepers et al., 2014), they can influence mobility behaviour outside of the existing street space allocation. The municipality of Groningen has implemented these policies and strategies to move from car use to more active transportation like cycling and walking. They achieved this by changing street space allocation and policy strategies (Gemeente Groningen, 2015, 2021).

The way the street space is allocated increases sustainability. More space for pedestrians, cyclists and public transport would result in less car use. Following the theory of transportation systems functioning in an equilibrium (Sasidharan *et al.*, 2023; Mogridge et al., 1987). Therefore, one way of attracting more people to use sustainable transportation modes is by making sustainable transport more attractive and making car use less attractive. More space for active and sustainable transport causes lower emissions and increases sustainable transport. Therefore, street use has a considerable effect on this research as the street space allocation, as they influence each other.

Another concept that does not favour sustainable transportation modes is the amount of space cars take in. So much so that a moving car takes up 70 times more space than a pedestrian (Figure 1)(Nello-Deakin, 2019). In this figure, you can see that cars take up the most space causing the street to be used inefficiently, in terms of sustainable road use. Cyclists, pedestrians and trams do not take up a significant amount of space and cause lower or no carbon emissions.

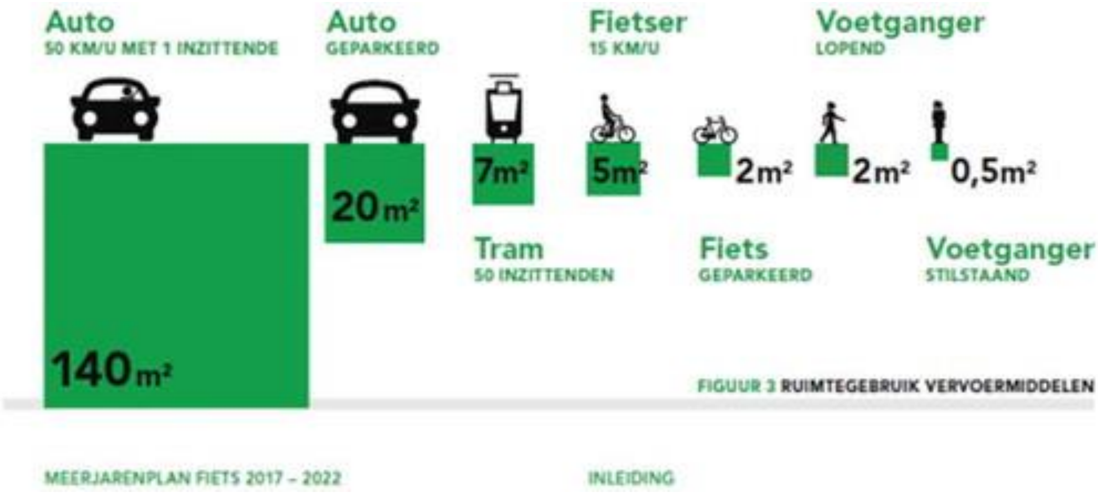


Figure 1: Amount of space occupied by several modes of transport. Nello-Deakin (2019)

There is, however, a debate on what fair street space distribution is. Cars are an example of transport that receives more space than others. However, it is difficult to say if this is fair. Since, it is not necessarily the case that governments are responsible for delivering adequate travel opportunities according to actual street use and the size of the different modes (Martens, 2017). In this research, we view fair street use with the government having the role of an agent delivering adequate travel opportunities according to the actual street use.

A significant number of streets are not used in a fair distribution. Often the car receives more dedicated space than other more sustainable transportation modes like cycling. An example of this is the study done by Creutzig et al. (2020) where cars received 3.5 times more space than non-car users. This is also the case in Amsterdam where they receive 20% less than deserved (Nello-Deakin, 2019). Therefore, this is probably not ethically fair (Hartman and Prytherch, 2015). In both these researches (Nello-Deakin, 2019; Creutzig et al., 2020) the method of observing real-life street use was used. In this research, this method will be used to observe the grade of sustainable transport.

In this paper, we define sustainable transport modes as modes with low or no emissions that provide mobility that can be sustained for a longer time. This is because they do not emit or emit lower amounts of emissions that do not affect the climate as much as privatised motor vehicles (Karahasanovic et al., 2020). In this research active modes like Walking and cycling are seen as sustainable transport modes. Therefore, Public transport is also seen as a sustainable mode of transport, as it causes a low individual emission.

4. Conceptual Model

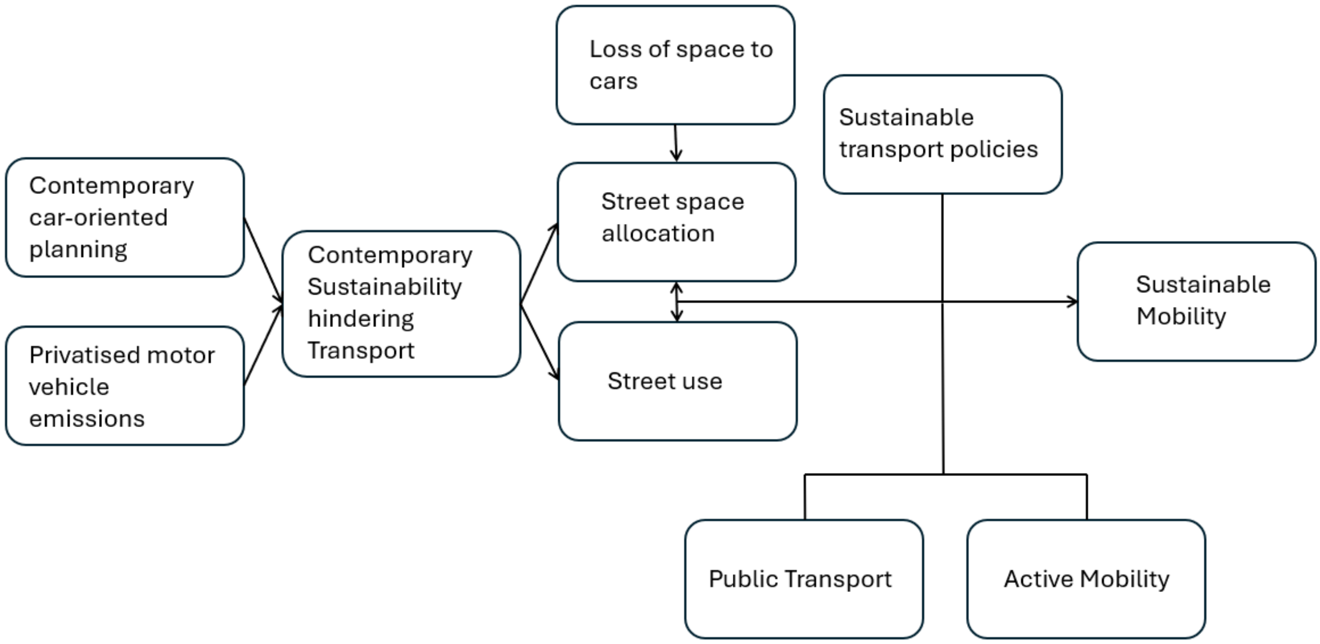


Figure 2: Conceptual Model. Author (2024)

5. Hypothesis/Expectations

For Groningen, the expected outcome is a relatively sustainable street space allocation/use. In multiple policy documents of the municipality of Groningen, the city stated their view of getting rid of cars and providing new public transport routes in the city (Gemeente Groningen, 2022, 2023), together with improving accessibility for active mobility modes and clearing the city centre of cars with the so-called "verkeerscirculatieplan" (Rijksdienst voor Cultureel Erfgoed, 2024). This would be done by the use of bicycle streets/ lanes. Therefore, it is expected that the city centre access streets will be more sustainable compared to Berlin.

However, Berlin also proposes views towards more sustainable mobility (Menge, Horn and Beck, 2014). Studies in Germany have shown a focus on the transportation planning towards privatised motor vehicles. In studies on street allocation in Berlin, the outcome was more favourable for car users over other more sustainable transportation modes (Hartman and Prytherch, 2015; Creutzig et al., 2020). Therefore, the expectation is that Berlin does not contain a sustainable street allocation and use. Thus, it is likely that Berlin can learn something from the sustainable mobility of Groningen.

6. Methodology

Typical city centre access streets

In Groningen, the typical city centre access streets would be defined as streets that lead into the city centre which are relatively busy. The city centre shown in Figure 4 represents the city centre of Groningen following the plan of the municipality (Gemeente Groningen, 2016). The researched streets in Groningen are: Brugstraat/Aweg (1), Nieuwe Sint Jansstraat (2), Oude- and Nieuwe Ebbinge straat (3), Gedempte Kattendiep (4), Hereplein (5) and Museumbrug/Ubbo Emmiusstraat (6) (Figure 3). These streets experience a significant amount of traffic leading into the city centre and therefore are most likely to experience a large amount of commuting. Because these streets provide access for all people living in the city to reach amenities. We can see this in the monitored city centre that has sensors measuring traffic activity in city centre streets (Gemeente Groningen, 2020). Some streets have different layouts, like the Museumbrug (6) which is primarily made for pedestrians. Taking all different kinds of city centre access streets into consideration provides a suitable overview of the use and allocation of these streets.

