



Assessing the Impact of Recent Legislation on the Connectedness of new Dutch Housing Developments to Public Transportation, a Groningen Case Study

Thijs van Soest – Master Thesis Final Version

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Abstract

In the Dutch 2022 coalition agreement, 7.5 billion euros were allocated to improving the connectedness of new Dutch housing developments. This research examines the integration of public transportation in new housing developments in Groningen. Using a mixed-methods approach, including GIS data analysis and eight semi-structured interviews with urban planners and stakeholders, this research assesses how policies and legislative changes influence urban connectedness.

Findings indicate that Groningen's approach to Transit-Oriented Development (TOD) is largely effective, yet challenges persist in aligning housing construction with transport infrastructure development. Stakeholders highlighted the need for clear roles in the development process, effective policies addressing the stakeholders' interests and concerns, and innovative funding to enhance connectivity. The analysis underscores the importance of designing neighbourhoods that support walking, cycling, and community interaction.

The results discuss stakeholders' views on connectedness, responsibilities regarding mobility, policy and funding challenges, practical implementation, mobility and accessibility, and future planning perspectives. This research offers insights into creating sustainable and connected urban environments that are relevant for policymakers and urban planners.



Introduction

On December 15, 2021, the coalition agreement of Dutch government Rutte IV was presented (Rutte et al., 2021). It included a remarkable aim: the intention to build approximately 100.000 houses per year to combat the widespread housing shortage in the Netherlands. Zooming in on this problem, it becomes clear that solving it is no easy task and faces challenges in various fields of the urban planning process (Knoop et al., 2024). Among these challenges, integrating public transportation (PT) in new housing developments stands out as an essential factor for ensuring sustainable and connected urban growth, as while cities expand, providing efficient and accessible transportation becomes crucial in maintaining the quality of living and economic vitality (Curtis and Scheurer, 2010; Ercan et al., 2017).

In the coalition agreement, it is agreed upon to spend 7,5 billion euros on improving the accessibility and physical connections of new housing developments, with the majority (4,0 billion) meant for public transportation (Rijksoverheid, 2022). Urban development and public transportation are intricately linked, and one of the critical challenges in urban development is ensuring that new neighbourhoods are well-connected to existing urban infrastructure, particularly public transportation (Ercan et al., 2017). Public transportation not only reduces dependency on private vehicles but also promotes equitable access to amenities, fostering a sense of connectedness within communities (Alberti et al., 2022). Connectedness in this context extends beyond mere physical proximity to transportation options; it encompasses social and spatial dimensions, influencing how residents interact with their surroundings and each other (De Martino et al., 2023). However, connectedness has various possible meanings and explanations (e.g. Bailey et al., 2020; Boeing, 2018; Li et al., 2023). In this study, connectedness is considered the physical presence of and distance to public transportation amenities.

In the Netherlands, the push for rapid housing expansion under the Rutte IV government's mandate has brought the issue of connectedness to the forefront. Ensuring that new neighbourhoods are well-integrated with public transport networks is essential for avoiding the pitfalls of car-dependent development, which can lead to increased congestion, environmental degradation, and social isolation (Ibraeva et al., 2022b; Kaplan et al., 2014). Furthermore, choices between infill development and city expansion have to be made. Where the first option could benefit from already-present public transportation infrastructure, the nuisance of housing development in existing urban areas and possibly following judicial processes are a threat and need a well-considered assessment of the possibilities.

As a rapidly growing city (Groningen, 2020), Groningen serves as a pertinent case study to explore these dynamics. By focusing on Groningen, a city known for its progressive urban planning policies (De Roo and Miller, 2004; Roggema, 2014), this research aims to provide insights that can be valuable not only for Dutch policymakers and urban planners but also for those in other countries facing similar urban development challenges. Another benefit is that the city of Groningen lies in a relatively desolate part of the Netherlands and only has one public transportation authority: the OV-bureau Groningen Drenthe. Thanks to the vast area of serving, its transportation agenda is not influenced much by planning policies from other authorities, making it an easier-to-observe place for a case study (OV-bureau Groningen Drenthe, 2023).



Groningen's approach to urban planning emphasizes the importance of public transportation in fostering connectedness (Gemeente Groningen, 2021a, 2020). The city's strategies align with Transit-Oriented Development (TOD) principles, which advocate for high-density, mixed-use development centred around public transit hubs to establish maximal accessibility and create a shift to minimize reliance on private cars (Gemeente Groningen, 2023, 2022a, 2022b, 2021b; Rongen et al., 2022). However, translating these principles into practice within the context of new housing developments involves navigating numerous challenges, from securing funding and aligning stakeholder interests to overcoming bureaucratic hurdles to creating spaces that enrich the quality of living and public interest (Machakaire and Mokhele, 2024).

