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Transformation of inner cities

Infrastructure planning in Groningen: the effect of real-time data

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Summary

Inner cities are one of the places where a lot of change is taking place. Within that transformation, one of the key drivers of change can be digitalization and with it, the move towards a smart city. Key components of a smart city that are affected by digitalization are technology, the people and institutions. In infrastructure, digitalization within smart cities can lead to smart mobility. Smart mobility relies partly on the use of real-time data.
This research aims to help gain insight into the effect of real-time data on infrastructure plans in the inner city of Groningen. This is done via a mixed-methods approach, where a dataset, policy analysis and interviews with experts will provide insight into the use of real-time data.
Real-time data means data that is directly processed. This type of data can be used to monitor traffic flows, which helps in understanding the current use of the infrastructure. Groningen is in the transition towards monitoring the use of streets within the context of their 'destination: city centre' programme. In this programme, the different projects are described that will alter the inner city of Groningen. This research has looked at five projects that are related to infrastructure planning. These projects focus on improving urban space by removing as many motorized vehicles as possible. During the interviews, it became clear that the use of real-time data had not contributed as much to the infrastructure plans as was expected from the existing literature. In Groningen, the use of real-time data in infrastructure could lie in communicating how busy the roads are and not as much in the infrastructure planning itself.

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Chapter 1 – Introduction

1.1 Background

Inner cities: the bustling places in which most of our current lives are taking place. All over the world inner cities are subject to transformative processes, changes and developments, which make them an interesting topic to study. The current digitalization of processes in a smart city is one of those transformations that is occurring. Dameri (2017) describes in her book how the phenomenon of the smart city is now a widely used innovative urban strategy that fits within the modern urban areas. In the Netherlands, multiple cities are taking steps to digitize certain aspects of inner-cities. When looking at the Northern region of the Netherlands, the city of Groningen is also going digital. This process of digitalization is one that requires preparation and adaptation when it comes to policymaking and planning (European Commission, 2017). An example of this digitalization in Groningen is coming from the 'Proeftuin Binnenstadsmonitoring'. This project concerns the digital monitoring of pedestrians and cyclists through the Brugstraat and Akerkhof (Gemeente Groningen, 2019a). This project shows the willingness to use digital data by the city of Groningen and therefore it makes it a city that lends itself to research the use of digital data.

1.2 Goal and questions of this research

This research will look at the digitalization of traffic flows and how real-time data might influence infrastructure planning within the inner city of Groningen. As real-time data has not been accessible or available, the topic and use of real-time data were discussed with subject matter experts. The aim is to make clear how real-time data can have an influence on infrastructure in the inner city of Groningen and how it can be used for future plans.

The central question then becomes: *'How does real-time data affect infrastructure planning in the inner city of Groningen, given the global trend of digitalization in urban areas?'*

The following secondary questions will be answered in this research:

What is a smart city and what are its concepts relevant in the context of this research?
What is real-time data in the context of infrastructure?
What kind of effects can real-time data have on infrastructure planning?
Are real-time data and the current plans within Groningen related?

These questions will delve into the concepts and aspects that are relevant to the main question and will, therefore, provide the handles to answer the main question.

1.3 Relevance

Since the concept of smart cities and digitalization of cities is a widely discussed topic, this research will look into the effect of that digitalization – specifically the use of real-time data – on infrastructure planning in inner cities. One of the top priorities from the Urban Agenda of the EU is the digital transition (European Commission, 2017). How then, is this digitalization process relevant for inner cities and infrastructure? Digitalization, for instance, can help ensure a more efficient urban management. Sensors in the road could, in theory, prevent congestion and discourage users to travel through the congested areas (van Winden & Carvalho, 2017). This research aims to analyse the effect of real-time data on infrastructure and will do so by taking the city of Groningen as a case.

1.4 The infrastructure of Groningen's inner city in context

In the city of Groningen infrastructure is becoming more and more of an issue. The city itself is dealing with a rise in population and a rise in people residing in the city centre. The municipality describes that the inner city sees an increase in users of the public space. People are staying longer and at different

times, which will only increase if the population keeps growing. To remain a liveable city, the inner city needs to adapt to the movements of these people. The new developments within the programme 'destination: city centre[1]' are meant to make room for people to reside and to make better use of the public space that is currently available. As described in the aforementioned programme, the infrastructure will be one of the aspects that will be altered to accommodate the changes made in Groningen. Pedestrians and bicycles will be given more space and because of that, traffic flows need to be adapted accordingly (Gemeente Groningen, 2016a).

This document will consist of the following chapters in which different aspects of the research will be elaborated. The second chapter gives the theoretical framework, in which various concepts are discussed to provide the theoretical background. Chapter three is about the methodology and will elaborate on how this research has been conducted, together with the ethical aspects of the research. Chapter four shows the results, where the answers to the secondary questions will be answered via the data that was found. Chapter five contains the conclusion and discussion of this research.

[1] In Dutch this programme is called: Ruimte voor jou - aanpak binnenstad 050.

Chapter 2 - Theoretical framework

As mentioned in chapter 1, inner cities are always undergoing transformations, even though these changes are not always planned. To ensure that inner cities remain liveable and that the urban quality doesn't deteriorate, they need to regenerate and adapt (Alpopi & Manole, 2013; Rauws et al., 2019). New strategies that utilize digitalization could provide an answer for urban regeneration and adaptation. Infrastructure is one of the aspects within a city that drives or accommodates urban transformation (Neuman, 2011) and in this chapter, it will be explained how infrastructure could be affected by the concepts of smart cities and the digitalization that takes place in those smart cities.

2.1 Smart cities

Urban areas face increasing problems in all sorts of fields. Think for instance about the scarcity of resources, air pollution, traffic congestions, but also high levels of interdependence and social and political complexity. Cities need to find smart ways to manage these challenges and those who do so, are increasingly described as a smart city. The concept smart city knows many different variants with different contexts and meanings and it is, therefore, a term with varying definitions (Chourabi et al., 2012). In the definitions in the articles of Albino et al. (2015) and Chourabi et al. (2012) the following components that are of relevance to a smart city are recognized:

- The people within the city that form the actors of change, since they are able to change the urban landscape by living most of their lives there (Albino et al., 2015);
- The digital actors, naming ICT[2] and technologies to connect the infrastructure components and services of a city in order to make it more efficient, sustainable and liveable (Harrison et al., 2010; Toppeta, 2010; Washburn et al, 2010).
- A linked system of different types of networks, such as the networks in a human body. This means that a smart city is a network and linked system of infrastructures in which no system operates by itself (Kanter and Litow, 2009).

Instead of giving an overarching definition, this research focuses on the key components of a smart city which can be found amongst those definitions: technology, the people and the institutions. All those components are affected by digitalization. A smart city integrates technologies, systems, services and capabilities in one network that can be used for future developments. It starts, however, with people. Smart and educated people could generate clever solutions to urban problems. ICT could become an asset in creating solutions, which makes it a supportive component. The institutions within a smart city act partially through smart governance. This is ICT-mediated governance that should be with and about the citizens, stressing the importance of participation. Smart governance also makes use of the data available in order to increase the predictive power of their analyses and eventually combining technology with knowledge of collective human behaviour to provide smart solutions (Albino et al., 2015; Van Dijk, 2015). Even though data gaps are closed with new technologies, there will remain issues that can't be captured in data or need human judgment to form decisions (Esty & Rushing, 2007). That means that data will not and cannot take over decision-making in smart cities completely.

[2] Information and Communications Technology – this term refers to the combination of manufacturing and service industries that capture, transmit and display data and information in an electronical way (OECD, 2002).

