Evaluating car redundancy policies in Groningen

While drawing lessons for Berlin

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Abstract

The use of the private car has for long been seen as the ultimate form of transportation freedom. However, negative side effects such as noise-and air pollution, space occupancy, health issues, inequality, combined with the move to a sustainable feature has made the role of the car in cities questionable. Already in the 1970s, Groningen and Berlin have changed their transportation paradigm to balance transportation and these negative impacts. The Groninger' *Verkeerscirculatieplan* (1977) was the first mobility concept of its kinds, and regarded as a successful concept reducing car dominance. Whereas Berlin's policies were less successful, and even though its high urbanity, has a significantly higher share of car usage than Groningen. Therefore, this case comparison between Groningen and Berlin focuses on success factors and car redundancy perception in Groningen, and aims to draw lessons for future mobility policy in Berlin. Literature studies and surveys were conducted in Groningen, which concluded measures taken in the city centre were successful and perceived as pleasant by visitors. Measures on car redundancy for the whole city (*Doorwaadbare Stad)* were furthermore positively looked upon. In Berlin, visitors of the Friedrichstrasse and Bergmannstrasse were interviewed regarding recent redesign of the streets with car redundant measures. Overall, the streets were perceived as more pleasant, safe and ambient. A significant correlation between perception of pleasantness and age, gender and mode of transport use was found. To compare, Berlin seems to have an unsaturated transportation demand for alternative transport options to the car. To obtain this, car redundancy measures taken in Groningen, such as the *Verkeerscirculatieplan,* seem to be efficient, and contemporary policies such as the *Doorwaadbare Stad* offer insights into comprehensive and holistic measures to end car-dominance.

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1. Introduction

The increase of car usage and private ownership has long been seen as the ultimate form of freedom for many, and worldwide it is the most used form of transportation in both and urban and rural setting (Hopkins et al., 2019). However, most cities are now facing the consequences of the perceived 'freedom' of ever-increasing volumes of cars in the city, and their negative side-effects and impact on the environement (Maibach et al., 2009; Monheim, 1996; Nieuwenhuijsen & Khreis, 2016; Saeidizand et al., 2022; Steinmeijer & Hermann-Fiechtner, 2017). That is why many cities around the world are aiming to change their transportation behaviour, from current car dominance, to active mobility and public transport efficiency (Gundlach et al. 2018; Maibach et al. 2009). A case comparions between Groningen and Berlin was therefore conducted, as Groningen has successfully implemented car redundant measures, and Berlin is shifting that way. Thus, the aim is to draw lessons from Groningen's policies. This has been facilitated by STOURIE (*Sustainable Transformations of Urban Regions in Europe)*, and results in data collection in the city centre of Groningen and two recently redesigned streets in Berlin, the Friedrichstrasse and Bergmannstrasse.

1.1 Car redundancy

This case comparison focuses on car redundancy measures that have been taken in both cities. Car redundancy is a previously non-existing term derived from the Dutch word *Autoluw*, which means car-reduction and implies making the car obsolete (Willemsen, 1997). It is also similar to Topp & Pharaoh (1994)'s term 'car-free'; however, to avoid confusion with entire car-free areas, a new term is used. Car redundancy implies service vehicles, deliveries and other exceptions are present to make sure the city stays functional. Therefore, this paper will work with the term car redundancy. This is obtained by implementing push & pull factors, as merely requesting people to change their behaviour is not effective often (Tertoolen et al., 1998). Examples of push factors include lack of parking, one-way streets, traffic circulation cuts, increased parking fees, zoning or time-of-day bans, lower speed limits and time of travel increase, all with the goal of making it a less desired transportation option (CROW, 1985; Gemeente Groningen, 2021; Topp & Pharoah, 1994). The most efficient pull factors include good alternatives to encourage modal split, by increasing public transport and cycling infrastructure, while also changing the city functions (Kwik & MacFarlane, 2014; Mueller et al., 2020).

1.2 Research aim

Based on the presented societal and scientific relevance of car redundant cities, the following main research question was posed:

"To what extent are car redundancy policies from Groningen appropriate for Berlin?"

It is therefore important to explore mobility concepts and their potential impact on the city centre of Groningen. The effectiveness is also researchable through the perception of the city centre on visitors. Lastly, the perception and attitude of Berlin residents on car redundancy measures needs to be established. Therefore, the following sub-questions have been formulated to answer the main research question:

1. *To what extent have car redundant concepts been effective in the city centre of Groningen?*
2. *How do people experience the city centre of Groningen after car redundant policy measures?*
3. *How do people perceive car redundant environments in the Bergmannstraße and Friedrichstraße, Berlin?*
4. *What are factors influencing negative thoughts on car redundancy in Berlin?*

1.3 Societal & scientific relevance

The rise of private car ownership and usage has posed cities across the world with challenges, including noise and air pollution, congestion, inequality, safety concerns, health issues and taken up space (Gundlach et al., 2018; Maibach et al. 2009; Monheim, 1996; Nieuwenhuijsen et al., 2019; Saeidizand et al., 2022). The world is in a climate crisis, partly caused by transportation producing CO_2 and NOx pollution (Chapman, 2007; Jung & Koo, 2018). Car usage and adherent pollution is also repeatedly cited as a cause for premature morbidity and mortality (Mueller et al., 2020; Nieuwenhuijsen & Khreis, 2016). A balance between mobility and health and environmental affairs is therefore deemed necessary (European Commission, 2004). A solution is active mobility, as it takes up less space, does not pollute and contributes to a healthy lifestyle (Fazio et al., 2021; Oja et al., 2011). Therefore, cities want to shift away from car-dependency, and adapt their space to car redundant concepts that induce other transportation usages (Gemeente Amsterdam, 2019; Gemeente Groningen, 2021; Maibach et al., 2009). By comparing the city of Groningen, that started car redundant concept implementations in the 1970's, and Berlin, that completely redesigned two streets just recently, a case comparison was made that aims to highlight effective concepts. The study therefore fills in a research gap posed by Nieuwenhuijsen & Khreis (2016), that state further research into these concepts and their effects on the city-scape itself is needed. It further builds on the welfare Groningers enjoy from their car redundant city centre (Kwik & MacFarlane, 2014), and the unsaturated transportation needs (especially safer bicycle options) of Berlin residents (Gundlach et al. 2018).

1.4 Outline

First, the theoretical framework presents several policy concepts that describe what measures and institutions for Groningen's mobility exist, and what their effects are. The methodology chapter explains the mixed methods performed per city and how these were conducted. These are then discussed to explore what Berlin could implement that worked in Groningen, and what should be avoided. Then recommendations for further research are made and combined with limitations of this study.

2. Theoretical framework

Over the past decades, a lot of mobility concepts involving car reduction have been introduced in Groningen and studied thoroughly. To make the study comprehensible, three main policy concepts were included that had or will have the most influence on Groningen's mobility. These include the innovative *Verkeerscirculatieplan*, or VCP (1977); arguably having the most impact on Groningen's mobility, while also laying the basis for other Dutch cities (CROW, 1985). Then the shared space concept is discussed to examine its functioning and pros and cons. Lastly, the contemporary (2021) approach of de *Doorwaadbare Stad* is discussed, as this concept aims to expand the measures taken in the city centre to the entirety of the urban space (Gemeente Groningen, 2021) (Figure 5).

2.1 Verkeerscirculatieplan

According to CROW (1985), the VCP (traffic circulation plan), was put into place to relieve Groningen from its traffic-induced problems, which deteriorated the liveability of the city. Positive experiences in Bremen (Germany) and Gothenburg (Sweden) led to the creation of over 5000 measures, all executed over the course of one night in 1977. While the measures were mainly aimed at reducing the impact of automobiles in the city to regain the quality of living, working and overall experience, the city centre also had to remain accessible. Measures included; dedicated bus lanes, one-way streets (for cars), bicycle lanes, parking outside of centre and most importantly the creation of four sectors (Figure 1). The Diepenring acted as the arterial road for access to the city centre. Once a car enters such a sector, it is not allowed to go into another sector without using the arterial road. This meant most car traffic was concentrated on a few arterial roads, which created space in the city centre for people. The Grote Markt (central square) could host markets again, other squares were no longer used as parking lots, and public transport became more efficient in the centre.