Following the new planning and financial legislation in the 2021 coalition agreement and the progressive planning policies of the municipality of Groningen, this paper aims to assess the impact of these recent legislative changes on the connectedness of new Dutch neighbourhoods to public transportation, using the city of Groningen as a case study. Three main sub-questions are posed to guide this research. First, what is connectedness? This question seeks to explore the multifaceted nature of urban connectedness, drawing on both theoretical frameworks and practical applications in urban planning. Second, how do (regional) policies affect differences in connectedness? Examining variations in policies across different projects in Groningen, the aim is to identify factors that influence the degree of connectedness in urban environments. And third, how long does it take until legislation is visible in practice? This question addresses the temporal aspect of policy implementation, investigating the lag between the introduction of new legislation and observable changes in urban development practices.

To address these questions, this study employs a mixed-methods approach. A small quantitative analysis of Geographic Information System (GIS) data derived from the Dutch BAG dataset, which includes cadastral data, and from OpenStreetMap, containing the locations of public transportation stops to measure physical connectedness, is combined with qualitative insights from interviews with key stakeholders in Groningen's urban planning sector, like representatives from the municipality, a housing corporation and the OV-bureau Groningen Drenthe. This approach allows not only quantifying the current state of connectedness but also understanding the complex factors influencing its implementation.

The paper is structured as follows: First, a comprehensive literature review exploring the concept of connectedness, its relationship to Transit-Oriented Development, and the 15-minute city concept is provided. Then, the methodology is outlined, detailing the data collection and analysis processes. The results section presents the findings from the GIS analysis and stakeholder interviews. In the discussion, these results are interpreted in the light of the research questions and the broader context of Dutch urban planning legislation. Concluding, implications for policy and practice are noted, and suggestions for future research are given.



Literature review

Connectedness

Connectedness is a core concept within the field of urban planning. Although studied in various existing literature, there is no set definition of connectedness, and its interpretation changes over time (De Martino et al., 2023). Boeing (2018), among others, focus on the built environment (i.e., the physical space in which we live) at different geographical scales and the role of urban form and planning on connectivity. Others, like Li et al. (2023), turn their attention to the relationship between nature and planning. Social interactions and psychological bonds, explained by Bailey et al. (2020), among others, offer another possible perspective on connectedness in the urban planning context.

For this research, the most relevant perspective on connectedness is that of the built environment. This includes the physical connectivity provided by transport infrastructure such as roads, tram and train tracks, cycling paths, and sidewalks, as well as the impact of urban form and land use on facilitating convenient and sustainable travel options for individuals. Emphasising the built environment allows for a comprehensive understanding of how urban design influences connectivity, aligning with the central themes of this thesis.

The following subsections elaborate on the possible meanings of connectedness: the built environment, mobility behaviour, and measuring connectedness. This structure allows for a comprehensive review of the concepts and literature most relevant to this research, providing a solid foundation for the analysis.

The Built Environment

The built environment encompasses all human-made physical spaces, including buildings, infrastructure, public spaces, and natural features (Fifth National Climate Assessment, 2023). An important aspect of the built environment's functionality is the land use mix, which refers to the distribution of different types of land uses, such as residential, commercial, and recreational areas (Carpio-Pinedo et al., 2021). The land use mix significantly affects the spatial arrangement of activities and services within a city, thereby shaping travel behaviours and patterns. Specifically, the design and layout of urban areas can facilitate or hinder efficient, convenient, and sustainable mobility choices, directly impacting daily activities such as commuting, shopping, and leisure (Poklewski-Koziel et al., 2023).

Connectedness in the built environment mainly refers to the degree to which a particular place is connected to its surroundings in terms of connections by roads, tram/train tracks, cycling paths and sidewalks, thereby facilitating convenient (and sustainable) travel options for residents when undertaking everyday activities (Boeing, 2018; Portugali, 2006). For instance, high-quality public transportation systems enhance place connectedness by providing efficient, affordable, and accessible mobility options, particularly benefiting underprivileged and elderly populations (Andrienko et al., 2020). Besides, TOD can improve the transportation network's efficiency, leading to higher accessibility and lower urban carbon emissions as trips are shortened and active mobility and public transportation are stimulated (Dou et al., 2016).

Two prominent concepts closely related to the built environment that exemplify these principles are Transit-Oriented Development (TOD) and the 15-minute city. The 15-minute city concept focuses on



mobility habits and daily life experiences, ensuring that all essential services and amenities are accessible within a 15-minute walk or bike ride. Conversely, TOD is a built environment approach that integrates land use and transport planning to create dense, walkable communities centred around public transit hubs. By facilitating multimodal transportation use and mixed-use development, TOD can lay the groundwork for achieving 15-minute cities, as they provide the necessary infrastructure and urban form to support localised living.

Jane Jacobs famously advocated for mixed-use development in city life, emphasising the importance of intermingling city uses and users for economic and urban development (Jacobs, 1961). She concluded that cities should be organic, spontaneous, and like patchwork in their configuration. The 15-minute city relies on a carefully planned land use mix that integrates complementary uses, such as retail, residential, and green spaces (Carpio-Pinedo et al., 2021). It aims to meet every resident's daily needs within a 15-minute walk, cycle, or public transportation ride (Poorthuis and Zook, 2023; Pozoukidou and Angelidou, 2022). These approaches leverage the built environment to enhance connectedness by clustering various land uses around transit nodes, thereby increasing the accessibility and attractiveness of urban neighbourhoods. This, in turn, supports sustainable mobility and vibrant community life.