2.2 Urban digitalization

It has become clear that technologies and digitalization play a role within the concepts and practices of a smart city. Finger and Razaghi (2016) indicate that there are three components of digitalization: data generation, data connection and data analysis. The generation of data is obtained from various sources, such as sensors and satellites. Data connection means the infrastructure that we use to access the data which is often referred to as the Internet[3]. Data analysis focuses on how the data can be used and how it's being dealt with. Computing power, transmission and storage capacities of the newly acquired data need to be taken into account in this third component of digitalization (Finger & Razaghi, 2016).

The effects of this digitalization on a city could be numerous. Monitoring the energy consumption within buildings, linking operations and management of different infrastructure systems or communicating initiatives for bottom-up governance are just three examples of such effects. All of the data that can be gathered and processed through digitalization could lead to improving the efficiency of urban systems, making cities more sustainable (Finger & Razaghi, 2016; Van Dijk, 2015).

In infrastructure, smart mobility is the main concept that belongs to smart cities. Smart mobility aims to reduce congestion and promote cheaper and greener options of transportation. It could also provide an answer to mobility problems within the current urban environment. These solutions are based on digitalization and can vary from optimizing the transport system to the creation of new transportation systems. Examples of smart mobility are smart parking, peer to peer ride services, personalized transport information, smart traffic control, adaptive connected cars and shared self-driving cars (Van Dijk, 2015).

Even though it seems that urban digitalization can have many positive effects, there are some aspects that need to be taken into account when it comes to the data that comes with digitalization. The data that is generated and used for the improvement of efficiency of urban systems must be widely available for the public to use. Various stakeholders, in that way, can subject the data to their own analysis. This transparency is not desired by every government or institution. The Internet and the computing power need to support the distributed data. Capacity needs to be created to cope with that increase in data and that costs money. Another aspect that could be negatively affected is individual privacy. Measures need to be taken in order to protect that. This means that the data should either be anonymous or encrypted where privacy is at stake (Lansky, 2007).

2.3 Infrastructure planning

As mentioned in the previous paragraph, infrastructure can be influenced by smart cities. Neuman (2011) argues that infrastructure lies at the base of city planning and that urban development is enabled by infrastructure since it forms the pathway towards the newly developed areas. So in order to make sure that the infrastructure can deal with the various challenges the current urban environment faces, the infrastructure needs to become flexible.

At the present day, infrastructure planning is a rigid process and the costs to alter or build infrastructure are high. Next to that, infrastructure systems tend to be planned by the project without looking at the integral picture (Neuman, 2011). This makes it difficult for the infrastructure to become flexible. To cope with rigid planning of infrastructure and the fast-changing urban environment, the government could implement adaptive policies or data-driven policies. With those two instruments, the needed flexibility can be introduced to infrastructure planning.

Adaptive policymaking in planning can ensure flexibility in policies. These policies enable planners to deal with uncertainties and dynamic outcomes, making them robust for a range of futures (Swanson et

[3] Internet – the global system of computers connected to each other thanks to a physical communication network (Finger & Razaghi, 2016).

al., n.d.; Venema & Drexhage, 2009; Adnan Rahman et al., 2008). It is unclear how real-time data could affect these adaptive policies and therefore data-driven policies as a way to tackle rigid planning in infrastructure is more relevant to this research.

Governments nowadays possess the necessary tools to gather information in a faster way than before, facilitating more responsive policymaking. Within a smart city, governments could use data-driven policymaking to lead to more tailored policies that are able to adjust quickly to changing circumstances (Esty & Rushing, 2007; Van Dijk, 2015). Data-driven policies help in making rational decisions and with new technologies, the problems and solutions of a case emerge faster. Currently, technology deployment, data generation, policy development and performance measurement, are seen as different stages in the policymaking process. By bringing those together a coherent whole can be created which is essential in data-driven policymaking. Esty and Rushing (2007) name the city of Charlotte in the USA as an example of data-driven policies. The city developed a neighbourhood "quality of life" ranking that is updated every two years. It is based on twenty indicators measuring different conditions in 173 areas. These indicators are used to identify and target fragile neighbourhoods for revitalization. Depending on data in policies can ensure more tailored and also more experimental policies. Policymakers and thus planners are able to respond faster to changes within the urban environment with data-driven policies (Esty & Rushing, 2007).

Even though there are options to deal with the rigid nature of infrastructure planning, they require change within institutions and the way people think about policymaking. The change in policymaking asks significant planning, coordination and investments and not every institution is willing to commit to that. Other than that, data-driven policies are not always desired. Not all decisions should be based on data and human judgment will always be necessary. Those barriers need to be overcome before the ways of planning will change (Esty & Rushing 2007; Lansky, 2007).

2.4 Infrastructural data

Data plays a role within the concept of a smart city, with the generation of data being one of the key components of the digitalization within a smart city. Infrastructure gives opportunities for generating data on various objects and topics that can be measured (Finger & Razaghi, 2016). One of the aspects of infrastructure in a smart city has been mentioned, smart mobility. The developments that are taking place within smart mobility are partially dependent on data. For instance, there are smart traffic control or smart parking, that depends on the traffic flows and the number of free parking spaces respectively.

When it comes to infrastructural data, two types of data can be derived: aggregate data and real-time data. Aggregate data refers to data that has been collected from multiple sources and with multiple variables, which is all combined into data summaries. Real-time data contains information that is near directly processed after collection. This means that no delay takes place in providing information to the user. Monitoring traffic flows is an example of the use of real-time data that can be useful to smart mobility.

One way to monitor traffic flows is with the Global Positioning System, GPS (Yakubu & Walker, 2011). With GPS the traffic flows can be monitored, concluding in Traffic Flow Monitoring Systems, TFMS. This data can also be acquired via sensors that are placed on the roads or via cameras and can provide digital data on the whereabouts and crowdedness of roads. TFMS can next to the GPS/GSM/GPRS systems, be derived from data out of moving vehicles and combines the GPS information of multiple vehicles. This is called Floating Car Data and can be monitored by for instance Google Maps. This data is real-time data that can give information about the positions of vehicles.

The software can monitor positions and identify bottlenecks and congestion (BAM Infra, 2018). This data put together leads to the creation of Spatial Data Infrastructure, SDI. The SDI combines the aforementioned data and with it, it creates a digital environment to access and retrieve data sets (Smith et al., 2004). An example where SDI can come into use is made clear in the research of Sutanta et al. (2009), where the use of SDI within disaster risk reduction is noted. In disaster risk management SDI will facilitate the sharing of spatial data between organizations.

Looking at the services smart mobility can provide, as mentioned in paragraph 2.1, there are many other aspects that rely on real-time data next to the traffic flows. With smart parking, the availability of parking spaces can be communicated real-time, which provides drivers with information about the nearest parking spaces. Finding available spaces in inner cities can cost time and lead to congestion, making it an unattractive option to park in the city centre (Golson, 2020). Personalized transport information can be found in the form of Google Maps. Smart traffic control can optimize traffic flows by adjusting the traffic lights and other signals, based on the data gathered by for instance sensors in the roads. Adaptive connected cars and self-driving cars depend on the data provided by location apps or other vehicles that communicate their position and by doing so, they depend on real-time data.

The use of data in infrastructure serves many purposes, but not every aspect is relevant to planners and policymakers. The use of real-time data in planning depends on which point in the process the data is being used. While the data of traffic flows can be used in calculation models and traffic simulations to base new plans on, it could also be used when the roads are already built. This is for instance with rush-hour lanes or reversible lanes. Based on how many cars pass a certain measuring point in the road, extra lanes can open or close off (Texas A&M Transportation Institute, n.d.). An example can be seen in figure 2.1. below. This strategy has its hurdles, mainly with public awareness and the operation, but in recent years it has been proven to be cost-effective and new technologies are making the reversible lanes easier to implement (Gross, 2015).