As the *VCP* was the first of its kind in the Netherlands, its effects have been studied tremendously for short term (1978) and long term (1983), as described by CROW (1985). On the short-term, inner-city visits were reduced by 7%, but by 1983 it was up by 40%, also positively affecting shop-owners. Moreover, the modal split changed: the first year after *VCP*, the car-share was reduced by ~44%, cycling and walking by ~10%, while the use of public transport increased by 13%. In 1985 car share was down 30% compared to 1977, while bicycle traffic increased by over 50%. Furthermore, traffic accidents decreased, alongside noise- and air pollution.

VCP division of Groningen city centre

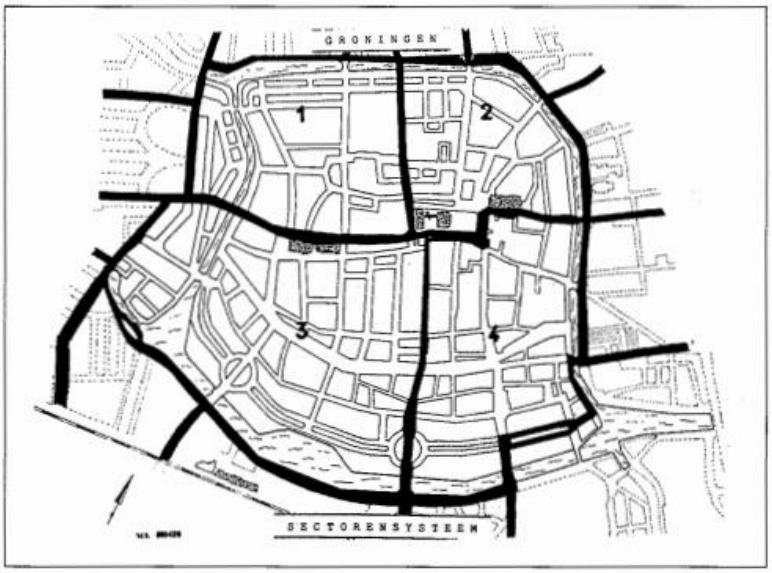

Figure 1. The Traffic Circulation Plan's sectors drawn on map of centre of Groningen. The Diepenring (outside ringroad) acting as arterial road, with minimized traffic in the actual centre (CROW, 1985).

In the centre decibel levels decreased by 2-12, while on the Diepenring they increased by 1-4. Subjectively, 20% less inhabitants experienced noise pollution inside their house, and where before 41% of inhabitants experienced air pollution, it was now only a quarter.

Since 1977, and research from CROW (1985), some modifications took place to solve certain tensions caused by the *VCP*. However, its effects are still seen as positive, and the city centre of Groningen is still benefitting from the car redundant area this act created (Huyink, 1995; kwik & McFarlane, 2014; Tsubohara, 2012)

2.2 Shared Space

Shared Spaces were originally introduced in the 1970s by Dutch traffic engineer Hans Monderman to increase road safety. Over the past years, the concept has seen an increase in implementation. According to Clarke (2006), the concept works by engineering a street to be perceived as rule-less. Traffic signs, curbs, lanes, markings etc. are removed, to create one space shared by pedestrians, bicyclists and sometimes also motorized vehicles (Figure 2). This removes the hierarchy on the road and adds confusion, and thus creates perceived risk for its users. From this risk perception, users tend to respect other users more, they drive slower and seek eye contact, while also paying more attention to their environment. The *Shared Space* environment is seen as more attractive and safer than other street designs aimed at increasing safety and reducing car traffic (Müggenburg et al., 2022). However, vulnerable groups tend to feel less safe because of these implemented measures. A study by Havik et al. (2012), found that all researched *Shared Space* environments in the Netherlands had potential problems for people with impaired eyesight. A solution according to Kaparias et al. (2012), is to make (vulnerable) pedestrians feel more seen on the road, either by minimising motorized traffic, increasing pedestrian traffic or adding pedestrian-only facilities. Overall, the concept has shown its promised effectiveness, accidents resulting from vehicular crashes are less severe, and happen less often (Hamilton-Baillie, 2018). However, it is not a city-wide solution, as it would severely slow down important traffic too. In the mobility vision of Groningen (*Doorwaadbare Stad*, Section 2.3) it is therefore only implemented at hotspot locations where there are also a lot of vulnerable users, like shopping centres (Gemeente Groningen, 2021).

Shared Space concept in Groningen

Figure 2. A shared Space in the Brugstraat, Groningen. A busy road for pedestrians and cyclists entering the centre, with room for lounging (Verkeersnet, n.d..).

2.3 Doorwaadbare stad

This policy plan of the Gemeente Groningen (2021) is a vision of mobility for 2040, essentially translating into the *Traversable City*. It is possible to go by car, but other options are preferred. The policy plan aims to make current *room for traffic* into *room for living space* (car redundancy), and has five main goals:

- More space for pedestrians
- More space for bicycle traffic
- More spatial quality
- More greenery and climate adaptation
- A more pleasant environment

Pedestrians, cyclists and public transport are thus prioritized, and car traffic is discouraged, while still being a possibility for those who prefer or need it. Nearly all residential roads will be changed to 30 or 15 km/h, and the car will be the guest (Figure 3). Furthermore, certain 'places to experience' are designated that attract a lot of pedestrians and vulnerable groups, these places can accommodate the car, but in the concept of the Shared Space. Other streets will become '*bicycle streets'*, where bicycle traffic is so intense the current capacity cannot handle it. Cars and busses will need to adjust to the speed of the bicyclists, which makes them the guests of the road.

Essentially, the measures taken in the city centre during the 1970's from the *VCP*, are implemented throughout the city. Proposed cuts (*knippen*) in the road network aim to stop car traffic circulating, with roads being able to only serve local traffic. At the same time, public transport reliability and speed is of the essence, so bus-only lanes are maintained or installed, and important PT routes will keep a maximum speed of 50 km/h. As the busses in the city centre tend to clash with other transportation forms, they are moved out of the Grote Markt area to outside the inner-city centre.

Doorwaadbare Stad measures in Groningen

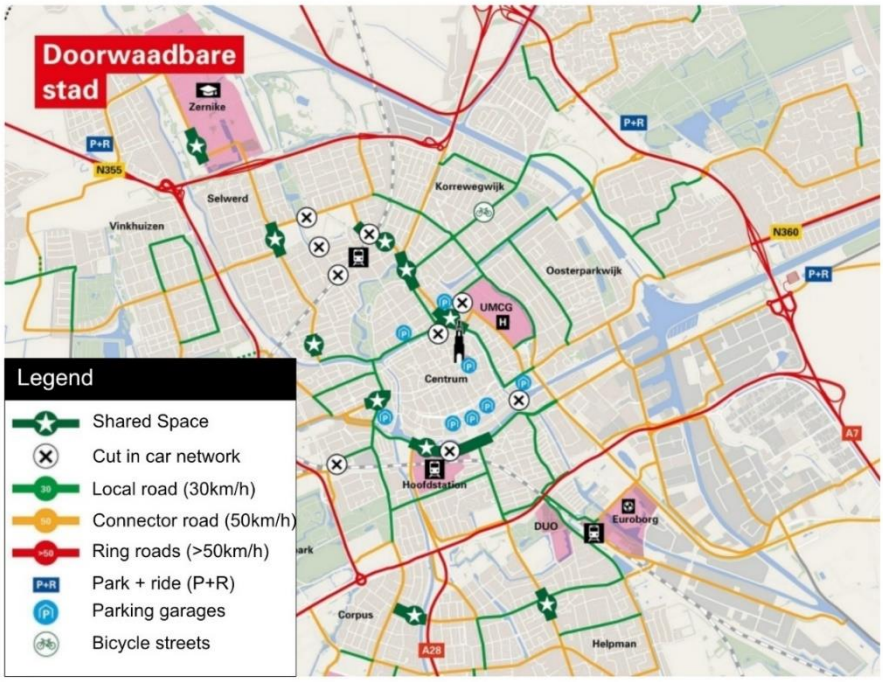

Figure 3. Proposed road purpose in the Doorwaadbare stad policy. The city centre is left untouched, as it already applied these proposed interventions through the VCP (CROW, 1985; Gemeente Groningen, 2021).