Pojani and Stead (2014a, 2014b, 2015, 2016) envision TOD as a planning concept that aims to create liveable, sustainable, and economically vibrant communities centred around high-quality train systems. Trains are emphasised because they provide efficient, high-capacity transit, which is particularly relevant in the Dutch context, where the rail network is extensive, and the rail transport frequency and capacity are high. These systems increase the ability of individuals to access places of interest, facilitating increases in land use mixing. The success of TOD hinges on land-use planning, which coordinates the location of diverse land uses in dense areas connected by multiple transportation modes (Jacobson and Forsyth, 2008). This is often achieved by clustering urban development around public transport nodes, creating high-density, diverse land uses and pedestrian- and cycling-friendly environments (Bian et al., 2023; Knowles et al., 2020; Wolański, 2023). This approach influences urban planning by providing a framework for integrating transportation and land use policies to create cohesive, sustainable urban areas.

Pojani and Stead (2014a, 2014b, 2015, 2016) formulated that the ideal TOD model envisions a mid-rise, medium-density neighbourhood characterised by mixed-use and an interconnected design centred around multimodal transport access nodes. The idea emphasises physical connectivity and the accessibility of places of interest, but also place attractiveness (i.e., through accompanying green space development) and a seamless fusion with other neighbourhoods. This corresponds with the findings of Bertolini et al. (2012), which show that the redevelopment of train stations and their surroundings is justified by the dual benefits of enhancing the attractiveness of urban neighbourhoods and promoting sustainable travel. Attractiveness, which can include factors such as safety, cleanliness, and the availability of amenities, is crucial for encouraging sustainable travel and improving the overall quality of urban life.

Poklewski-Kozieł et al. (2023) highlight the importance of understanding socio-economic history in shaping urban environments. For example, a historically industrial city like Manchester will likely have different spatial characteristics than a city like Amsterdam, with a commodity and textile trading history. Therefore, a different approach will be required when applying TOD. Lyu et al. (2020) suggest that certain consumer-service-related sectors, such as retail, hospitality, and personal services, may



benefit from areas with stronger TOD characteristics. This preference is due to the increased foot traffic, elevated accessibility, and increased interactions, characteristics known to produce positive agglomeration effects and associated externalities (See Ahlfeldt and Pietrostefani (2019) and Duranton and Puga (2020) for recent reviews of such topics).

Sustainable mobility and healthy cities are intertwined concepts because both aim to enhance the quality of urban life by promoting environmental sustainability, reducing pollution, and encouraging active lifestyles. A well-designed city can facilitate this by integrating efficient public transportation, walkable neighbourhoods, and ample green spaces, thereby supporting both sustainable mobility and public health. Li et al. (2023) explore the connectedness among urban parks and highlight the importance of addressing both physical and psychological aspects of connectedness in park planning and design. This connectedness supports sustainable mobility by providing accessible recreational areas encouraging walking and cycling. Nowadays, planning research also focuses on strategies and tools that support practitioners in designing local areas where human and natural presence come together (De Montis et al., 2016), thereby fostering both environmental sustainability and community well-being, reinforcing the link between healthy cities, sustainable mobility, and urban connectedness.

Mobility Behaviour

The 15-minute city emphasises the importance of land-use mix as a cornerstone for urban sustainability. It opposes the segregation of distinct land uses across space, also known as functional segregation (Carpio-Pinedo et al., 2021). While some argue that functional segregation, such as in suburban areas or separated industrial zones, can be attractive in certain contexts, the 15-minute city approach aims to create more vibrant and diverse urban environments by integrating various activities and reducing the need for long commutes. The emphasis on mixed land use and pedestrian accessibility directly enhances urban connectedness by ensuring that residents have easy access to various services and opportunities for social interaction (Moreno et al., 2021; Caselli et al., 2022). It gained traction during the COVID-19 pandemic, highlighting the shortcomings of current urban planning models, such as the Smart City concept, as the pandemic emphasised the need for accessible basic amenities and social interactions (Moreno et al., 2021). The core idea behind the Smart City concept is the use of various technologies to enhance different aspects of urban life. The rise in technologies like bike- and car-sharing services and online shopping aims to ensure safety and punctuality by eliminating the need for travel to purchase items. When travel is necessary, using bicycles or walking avoids traffic and saves on auto expenses (Moreno et al., 2021).