Figure 2.1. Reversible lanes in Miami (Lewin, 2018).

2.5 Conceptual model

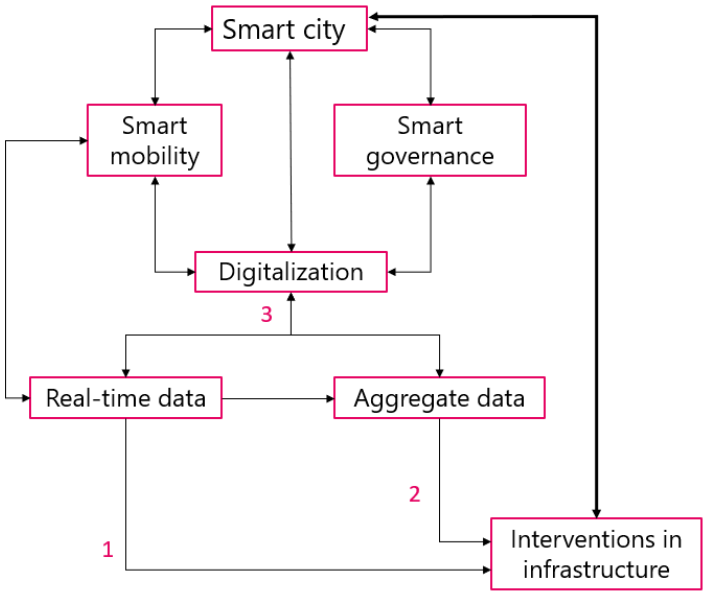

Figure 2.2. Conceptual model.

The concepts that came forward in the existing literature led to the conceptual model that can be seen in figure 2.2. This model shows the different relationships between the concepts and how data can lead to interventions in infrastructure. It also shows how real-time data can affect that planning and how that, in turn, leads to affect a smart city.

1. The relation between real-time data and interventions is the relationship that is central to this research and therefore the most important one. This relationship will be discussed and become clear during the interviews that are conducted. Real-time data could provide policymakers and planners with input to alter the infrastructure.
2. The relation between aggregate data and interventions in the infrastructure in Groningen will also be discussed. This will be done via a policy analysis and a data analysis. Just as with real-time data, the aggregate data will provide the input for possible interventions in infrastructure.
3. Digitalization and the relationships between both types of data will influence each other both ways. Monitoring real-time data in the way of traffic flows in Groningen, such as with the 'Proeftuin Binnenstadsmonitoring, is done digitally, just as aggregate data could be stored and shared digitally. Since digitalization entails the generation, connection and analysis of data, both types can become input for it.

In this research, the connection between smart city concepts and interventions in infrastructure is explored. How that is done can be found in the next chapter, the methodology.

Chapter 3 - Methodology

To research how real-time data can affect the infrastructure planning in the inner city of Groningen the questions mentioned in chapter 1.2 will need answering. This is done through a mixed-methods approach. To provide the experts view on the use of real-time data and its effect on plans, interviews will be conducted (Clifford et al., 2010). Also, infrastructural plans will be analysed through a policy analysis and next to that the data of traffic flows will be analysed as well. In this chapter, it is explained how the data collection is done, how the interviews will be conducted, how the interviewees will be selected, how the data is analysed and lastly, the ethical considerations will be discussed.

3.1 Data collection

The focus of the primary data collection will be on semi-structured interviews with the experts. With semi-structured interviews, there is more flexibility in the way certain topics are presented to the informant and it leaves room for a direction chosen by the informant (Clifford et al, 2010). The research method of a semi-structured interview is, in this case, a useful method, since probing and open-ended questions are necessary to obtain the required data from key informants (Adams, 2015). Next to the opinions of the experts, this research looks into the current plans of the municipality of Groningen on infrastructure. The infrastructural plans within the policy analysis will show how infrastructure planning is done and how those plans will affect the infrastructure within the inner city of Groningen. To see if that effect is taking place, a dataset that shows the number of cars, before and after interventions, on specific roads in Groningen is used. The policy analysis and the dataset are used parallel to the data that comes out of the interviews to provide an in-depth understanding of the situation in Groningen.

As stated in chapter 1.2 the aspect of real-time data is looked at indirectly. Real-time data was hard to access and did not turn out to lend itself for a proper analysis that would be fit for this research. This is why, in this research, the experts will give the most insight into the use of real-time data and the policy analysis and dataset provide an extra framework for infrastructure planning in Groningen.

For the policy analysis, the plans for the programme 'destination: city centre' will be analysed. This program contains the plans for the adjustments that will be made in the inner-city of Groningen. Not all projects are relevant, which is why this research focuses on the ones that have to do with the main arteries of infrastructure within the inner-city. Which plans are meant by this will be made clear in chapter 4, where the results are discussed. An overview of the policy analysis can be found in appendix IV.

The dataset that shows the number of cars on the road has been provided by 'dataplatform Groningen'. It contains the numbers of passing cars during a working day, as measured by wires in the road surfaces. These wires have been placed strategically throughout the municipality of Groningen. The dataset contains data from 2010 up to 2017, but not all the roads were measured every year. The data, therefore, might not be perfectly representative. Nevertheless, the data can be used to check on the plans from the municipality of Groningen to see if the infrastructural plans have had an effect on the infrastructure and the number of cars passing certain roads.

3.2 Selecting interviewees

In the matter of selecting key interviewees for this research, it is of importance to select people based on their expertise. The municipality of Groningen has committees that are concerned with mobility and infrastructure. These committees within the municipality of Groningen will have knowledge about the topic of this research and are therefore best suited for an in-depth interview. In the end, four experts from the following backgrounds were interviewed, as can be seen in figure 3.1. The expert on real-time data from the Ministry of Defence may seem odd, but the expertise of the interviewee is fit for this research. The reason for this is that the expert designed the programme with which Dutch army vehicles

and soldiers can see their positions on a map. In order to make their positions visible, their GPS coordinates are used and that is real-time data. This entails that the expert knows how real-time data works, how to process it and how the data can be used.

Interviewee 1	Municipality of Groningen	Expert on infrastructure planning within the municipality
Interviewee 2	Aanpak Ring Zuid	Expert on a large infrastructure project done by municipality of Groningen
Interviewee 3	Groningen Bereikbaar	Expert on accessibility and infrastructure of Groningen
Interviewee 4	Ministry of Defence	Expert on the use of real time spatial data

Figure 3.1. Overview of the interviewees

As can be seen in appendix I, where the questions of the semi-structured interview can be found, the questions differ per type of expert. Since the municipality of Groningen knows their plans best, the interview will mostly focus on their plans on how data can affect infrastructure planning in the future. Their look on the plans that have already been finished will also be discussed. By doing so, the mismatch of reality and plan or vision can be examined. With regards to the expert on real-time data and data processing, the questions will be focused on their expertise. That means that the focus of these interviews will lie on real-time data and not so much on the plans of the municipality of Groningen, even though some relations might be discovered between the two. In appendix II, the consent form can be found, which has been filled in by the interviewees.

3.3 Data analysis

To analyse the data that has come forward from the interviews a data analysis scheme is put to use. This scheme is modified after the analytical tasks as described by Henink et al (2011).