2.4 Effects of concepts

The above-mentioned concepts all centre around reducing car traffic and dependence in the city. However, what exactly are the effects of car reduction? Firstly, one of the most important consequences is the reduction of air pollution, also observed after VCP, namely CO_2 and NOx (Chapman, 2007; CROW, 1985; Jung & Koo, 2018). This is beneficial for the climate, and reduces premature mortality and morbidity (Mueller et al., 2020; Nieuwenhuijsen & Khreis, 2016). Furthermore, reduced car numbers also translate into less lanes, parking spaces and other car-related facilities, freeing up space for liveability such as green space, street furniture, and public squares (Figure 4) (Nieuwenhuijsen & Khreis, 2016; Roo et al. 2011).

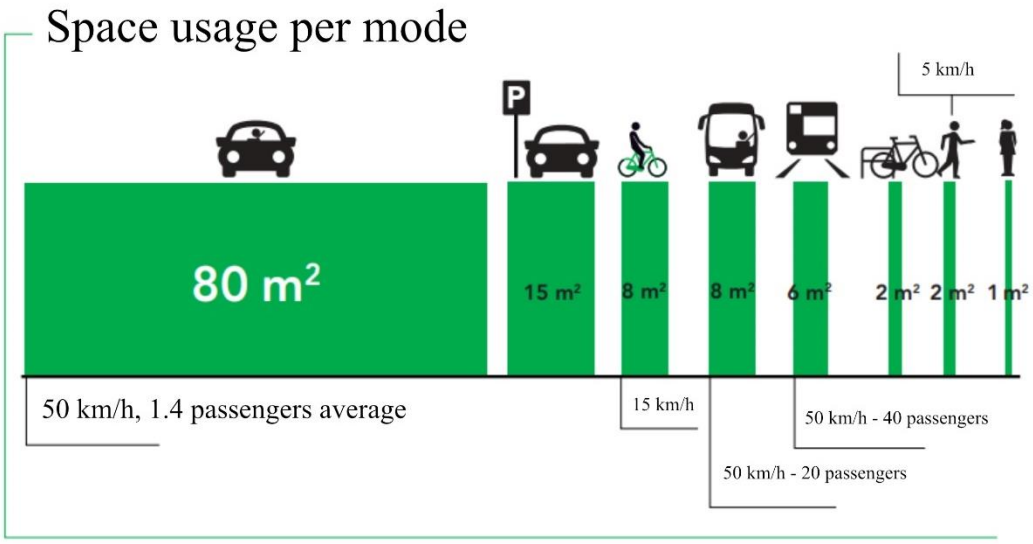

Figure 4. Space needed per modality (Gemeente Amsterdam, 2019).

This also frees up space for active and physical activity, from commuting to leisurely activities, increasing health effects (Mueller et al., 2020). It also facilitates social interaction at more spontaneous moments (Nieuwenhuijsen & Khreis, 2016). A healthy city is also often a liveable city, due to how the city space is more appeased to the human scale for commuting, relaxation or recreating (Khomenko et al., 2020; McArthur & Robin, 2019). This human scale includes visible life on the city streets; people want to see what is going on, there is always something happening (Roo et al. 2011). Cities designed for cars are often too anonymous and grand, and thus activities are hidden inside the buildings creating dead cities (Roo et al. 2011). Another effect is urban compactness, as car redundancy allows for density and lively public meeting spaces close-by, creating a sense of community (Mueller et al., 2020; Topp et al., 2020).

2.4.1 Negative effects

There are also negative consequences derived from car reduction. Older people or other vulnerable demographic groups can have a sense of feeling less mobile, as they cannot travel by car everywhere. However, Kwik & McFarlane (2014) note this consequence can be countered by efficient public transport and certain permit allowances for these groups. Furthermore, inclusivity should not decrease from implementation of car redundant areas by socio-economic separation, as prices may increase and less fortunate groups are pushed to the outskirts of a city (Nieuwenhuijsen & Khreis, 2016). This mechanism is also present in green spaces and can contribute to gentrification (Jelks et al., 2021). This is refuted by Gemeente Amsterdam (2019), who claim places with car reduction measures have an increased inclusivity, from more affordable and efficient transportation options. Nieuwenhuijsen & Khreis (2016) further stress the need for research into traffic related stress on detour roads, something that Groningen experienced first-hand from the *VCP* (CROW, 1985).

The effectiveness of car redundant measures has been researched in Groningen before (CROW, 1985; Kwik & MacFarlane, 2014; Tsubohara, 2012). However, Mating & Daalhuizen (2017) describe car ownership to be a potential factor too, as mobility policies regarding car dominance influence ownership.

2.5 Conceptual Model of the theoretical framework regarding car redundancy

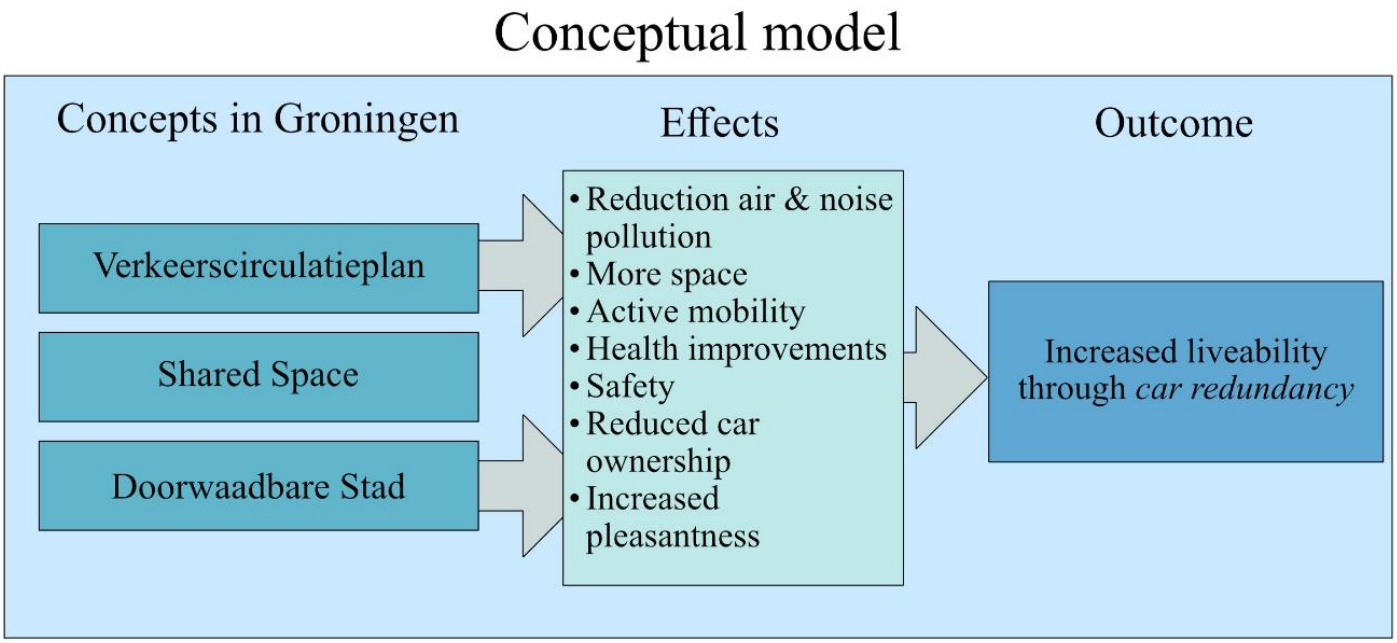

Figure 5. Conceptual model visualising policy plans and concepts applied in the city of Groningen, their intended effect and the resulting outcome for Berlin.

3. Methodology

This study compares the cases of Groningen and Berlin. Participants' perception on mobility concepts and resulting measures in both cities was measured, with the help of primary & descriptive data collection. Also, the general success of previously implemented mobility measures in Groningen was researched. As this is a complex topic involving two cities with very different mobility features, mixed methods were used (Clifford et al. 2016). This triangulation increases validity and adds new insights and perspectives to the study, and ensures qualitative and quantitative qualities are taken into account. This resulted in the following; literature study & web-based surveys in Groningen (sub-question 1 & 2), and semi-structured interviews and observations in Berlin (sub-question 3).