In theory, the Smart City concept promises significant urban liveability and enhancements in sustainability. However, evolving research highlights that implementing these technologies, if not managed inclusively, could exacerbate existing urban inequalities. As Lee et al. (2020) argue, smart city initiatives often privilege affluent neighbourhoods or socio-economic groups by misrepresenting less affluent areas as 'unsafe' or excluding them from urban maps altogether. This 'big data security assemblage' reinforces inequalities by prioritising the securitisation of cities over equitable development. While Caragliu and Del Bo (2022) suggest that the integration of smart technologies may inadvertently favour wealthier and more skilled segments of the population, leading to potential income inequalities, their empirical findings intriguingly indicate that cities with higher levels of 'smartness' might exhibit lower income disparities, challenging the notion that smart city initiatives inherently benefit only the affluent.



Furthermore, Pozoukidou and Angelidou (2022) highlight the risk of spatial inequalities arising from uneven access to the benefits of urban connectedness at the neighbourhood level, underscoring the critical need for strategic urban governance to ensure equitable access to resources across the city. To truly evolve into dynamic and sustainable environments, as Padrón Nápoles et al. (2020) emphasised, cities must prioritise the social inclusion of marginalised groups, such as the elderly and immigrants. Thus, while smart city technologies offer substantial benefits, their implementation must be critically assessed and managed to prevent the deepening of urban inequalities and ensure inclusivity for all residents.

The 15-minute city concept also encourages cities to strengthen pedestrian accessibility through the manipulation of local spatial characteristics so that they align with urban design strategies promoting walkability (Poklewski-Koziel et al., 2023), for instance, by introducing alleys to help disconnected street networks become more efficient (Alawadi et al., 2021), as 15-minute cities can only work if cities are both efficient and encouraging to active modes of transportation (Abdelfattah et al., 2022). A widespread Dutch example is the implementation of the STOMP principle in planning policies. STOMP is an abbreviation for walking, cycling, public transportation, Mobility as a Service (MaaS) and (personally) driving (CROW-KpVV, 2023)¹, indicating the ladder of descending importance in the mobility aspect of area (re)development.

However, various other factors influence people's travel choices as well. Albacete (2019) found that families with children are more likely to live in car-dependent places, such as suburbs, where accessibility by walking and public transport is limited. These areas often attract families because they offer larger living spaces and safer environments. Wolday (2023) identified that people in small cities and villages are significantly more likely to engage in active modes of transportation when urban amenities are concentrated rather than dispersed. This suggests that while cities might be geographically small enough to 'satisfy the requirements' for a 15-minute city-based neighbourhood, the degree of centralisation of amenities plays a crucial role in promoting active travel.

TOD further supports the concept of connectedness by integrating high-quality public transportation systems with urban development, and it has been shown to significantly impact travel behaviour, particularly in reducing car use. Ibraeva et al. have conducted four studies on TOD in Porto (2020, 2021, 2022a, 2022b) in which they found that a supportive station environment and service levels play a crucial role in this reduction, with the share of car trips significantly reducing when these factors are considered, thereby enhancing connectedness and accessibility within the city. TOD features, such as improved transit access and walkability, make areas more desirable, leading to increased demand for housing, increased population density and, consequently, higher property prices (Forouhar and Van Lierop, 2021), a phenomenon known as capitalisation effects. This increased demand can lead to densification and gentrification over time (Ibraeva et al., 2020). Such an increase

¹ According to the STOMP principle, mobility can be divided into walking (Stappen), cycling (Trappen), public transport (OV), Mobility as a Service (MaaS), and private cars (Particuliere auto). The human being is central to this principle. By applying mixed-use development and compactness where possible, walkable areas (S) are created. Together with cycling (T), these types of short-distance movements are preferred because they are healthy and clean. For longer distances, bicycles and public transport provide solutions as clean and space-efficient modalities. MaaS can facilitate and further encourage this use. Since MaaS involves the smart integration of movements across different modalities, movements via M influence movements via S, T, O, and P. The private car serves as a last resort. However, this does not mean that there should be no place for cars.



in housing prices was also found to emerge after the RandstadRail TOD project in the Rotterdam – The Hague Metropolitan Area of the Netherlands (Forouhar and Van Lierop, 2021).

The concept of the 15-minute city model is exemplified by the Utrecht region in the Netherlands, where 100% of the population has access to at least one of nine pre-defined destination types within 15 minutes (Knap et al., 2023). This figure decreases slightly to 94% within a 10-minute cycling threshold, highlighting Utrecht's status as a cycling city with extensive cycling-friendly infrastructure (Knap et al., 2023). Although the term "15-minute city" emphasises urban settings, the principles underlying this model – such as accessibility and infrastructure – are equally relevant in non-urban areas. Effective implementation must consider the unique challenges of these regions, particularly the reliance on cars (Poorthuis and Zook, 2023). Therefore, it is the characteristics and policies promoting accessibility and sustainability that are crucial.

The implementation of TOD is not without challenges. For instance, it has been associated with decreased car ownership but increased ride-hailing demand (Bian et al., 2023), possibly due to missing alternatives for the so-called 'last mile', or the trip from the public transport stop to the final destination. While one could argue that ride-hailing reduces per-capita emissions relative to regular car usage and makes it more efficient, it is important to consider the potential downsides. Besides the high user costs, increased ride-hailing can lead to higher vehicle miles travelled and higher traffic congestion (Henaoui and Marshall, 2019) and may not always result in net environmental benefits if the ride-hailing vehicles are not adequately utilised or are idling between rides (Morrison et al., 2022). Another challenge is considering the possible public transport gaps – where there is no or limited public transportation availability – in certain geographical places, such as rural areas, as identified by Fransen et al. (2015).