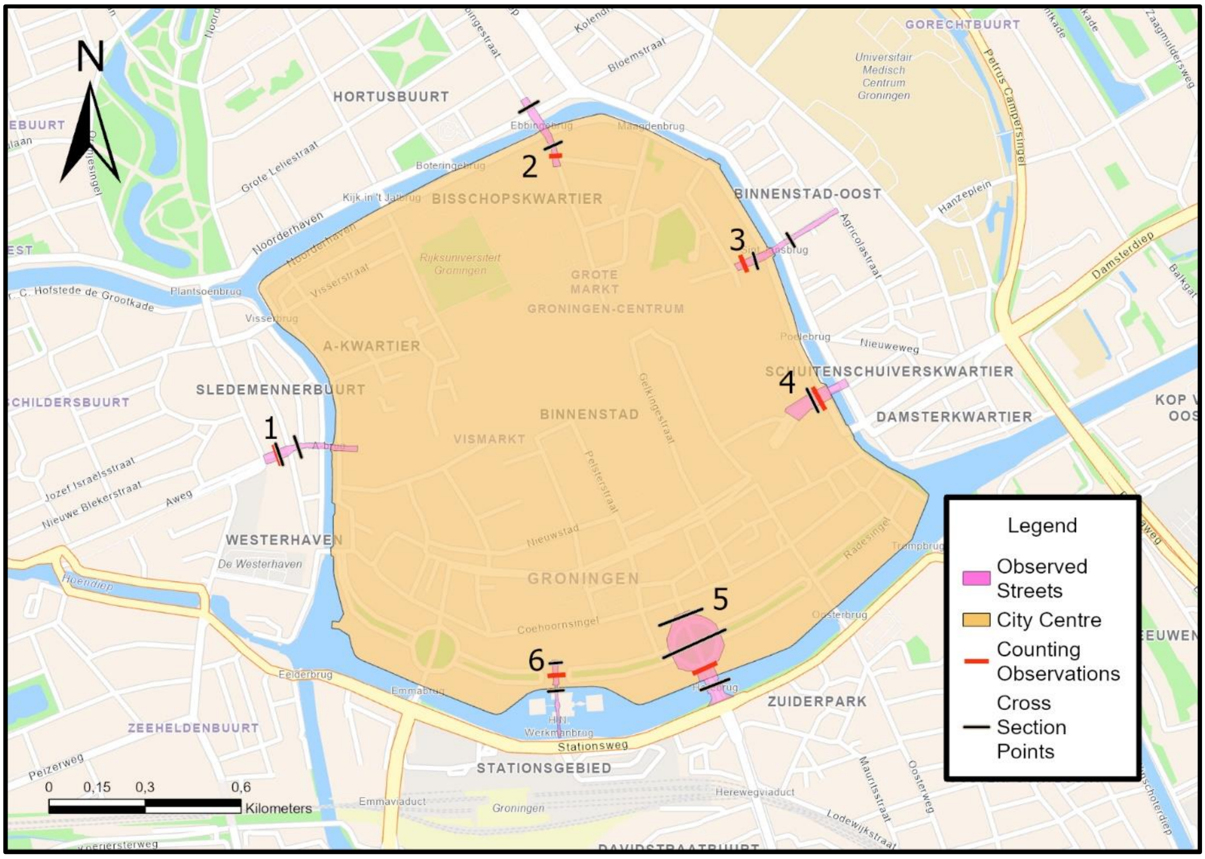


Figure 3: Counted and observed streets in Groningen. Author (2024) (ArcGIS, 2024)

In Berlin, the definition of a city centre access street remains the same. However, the concept of a city centre is not as easily defined as in Groningen. Berlin has multiple city centre-like locations as a result of historical events. First, there was the Greater

Berlin Act in 1920 (Whyte, Frisby and Boyd, 2012). This act brought regions like Charlottenburg and others into Berlin. Having developed their self-sufficient city before the combination. This brought many different city centres into Berlin. Secondly, there was the Cold War which left Berlin in two different parts. Making it possible for both sides to construct a city centre (Berlin, 2024). This makes it more difficult to point out city centre access streets. Therefore, typical city centre access streets will be defined using the city centre strategy of Berlin (Berlin, 2023).

In this research, two of the city centres defined by Berlin will be used to consider more than just one of the defined city centres of Berlin. For this research, the East and West city centres were compared. Furthermore, these streets also comply with this research question, since they provide access to their city centre (Berlin, 2023). Three streets were researched in the defined city centre of the west. These were: Carmerstraße (1), Hardenbergstraße (2) and Schillerstraße (3) (Figure 4). In the defined city centre of the East, the Spandauer Straße (1), Dircksenstraße (2) and the Klosterstraße (3) (Figure 5) were selected. The Spandauer Straße was measured twice since the street provides two different street layouts. This makes 7 streets researched in Berlin and 6 in Groningen. These streets consist of different types and therefore represent multiple types of city centre access streets. The Hardenbergstraße for example is primarily focused on heavy car use while the Carmerstraße does not have the composition for this.

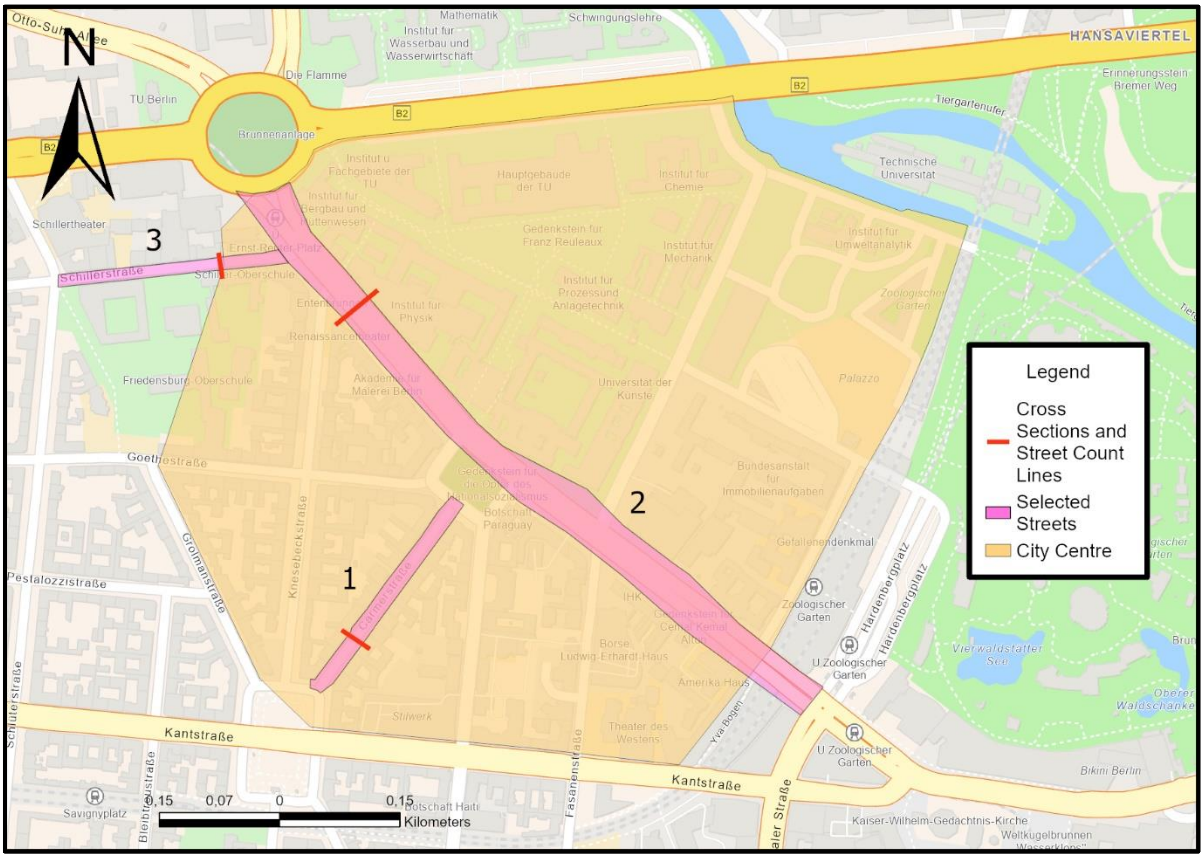


Figure 4: Counted and Observed streets in West Berlin. Author (2024)(ArcGIS, 2024)