3.1 Mobility characteristics of Groningen and Berlin

Characteristic	**Groningen**	**Berlin**
Important mobility policy	*1977 - Verkeerscirculatieplan* Improve liveability Push car use outside city centre Innovative and successful	*1970s - Integrated traffic paradigm solutions* Traffic solutions -> integrated urban planning Increase mobility by PT Ineffective, promoting PT and the private automobile
Contemporary mobility policy	*2021 - Doorwaadbare stad* Car-centric -> post car approach Improved spatial quality for entire city Preference for pedestrians, bicyclists, PT Shared Space Concept	*2017 - Berlin mobility act* Increase preferred urban mobility options Sustainable and future oriented
Modal share	*2018*	*2013*
Car	30	30
Public transport	6	27
Bicycle	43	13
Pedestrian	21	31
Vehicle ownership per person	2020	
Private automobile	0.35	0.35
Bicycle	1.4	0.75
Infrastructure pattern	Radial – concentric	Radial – concentric + outward arterial
Bicycle share	Inner city 60 Outer city 37,5	Inner city 18 Outer city 10
Population	230.000	3.645.000
Pop. Density	1257 / sq. km	4193 / sq. km

Tabel 1: Groningen and Berlin compared on most important mobility policies, current policies and modal share alongside other characteristics. Sources: Basismonitor Groningen, 2019; Crow 1985; Gemeente Groningen, 2021; Kwik & MacFarlane, 2014; Ozisik, 2018; Reinhold, 2008; Steinmeijer & Hermann-Fiechtner, 2017.

Groningen was chosen as it is a frontrunner when it comes to mobility policy, as it was the first city to implement 5000 car redundant interventions in 1977 (CROW, 1985). It is now known as a city where biking is more common than taking the car, and generally seen as a success (Gemeente Groningen, 2021). Berlin chose a different mobility vision in the 1970s, as a paradigm shift took place during that time with a more integrated focus on urban planning as opposed to traffic planning (Haefeli, 2006). Main objective was increasing individual mobility, while containing unstoppable traffic growth of private vehicles. In reality this focus was mainly on public transport and creating small, pedestrian only places: the bike was largely ignored. It was a mobility paradigm that was at first rather weak, but did manage to control car usage in Berlin to a certain extent (Haefeli, 2006). Nowadays, there is a large unsatisfied potential for other transportation options, as Gundlach et al. (2018) report over 60% of inner Berlin residents favouring a car-free city centre. The two cities and their mobility history and specifications are compared in Table 1.

3.2 Web-based survey - Groningen

In Groningen, the data collection consisted of web-based surveys to explore mobility effect and perception of the city centre (sub-questions 1& 2). Simple survey questions were asked to gather an insight into how the city centre is perceived. As surveys are mostly quantitative, they offer reliable and comparable data, however, this method can lack in-depth responses (Clifford et al. 2016). To offset this, the data is compared to literature on mobility concepts to compare general concepts.

3.2.1 Encountered limitations

The survey was distributed in the city centre of Groningen and has a sample size of 42. This low amount is unsuitable for real quantification studies; however, it does add to the explorative nature of this study. Sampling bias and nonprobability sampling occurred, as random passers-by were approached. Overall, the non-response was high at around 90% of people approached not wanting to participate. Furthermore, the study is not representative for the population, as mainly people in the age-bracket of 18-24 were willing to participate, making up for 61% of respondents. The general demographics for the municipality of Groningen for this group are much lower, according to CBS (2021). Reasons for this phenomenon could potentially be:

- More willing to participate in questionnaire as they were students in similar situation;
- Topic appeal, as Gundlach et al. (2018) describes, students seem to be more interested & in favour of sustainable mobility.

The questionnaire included ten questions, and took approximately two minutes to complete. It consisted of multiple choice, Likert scale and slider or discreet choice experiment questions (Gundlach et al.,2018). Basic demographic questions were asked to seek for certain patterns. Other questions were based on previously mentioned concepts, to determine if perceptions in Groningen align with literature on car redundant places. For a conclusive list of the questionnaire, see appendix 1.

3.3 Semi-structured interviews & observations - Berlin

This part of the research was conducted by a group of four students partaking in the STOURIE Erasmus programme, and intended to research perception of car mitigation efforts on two streets (sub-question 3 & 4). In Berlin, the BergmannstraßE and FriedrichstraßE (Figure 11 & 12) were chosen to conduct the semi-structured interviews and observations. Questions asked were about perceived pleasantness, potential changes and favourability of respondents, to explore effects of redesign on sample population. The semi-structured interviews result in comparable, reliable data while also being able to go more in-depth with participants. However, there is a change of responder bias, as participants might feel pressured to give answers that they think the interviewee prefers (Clifford, 2016).

The semi-structured interview was convenience sampled, with a size of 56 and reached saturation. The key-points of the interviews were written down shortly after they took place, for a full overview of questions, see Appendix 2. Both the interviews and the observations were conducted over the course of three days, during different time frames. The observations took place on specific sections of both streets and resulted in sketches that depicted the usage of the streets.

In general, the semi-structured interviews in the BergmannstraßE and FriedrichstraßE did not show substantial differences regarding the interview results. And although the streets were redesigned with different measures, the overall concepts of car redundancy have been applied. Therefore, the interviews for both streets are combined in the datasets, except for the observations.

3.4 Validity & ethicality

By means of mixed methods, the research increased its validity by capturing more aspects of the mobility policies and their implications, similar to triangulation (Clifford et al. 2016). Also, for multiple choice questions a split between so-called ‘positive’ and ‘negative’ perceptions and thoughts was strived for, giving room for more opinions. However, the sampling validity is still questionable as it covers a complex topic on various levels. Also, the chosen concepts in the theoretical framework are not based on scientific concepts, but chosen by the researcher, further enhancing sampling variety. Data resulting from surveys and interviews have mostly been tested for normality and outliers, to improve their validity even though the sample is small.

Data gathering for this research has been done in a confidential and anonymous manner, as prescribed by Clifford et al. (2016). The survey conducted in Groningen is anonymous, and respondents have been informed what will happen with the information they provide. The data is not connected to their identity, and thus it is highly anonymized. In Berlin, the semi-structured interviews were completely anonymous, and people participating were informed on what their response was for and gave consent. The observations have also kept observer people anonymous.

4. Results

The following section aims to answer the posed research questions. Sub-question 1 and 2 are answered in the Groningen section, while 3 and 4 are contained in the Berlin section.

4.1 Groningen

4.1.2 Evaluation car ownership per household in Groningen

Car ownership in Groningen seems to follow a concentric pattern (Figure 7), with the centrality of a neighbourhood having influence on the car ownership per household (centre, low -> periphery, high). As the city centre of Groningen has endured the most car redundant concepts, this could be an indication of its effectiveness. Furthermore, in Figure 8 a comparison between various Dutch cities is made. Big cities (blue) and Groningen have the least ownership. University cities (orange) and cities with similar population (light orange) both generally have higher rates.

4.1.3 Perceived pleasantness characteristics

To explore the perception of visitors regarding the pleasantness of the city centre of Groningen, the following question was posed: '*the city centre of Groningen is a pleasant location'*. Respondents overwhelmingly agreed with this statemen, with 82% (mostly) in favour, 12% neutral and only 5% disagreeing. The question: '*What makes the city centre of Groningen a pleasant environment?'* gives more insight into the reasons for this (Figure 6). Two perceptions of liveability are most common; the atmosphere and appearance. Accessibility is reported by half of the responders, even though getting to the centre of Groningen by car is made explicitly hard (Gemeente Groningen, 2021). Not all characteristics or consequences of car-free policy are reported by respondents, such as easier and more interaction (only 27%), described by McArthur & Robin (2019) & Nieuwenhuijsen & Khreis (2016) to be a result of car-free measures. This also applies to safety, only reported by ~25% of respondents while being one of the main priorities of car-free policies (CROW, 1985; Clark, 2006; Gemeente Groningen, 2021). Relaxation, thought to accompany a liveable city (Khomenko et al., 2020) is least mentioned, perhaps due to the opposing live on the streets it creates, as described by Roo et al. (2011).