Furthermore, (mental) health is another aspect significantly influenced by city design and mobility behaviour. Barton (2009) acknowledges the complex relationship between health and land use, especially in urban areas. Nieuwenhuijsen (2018) stresses that cardiovascular disease and mortality could be reduced by implementing urban and transport planning measures that promote physical activity, such as cycling and walking in a 15-minute city project, reducing levels of air pollution, noise, and heat island effects, and increasing green space. This is another reason why the earlier-mentioned STOMP, which principle prioritises this active mobility, gains in popularity. Also, when it comes to mental health, a well-designed city is necessary. Especially after COVID-19, social connectedness was recognised to be important (Sones et al., 2022), something the 15-minute city could help increase (Moreno et al., 2021). For example, research shows the vital role the public transportation infrastructure in New York has in enabling social networks throughout the city (Bailey et al., 2020).

Measuring Connectedness

Observing and measuring connectedness has been done in various ways, emphasising two perspectives: physical connectedness and social connectedness. (Boeing, 2018) links connectedness to the connectivity of places, similar to how Moreno et al. (2021) describe proximity as an important aspect of connectedness following the 15-minute city principle, and Singh et al. (2014, 2017) view it as the accessibility to transit. Most of these use spatial data and measure connectedness using physical distance measures.

On the other hand, connectedness can also be measured from a social perspective. Phillips et al. (2021) argue, by analysing geotagged messages, that a city's degree of connectedness can be



predicted by its demographic characteristics. Bailey et al. (2020) use Facebook user data to explore the relationship between commuting flows and social connections measured in Facebook friendships. And Kaplan et al. (2014) studied equality and social inclusion using GIS data around the Greater Copenhagen TOD 'finger plan', finding that TOD overall improved spatial equity but that this effect was hurt at some places, linked with a lower frequency of trains and longer access times.

Considering the various interpretations of connectedness in the literature, one definition should be set for this thesis to conduct a constant analysis. Therefore, in this research, connectedness is considered the physical presence of and distance to public transportation amenities. By selecting this definition, objective data analysis can be carried out alongside interviews. Following the literature, it appears that as time progressed over the past decades, increasing institutional focus was placed on the shift away from car transportation to public and active forms of transportation, for instance, the introduction of the STOMP principle and public transport hubs, which will be explored in this thesis.

Data & Methods

The data for this research was gathered through semi-structured interviews, complemented with policy documents. As it is a case study in the municipality of Groningen, the secretariat of the relevant alderman² was contacted, which led to interviewee 1. Thanks to the contact information received, interviewees 2 and 3 were contacted after the interview with 1. Interviewee 4 was contacted via the employer, which led to interviewee 6. Interviewees 5 and 7 were contacted via the employer. Interviewee 8 was contacted via direct email obtained from the supervisor.

Before each interview, a participation form was signed by the author and sent to the interviewee for his/her signature. This form included statements regarding the base of voluntary participation, privacy, and agreeing on using the interview data for this master thesis. Although each interviewee agreed to use the full name (i.e. no anonymity), the author acknowledges that it is in line with good practice that complete anonymity for the interviewees will be applied in this thesis. In Table 1 below, limited background information about the interviewees is shown.

Interviewee data	Employer	Role
Interviewee 1	Municipality of Groningen	Policy advisor city development
Interviewee 2	Municipality of Groningen	Policy advisor public transportation
Interviewee 3	OV bureau Groningen Drenthe	Public transportation management
Interviewee 4	Dura Vermeer Bouw Hengelo	Development manager
Interviewee 5	Housing corporation Nijestee	Project developer
Interviewee 6	Housing corporation Nijestee	Area development
Interviewee 7	Netherlands Institute for Transport Policy Analysis	Senior researcher
Interviewee 8	University of Groningen	Researcher

² In the Netherlands, every four years there are municipal elections. A group of parties that together form a majority will set up a coalition and form an executive board, the 'college van burgemeester en wethouders (B&W)', or the college of the mayor and alderman. These aldermen are the deputies for posts like city planning, traffic and nature.



Table 1, List of interviewees

Appendix 1 contains the questions asked during each interview (the interview guide). The questions in the interview guide are deeply connected to the content and objectives outlined in the introduction and literature review. Their origins: 1) This question sets the stage by understanding the interviewee's expertise and relevance to the study. 2) The literature review emphasises the multifaceted nature of 'connectedness' in urban planning and emphasises the lack of a set definition. 3) This question aims to contextualise the additional funding in the 2021 coalition agreement within existing budgets and understand its impact on policy implementation and urban development. 4) Understanding the impact of policy changes is a core goal in this research, especially regarding how new legislation influences urban development and connectedness over time. 5) This question explores the trickle-down effect of national policies on local governments and urban planning initiatives. 6) Evaluating policy effectiveness is integral to this research, as it examines the impacts of legislative changes on urban connectedness and planning. 7) The research considers regional variations in how policies are applied and their effects on connectedness across different areas. 8) Future projections and the long-term impact of current policies on urban connectedness and housing development are explored.