1. Prepare verbatim transcripts
2. Anonymize data
3. Develop codes
4. Code data
5. Describe
6. Compare
7. Test with theory

With this scheme, the data from the interviews can be processed to be tested with the theory found in chapter 2 of this research. In that chapter certain expectations of the use of real-time data have been created, which can be tested with the data that comes from the expert interviews. A scheme that shows the process of coding data can be found in appendix III.

Concerning the policy analysis, the following aspects of the projects will be looked at: why is the change in the infrastructure necessary, how did this plan come to be, how does the project influence the infrastructure and what the desired outcome is. These aspects will be generalized and put into a table, where each project has its own columns in order to compare the policies. The projects that are chosen are the ones that will or are influencing the infrastructure of the inner-city of Groningen when it comes to transport by car. These projects will be shown on a map and will be discussed in chapter four.

The dataset that has been provided by the data platform Groningen, an open-source data website, contained information about the number of cars that drove through a certain counting point on the road. This data described the street and the number of vehicles that passed. In order to make use of the data, it has been filtered to certain locations that are of importance to the inner city of Groningen. Those

points have been imported to ArcMap and the data was made spatial. After that, the data was filtered again to show the locations that are directly related to projects in the 'destination: city centre' programme. By importing the number of passing cars per year an overview was created. To make the differences per year and per street visible, the data has been categorised. To do so, natural breaks (jenks) have been used. By doing this, the data has been classified into natural groupings inherent to the data. This way the data had the best group similar values and the difference between the classes is maximized (Esri, 2016). The dataset will illustrate the effects of the changes in infrastructure and serves as a link to the policy analysis of the projects from the 'destination: city centre' programme. Even though it is aggregate data that is being used, the data shows that changes, and thus the effects on infrastructure, can become noticeable. This shows the value that data can have.

3.4 Ethics

Ethical considerations within this research conclude all aspects of the design and way of conducting the research. This focuses on informed consent and research integrity, which entails the habits and attitudes of the researchers to conduct research according to various standards (ENERI, 2019). During this research, these standards have been taken into account, just as the five principles at the base of Dutch integrity in research: honesty, scrupulousness, transparency, independence and responsibility (KNAW et al., 2018). Another note has to be made on the relationship between the interviewer and the interviewee. It could be that the interviewer leads the interviewee to give certain answers to questions that confirm the interviewers expectations instead of giving the answer that is most objective. Finally, there is also the aspect of privacy. In this research, it has been chosen to give the interviewees their anonymity in order to respect the privacy laws.

Having explained how the data is collected and analysed and which ethical aspects are at play, the next chapter will show the results that have come forward during the research process.

Chapter 4 – Results

This chapter discusses the outcomes of the data collection and will be separated into parts aligned to the secondary questions. Answering the secondary questions will be done based on the contents chapter 2 and the findings that came forward during the analyses and interviews.

4.1 Question 1 - smart city and its relevant concepts

What is a smart city and what are its concepts relevant in the context of this research?

In chapter 2 the following concepts from a smart city have been explained: digitalization, smart governance and smart mobility. In Groningen, digitalization activities can be seen with the available dataset online and all the policies and plans that were also digitally accessible. Within smart mobility, the pilot project of 'Proeftuin Binnenstadsmonitoring' that monitors the flows of pedestrian and cyclists could lead to smart traffic control which is one of the examples given in chapter 2. The concept of smart governance in Groningen has not really become visible during this research.

4.2 Question 2 - real-time data in infrastructure

What is real-time data in the context of infrastructure?

Infrastructural real-time data can be provided by for example GPS, the communication of the availability of parking spaces within a parking garage or facility, numbers of traffic that have been monitored with cameras and sensors in the roads. This type of data can be processed in different ways to be used in infrastructure, which is explained below.

The GPS data and the data from sensors on the roads are mainly used to monitor traffic flows. This data is input for a TFMS, which could form input for an SDI. SDI can be a tool to access and retrieve spatial relevant data on which decisions can be based. Monitoring these traffic flows can be of use in infrastructure planning processes.

Interviewee 2, from Aanpak Ring Zuid, stated that for the project these traffic flows were of importance in the decisions on the final outcome of the project. By monitoring the traffic flows they gained insight into the amounts of cars and their directions. This affected the plans of Ring Zuid, where roads were adjusted based on the data. But the data was not the only factor that drove the design, the wishes of the municipality played a large role as well, which was mentioned by interviewee 1.

Smart traffic control could steer reversible lanes or rush-hour lanes, where the amount of traffic decides which lanes are open and closed. This is less useful within an inner-city since the available space is already limited and the amount of traffic is not comparable with that on the highway.

Other forms or real-time data that are used in smart parking, personalized transport, adaptive connected cars and self-driving cars, are not directly of use in infrastructure planning. Within these applications of real-time data, the focus lies on communication with the driver/user of roads. The data is processed and passed on to monitors such as a matrix sign or devices such as a mobile phone, to show suggested detours or the crowdedness of roads. Interviewee 4, the expert from the Ministry of Defence, recognized that this aspect of real-time data was more important than the use in infrastructure planning. Interviewee 2 and 3 agreed that this aspect is one of the most influential aspects of real-time data. Interviewee 3 added that within Groningen Bereikbaar, they use the communication aspect by providing users of their website with an overview of the situation on the roads.

In the context of Groningen, the municipality is not yet using smart parking. During the policy analysis, it became clear that the roads and parking spaces within the inner city will be adjusted. These plans are shown in figure 4.1. Real-time data can play a part in the strategy of the municipality to move people towards parking garages or 'P+R[4]' at the edges of the inner city or outside of the city. By communicating the availability of spaces real-time, drivers spend less time looking for a parking place. This contributes to the goal of the 'destination: city centre' programme that has been published by the municipality of Groningen in 2016. Public space and accessibility are two of the aspects that has been described in this plan to change the inner city of Groningen, which will be improved on by reducing the number of motorized vehicles in the inner city (Gemeente Groningen, 2016a). Up until now, the city of Groningen does not make use of the smart parking concept yet.