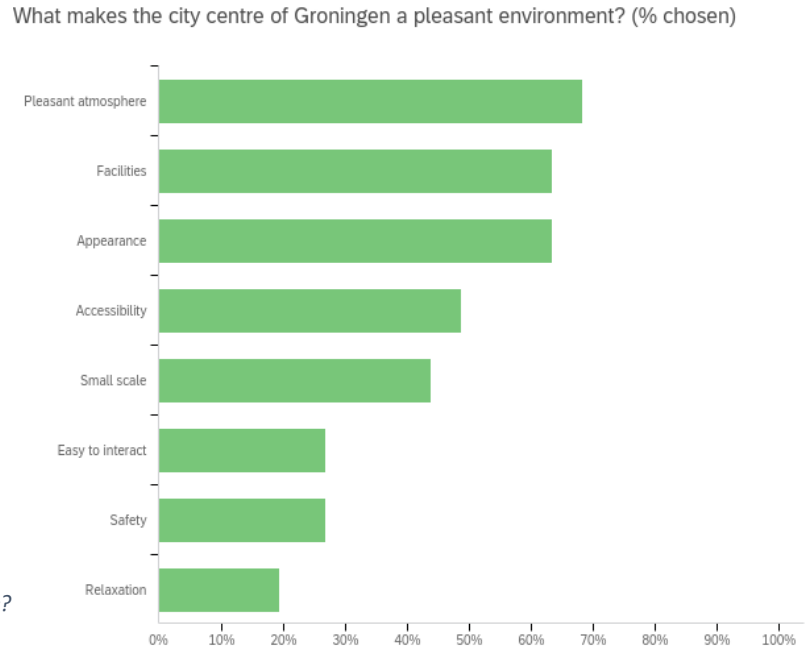

Figure 6. What made the city centre of Groningen a pleasant environment to be?

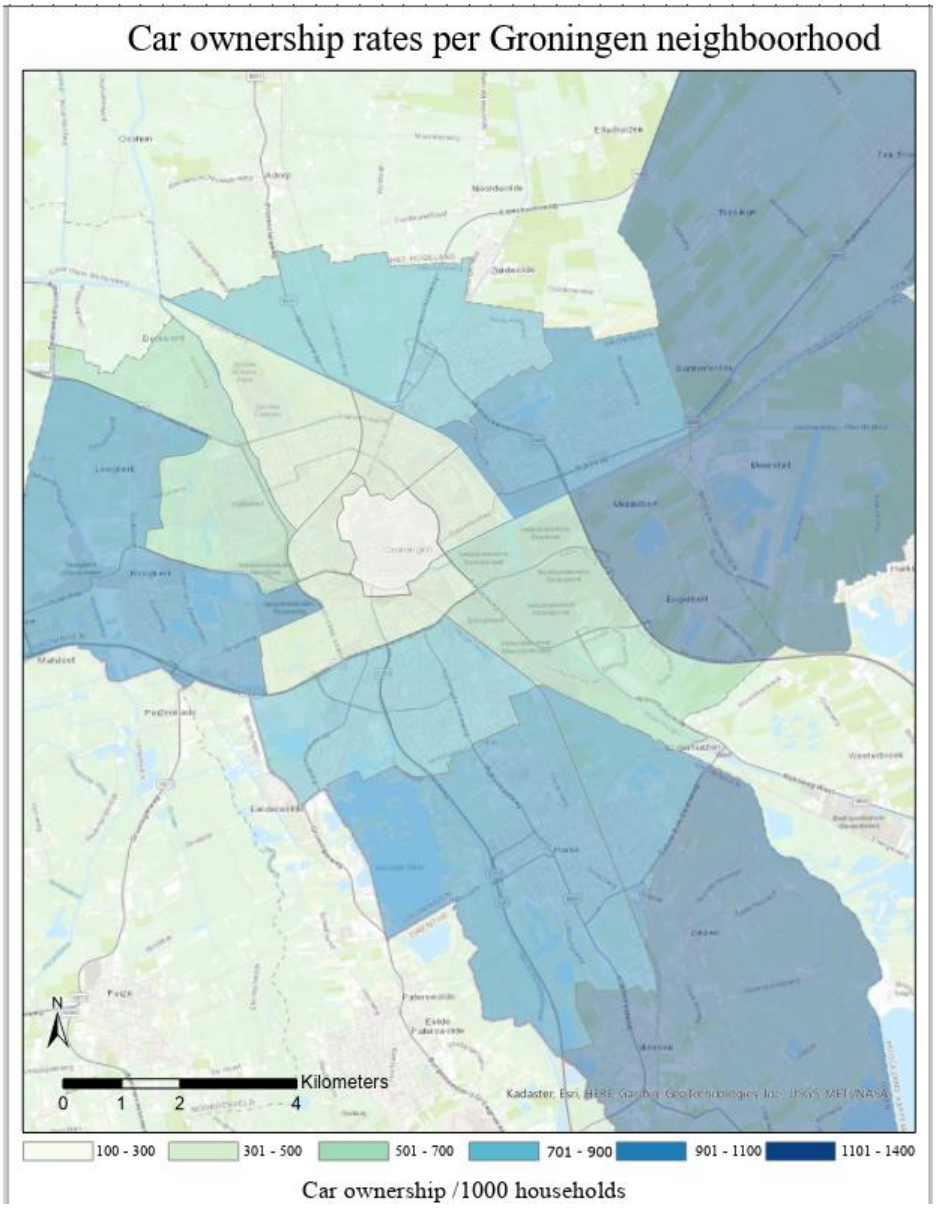

Figure 7. Car ownership rates per household in Groningen neighbourhoods. The further away from the city centre, the more cars per household are owned (CBS, 2020a; CBS, 2020b).

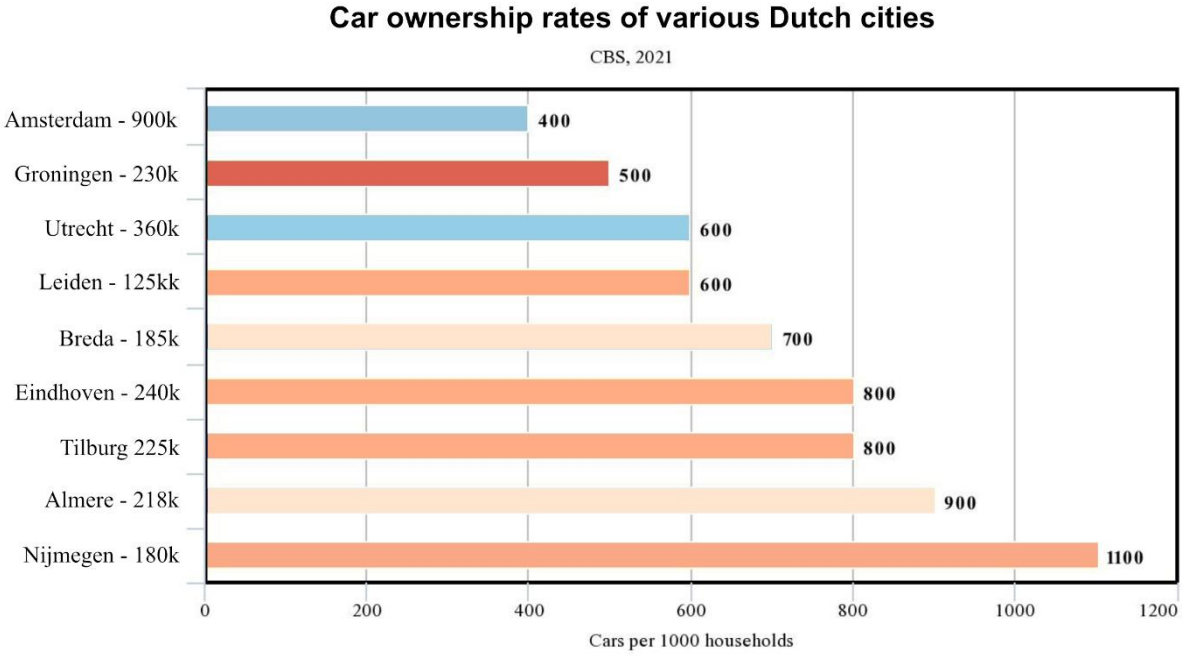

Figure 8. Bar chart of car ownership rates per household, from lowest to highest, categorized by big cities (blue), Groningen (red), university cities (orange) and similar cities (light orange) (CBS, 2020a).