The eight interviews lasted an average of 45 minutes and were recorded with permission. After the interviews, all recordings were transcribed. A snippet of one of the interview transcripts can be found in Appendix 2. The Research Data Management Plan can be found in Appendix 3. Following the literature review and interview transcripts, the results section has been divided into six subchapters: 'Views on connectedness', 'Responsibilities of the involved parties concerning mobility in relation to housing developments', 'Policy and funding', 'Developments and implementation', 'Mobility and accessibility' and 'Evaluation and future perspectives'.

'Views on connectedness' followed from the different interpretations of connectedness in the literature and allows for an exploration of how different stakeholders in Groningen view and define it, taking their different functions and backgrounds into account.

The literature emphasises the importance of integrating land use and transport planning, which involves various stakeholders. 'Responsibilities of the involved parties concerning mobility in relation to housing developments' explores how different parties view their roles and responsibilities in ensuring mobility and connectedness in new housing developments.

The STOMP principle (CROW-KpVV, 2023) is one example that emphasises the importance of policy frameworks in Dutch planning policies. 'Policy and funding' delves into the specific policies and funding mechanisms in Groningen to support connectedness in new housing developments.

'Developments and implementation' relates to the practical aspects of implementing connectedness principles in housing developments. The literature review discusses various approaches to urban development, such as TOD and the 15-minute city concept and explores how these concepts are being applied in Groningen's new housing developments.

The literature review extensively covers topics related to mobility behaviour and accessibility, including car usage, active transportation modes, and public transportation. 'Mobility and accessibility' focuses on how mobility and accessibility are considered and implemented in Groningen's new housing developments.



'Evaluation and future perspectives' examines what evaluation methods are currently used by the stakeholders, as the literature shows the need to assess the effectiveness of current approaches in evolving transportation policies and institutions. Furthermore, a light is shed on what the interviewees expect from connectedness in the future.

A small GIS analysis has been conducted in addition to the interviews. This analysis aims to visualise the relationship between the year of construction of houses in the Groningen region and their distance from the closest public transportation stop to see if the changing institutional views on transportation, which emerged in the literature, can also be identified by real-life evidence. The data used to conduct this analysis consists of the base registration addresses and buildings (BAG), in which all properties in the Netherlands, including their location and function, are present. Complementary to this data is an overview of public transportation amenities, including stops, obtained from OpenStreetMap (OSM). In ArcGIS Pro v3.3.0, all properties without a 'living function' were first removed from the BAG dataset. Also, all irrelevant data from the OSM map was removed.

Then, with the ArcGIS geoprocessing 'near' tool, the distance from each property to the closest PT stop was calculated, followed by an average on a neighbourhood level and the average year of construction on a neighbourhood level. This first variable is plotted for all individual properties to visualise PT lines' presence (or absence) and stops in the Groningen region. The second and third variables are used to determine if there is a relationship on the neighbourhood level between those two, possibly indicating a correlation between the year of construction, in combination with the then-in-use legislation, and the average distance to PT.

Results & Discussion

GIS analysis

The first findings from the GIS analysis can be found in Figure 1. This map shows the distance from each house in the municipality of Groningen to its closest public transportation stop. At first glance, it becomes clear that essentially the entire city itself, as well as the neighbouring villages like Haren and Ten Boer, are well-connected. The Groningen Central Station, located at the southern end of its city centre, is the largest transportation hub in the region, with all important train routes and almost all major bus routes stopping there. This is also the place where passengers from the wider region using public transportation will most likely arrive in Groningen. Although cycling is the most common form of transportation in Groningen, its vast public transportation network enables people coming from further away and people who are unable to cycle or walk far distances, like elderly and disabled people, to reach their destination in the wider Groningen region.

The central areas and parts close to major roads are marked predominantly by blue and green dots, indicating shorter distances to public transport. The central areas and parts close to major roads are marked predominantly by blue and green dots, indicating shorter distances to public transport. When moving towards the outskirts, particularly in the north and some parts of the south and east, there are more teal and fewer blue dots, indicating that these areas are further away from public transport facilities. The distribution of colours suggests that access to public transportation only varies slightly within the city, with more significant distances only observed on the city's outer bounds.