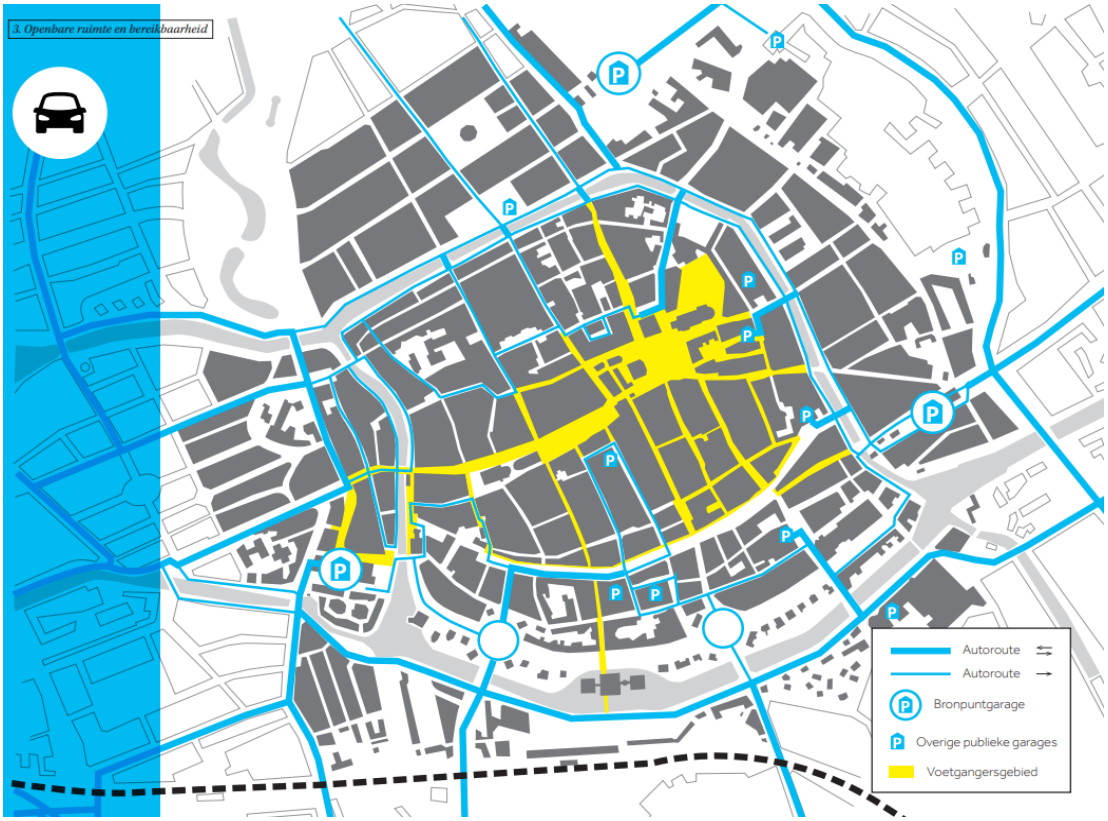

Figure 4.1. Car routes and parking facilities as shown in destination: city centre (Gemeente Groningen, 2016a).

4.3 Question 3 - the effects of real-time data on infrastructure planning

What kind of effects can real-time data have on infrastructure planning?

As described in chapter 2, the real-time aspect can either play a role in the policymaking process as a base for the policies or play a role in communication between vehicles or with the users of the infrastructure, which in turn can affect infrastructure planning. In Groningen, this is quite different. All the experts mentioned during their interview that the effect real-time data has on policymaking and plan-making is very small. The expert from the municipality declared that real-time data had been used in assumptions, but this was only a small part within the process. The peak loads played a role in the process of the municipality, as was described by interviewee 1, but this was not the case with Aanpak Ring Zuid, which became clear during the interview with interviewee 2. The data from traffic flows did play a role in the planning process according to interviewee 2, but that was the only aspect of real-time

[4] P+R: parkeren en reizen - this entails parking your car and travel on with another mode of transport.

data that had been used. Interviewee 4 indicated that the use of real-time data within infrastructure planning would not be as beneficial as using other datasets: 'I would rather work with a large dataset than GPS information'. He explained that a larger dataset was more easy to base plans on since the real-time data was only a snapshot of the situation and that would not always to the best estimation of situations.

The municipality of Groningen, however, is looking into the possibilities of using the traffic flows of pedestrians and cyclists within 'Proeftuin Binnenstadsmonitoring'. The data could be used as input for dynamic traffic signs, that could reroute cyclists towards alternative routes when a street becomes too busy (Gemeente Groningen, 2019a). Even though it seems that data does not play that much of a role, the planner could take the use of real-time data into account when setting up the road or the environment as has been described in chapter 2.4 as well as chapter 4.2.

The effect the real-time data has on infrastructure planning in practice lies within the assumptions and the end product of planning and not within the policy-making part as mentioned in chapter 2. Interviewee 1 attested to this. Planners could use the benefits of real-time data and adapt the road in order to make use of that availability, but in Groningen, this is not yet the case.

4.4 Question 4 - real-time data and the plans of Groningen

Are real-time data and the current plans within Groningen related?

In order to answer this question, the infrastructural plans from the municipality of Groningen within the inner city will be discussed. For this research, five projects have been analysed, which are numbered in figure 4.2 and named below.

1. rerouting the buses Eeldersingel/Westerhaven/A weg
2. redesign of the Astraat
3. redesign of the Brugstraat/Munnekeholm
4. redesign of the Oosterstraat
5. redesign of the Diepenring

Figure 4.2. Overview of the project locations within 'destination: city centre' where the locations marked pink are the locations that are to do with infrastructural changes and the ones numbered are the projects chosen to analyse for this research (Gemeente Groningen, 2019b).

In appendix IV an overview of the policy analysis can be found in which these projects have been analysed. In that analysis, the column that states the influence on the infrastructure is most relevant to this research since it is the estimated and predicted outcome of the projects. The other aspects that have been analysed are based on the plans of the municipality. Examining the policies of the municipality, there are a few key issues that the municipality of Groningen wants to address in the inner city. These are to increase the liveability and attractiveness within the inner-city, decrease the number of cars and to promote walking and cycling. The consequences of these focal points in the policy of the 'destination: the city centre' will be that the infrastructure of the city centre will be adjusted to those modes of transport. This is especially made clear in the second, third and fourth project that have been analysed. The first and the fifth project focus on giving room to multiple forms of transport but most importantly giving room to public transport. Not only should that public transport still make the inner city accessible, but it should also give room for the shopping streets to flourish and give an economic boost to the inner city. In a way, the reduction of the number of cars within the inner city also gives a boost to the quality of the urban living environment by reducing air pollution that is caused by motorized vehicles.

The following figures, 4.3 and 4.4, have been made from the dataset that has been analysed. This analysis is elaborated in appendix V and serves to check if data can show the effects the projects have on the infrastructure. Both figures show the two years when the projects were taking place. It shows that during the construction of the projects, the amount of cars on the Eendrachtskade has increased. This is only true however for the Eendrachtskade Noord, which can be explained by the fact that the route those cars previously took, was no longer accessible to them. This means that the datasets support the analysis in saying that the Eendrachtskade will become busier. Sadly not much can be said about the A weg and Schuitendiep since the measurements did not take place in those years.

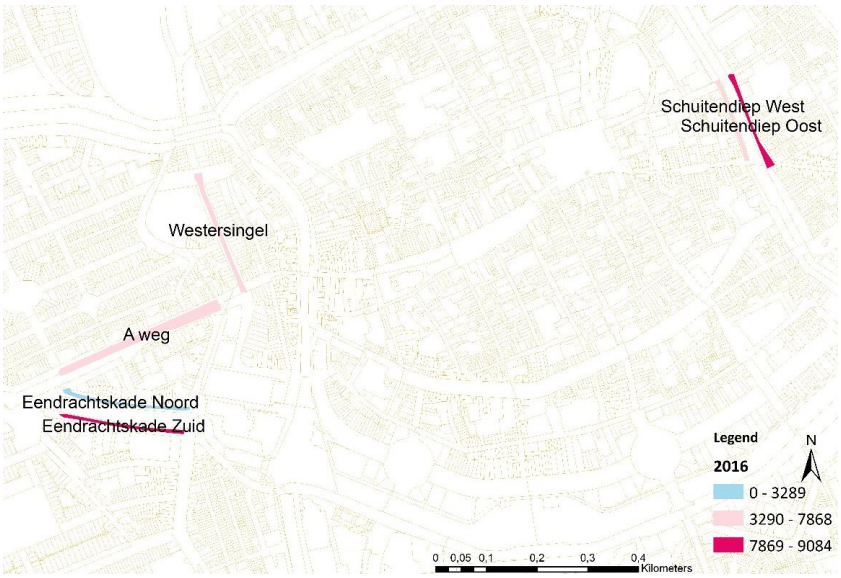

Figure 4.3. Map of the numbers of cars on the counting sections that are related to the projects in 2016.