4.1.4 Support for expansion of Doorwaadbare Stad

Another indication of visitor's perception of the city centre, is the support for Groningen's contemporary mobility policy of the *Doorwaadbare Stad*. The result from the surveys is a mean of 7.2 with a standard deviation of 2.2, resulting in a non-normality distribution. Standalone, these numbers are meaningless as they have no 'real objective' meaning attached to them (Clifford, 2016). But taking a look at the boxplot in Figure 9 searching for outliers, a tendency towards the upper side of the scale is clear. It suggests respondents generally have a more positive view on *Doorwaadbare Stad* policy. Even though they are not likely to know the details, their attitude was mostly favourable for the expansion of car redundant measures throughout the city.

Boxplot on perceptions Doorwaadbare Stad

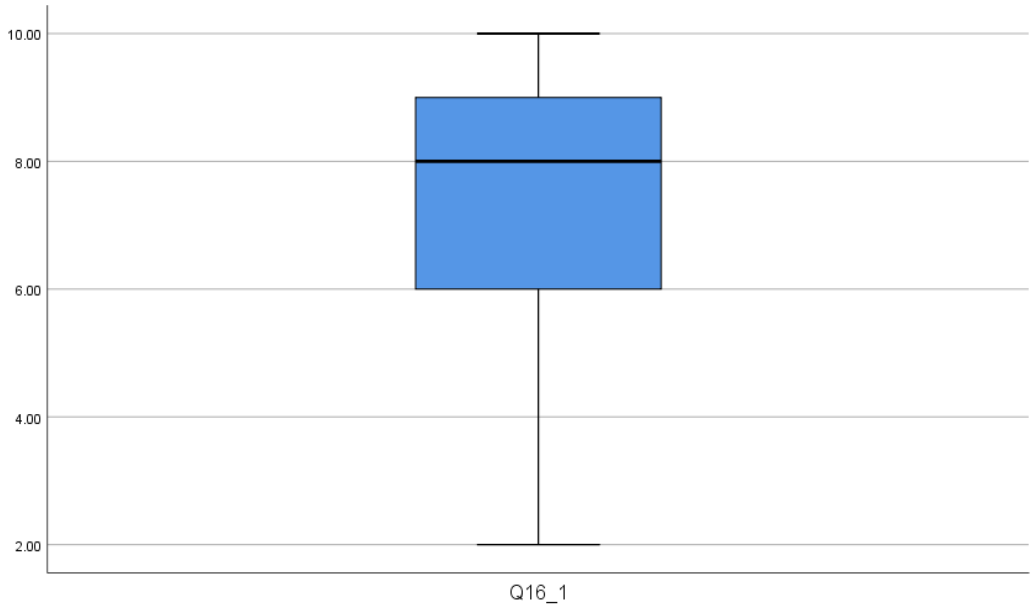

Figure 9. Box plot from survey data on perception of the Doorwaadbare Stad. A tendency towards the higher numbers is visible, suggesting a positive view.

4.2 Berlin

The case study in Berlin focused on two well-known streets, the Friedrichstrasse in Mitte and the Bergmannstrasse in Kreuzberg (Figure 10, 11 & 12). These streets were chosen as they recently have been redesigned with car redundant concepts in mind, thus adhering to unsatisfied transportation demands (Gundlach et al, 2018).

1. *Friedrichstrasse:* The scope of this study will be limited to part of this street between the Franzosische Strasse and Leipziger Strasse. Observations have shown the street acts as an economic district, with offices, shops and practitioners located there. It has less of a residential function, and people that visit are often not from the area (interviews). The street was formerly a four-lane road accommodating cars and buses, but after a two-week trial has been permanently converted to be closed for car traffic. Instead, a wide bicycle path, greenery, street furniture and art galleries have been installed (Berlin.de, 2021).

Figure 10. Comparison between the redesigned Friedrichstrasse (right) and the previous situation (left) (Google Maps 2009).

2. *Bergmanstrasse:* in the previous situation, this was a two-lane street acting as arterial road for the general neighbourhood. A lot of pilots and tests have been done along the stretch of this street, but the focus of this study is on the area between the Nostitstrasse and Zossenerstrasse. This stretch is now a one-way street, with space for parking. The freed-up lane is utilised for greenery and street furniture, and a bidirectional bike lane has been implemented. Our observations further show the street has a more residential function than the Friedrichstrasse, with people visiting it being more local (Berlin.de, 2020).

Figure 11. Comparison between redesigned Bergmannstrasse (right) and the previous situation (left) (Google Maps, 2009).

Locations Friedrichstrasse and Bergmannstrasse

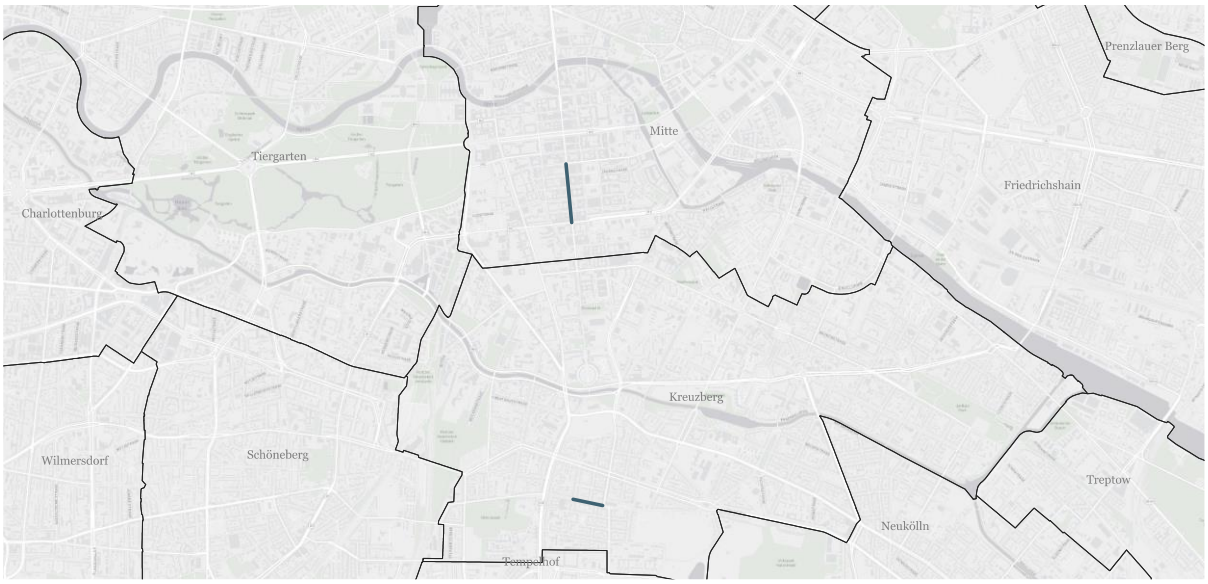

Figure 12. General map of the locations of the Friedrichstrasse at the top in Mitte, and the Bergmannstrasse at the bottom in Kreuzberg.

4.2.1 Perceived pleasantness

To gather insights into the perception of these redesigned streets, people interviewed were asked how pleasant the streets were post redesign. A majority of 70% responded they thought the streets were more pleasant (Figure 13). In contrast, 23% thought the redesign made the streets less pleasant. Respondents with this belief mainly thought the streets looked temporary, or considered the bidirectional bicycle path was dangerous. For example, an elderly man who has cycled in Berlin for over 20 years reported he would rather crash head-on into traffic, as opposed to another bicyclist, and thus avoided the new bidirectional bike lanes. Other factors were mainly the reduced parking options and speed, as well as car accessibility. Overall, three characteristics were found to have a significant influence on whether respondents perceived the redesigned streets as pleasant or not;

Gender: Respondents age and gender were deduced to decrease the interview length. In total, 31 males and 25 females were interviewed, of which 1 case was excluded from the test. A comparison of the means was conducted for $p < 0.05$ with the conditions of [$F(1, 53) = 6.903$, $p = 0.011$], thus there is a significant difference in perceived pleasantness related to one's gender.

Age: A clear trend is visible, younger people tend to experience the street as more pleasant, whereas older people (aged 55+) rarely responded with a 'probably or definitely yes'. A one-way ANOVA with $p = < 0.5$ was conducted for the conditions [$F(3, 52) = 4.338$, $p = 0.008$], and age is thus a significant factor for perception of pleasantness. However, a Post Hoc test using Games-Howell showed no significance between certain age groups. A possible reason for this could be the number of respondents not being large enough for the ANOVA test, however, it does suggest there is a link between age and perceived pleasantness of the redesigned streets.