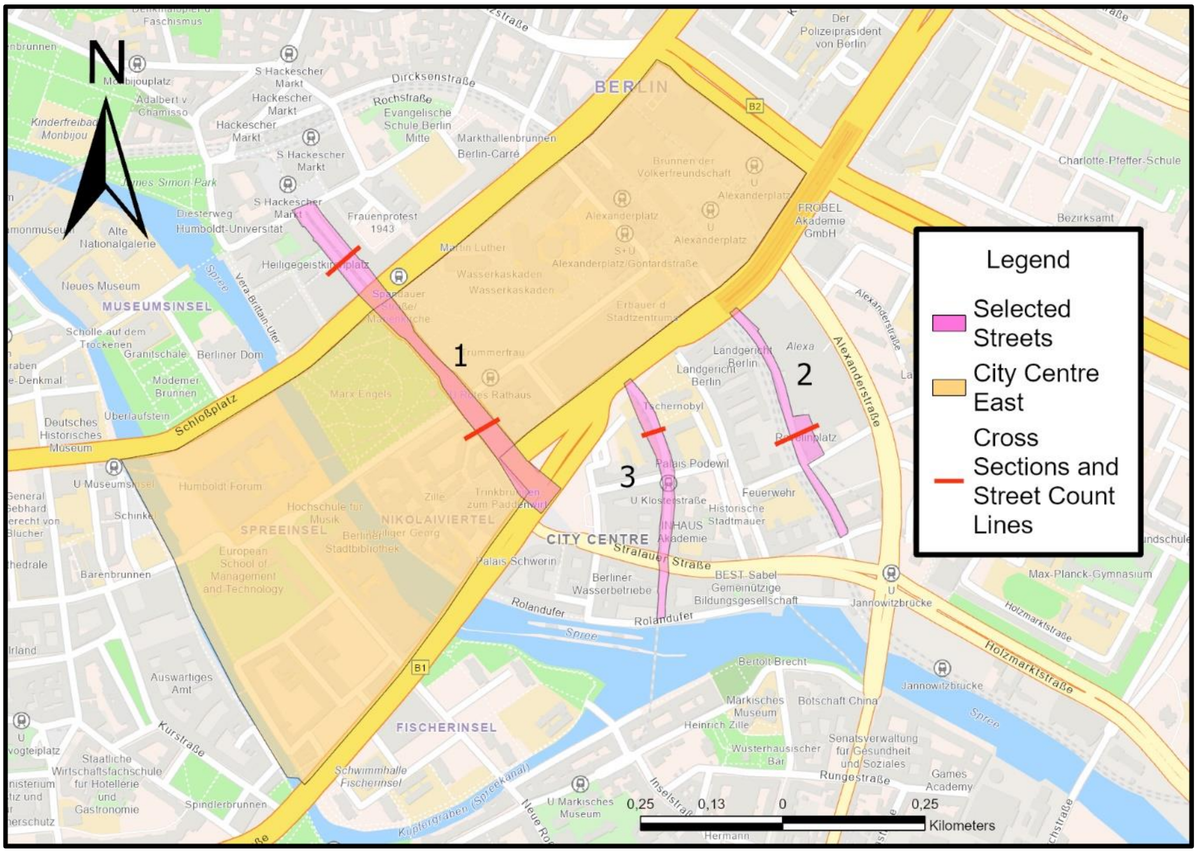


Figure 5: Counted and Observed streets in East Berlin. Author (2024)(ArcGIS, 2024)

Street use

To gather data for the research, the researcher performed real-life observations on streets that lead up to the city centre. Providing the researcher with primary data, by counting all the users of these streets using different transportation modes through the streets. These streets are observed for around 40 minutes during the day and rush hours depending on the time available with the STONIE mobility group 1 schedule.

The possible transportation modes are: car, cyclist, pedestrian, bus, tram, scooter, e-scooter and motor. People in scoot mobiles will be registered as pedestrians since they similarly make use of streets as pedestrians. The use of these streets will be reflected. To overcome the problem of counting cars, buses and trams as one, an average was calculated on the amount of people in these modes. For the trams, the number of seats was taken as a representation. This came down to 71 seats following the type of tram (Wikipedia, 2024a). The buses in Berlin and Groningen have similar types and therefore the same average of 40 seats (Wikipedia, 2024b). The average amount of people inside a car was different in both countries with an average of 1,2 in Germany and 1,3 in The Netherlands (Eurostat, 2021). These standards were taken in every count. This is because counting people inside vehicles turned out to be impossible due to counting multiple modes and the pace of the traffic.

In Groningen, all streets were counted for 30 minutes per street on Wednesday the 17th of April 2024. This was done specifically on a work day during the daytime to catch a good representation of ongoing traffic in the streets at these times. The streets were counted again on Monday the 13th of May 2024 during rush hour for 7 minutes to see if the streets are used differently at these times of the day. To find out differences between different times of the day. During rush hour, it was more difficult due to activity on the street and therefore impossible to do for 30 minutes. During all these counts the researcher was alone in the counting, making it more difficult to perform alone. Therefore, these counts only lasted 7 minutes. Observed lines are illustrated in Figure 3.

In Berlin, all streets were counted for periods of 10 minutes. Twice during the daytime and twice during rush hour. The streets were counted twice to investigate differences in these times. These counts were performed during the STONIE trip to Berlin from the 28th of April to the 4th of May in 2024. During this period the researcher received help from his research group STONIE Mobility Group 1 filled with Erasmus students doing research in Berlin and their home university. This made counting easier since tasks could be divided during the counting, which was all done simultaneously and combined after the counting. Observed lines are illustrated in Figures 4 and 5.

The Spandauer Straße was separated into two different streets during the counting because it showed vast differences when looking at street space allocation. This brought up the idea of counting it separately, as one part is primarily dependent on cars. At the same time, the other allocation showed an allocation for trams. Therefore, counting one would not result in the same sustainability percentage. The other observed streets with different compositions did not show this problem.

All before-defined sustainable transport modes will be combined and divided by the total amount counted in the street. From this, a percentage of Sustainable Mobility Percentage is calculated to make statements about the overall sustainability of the streets individually. After this, an average per city is calculated to make a statement of the cities.

Street space Allocation

The measurements of the streets are using the measuring tool on ArcGIS Pro (ArcGIS, 2024) in a linear cross-section method (Figures 4,5 and 6). By using this software the measurement of the different street characteristics will be measured accurately and compared with one another on the ArcGIS Pro base map. With these measurements, cross-sections will be made (using the program inkscapes) to visualise the street composition. The amount of cross-sections per street depended on the way the street varied at different points. Streets with a large variation in the composition required more than one cross-section. The measurements were done with ArcGIS Pro with a projected coordinate system of RD New for measurements in Groningen and with DHDN Soldner Berlin in Berlin.

Data protection and Ethical considerations

All data will be stored in Word, Excel and GIS documents stored on databases provided by the University of Groningen. These are protected following the suitable guidelines of the Dutch Government. There will not be any ethical problems, as there will be no interaction with the street users. Any other private information will not be written down because it does not provide useful information towards the research.

Data influencing factors

The counting in Berlin and Groningen was conducted at different times and locations and could therefore differ depending on weather conditions. The counting was also done in different time slots. In Groningen, it was 30 minutes during the day and 7 minutes during rush hour. In Berlin, it was done in periods of 10 minutes. Twice during the day and twice during rush hour. This could explain differences in the data.

Another thing that influenced the public transport count is the U-Bahn in Berlin. Since this mode of transport cannot be found in the street space allocation, it was not taken into account in the research. However, this mode of transport still contributes to the share of sustainable transport.

Furthermore, the measuring tool in ArcGIS Pro could be wrong and therefore provide false distances. However, this was done the same way to overcome differences between all measurements.

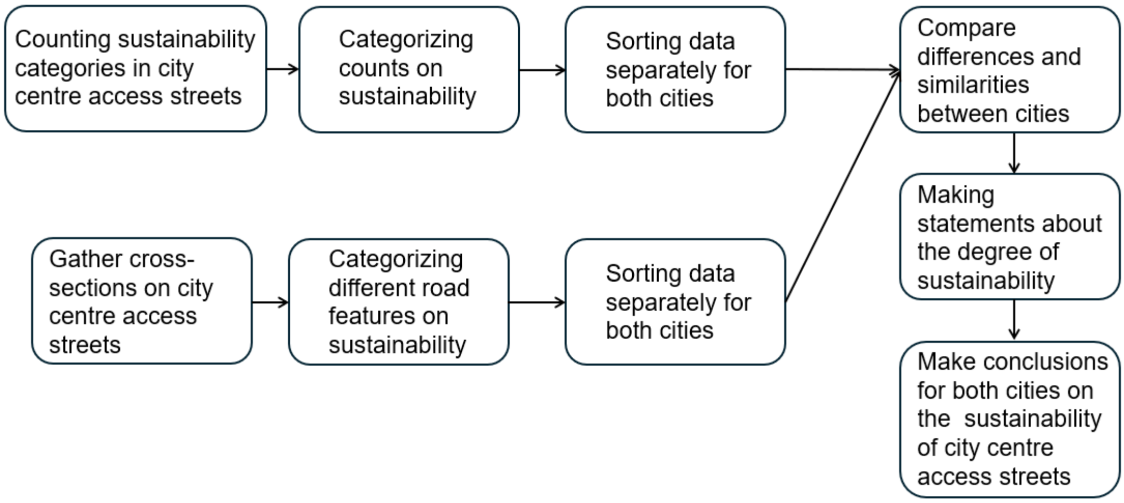


Figure 6: Data Gathering Scheme, Author (2024)

7. Results

7.1 Street count Groningen

After conducting research, the results illustrate a prominent active mobility in all city centre access streets in Groningen. In all streets, there are high counts of pedestrians and cyclists. Especially streets that are located close to commercial spaces like the Brugstraat/Aweg and the Museumbrug/Ubbo Emmiustraat see significant active mobility (Table 1). The Brugstraat/Aweg receives high active mobility, providing a lot of commercial space. This could be a reason for the high number of pedestrians. Furthermore, the street offers a gateway option for cyclists to reach the city centre from the west of the city. The Museumbrug/Ubbo Emmiustraat is used as direct access from the main station of Groningen straight to the Vismarkt which is one of the main squares of the city.

Groningen	Pedestrians	Cyclists	Cars	Scooters	Bus	Total Per Street	Percentage Sustainable Mobility
Brugstraat/Aweg NT - 10:50 to 11:20 - 17-04-2024	265	475	36	38	0	**814**	**90,91%**
Brugstraat/Aweg RH - 17:20 to 17:27 - 13-05-2024	100	171	7	15	0	**293**	**92,65%**
Museumbrug/weg NT - 15:01 to 15:31 - 17-04-2024	425	192	3	7	0	**627**	**98,41%**
Museumbrug/weg RH - 18:39 to 18:46 - 13-05-2024	88	57	0	1	0	**146**	**99,32%**

Table 1: Counts Brugstraat/Aweg and Museumbrug/Ubbo Emmiusstraat. Author (2024)

The Ebbingestraat has a higher car use than the Brugstraat/Aweg and the Museumbrug/Ubbo Emmiustraat (Table 2). This is because the street provides access from the large housing population in North Groningen to the city centre. This street in particular leads straight to the Grote Markt (Main square of Groningen). Parking in the city centre is located at the end of the street and provides access to some amenities in the city centre.