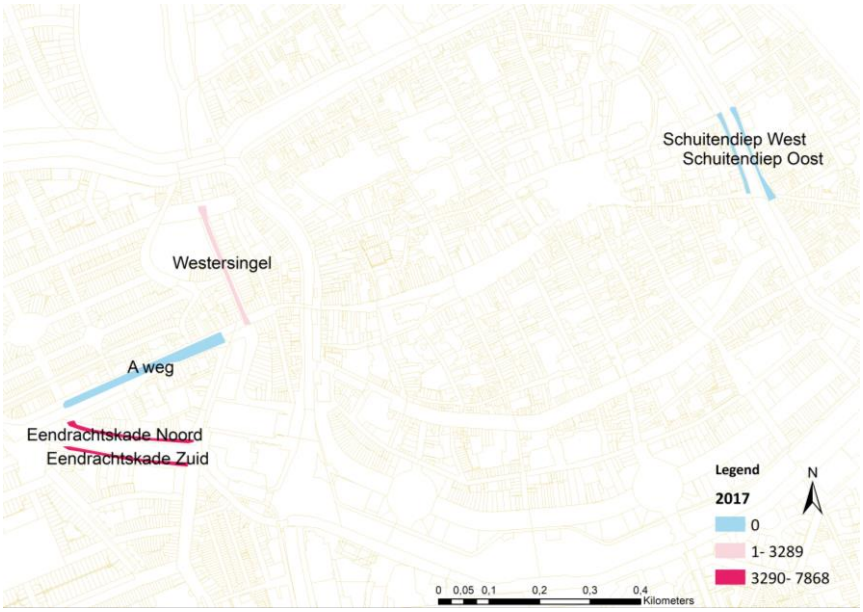

Figure 4.4. Map of the numbers of cars on the counting sections that are related to the projects in 2017

At this point, not a single project that has been analysed within 'destination: city centre' has mentioned the use of real-time data. But there is another project that is of relevance. It has been mentioned in chapter 1.1 and shortly in 4.1 and 4.3. The 'Proeftuin Binnenstadsmonitoring' is a pilot where smart sensors monitor bicycle and pedestrian movements through the Akerkhof and Brugstraat. These results will provide input in improving public space and traffic safety. The municipality names real-time solutions to regulate the traffic flows, namely dynamic traffic signs that could reroute cyclists to alternative routes (Gemeente Groningen, 2019a).

Even though the analysed projects did not have any relation with real-time data, the last project, 'Proeftuin Binnenstadsmonitoring', shows that real-time infrastructural data is being used in Groningen. The outcome of the pilot will be made public in the summer of 2020, which shows that the municipality is willing to look into what real-time data can mean for infrastructure.

With these results to the secondary questions, the main research question can be answered, which will be done in the following chapter, chapter five.

Chapter 5 - Conclusion and discussion

In this chapter, the main research question will be answered and the results and this research itself will be discussed.

5.1 Conclusion

In this research, it has become evident that data could play a large role in planning. This is illustrated by the role that data plays within smart cities. Through digitalization, the importance of data grows. Digitalization can combine data with new technologies to provide smart solutions in planning. In infrastructure, there are two types of data that can be used for planning: real-time data and aggregate data. In this research, the aspect of real-time data in Groningen has been explored. This type of data has many uses in infrastructure: it can be used to monitor traffic flows and contributes to smart mobility.

From all the different uses of real-time data that came forward during this research, the traffic flows have been the most influential type on infrastructure planning in Groningen. The other uses of the real-time data focus more on communication between vehicles and towards users of the infrastructure. It has been made clear that this aspect of data had little effect on planning. Within the inner city of Groningen, there are different projects that are dealing with infrastructure. These projects have affected and will affect the infrastructure within the inner city, but the role of real-time data has only come forward in one of those projects. The effect of real-time data on the infrastructure planning in the inner city of Groningen is therefore minimal.

5.2 Recommendation

Real-time data could help planning by creating an overview of the crowdedness and other aspects from communication that could be relevant to planning. Policymakers and planners can use real-time data to their advantage. By knowing the crowdedness and analysing flows they can adjust the infrastructure. That way the inner city of Groningen can become what the municipality wishes it to be: a safer and high-quality environment where pedestrians and cyclists can move freely.

5.3 Discussion

This research consisted of three aspects: analysis of the dataset provided by the dataplatform Groningen, the policy analysis and the interviews. In order to provide a framework for data collection, the theoretical framework was created. Within the analysis of the dataset, several aspects of the data collection and analysis have already been mentioned in chapter 3. The conclusions drawn from the dataset have been done with caution but provided a clear link with the crowdedness of the roads and the project from the municipality. The policy analysis, which can be seen in appendix IV, provided the necessary background information on the infrastructure projects within the inner city of Groningen. The plans and policies proved to contain no direct link with real-time data, but this resulted in noting that there is untapped potential for the municipality. The interviews did, in the end, not contain all the aspects of this research, but the context and use of real-time data, which this research was about, has been discussed to great lengths. Comparing the concepts and theory as reviewed in chapter 2 with the practice that has been researched in Groningen, it shows that the municipality could make more use of data and more specific, real-time data.

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Appendix I - Interview guides

I.1 - Interview guide for experts from the municipality of Groningen

Introduction

First of all, thank you for taking the time to speak with me today about the usage of real-time data in infrastructure planning in Groningen. With this in-depth interview, I would like to gain more insight into the transformation in inner cities and specifically when it comes to the digitalization that is currently happening and how that can affect infrastructure planning.

Consent

We would like to remind you that this interview will be recorded to examine further after the interview is done. Before we begin, do I have your voluntary permission to document our conversation?
[Consent form, as can be seen in appendix II]

[START RECORDING]

This is the interview (X) on (X) and he/she understands that this interview is being recorded. Is this correct?

Warming up

- What is your professional background?
- Are you currently living in the city of Groningen?
  - ☐ For how long?
- How long have you been working within the municipality?
  - ☐ What is the largest project you have worked on?
  - ☐ How do you experience working for the municipality?
  - ☐ What made you choose to work for a governmental organization?

Exploration of present aspects

- What can you tell me about the infrastructural plans within the inner city of Groningen?
  - Traffic wise, what do you think the consequences of those changes will be?
- In the urban traffic plan of Groningen it is mentioned that the inner city will be redesigned to fit bicycles and pedestrians and that car traffic will structurally be brought down to lesser numbers, how do you think you can best do that?
- What is, according to you, the biggest incentive for the current plans of the municipality?
  - What other factors can contribute to the plans
- What do you think should the biggest incentives be for the changes made in infrastructure?
- To what extent did real-time data, such as the Floating Car Data, affect those infrastructural projects?
  - What kind of data was used?
  - How was that data obtained?
- What is the exact function of the traffic model that is currently being used?
  - Do you think this can be useful in infrastructure planning, if yes: in what way? (not focused on function, but on the structure)
  - What are the limitations of the data?
- What do you think about the digitalization of inner cities?
  - Pros vs cons

Exploration of future aspects

- How big do you think the role of data can be for infrastructure planning?
  - What kind of plans are there for the future that can take into account data?
- How can you predict future use of the different modalities?
- What are the plans from the municipality in respect of using the data provided by other parties?

Finish

Remark that the end of the interview is near.

- How would you put to use the data from traffic flows when it comes to infrastructure planning?
- What do you think would the ideal commute look like?
  - Explain

Before we end the interview, is there anything you would like to tell or state that has not been mentioned in our conversation already? In other words: is there anything you would like to add or discuss?

[Thank the expert/informant]
[END RECORDING]

I.2 – Interview guide for experts on real-time data

Introduction

First of all, thank you for taking the time to speak with me today about the usage of real-time data in infrastructure planning in Groningen. With this in-depth interview, I would like to gain more insight into the transformation in inner cities and specifically when it comes to the digitalization that is currently happening and how that can affect infrastructure planning.