Figure 2 then shows a map with the average year of construction of houses per neighbourhood. The city centre of Groningen, the central part of the city bounded by the station on the south side, the Noorderplantsoen (in black) on the north side and the city canals on the east and west side, can clearly be recognised as dating back far before the Second World War. Also, it can be identified from Figure 2 how the city started expanding halfway through the twentieth century, with Meerstad to the east of the city as the most recent addition to Groningen's housing stock. The blank spots in between the coloured polygons are neighbourhoods without any properties that are currently used for living, according to the BAG. Figure 3 is similar to Figure 1, with the major difference between the two being that Figure 1 shows the distance from each individual house, whereas Figure 3 shows the averages per neighbourhood, so it can more easily be compared with the neighbourhood-level average construction years in Figure 2. This way, possible outliers are smoothed, and as most neighbourhoods have been built within relatively short timespans, certain PT- or car-centric policy periods would possibly be distinctive.

For statistical evidence, in ArcGIS Pro, two scatterplots were made to determine whether there is indeed a linear correlation between a house's year of construction and its distance to the nearest PT stop. This would be a logical result if the trend of increasing institutional focus on public transportation, as described in the literature review, would appear in real-world data. Using the individual properties in the comparison, the correlation coefficient is just 0,00089, indicating that there is basically zero evidence in this dataset for this trend. Doing the same for the neighbourhood-averaged values, the correlation coefficient is 0,0081, an order of magnitude larger but still very much irrelevant. This shows that although there might be an increase in political and institutional focus on moving away from car transportation to active modes of transportation and public transportation, practical evidence is missing.

In the northern and some southern parts of Groningen, newer developments frequently accompany longer distances to public transport facilities, indicating a potential need for enhanced transit infrastructure. Furthermore, it is noteworthy to examine Meerstad's development. This neighbourhood is still in development and consists of several smaller areas. In Figure 2, the four areas with the most recent constructions can be identified. Comparing these sections in Figure 3, it is remarkable to spot the differences in public transportation connectivity between them, signalling multiple public transportation strategies for the different areas in the Meerstad neighbourhood. This also suggests that modern urban planning, although considering public transport, sometimes seems to struggle to keep pace with relatively rapid urban expansion as it appears that the PT accessibility is not always on par there yet compared to longer-established areas.