Mode of transport: In Table 2, the relation between used mode of transport and mean of pleasantness change is visible. The closer to 5, the more positive a group is regarding pleasantness change. People reporting to come to the streets by car have a significantly lower mean, meaning they are considerably more negative on pleasantness change. A one-way ANOVA was conducted to further measure the effect of used mode of transport on perceived pleasantness of redesigned streets. With a $p < 0.5$ there was a significant effect on mode of transport for perceived pleasantness, for the conditions [$F(3, 52) = 3{,}154$, $p = 0{,}032$]. Thus, there is a significant difference between the mode of transport groups and their perceived pleasantness of the redesigned streets. Further post-hoc testing was not significant.

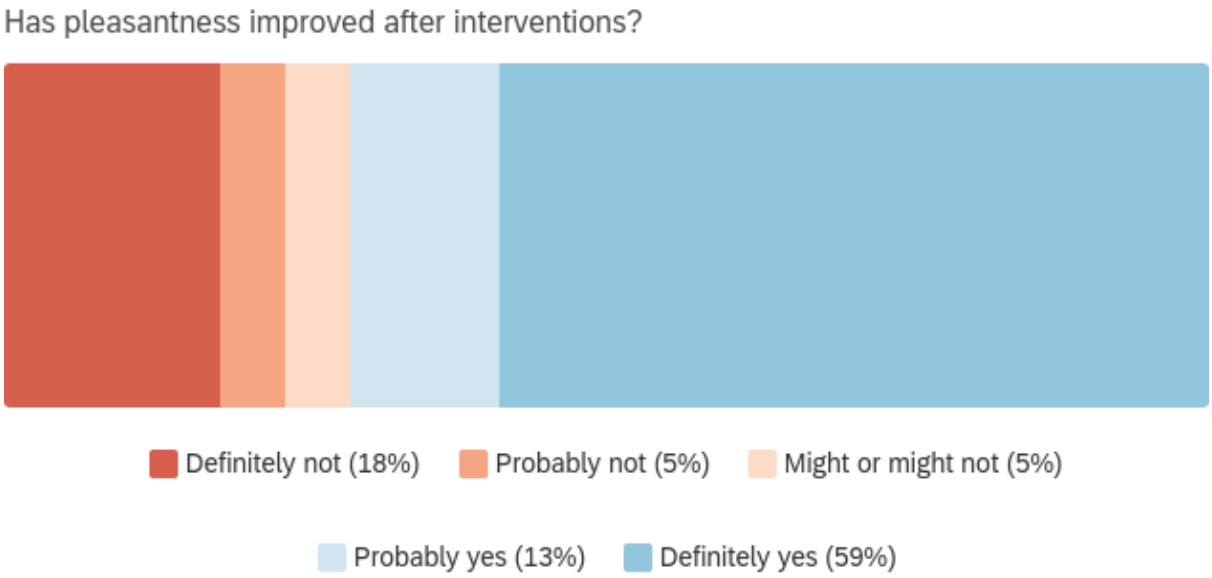

Figure 13. Stacked bar chart depicting if respondents thought the streets were more pleasant after redesign.

Mode of transport used	**Mean (perception of pleasantness)**	**Respondents count**
Walking	3.44	18
Bicycle	4.69	13
Public Transport	4.26	19
Car	2.56	9
Average	3.89	59

Table 2: mode of transport used and their perception of pleasantness. Where 1 = definitely not; 2 = probably not; 3= might or might not; 4 = probably yes and 5 = definitely yes. A number closer to 5 thus represents a more positive attitude to perceived change of pleasantness. Note the count is higher than the *n* of respondees, as some used multiple modes of transport to get to the streets.

4.2.2 Potential favourable changes

What made the respondents think the redesigned streets were more pleasant? For nearly 60%, the street felt safer, but also less noise (39%), less stressful environment (38%), more ambience (32%) and more sitting places (30%) were mentioned. Notable, the addition of green to the city scape was hardly ever noticed or mentioned. Similar to perceived pleasantness, an interesting divide between used mode of transport (pedestrians, bicyclists, PT vs. car) and potential changes to the street was visible. Further changes requested were;

- More greenery
- More sitting places
- A less temporal design
- Less parking

While the automobile users often reported they wanted to the street reverted back to the previous situation, would add more parking or remove bicycle lanes. However, they were a minority, as more than half of the Bergmannstrasse respondents would rather see the street blocked for cars entirely. Furthermore, 6 respondents have changed their mode of transport post-redesign. And about a third of respondents was in favour of extensive expansion.

4.2.3 Observed uses of street

The Friedrichstrasse redesign was observed to be successful too, with street furniture being used during lunch break and the bicycle path acting as a 'bicycle-highway.' However, this was not preferred by some interviewees, as they thought the bicycle lane was just as dangerous as the previous car-centric ones. An interesting observation is the difference between night and day, as it is desolated outside of office hours, also with bicycle through-traffic.

The observations on the Bergmannstrasse show the redesign was successful; it is being used as intended, with people using the street furniture and the bike path. However, the new speed limit of 10km/h is not adhered to by car users, and a lot of interviewed people perceived the new intersection to be more dangerous than previously. During the evening, the street changes from a transportation to a destination function, with nearly all seats available (street furniture and restaurants) being used. Cars and bicyclists were hardly present, yet the street was lively and had a pleasant atmosphere.

5. Discussion

Car-dominance is known to cause tremendous negative side effects on the human health, our cities and the environment. It is therefore imperative for cities to undergo a modal shift, towards sustainable and green transportation options. This paper explores to what extent Groningen's mobility policies of the past have been effective, and how they have been perceived by city centre visitors. The perception of pleasantness and acceptance regarding two recent redesigns was also studied in Berlin. To compare these two cities and answer the main research question, the outcomes are first analysed.

In Groningen, a concentric pattern of car ownership was observed, with low amounts of ownership in the centre, and higher amounts in the periphery (Figure 8). Groningen further ranks as 2nd lowest regarding car ownership, which according to Manting & Daalhuizen (2017), could be a possible indication of effective car redundancy policies. However, a city centre has a higher population, facility and job density than the periphery, allowing for more extensive and efficient transportation alternatives, ultimately making the car a less desirable transportation option (Bento et al., 2005; Coevering & Schwanen, 2006; Ingvardson & Nielsen, 2018; Manting & Daalhuizen, 2017). Another factor could be Groningen's student population (Klein, 2013), however, other Dutch student cities such as Leiden, Nijmegen or Eindhoven show higher car ownership rates.

The survey data of Groningen suggests most respondents perceive the city centre pleasantly, while also being in favour of expansion of car redundancy measures throughout the city. However, the aspects known to increase pleasantness are not distributed equally. Pleasant atmosphere, facilities and appearance were chosen quite often, in accordance with research from Khomenko et al. (2020), Mueller et al. (2020) and Roo et al. (2011). However, other effects of car redundancy such as easier and more interaction (McArthur & Robin, 2019; Nieuwenhuijsen & Khreis ,2016), or safety (CROW, 1985; Clark, 2006; Gemeente Groningen, 2021) are not mentioned frequently. This might be enhanced by the fact that changes to the city centre happened decades ago, and people simply do not know the previous situations. Furthermore, the context of safety is perceived different than other preferences, and varies a lot per person (Campagnaro et al., 2020). This highlights the limitation of the survey, as posed questions could be superficial and not in-depth enough to generate sufficient results, especially since safety is a complex aspect.

In Berlin, the redesigned Friedrichstrasse and Bergmannstrasse seem to be perceived as pleasant by respondents. However, it is less than compared to Groningen, with 73% and 82% respectively. A limitation to the study was the relatively small pool of car mode & PT users, which don't adhere to demographics of Berlin (Table 1). Furthermore, one of the most outstanding differences in the city is the safety perception aspect, as 60% of respondents in Berlin felt the streets were safer. Perhaps time has to do with this, as the previous car-dominated situation was the norm only 1-2 years prior. A clear unsaturated transport demand (Gundlach et al., 2018), is also visible, as 6 out of 56 respondents mentioned they changed their mode of transport due to redesigns.
Males, older people and car users were less likely to think the street design was more pleasant, which is in line with research from Borges & Goldner (2015) and Gundlach et al. (2018). They further claim that pleasantness (alongside acceptance) can be increased with more sophisticated networks for PT and bicyclists. Other research suggests vulnerable road users (elderly, less mobile, low socio-economic status etc.) also tend to view car redundant places as less safe and pleasant (Havik et al., 2012; Kaparias et al., 2012). However, this is refuted by policy reports from Gemeente Amsterdam (2019), who claim the opposite.