Consent

We would like to remind you that this interview will be recorded to examine further after the interview is done. Before we begin, do I have your voluntary permission to document our conversation?
[Consent form, as can be seen in appendix II]

[START RECORDING]

This is the interview (X) on (X) and he/she understands that this interview is being recorded. Is this correct?

Warming up

- What is your professional background?
- How long have you been working within [name company]?
  - ☐ What is the largest project you have worked on?
  - ☐ How do you experience working for [...]?
  - ☐ What made you choose to work for this organization?

Exploration of present aspects

- What kind of data is used in infrastructure projects?
  - ☐ How often?
- Where do you use real-time data for?
  - ☐ Floating Car Data? Google Car?

- What is the biggest incentive to collect infrastructural data?
    - / Why are they collecting these types of data?
- According to you, what kind of data is best suited in infrastructure plans?
- What types of data will be used to monitor traffic flows?
    - In what way do they respond to that data?
    - To what extent are they real-time?
- How do you make use of all the information gained from the data?
- How can you best manage the data?
- What could be the effect of using all the information directly?
    - Should we use all the data available to experts?
- To what extent does the municipality of Rotterdam use the available data?

Exploration of future aspects

- How can data from now affect a plan according to you?
- Do you think there will be a future where a city like Groningen is regulated by using data?
- What do you think about the digitalization of society?
    - And the digitalization of inner cities?

Finish

Remark that the end of the interview is near.

- How would you put to use the data from traffic flows when it comes to infrastructure planning?
- What do you think would the ideal commute look like?
    - Explain

Before we end the interview, is there anything you would like to tell or state that has not been mentioned in our conversation already? In other words: is there anything you would like to add or discuss?

[Thank the expert / informant]
[END RECORDING]

Appendix II - Form for informed consent

(name participant)

……
hereby consents to be a participant in the current research performed by Leia Vader

I have agreed to take part in the study entitled Infrastructure planning in Groningen: the effect of real-time data and I understand that my participation is entirely voluntary. I understand that my responses will be kept strictly confidential and anonymous. I have the option to withdraw from this study at any time, without penalty, and I also have the right to request that my responses will not be used.

The following points have been explained to me:

1. The goal of this study is

……
2. Participation in this study should help advance our understanding of

……
3. I shall be asked to

……

4. My responses will be treated confidentially and my anonymity will be ensured. Hence, my responses cannot be identifiable and linked back to me as an individual.

5. The researcher will answer any questions I might have regarding this research, now or later in the course of the study.

Date: Signature researcher:

Date: Signature participant:

Appendix III – Coding scheme

Category	Description	Example	Inductive/deductive
Influence of data on planning	In this category, the influence of different types of data on infrastructure planning is noted.	'We did not only use traffic flow measurements, but we've also looked into the number of people in public transport, the number of bicycles in the inner city and the number of cars on the road'	Inductive
Usage of real-time data	This category contains information from the interviewees on the topic of the uses of real-time data.	'Real-time data for us means that we can communicate the crowdedness of the roads to the viewers of our website [...] and with it, we show how the roads are used'	Inductive
Digitalization and its effects	Within this category, the process of digitalization and the consequences are discussed.	'With our mobile phones we have so much access to data, but we also provide data with our positions or search histories...'	Deductive
Digitalization in infrastructure	Other than the previous category, the digitalization in this one is focused on infrastructure.	'Digitalization provides an extra piece of communication to me as the user of the road, which makes the ride easier in the end'	Inductive
Infrastructure planning	This category encompasses general information about infrastructure planning.	'The traffic circulation on Julianaplein has led to many discussions within the municipality and has thankfully led to the construction that is currently taking place'	Inductive

Appendix IV – Policy analysis

IV.1 Project rerouting the bus from Eeldersingel/Westerhaven/Aweg

Spatial Context	Why change	The desired outcome of the plan/project	Influence on the infrastructure
The development of an inner-city where pedestrians and cyclists have priority. This means parking on the outside of the city with high-quality public transport towards the centre of Groningen. Public transport is seen as an important connection between the region and the city centre of Groningen. In order to provide in transport around the city centre, the bus lines that fare towards Westerhaven, which will be connected with the shopping area of the Vismarkt, will receive a new bus stop on the altered route.	Due to the priority given to pedestrians and cyclists, the city centre needs to give those modes of transport more space. This means that other forms of transport will be driven to the outer edges of the city centre. With Westerhaven, an important bottleneck redesigned there is more room for people to stay and recreate. The buses are too dominant in the city and in order to improve the quality of the public space the municipality has chosen to reroute the bus on the Western side of the city.	By taking up less space in the city-centre the bus gives more space to pedestrians and cyclists, making the environment safer. The route should be just as fast as it was before the change and on the location of the new stops in the city centre strategic and attractive locations are created. This entails that the heart of the city has become less accessible by car, but more by other ways of transport (Gemeente Groningen, 2016b).	Looking at the project from a car perspective, the route towards the Western part of the city will go via the Hoendiep and Aweg, but also via the Eeldersingel. Westerhaven will not be the disclosure of the area anymore. Because of the changes to the circulation, there will also be adjustments to the Bleekerstraat to prevent its usage as a shortcut, just as the Willem Barentzstraat. The parking garage at Westerhaven will only be accessible via the Aweg, which will not affect the traffic circulation in that area and leads to fewer conflicts.
Use of data: no direct link with real-time data was made clear in the plans			

IV.2 Project redesigning Astraat

Spatial Context	Why change	The desired outcome of the plan/project	Influence on the infrastructure
As with the rerouting of the bus and with the inner city in general, the public space needs to improve in quality and to accommodate the change from 'place to buy to place to be' the motorized vehicles need to make way for healthier modes of transport such as bicycles.	In line with the alteration of the bus route at the Western part of the city-centre, the Astraat will give the western part of the inner city a large impulse when it comes to recreation. It will form the connection between the hub of Westerhaven and the heart of the city.	By making the street hybrid, removing the buses and prioritizing pedestrians the road should now function as a green entrance into the inner city. Next to that, the quality of stay will be improved by the broadening of the sidewalks, giving the pedestrian the said space. The decline in motorized traffic allows for a safer and more pleasant environment. (Gemeente Groningen, 2017).	The main effect this change will have on the infrastructure is the removal of the buses that previously drove through the Astraat. In the plan, the roads will contain so-called hybrid parts. On these hybrid parts mixing of transport modes is possible to ensure a good flow of traffic during peak moments of the day. Pedestrians have priority and because of that, the sidewalk is at the same level as the rest of the roads. The route for residents remains the same, meaning a one-way street moving away from the inner-city. This direction is now also implemented for taxis and supply traffic.
Use of data: no direct link with real-time data was made clear in the plans			

IV.3 Project redesigning Brugstraat/Munnekeholm

Spatial Context	Why change	The desired outcome of the plan/project	Influence on the infrastructure
As a consequence of the alterations done by the previously mentioned projects, the Brugstraat and Munnekeholm will see a decline in motorized traffic, since the buses will not be travelling along that route any longer. This left room for a redesign of said roads, again giving space back to cyclists and pedestrians.	Due to the rerouting of the bus that has already been described, the Munnekeholm and Brugstraat can use another layout. To continue the line of hybrid zones and to again prioritize pedestrians and cyclists, alterations need to be made.	Along with creating a safer public space for pedestrians and cyclists by creating shared space sections that interrupt the road, the quality of stay is also improved. The hybrid lanes will contribute to a more even distribution of transport modes. It should contribute to an attractive and comfortable entrance to the inner city from the West.	Brugstraat: lowering the level of sidewalks to the other road to include the hybrid feel of the road. The only motorized traffic allowed is supply traffic which has to adhere to the one-way direction out of the city via the Astraat. Shared space on Munnekeholm with hybrid zones that allow for different uses at various different peak hours during the day. At the Munnekeholm the motorized vehicles are able to drive both ways of the street. In both cases, the driving lane is being narrowed, to 4.5m and 3.5 respectively.
Use of data: no direct link with real-time data was made clear in the plans			