Groningen	Pedestrians	Cyclists	Cars	Scooters	Bus	Total Per Street	Percentage Sustainable Mobility
Oude ebbingestraat NT - 11:30 to 12:00 - 17-04-2024	299	301	62	26	0	**688**	**87,21%**
Oude ebbingestraat RH - 17:34 to 17:41 - 13-05-2024	89	96	14	6	0	**205**	**90,11%**

Table 2: Counts Oude Ebbingestraat. Author (2024)

In the South and East of the city centre, you can see more cars and buses on the streets. In the Sint Jansstraat, next to a large number of active mobility, there is a high count of cars (Table 3). This can be explained by a car garage under the Forum. This is popular, as it provides people access to the city centre by parking their vehicle near the city centre. The Gedempte Kattendiep and the Hereplein are the only streets in this research that provide bus transport. These streets are both connected by the Gedempte Zuiderdiep street in the city centre. This connection is the only street connection going to the East where busses are allowed in the city centre of Groningen (Gemeente Groningen, 2021). Therefore, all bus lines going to the east are via the city centre and find their route along this connection.

Groningen	Pedestrians	Cyclists	Cars	Scooters	Bus	Total Per Street	Percentage Sustainable Mobility
Sint Jansstraat NT - 12:10 to 12:40 - 17-04-2024	508	194	91	12	0	**805**	**87,20%**
Sint Jansstraat RH 1 - 17:54 to 18:01 - 13-05-2024	34	69	22	3	0	**128**	**80,41%**
Sint Jansstraat RH 2 - 18:03 to 18:10 - 13-05-2024	31	65	10	2	0	**108**	**88,56%**
Gedempte kattendiep NT - 14:20 to 14:50 - 17-04-2024	101	47	74	4	1240	**1466**	**94,68%**
Gedempte kattendiep RH - 18:14 to 18:21 - 13-05-2024	39	12	12	1	200	**264**	**95,18%**

Table 3: Counts Sint Jansstraat and Gedempte Kattendiep. Author (2024)

The Hereplein/Hereweg (Table 4) is the street with the highest count of cars in this research. This street offers the main connection for people living in the south of Groningen and the main access to the town of Haren in the municipality of Groningen. This street forms the primary connection between the two places. This street has been a street that provides access to people living south of Groningen straight to the Vismarkt and the Grote Markt. This made the street a vital street with a history of car use and freight transport.

Groningen	Pedestrians	Cyclists	Cars	Scooters	Bus	Total Per Street	Percentage Sustainable Mobility
Hereplein NT - 13:42 to 14:12 - 17-04-2024	228	445	196	27	1440	**2336**	**90,45%**
Hereplein RH - 18:26 to 18:33 - 13-05-2024	26	99	25	15	280	**445**	**91,07%**

Table 4: Counts Hereplein. Author (2024)

Overall, Groningen has a high percentage of Sustainable Mobility. The Average of all the streets is 91,47% (Table 5). Therefore, the streets in Groningen have a high sustainability, primarily dominated by the active transport modes of Cycling and walking.

Groningen	Pedestrians	Cyclists	Cars	Scooters	Bus	Total Per Street	Percentage Sustainable Mobility
Total	**2223**	**2223**	**552**	**157**	**3160**	**8315**	**91,47%**

Table 5: Counts Groningen. Author (2024)

7.2 Street count Berlin

After conducting research in Berlin, it becomes clear that the streets have vast differences. Beginning with the Dircksenstraße (Table 6), which is a street running between a mall and an S-Bahn track running towards the Alexander Platz. The S-Bahn track makes the street used by trains bringing in a high count of public transportation. The reasons for the high count of pedestrians are the location next to the mall and the proximity to the city centre. This makes the street very suitable for pedestrians and less for privatised vehicles. The Klosterstraße (Table 6) is a street with a low number of people. Momentarily the street is situated between two construction sites at the Spandauer Straße and the beginning of the Klosterstraße. This makes the street less attractive for car users. The street also provides sufficient space for pedestrians leading up to a shopping centre located in the city centre.

East Berlin	Cars	Cyclists	Pedestrians	Bus	Tram	E-Scooter	Scooters	Motors	Total	Percentage Sustainable Mobility
Dircksenstraße NT1 - 13:12 to 13:22 - 29-04-2024	9	8	153	0	240	0	0	1	411	**97,65%**
Dircksenstraße NT1 - 10:32 to 10:42 - 2-05-2024	26	9	100	0	200	0	1	3	339	**91,04%**
Dircksenstraße RH1 - 9:00 to 9:10 - 3-05-2024	7	7	59	0	400	0	0	0	473	**98,48%**
Dircksenstraße RH2 - 9:15 to 9:25 - 3-05-2024	10	7	62	0	320	0	0	0	399	**97,59%**
Total Dircksenstraße	**52**	**31**	**374**	**0**	**1160**	**0**	**1**	**4**	**1622**	**96,19%**

East Berlin	Cars	Cyclists	Pedestrians	Bus	Tram	E-Scooter	Scooters	Motors	Total	Percentage Sustainable Mobility
Klostertsraße NT1 - 13:42 to 13:52 - 29-04-2024	5	8	79	0	0	0	0	0	92	**94,77%**
Klostertsraße NT2 - 10:53 to 10:03 - 29-04-2024	2	3	47	0	0	0	0	0	52	**95,42%**
Klostertsraße RH1 - 8:58 to 9:08 - 3-05-2024	0	7	44	0	0	0	0	1	52	**98,08%**
Klostertsraße RH2 - 9:18 to 9:28 - 3-05-2024	0	3	39	0	0	0	0	1	43	**97,67%**
Total Klosterstraße	**7**	**21**	**209**	**0**	**0**	**0**	**0**	**2**	**239**	**96,49%**

Table 6: Counts Dircksenstraße and Klosterstraße. Author (2024)

The Spandauer Straße East is primarily car-dominated (Table 7). On this side of the street, the road provides a function of transporting cars through Berlin. The street is a gateway to reach different parts of the city and therefore widely used by cars or buses travelling through Berlin. The buses make the street have sustainable usage. The Spandauer Straße West (Table 7) is not primarily allocated for cars. however, it still experiences a significant number of cars, it also provides alternative use. In the count, we can see a high number of pedestrians wanting to reach the commercial space in the street and Alexander Platz. There is a tram connection that connects the street with other connection options in Alexander Platz and Hackescher Markt.

East Berlin	Cars	Cyclists	Pedestrians	Bus	Tram	E-Scooter	Scooters	Motors	Total	Percentage Sustainable Mobility
Spandauer Straße East NT1 - 11:45 to 11:55 29-04-2024	223	30	38	200	0	0	2	5	498	**53,79%**
Spandauer Straße East NT2 - 12:55 to 13:05 - 2-05-2024	161	32	93	400	0	1	2	3	692	**75,89%**
Spandauer Straße East RH1 - 8:21 to 8:31 - 3-05-2024	120	31	26	120	0	0	1	6	304	**58,22%**
Spandauer Straße East RH2 - 8:36 to 8:46 - 3-05-2024	121	53	19	180	0	0	2	4	379	**66,46%**
Total Spandauerstraße East	**625**	**146**	**176**	**900**	**0**	**1**	**7**	**18**	**1873**	**63,59%**

East Berlin	Cars	Cyclists	Pedestrians	Bus	Tram	E-Scooter	Scooters	Motors	Total	Percentage Sustainable Mobility
Spandauer Straße West NT1 - 11:45 to 11:55 - 2-05-2024	116	31	143	0	639	6	0	5	940	**86,45%**
Spandauer Straße West NT2 - 12:35 to 12:45 - 2-05-2024	114	40	104	40	360	1	2	2	663	**82,05%**
Spandauer Straße West RH1 - 7:45 to 7:55 - 3-05-2024	90	33	23	0	240	1	1	2	390	**75,90%**
Spandauer Straße West RH2 - 8:02 to 8:12 - 3-05-2024	73	34	24	0	360	0	0	3	494	**84,58%**
Total Spandauerstraße West	**394**	**138**	**294**	**40**	**1599**	**8**	**3**	**12**	**2488**	**82,25%**

Table 7: Spandauer Straße Easte and -West. Author (2024)

The Carmerstraße and the Schillerstraße (Table 8) are streets that connect the surrounding area to the centre in the west. Both streets do not have any public transport connections and are primarily used as residential areas. This makes the streets unattractive for traffic. Most of the traffic in the west of the city takes place in the Hardenbergstraße (Table 8). This street connects the Zoologischer Garten and the Ernst Reuter Platz. This is done primarily by car use. Buses are running on this street, but these do not run that frequently. These buses are the only public transport option next to the U-Bahn (metro) that runs the same route but cannot be counted as street use since it is not part of the street composition.