Conclusion

Cities around the world are struggling with car dominance and their adverse side effects, resulting in car redundancy policies and aspirations. Groningen is a city that has long been considered a frontrunner, as it introduced the *VCP* in 1977, to make the city more liveable and less car-dependent. Berlin has recently redesigned two streets according to the same principles of car redundancy. This research therefore conducted a case comparison between Groningen and Berlin, to establish to what extent car redundant policies were successful in Groningen, and what Berlin could potentially consider to implement.
In Groningen, the *VCP* and *Shared Space* concept have been found to be successful in mitigating car-dominance, according to the research conducted. Respondents enjoy characteristics associated with car redundant areas, such as the ambience, appearance and its accessibility. Some expected characteristics, such as safety and easy interaction, were less commonly noticed. Furthermore, the *Doorwaadbare Stad* concept is perceived quite highly by respondents, suggesting car redundancy concepts are well-liked.
In Berlin, the recent redesigns of the Friedrichstrasse and the Bergmannstrasse are also pleasantly perceived, although it is dependent on age, gender and mode of transport used. Observations show the street redesign are used plentiful, confirmed by respondents who say they use them and enjoy the atmosphere.

Based on the results, a comparison between Groningen and Berlin can be made that features certain success factors of Groningen's car redundancy. Considering Berlin has more persons/ sq. km, equal car ownership and an unsaturated transportation need regarding bicycles, it can be confidently claimed that car redundancy measures can be successfully implemented. In the 1970s, Groningen's policies were aimed at making the city liveable and meant pushing the car out. Berlin had similar problems, but policies were implemented that did not address the root of the problem directly. This decision has shown its effect, where car redundancy measures are seen as very normal in Groningen, and experimental in Berlin. Considering that the network of an entire city has to be designed for car redundancy to maximise efficiency, Berlin should contemplate a strategy similar to the *Doorwaadbare Stad* in Groningen. An extensive, holistic and efficient concept, covering the entire city as opposed to sporadically redesigning streets. Regarding opinions of interviewees in Berlin and their thoughts on perceived pleasantness and safety, the *Shared Space* concept could be introduced at places that attract lots (vulnerable) people, such as the Bergmannstrasse. Of course, not all measures in the *Doorwaadbare Stad* would be successfully implemented, as the cities differ tremendously. However, with a general outline it would improve the transportation options and liveability in Berlin, as experienced in Groningen from 1977 onwards.

Limitations to this study are mainly the complexity of the topic. Car ownership can potentially be linked to effective car redundancy measures; however, there is a wide variety of alternative causations. Groningen and Berlin both average 0.35 cars owned per capita; however, Berlin's car modal split is double that of Groningen. Other factors, such as urban fabric, student population or PT efficiency also play a role in car ownership. Further research into this correlation is thus recommended, as it could effectively determine efficient car redundancy concepts. The low amount is also a limitation. Furthermore, insufficient data was collected for vulnerable groups, even though they are more likely to perceive a car redundant place as more unsafe. More research into effects on these groups is recommended to increase inclusivity of concepts.

As an explorative research, qualitative data is more valuable, and sample numbers were not large enough for statistical testing. Considering this, the web-based surveys conducted in Groningen are too quantitative; more value to the research would have been added by conducting semi-structured interviews as in Berlin. Furthermore, to compare two cities, similar research methods are necessary for each city, something that was not adhered to in this research. The data could also be worth more if the

general population had similar demographics to the sample, something not the case now. Moreover, the data is not generalisable, as it applies specifically to the two researched cities. While certain concepts can be applied elsewhere, their success depends on the surrounding urban environment. As this is highly complex and local, generalisation becomes inoperative.

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Appendices

Appendix 1. – Questionnaire Groningen

Web-based questionnaire – Groningen (in Dutch)
Demographics; questions 1 – 3
Mobility behaviour; questions 4 – 6
Perception current situation; questions 7 & 8
Perception of potential future situation; questions 9 & 10

1. Wat is uw geslacht?
    - Vrouw
    - Man
    - Iets anders/ zeg ik liever niet
2. Wat is uw leeftijd?
    - Onder de 18
    - 18-24
    - 25-34
    - 35-44
    - 45-54
    - 55-64
    - 65-74
    - 75+
3. Wat is uw hoogst afgeronde opleidingsniveau?
    - Basisschool/ geen opleiding
    - Middelbare school
    - MBO
    - HBO
    - Universiteit Bachelor
    - Universiteit Master
    - Universitair doctoraal (Kandidaats/ PhD)
4. Hoe vaak bent u in het centrum van Groningen?
    - Elke dag
    - Aantal keer per week (>3)
    - Wekelijks
    - Maandelijks
    - Jaarlijks
    - 1e bezoek/ minder dan 1 keer per jaar
5. Welke vorm van transport gebruikt u doorgaans naar het centrum van Groningen?
    - Wandelen
    - Fietsen
    - Auto
    - Openbaar vervoer
    - Deel-scooter/ auto
    - Anders, namelijk:
6. Welke vorm van transport gebruikt u doorgaans naar werk, school of andere activiteiten?
    - Wandelen
    - Fietsen
    - Auto
    - Openbaar vervoer

- Deel-scooter/ auto
- Anders, namelijk:

7. Bent u het eens met de volgende uitspraak? ‘Het centrum van Groningen vind ik een prettige omgeving om te zijn.’
   - Helemaal oneens
   - Oneens
   - Neutraal
   - Eens
   - Helemaal eens
8. Waarom vindt u het centrum van Groningen een prettige omgeving? (Meerdere antwoorden mogelijk).
   - Ruimte om te ontspannen
   - De faciliteiten
   - Gemakkelijk te bereiken
   - Kleinschaligheid
   - Makkelijk mensen te ontmoeten
   - De uitstraling/ het aanzicht
   - Veiligheid
   - Anders, namelijk:
9. Wat zou er volgens u beter kunnen in het centrum van Groningen om de omgeving prettiger te maken? (meerdere antwoorden mogelijk).
   - Meer groen
   - Meer zitgelegenheid
   - Meer ruimte voor voetgangers/ fietsers
   - Meer parkeergelegenheid voor de auto
   - Makkelijker te bereiken met de auto
   - Minder bussen/ fietsers
   - Minder auto’s
   - Anders, namelijk:
10. Het verkeerscirculatieplan (1977) had als effect dat het centrum minder aantrekkelijk is om met de auto te bezoeken. Maatregelen zijn bijvoorbeeld, een lagere maximum snelheid, het verbod op rijden tussen sectoren in de binnenstad en minder parkeergelegenheid. Hierdoor is er meer 'leefruimte', voor o.a. voetgangers & fietsers, en minder geluids-en luchtvervuiling. Nieuwe mobiliteitsplannen schrijven dezelfde maatregelen voor om door te trekken naar de rest van de stad.In welke mate zou u hier een voorstander van zijn? (1 = geen voorstander, 10 = geheel voorstander.)
    - Ik ben voorstander van deze nieuwe mobiliteitsplannen – schaal 1 – 10.

Appendix 2 – Interview guide Berlin

Semi-structured interview – Berlin, Germany
Some questions can be made quantitative, e.g., mode of transport, what can be changed etc.

Demographics

1. Reason of Bergmanstrasse visit
2. Do you come to Bergmannstrasse frequently?
3. Mode of transport: motorized vehicle, bicycle, public transport, walking, other
4. Deduce age + gender

Gather perception - frequent visitors

1. Have you noticed a change in this street?
2. Have you noticed there's less cars in the street? What do you think about it?
3. Do you think the street is more pleasant to be in?
4. How are you affected by the car reduction measures?
5. Are you using the street differently?
6. What would you like to change in the street?

Gather perception - first time visitors

1. Do you enjoy the atmosphere of the street?
2. Have you noticed something different compared to other streets?
3. Would you have preferred to be able to drive here?

General

1. Do you feel safer on such a street?
2. Do you prefer the car reduction measures -> would you like to see it expanded?