IV.4 Project redesigning Oosterstraat

Spatial Context	Why change	The desired outcome of the plan/project	Influence on the infrastructure
The Oosterstraat is currently one of the main roads for the buses still going from south to north within the inner city. The busy street has lots of stores and therefore a mix of pedestrians, cyclists and other motorized transport, apart from cars, can be found on the street.	As public space in Groningen is one of the focuses of the programme, the Oosterstraat, just as the Astraat and Brugstraat projects, will make space for pedestrians and cyclists alike. Since the Oosterstraat is part of the inner city and connects the south with the Grote Markt, it becomes an artery for said transport modes.	The new Oosterstraat should be a safe public space where people want to recreate and stay. With this safer environment sans motorized traffic, the street should get an economic impulse. Concerning the usage of the roads, the municipality is not sure yet, as they will be hybrid zones like in the Astraat or Munnekeholm (Gemeente Groningen, 2016a).	Since the Oosterstraat will be accessible only for pedestrians and cyclists, the buses will be rerouted to the Diepenring. The Oosterstraat itself will become mainly focused on the pedestrians, as the parallel Gelkingestraat has been appointed as the cycling street in the new cycling strategy.

Use of data: no direct link with real-time data was made clear in the plans

IV.5 Project redesigning the Diepenring

Spatial Context	Why change	The desired outcome of the plan/project	Influence on the infrastructure
The Diepenring is currently one of the ring roads around the heart of the city centre of Groningen. The road has already been addressed in 2017-2018 within the framework of major maintenance. This maintenance connects to the plans from destination: city centre.	Due to the alterations of the Oosterstraat, the Diepenring will now have to accommodate the bus lines previously going through the Oosterstraat. That said, the situation for cyclists and cars alike was unsafe and unclear. With this change, the Diepenring will become more part of the inner city.	With these plans, the Diepenring should be able to function as a new bus route as well as become a part of the inner city of Groningen. The road should improve the quality of the Diepenring itself and become an important route for cyclists around the city centre. This entails that it should be a more safe infrastructure that can support the two modes of transport.	The two lanes will be changed into one, with a distinct cycling lane on the side and broad sidewalks where possible. Further, plans have not been made public yet, as this process will last until 2023. It can be predicted however that with the new lane layout the traffic flow will be different and at peak times could be busier than before the changes were made.
Use of data: no direct link with data was made clear in the plans			

Appendix V– Analysis of the dataset

After filtering the different locations where the number of passing cars was measured, the following locations were deemed most influential to the inner city of Groningen. Looking at the projects that are analysed in the policy analysis, the highlighted streets are the ones most closely related to the infrastructural plans mentioned in the 'destination: city centre' programmes.

KENM_TEKST	KENM	Telpunt	Weg	Telvak	2010	2011	2012	2013	2014	2015	2016	2017
Eikenlaan	G027	G027	Eikenlaan	Dierenriemstraat - Elzenlaan	11533	11340	11131	11392	10955	11109	10892	10512
Bedumerweg	G114	G114	Bedumerweg	Sumatralaan - Rodeweg	7207	6944	6421	6016	5811	4705	4860	5343
Kastanjelaan	G170	G170	Kastanjelaan	Mutua Fidesstraat - Parallelweg	4411	4285	4018	3934	3759	3923	2844	3799
Kastanjelaan	G170	G170	Kastanjelaan	Mutua Fidesstraat - Parallelweg	4411	4285	4018	3934	3759	3923	2844	3799
Eikenlaan	G186	G027	Eikenlaan	Dierenriemstraat - Elzenlaan	11533	11340	11131	11392	10955	11109	10892	10512
Eikenlaan	G186	G027	Eikenlaan	Dierenriemstraat - Elzenlaan	11533	11340	11131	11392	10955	11109	10892	10512
Prinsesseweg	G189	G189	Prinsesseweg	Grote Beerstraat - Stadhouderlaan	6082	5846	5724	5606	5247	5333	5203	4831
Friesestraatweg	G243	G243	Friesestraatweg	Laan 1940-1945 - 2e Spoorstraat	5610	5235	5119	4955	5170	4856	4706	5156
Griffeweg	G460	G460	Griffeweg	Meeuwerderweg - Europaweg	14511	14272	14445	12625	12589	12448	10968	12169
Griffeweg	G460	G460	Griffeweg	Meeuwerderweg - Europaweg	14511	14272	14445	12625	12589	12448	10968	12169
Korreweg	G572	G572	Korreweg	Rodeweg - Sumatralaan	5566	5514	5209	5379	5159	5086	4986	5188
Damsterdiep		-	Damsterdiep	Zaagmuldersweg - Eltjo Ruggeweg	0	0	0	0	0	0	11745	10900
Kapteynlaan	T126	T126	Kapteynlaan	Korreweg - Oosterhamrikkade	10735	0	10912	0	10140	0	10314	10542
Petrus Campersingel	G213	G213	Petrus Campersingel	Vrydemalaan - Damsterdiep	12869	12417	12525	11402	10966	10834	10771	10752
Schuitendiep Oost		-	Schuitendiep Oost	Nieuweweg - St. Jansstraat	0	0	0	0	0	0	9051	0
Schuitendiep West		-	Schuitendiep West	St. Jansstraat - Nieuweweg	0	0	0	0	0	0	6518	0
Lopendediep Zuid		-	Lopendediep Zuid	Kijk in 't Jatbrug - Boteringebrug	0	0	0	0	0	0	4745	4536
Lopendediep Noord		-	Lopendediep Noord	Boteringebrug - Kijk in 't Jatbrug	0	0	0	0	0	0	8496	6117
Westersingel		-	Westersingel	Verlengde Visserstraat - A straat	0	0	0	0	0	0	7868	3104
A weg	T112	T112	A weg	Westerhaven - Eendrachtskade	6889	0	7056	0	6736	0	7724	0
Eendrachtskade Noord	T136	T136	Eendrachtskade Noord	Westerhaven - A weg	3699	0	3394	0	3376	0	3289	5672
Eendrachtskade Zuid	T061	T061	Eendrachtskade Zuid	A weg - Westerhaven	8458	0	8592	0	8675	0	9084	7642
Stationsweg	T064	T064	Stationsweg	Emmaviaduct - Hereweg	0	0	13379	0	12881	0	13224	11784
Stationsweg	T064	T064	Stationsweg	Emmaviaduct - Hereweg	0	0	13379	0	12881	0	13224	11784

Figure V.1. Attribute table with the counting sections and numbers of cars on a measured day

In figure V.1. the selected sections are visible as well as the number of cars measured per year. It shows that certain sections have not been measured each year, which will explain the amount of zero shown on the maps that follow. Deriving from this table an average decline in the number of cars can be seen on the Eikenlaan, Bedumerweg, Kastanjelaan, Prinsesseweg, Damsterdiep, Lopendediep Noord, Griffeweg, Westersingel and Stationsweg. The biggest fluctuation in numbers can be found on the Friesestraatweg and A weg. Sections who have quite remained the same are the Kapteylaan, Korreweg and Lopendediep Zuid. The largest increase in number can be seen on the Eendrachtskade Noord.