West Berlin	Cars	Cyclists	Pedestrians	Bus	Tram	E-Scooter	Scooters	Motors	Total	Percentage Sustainable Mobility
Hardenbergstraße NT1 - 13:30 to 13:40 - 30-04-2024	349	31	81	160	0	1	11	8	641	**42,42%**
Hardenbergstraße NT2 - 13:46 to 13:56 - 30-04-2024	352	38	72	120	0	0	7	5	594	**38,72%**
Hardenbergstraße RH1 - 17:31 to 17:41 - 30-04-2024	343	46	66	80	0	0	4	2	541	**35,48%**
Hardenbergstraße RH1 - 17:11 to 17:21 - 3-05-2024	324	44	62	280	0	0	2	8	720	**53,61%**
Total Hardenbergstraße	**1368**	**159**	**281**	**640**	**0**	**1**	**24**	**23**	**2496**	**42,56%**

West Berlin	Cars	Cyclists	Pedestrians	Bus	Tram	E-Scooter	Scooters	Motors	Total	Percentage Sustainable Mobility
Carmerstraße NT1 - 15:52 to 16:04 - 30-04-2024	26	10	28	0	0	0	0	0	64	**59,01%**
Carmerstraße NT1 - 16:10 to 16:20 - 30-04-2024	18	7	21	0	0	0	1	0	47	**59,57%**
Carmerstraße RH1 - 18:30 to 18:40 - 30-04-2024	20	9	17	0	0	0	0	0	46	**56,03%**
Carmerstraße RH2 - 18:45 to 18:55 - 30-04-2024	23	10	22	0	0	0	0	0	55	**58,39%**
Total Carmerstraße	**88**	**36**	**88**	**0**	**0**	**0**	**1**	**0**	**213**	**58,25%**

West Berlin	Cars	Cyclists	Pedestrians	Bus	Tram	E-Scooter	Scooters	Motors	Total	Percentage Sustainable Mobility
Schillerstraße NT1 - 16:29 to 16:39 - 30-04-2024	32	20	67	0	0	1	0	0	120	**72,26%**
Schillerstraße NT2 - 16:44 to 16:54 - 30-04-2024	20	28	69	0	0	0	0	2	119	**81,24%**
Schillerstraße RH 1 - 17:53 to 18:03 - 30-04-2024	28	44	44	0	0	0	1	0	117	**75,47%**
Schillerstraße RH2 - 18:08 to 18:18 - 30-04-2024	26	23	44	0	0	0	1	0	94	**70,97%**
Total Schillerstraße	**107**	**115**	**224**	**0**	**0**	**1**	**2**	**2**	**451**	**74,99%**

Table 8: Counts Hardenbergstraße, Carmerstraße and Schillerstraße. Author (2024)

All streets in Berlin have vast differences (Table 9). The West seems to have a lower amount of Sustainable Mobility. The combination of the West and the East brings an average of 70,80%, a relatively high sustainable mobility percentage. The major factor bringing the difference is the lack of public transport connections in the West compared to the East. The West is still more dependent on privatised motor vehicles like cars, motors and scooters.

Comparison	Cars	Cyclists	Pedestrians	Bus	Tram	E-Scooter	Scooters	Motors	Total	Percentage Sustainable Mobility
Total West-Berlin	**1563**	**310**	**593**	**640**	**0**	**2**	**27**	**25**	**3160**	**49,68%**
Total East-Berlin	**1078**	**336**	**1053**	**940**	**2759**	**9**	**11**	**36**	**6222**	**81,95%**
Total Berlin	**2641**	**646**	**1646**	**1580**	**2759**	**11**	**38**	**61**	**9382**	**70,80%**

Table 9: Comparison of the streets in East- and West-Berlin. Author (2024)

7.3 Street Space Allocation Groningen

The street space allocations for the Aweg are constructed for active mobility and privatised motor vehicles in a constructed shared space. However, this street is used mainly by pedestrians and cyclists. Figure 7 shows space for cars to drive but the street is broad enough for car traffic. When you move further into the street to figure 8.2, this changes. With limited access to the city centre by car further into the centre, this street mainly functions as a gateway for people walking or cycling to get to the city centre. Although, there are no protective bike lanes or sidewalks. The street does have parking spaces for bikes.

Figure 7: Aweg with multiple street space allocations. Author (2024)

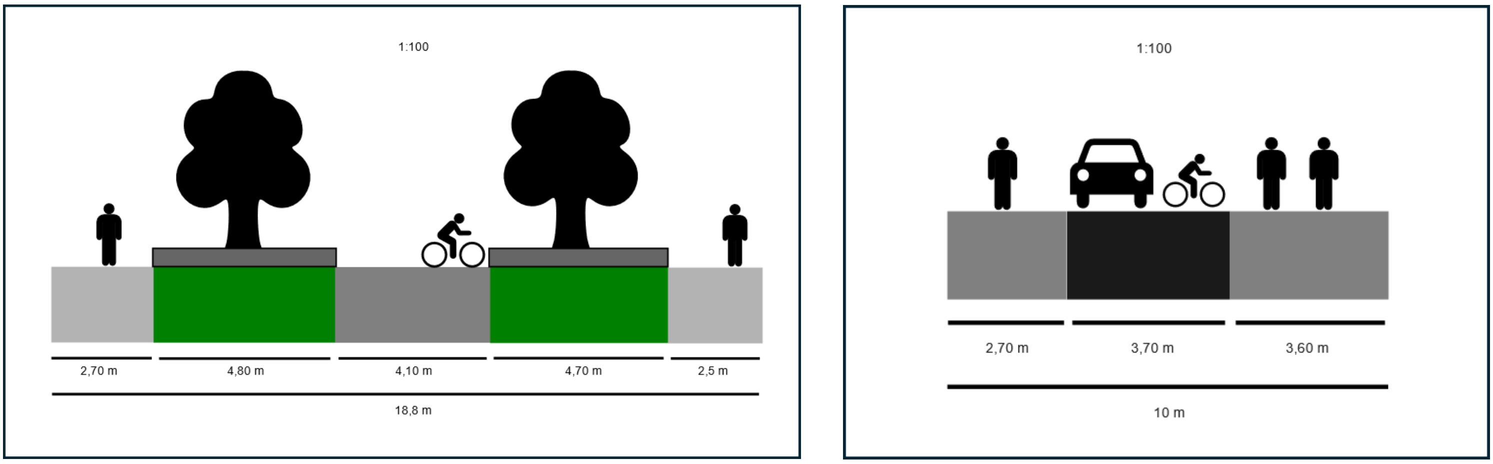


Figure 8.1 and 8.2: Multiple street space allocations Aweg. Author (2024)

Figure 9 shows a dominant space for car users with enough room for both ways of traffic. The street offers enough space on the sidewalks for pedestrians to reach the city centre. There is one bike lane on one side of the street, the Nieuwe Ebbing-estraat, which is not protected (Figures 10.1 and 10.2). This lane gets terminated in the Oude Ebbingestraat. The street invites all modes except for buses. The cross-sections of the Sint Jansstraat (Figures 12.1 and 12.2) show a similar composition to the Nieuwe- and Oude Ebbingestraat. However, it does not have a bike lane whatso-ever, it does have bike parking. Again there is an allocation that invites active mobility and privatised motor vehicles.

Figure 9: Oude Ebbingestraat. Author (2024)

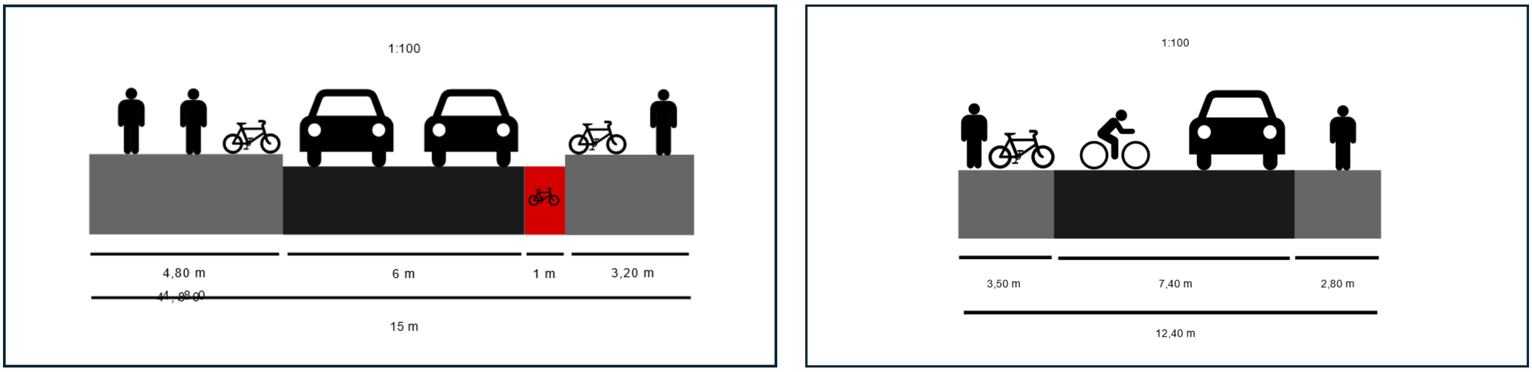
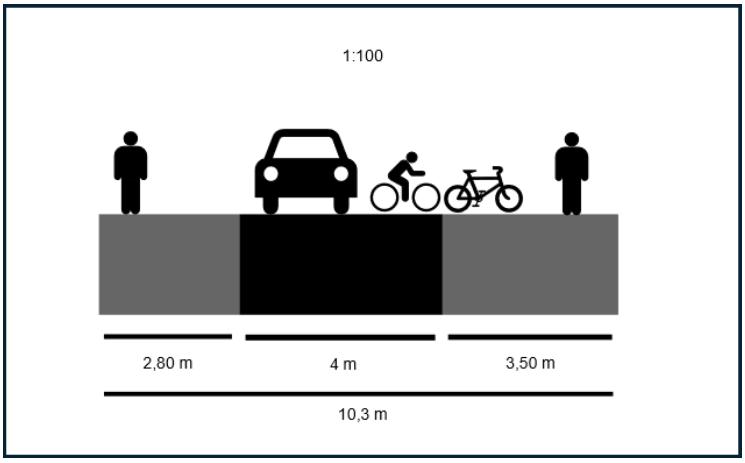


Figure 10.1 and 10.2: Street space allocations Nieuwe- and Oude Ebbingestraat. Author (2024)

Figure 11: Sint Jansstraat. Author (2024)



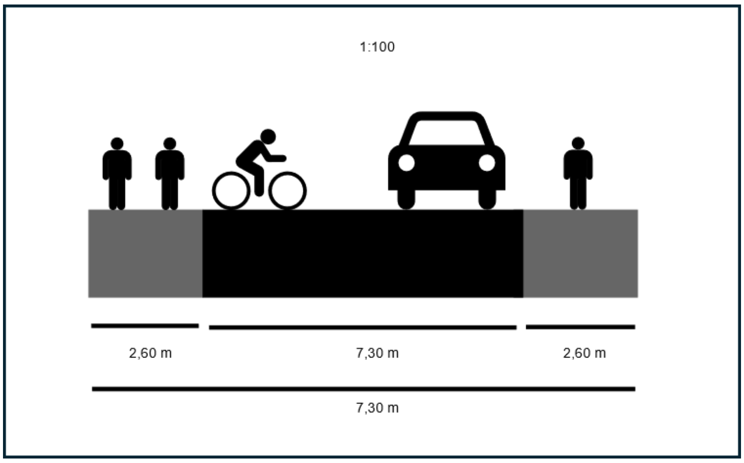


Figure 12.1 and 12.2: Street space allocations Sint Jansstraat. Author (2024

The street space allocation of the Gedempte Kattendiep (Figure 14) invites all types of transportation and is primarily constructed for Buses to get in and out of the city centre. Therefore, it has a broad construction with protected bike lanes and parking options for cars and bikes.

Figure 13: Gedempte Kattendiep. Author (2024)

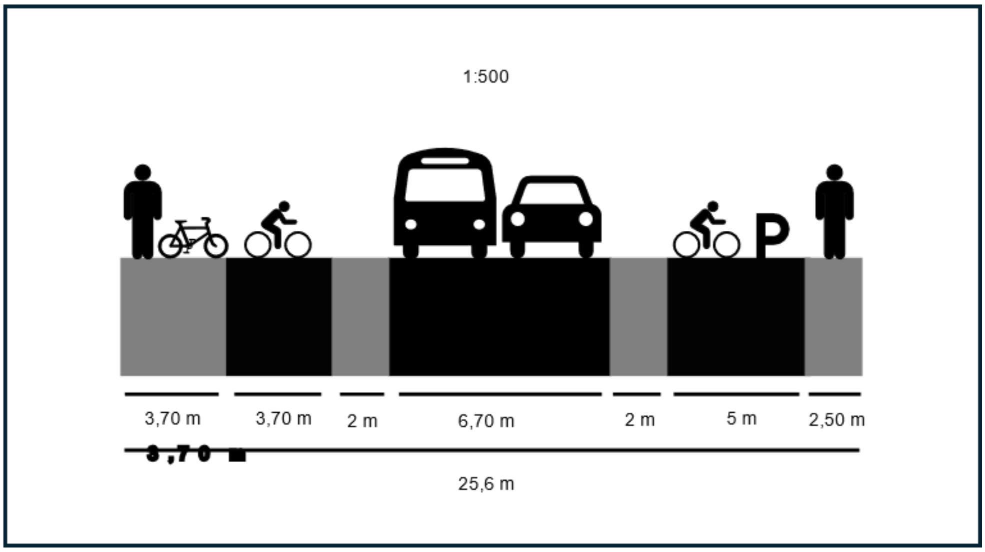


Figure 14: Street space allocation Gedempte Kattendiep. Author (2024)

The Hereplein has multiple different allocations. Figure 16.1 shows space for all modes. Buses are however prioritised in this composition. They can drive straight on the street. while bicycles and cars have to use the roundabout to reach the city centre. In this allocation, a significant amount of space is used for greenery as a roundabout. The roundabout is set up to provide the chance for buses to stop at the bus stop and divert traffic. Figure 16.2 shows the street becoming more narrow with two lanes. There are no bike lanes. The space is filled up with broader sidewalks and bike parking. The Herebrug, (Figure 16.3) shows an allocation mainly focused on motorised vehicles. Four lanes allow cars and buses to get around more easily. There are unprotected bike lanes on both sides of the street. There is also a sufficient amount of space for pedestrians on both sides of the street.

Figure 15: Hereplein. Author (2024)

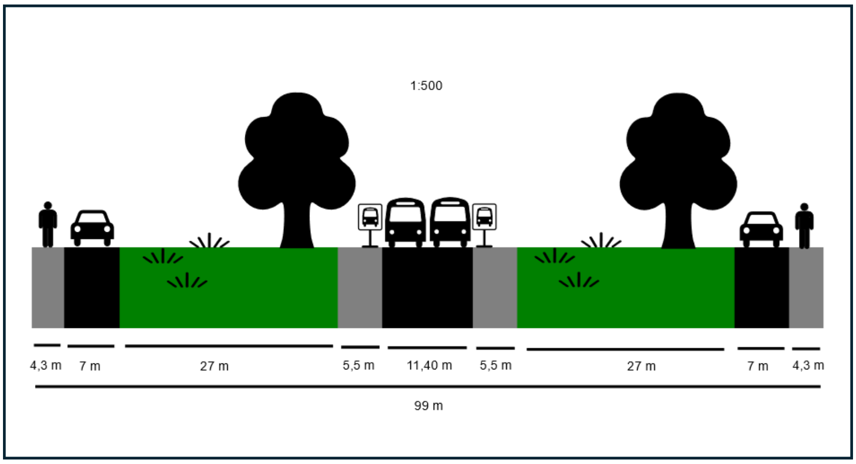


Figure 16.1: Street space allocation Hereweg. Author (2024)

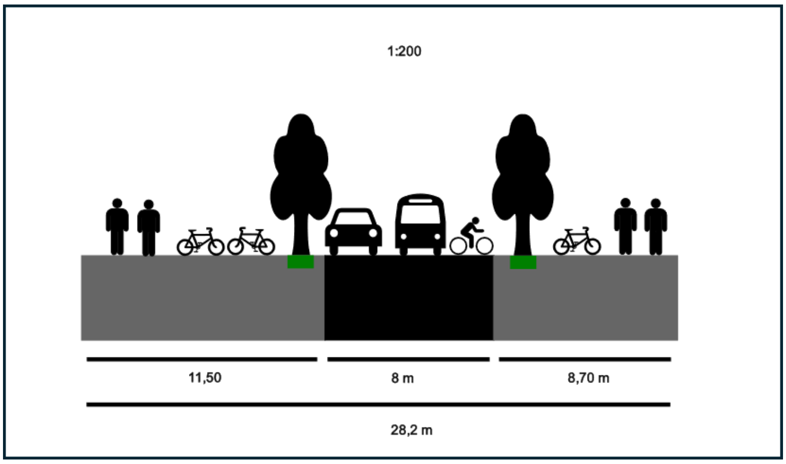


Figure 16.2: Street space allocation Hereweg. Author (2024)

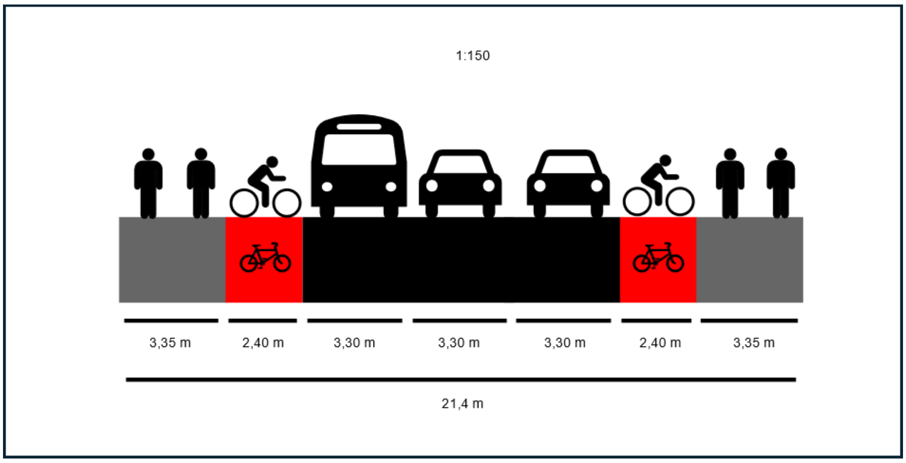
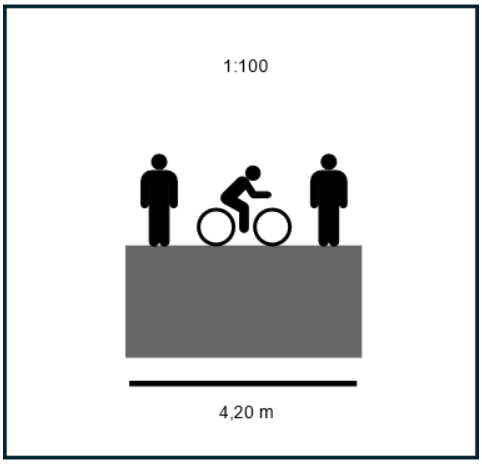


Figure 16.3: Street space allocation Herebrug. Author (2024)

The Ubbo Emmiusstraat and Museumbrug (Figure 12) are primarily allocated for active mobility since part of it is only prohibited for cars. The Ubbo Emmiusstraat is a one-way street for necessary car transportation. However, it mainly provides road use for bikes with sufficient parking space and sufficient sidewalks. The Museumbrug can only be used by people cycling and walking. This is a street without any form of emission.

Figure 17: Museumbrug (Left) Ubbo Emmiusstraat (Right). Author (2024)



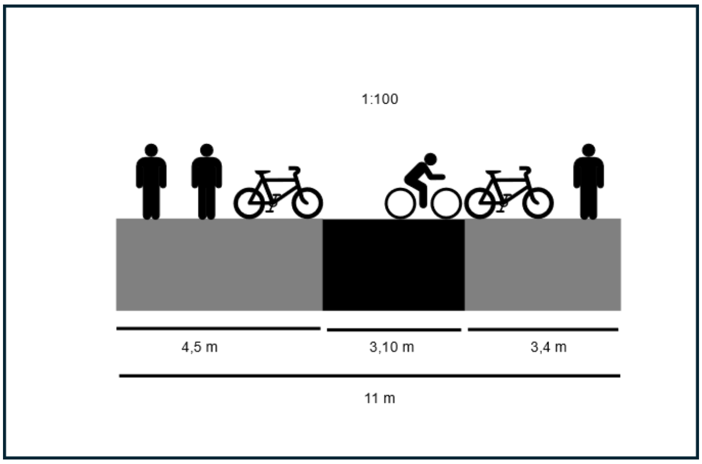


Figure 18.1 and 18.2: Street space allocations Museumbrug (Left) Ubbo Emmiusstraat (Right). Author (2024)

7.4 Street Space Allocation Berlin

The Eastern side of the Spandauer Straße (Figure 20) focuses on cars. It has six lanes for either cars or buses leading to Alexander Platz (Figure 21.1). Next to these lanes, there are two unprotected bike lanes. Between the sidewalk and the bike lane, there is space for greenery on one side. This sidewalk has proven to be used more prominently than the one straight next to the road. The Western part (Figure 19) is more focused on public transport. Instead of 6 lanes for cars, there is room for a tram station on one side and trams going both ways (Figure 21.2). There are however still 4 lanes of which two can be used for short-term parking. The bike lanes from the east become protected and more pleasant for cyclists. The sidewalks are a bit smaller and provide room for restaurants and commercial space.

Figure 19: Spandauer Straße West (Tram). Author (2024)

Figure 20: Spandauer Straße East (Car dependent). Google Maps (2022)

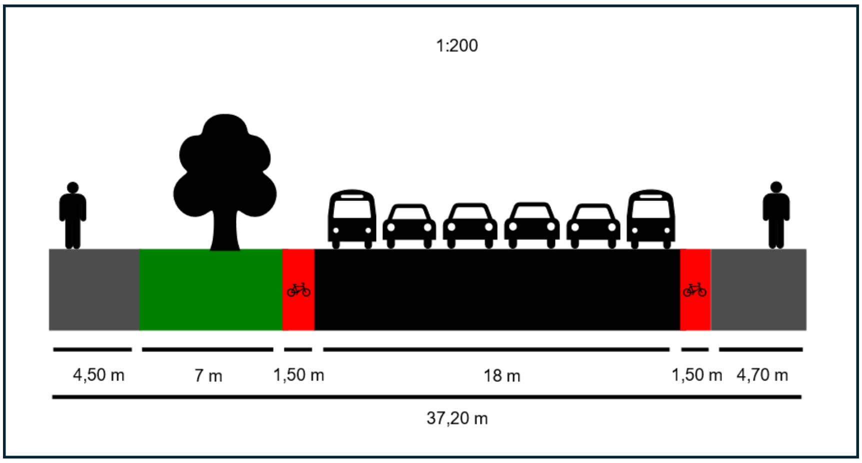


Figure 21.1: Street space allocation Spandauer Straße East (Car dependent). Author (2024)

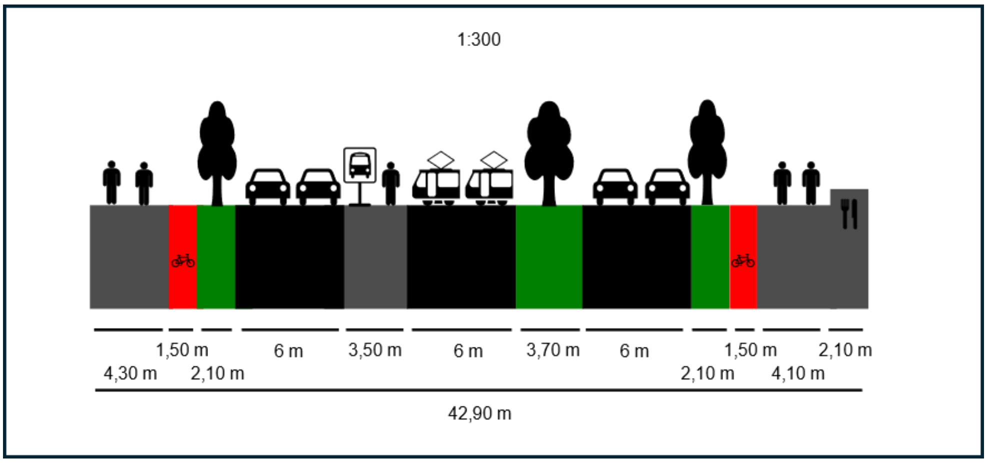


Figure 21.2: Street space allocation Spandauer Straße West (Tram). Author (2024)

The Dircksenstraße (Figures 23.1 and 23.2) has a street allocation devoted to car use. With two lanes going both ways and two parking lanes on the outside of the road. There are no cycling paths on both allocations. There is however bike parking in the allocation on 23.1. Both allocations show wide sidewalks with 23.2 having a plaza that provides access to a mall. This gives more access to pedestrians. The street also has rails on top of the commercial space on the left side. This makes the street more sustainable.

Figure 22: Dircksenstraße. Google Maps (2022)

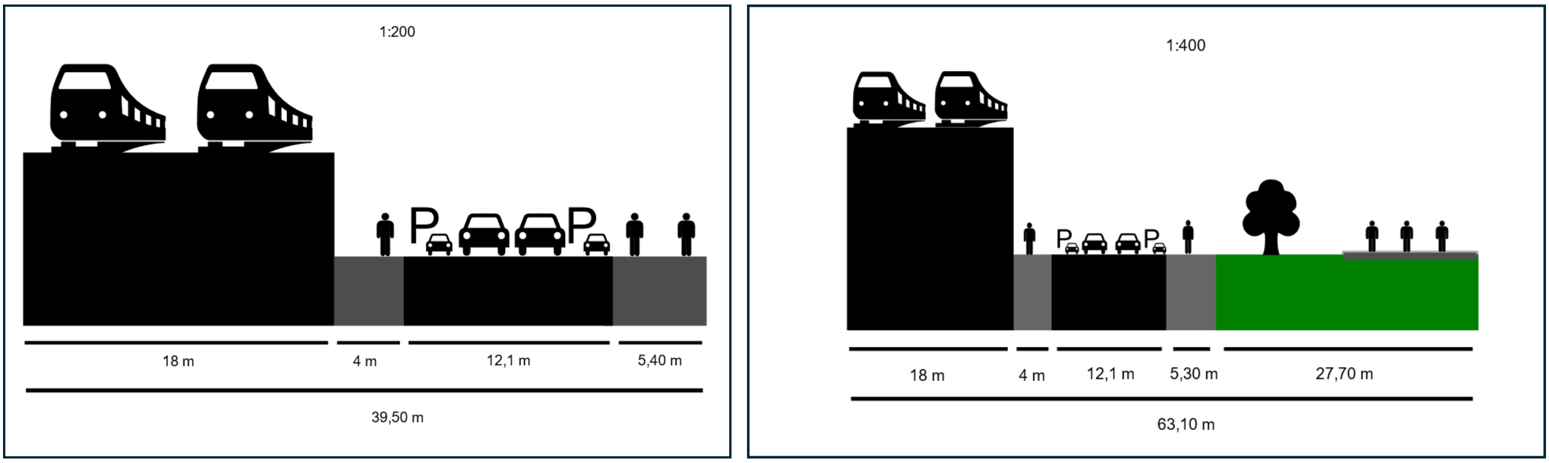


Figure 23.1 and 23.2: Street space allocations Dircksenstraße. Author (2024)

The Klosterstraße (Figure 26) has an allocation focused on cars. It has multiple opportunities for car and bicycle parking and a two-lane road allocated for the use of cars. The street has sidewalks on both sides of the street which are quite broad and inviting for pedestrian use.

Figure 24: Klosterstraße. Google Maps (2022)

In West Berlin, there are similar street space allocations between the Schillerstraße and the Carmerstraße (Figure 25). They are primarily made for car use. They both have two lanes for ongoing traffic and two lanes for parking on the outside. The Schillerstraße is more suitable for bike usage since it has bicycle parking. The Carmerstraße has more focus on wider sidewalks making it more pedestrian-friendly.

Figure 25: Schillerstraße (Left) Carmerstraße (Right). Author (2024)

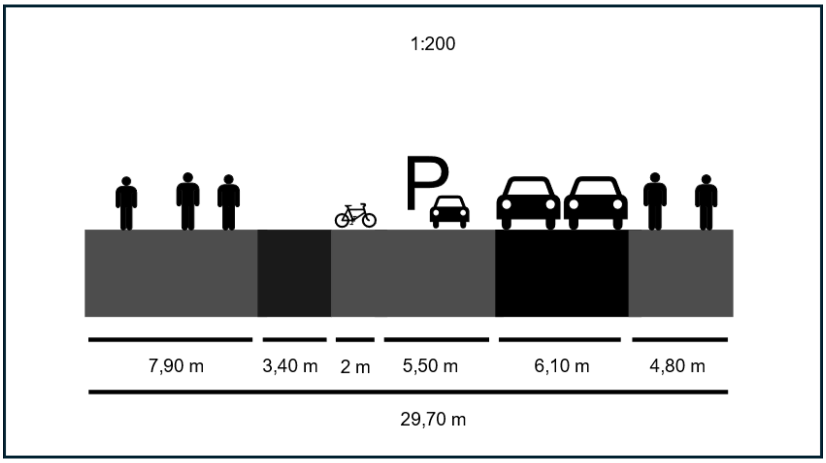


Figure 26: Street space allocation Klosterstraße. Author (2024)

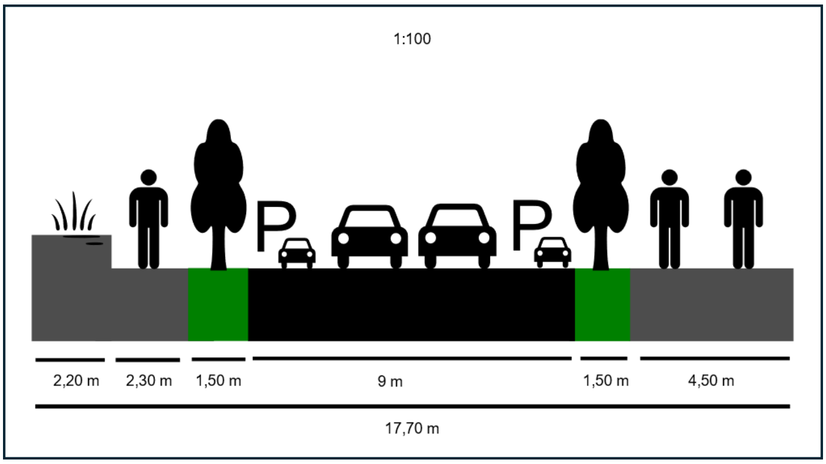


Figure 27: Street space allocation Carmerstraße. Author (2024)

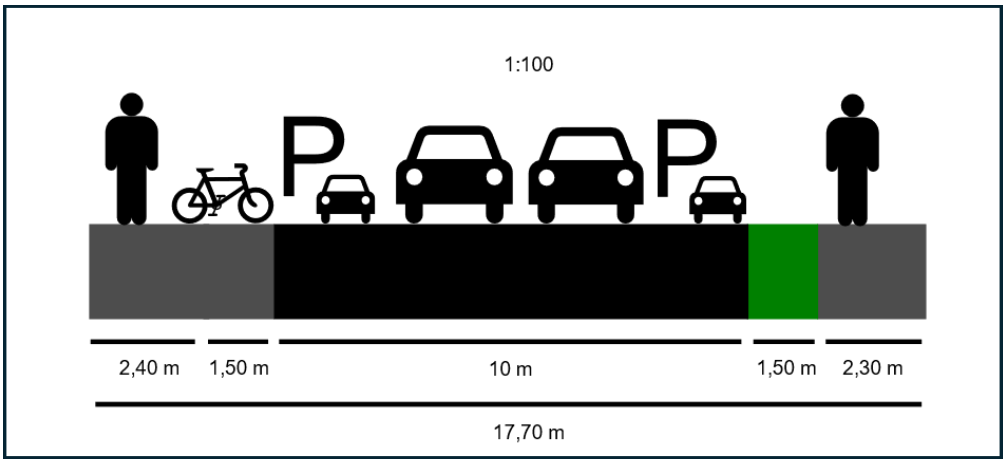


Figure 28: Street space allocation Schillerstraße. Author (2024)

The Hardenbergstraße is primarily focused on car flow. This means that there is limited to no opportunity for car parking along the road. It has six wide lanes for privatise motor vehicles and buses. There are no bike lanes and insufficient opportunities for bicycle parking. The sidewalks on the left side are significantly wider than the other side of the road and attract more users because of this. Between the two is a buffer of trees. In between the six lanes, there is a safety buffer dividing ongoing traffic.

Figure 29: Hardenbergstraße. Author (2024)

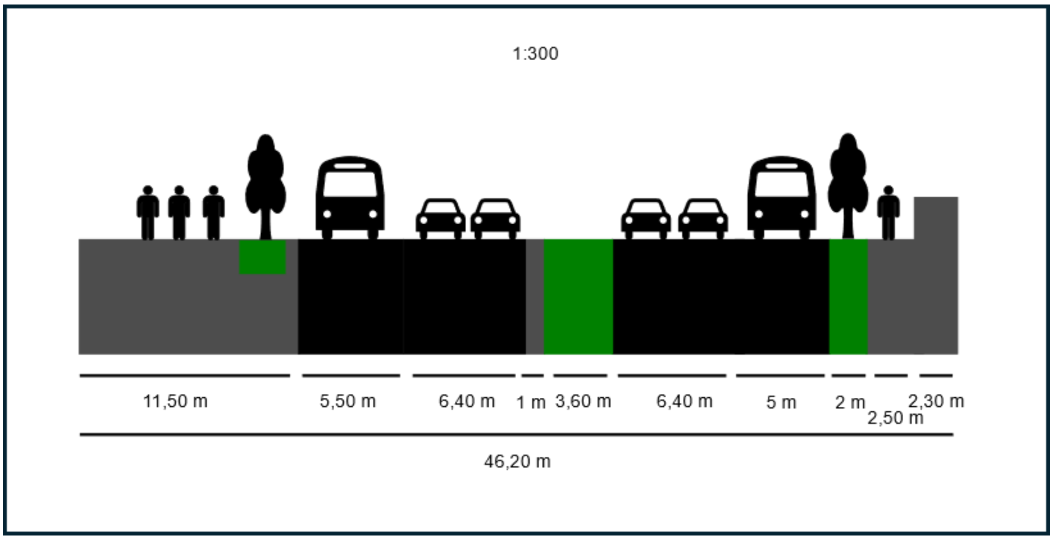


Figure 30: Street space Allocation Hardenbergstraße. Author (2024)

8. Discussion

Groningen has a significantly higher percentage of sustainable mobility than Berlin with approximately 10% (Table 10). In Groningen, street use is more focused on cycling while Berlin has a prominent focus on car use and public transport. However, the bus count is still higher in Groningen since they run more frequently than in Berlin. Furthermore, Berlin does have more public transport options with the tram, bus, S-Bahn and the U-Bahn. The count of pedestrians is higher in Berlin than in Groningen. However, there is still 20% unsustainable mobility in an area that is most suitable for sustainable modes of transport because of the density and activities. This suggests that there is still room for Berlin to grow in sustainable mobility. After comparing the cities, active mobility can be a factor to decrease the almost 20% unsustainable mobility in Berlin.

Comparison	Groningen	Berlin
Cars	552	1646
Cyclists	2223	646
Pedestrians	2223	2641
Bus	3160	1580
Tram	0	2759
E-scooter	0	11
Scooter	157	38
Motor	0	61
Total	**8315**	**9382**
Percentage Sustainable Mobility	**91,74%**	**81,40%**

Table 10: Results of counting in city centre access streets in Groningen. Author (2024)

There are significant differences between the street space allocation in Groningen and Berlin. For instance, the size of the street is wider in Berlin. This can be explained by the size of the city and the amount of road users and inhabitants in general. Due to this, the streets had wide sidewalks which is attractive for pedestrians. The streets in Berlin are allocated for the use of private vehicles. Multiple streets in Berlin have more the two lanes used for cars. In Groningen, there is only one street allocation that exceeds this limit. In Berlin, there are more opportunities for parking cars alongside the street. In Groningen, this is not possible in the streets that were researched. Instead, these streets were filled with bicycle parking which is very rare in Berlin. Groningen however does not promote cycling when it comes to street space allocation with only three bike lanes. Whereas Berlin came in a bit lower with two bike lanes. Groningen however, does have more shared space locations that experience heavy bicycle usage. This is not necessarily allocated for bicycles but used in this manner. Therefore, Groningen would be considered more sustainable since it has fewer car lanes and more bicycle parking.

9. Conclusion

This paper provides an overview of the level of sustainable mobility in Groningen and Berlin. Groningen is more active in the promotion of cycling mobility in Groningen. The city has implemented multiple policies and physical changes to the street patterns to prioritize cycling in most streets that were researched. This has resulted in sustainable mobility where active mobility is the most important part of transportation. However, the city does not necessarily provide the streets with a street space allocation that focuses on active mobility. Bike lanes are neither protected nor prominent in the street patterns. Berlin has one protected bike lane but the other bike lanes are less protected than Groningen. Other reasons like policies and mobility strategies seem to explain the high amount of cyclists and pedestrians. The availability of a large supply of bicycle parking also affects the count as concluded by earlier research (Möser and Bamberg, 2008).

Berlin is proven to be focused on motorised transport. Together with the amount of parking spaces created inside the city, car usage is promoted. The share of public transport is higher than Groningen and the main contributor to the calculated percentage of sustainable mobility. This overlaps with the results of the study by (Currie, Sarvi and Young, 2007) on public transport. There are vast differences in the city when it comes to both street use and -space allocation. The West has a higher car use which makes it less sustainable while the East has more focus on trams and buses.

Both cities have chosen different types of modes to achieve more sustainable mobility. This makes all cities difficult to compare and learn from each other. The city of Groningen is the leader in this research and provides the most points towards more sustainable mobility. Strategies and policies towards cycling mobility have seemed to help. This is a contrast to the view of contemporary transport planning being dominated by cars (Gössling, Schröder and Freytag, 2015; Guzman *et al.*, 2021). Berlin could implement more focus on these kinds of strategies. A drastic change in street space allocation is not necessary but can help to achieve more sustainable street use. This could be done by increasing active mobility strategies. This has proven to be effective in Groningen and past practices (Yang *et al.*, 2010). Berlin has a high use of public transport in the city. Groningen seems to have fewer pedestrians inside the city. To change this the city could look into more pedestrian-friendly infrastructure. Berlin provides wide sidewalks that make this attractive. How this can be implemented the best for Berlin, Groningen and all cities around the world could be topics for further research.

In conclusion to this research, Sustainable mobility can be achieved when implementing active mobility strategies and applicable sustainable street space allocation. By combining these factors, cities force a transport switch to a more sustainable future in city centre access streets. Future research can be done on the best way to implement this.

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