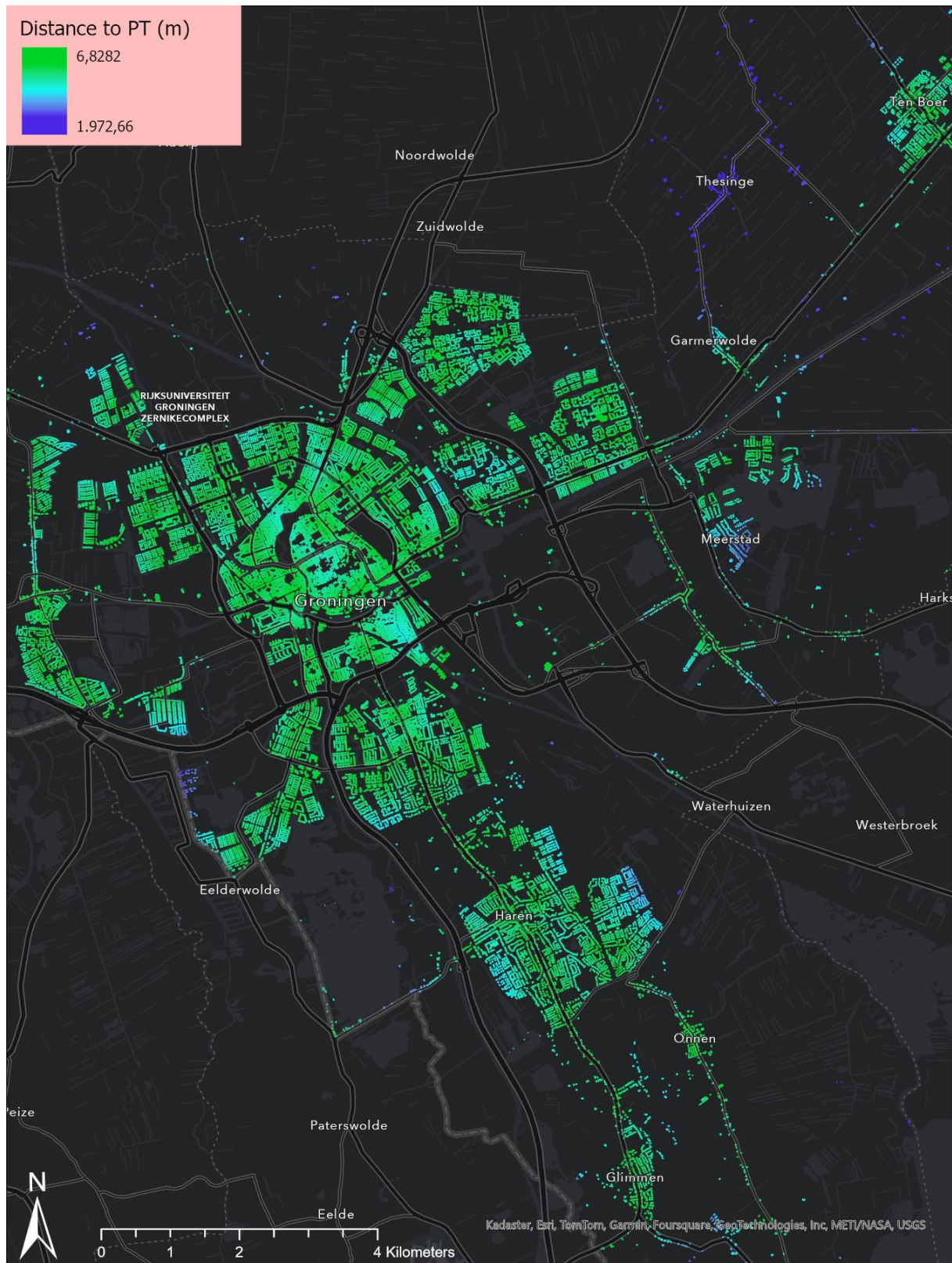


Figure 1, the distance from each house in the Municipality of Groningen to the nearest public transportation stop in meters. Own work

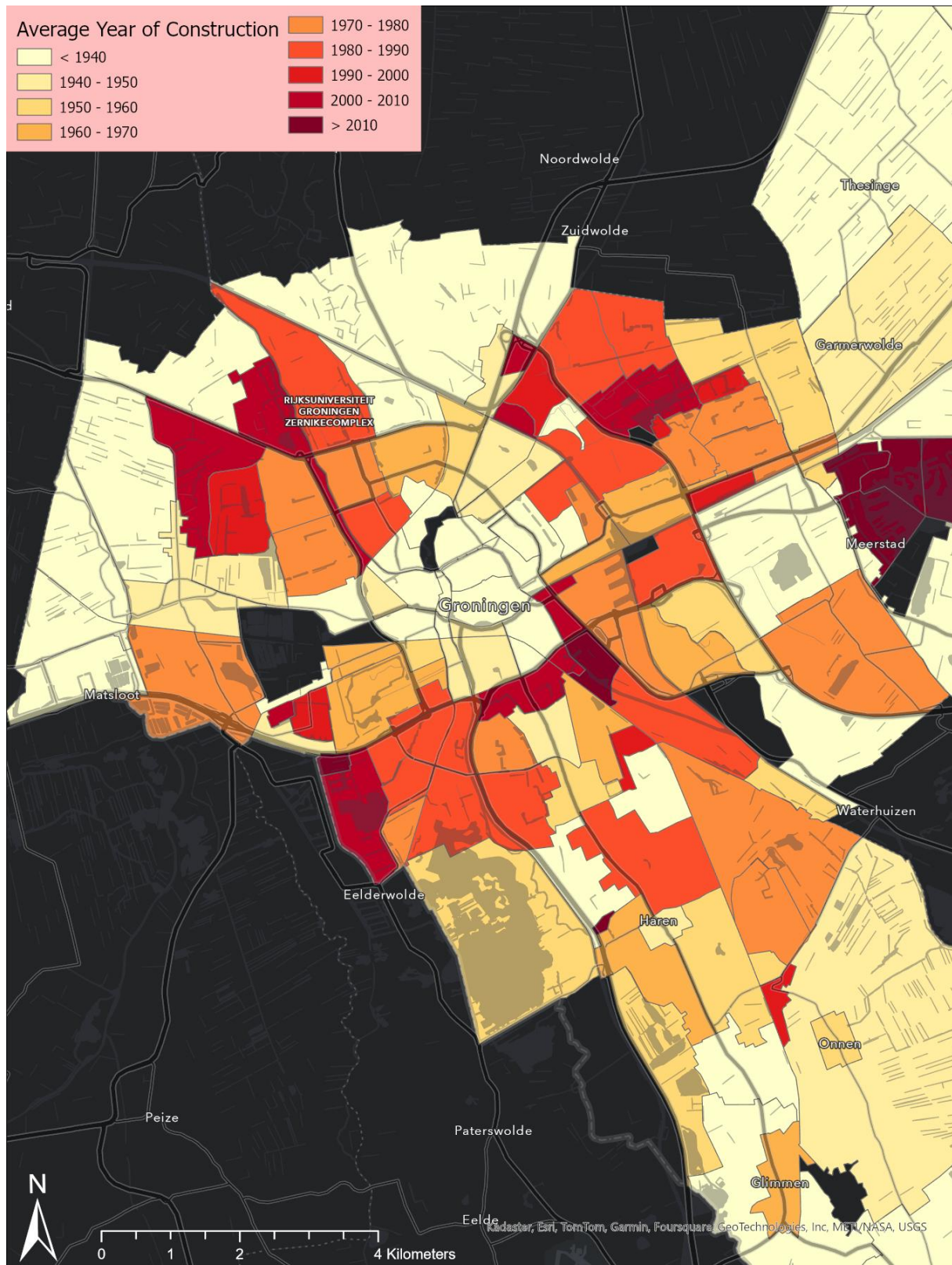


Figure 2, the average year of construction of houses per neighbourhood in the Municipality of Groningen, own work.

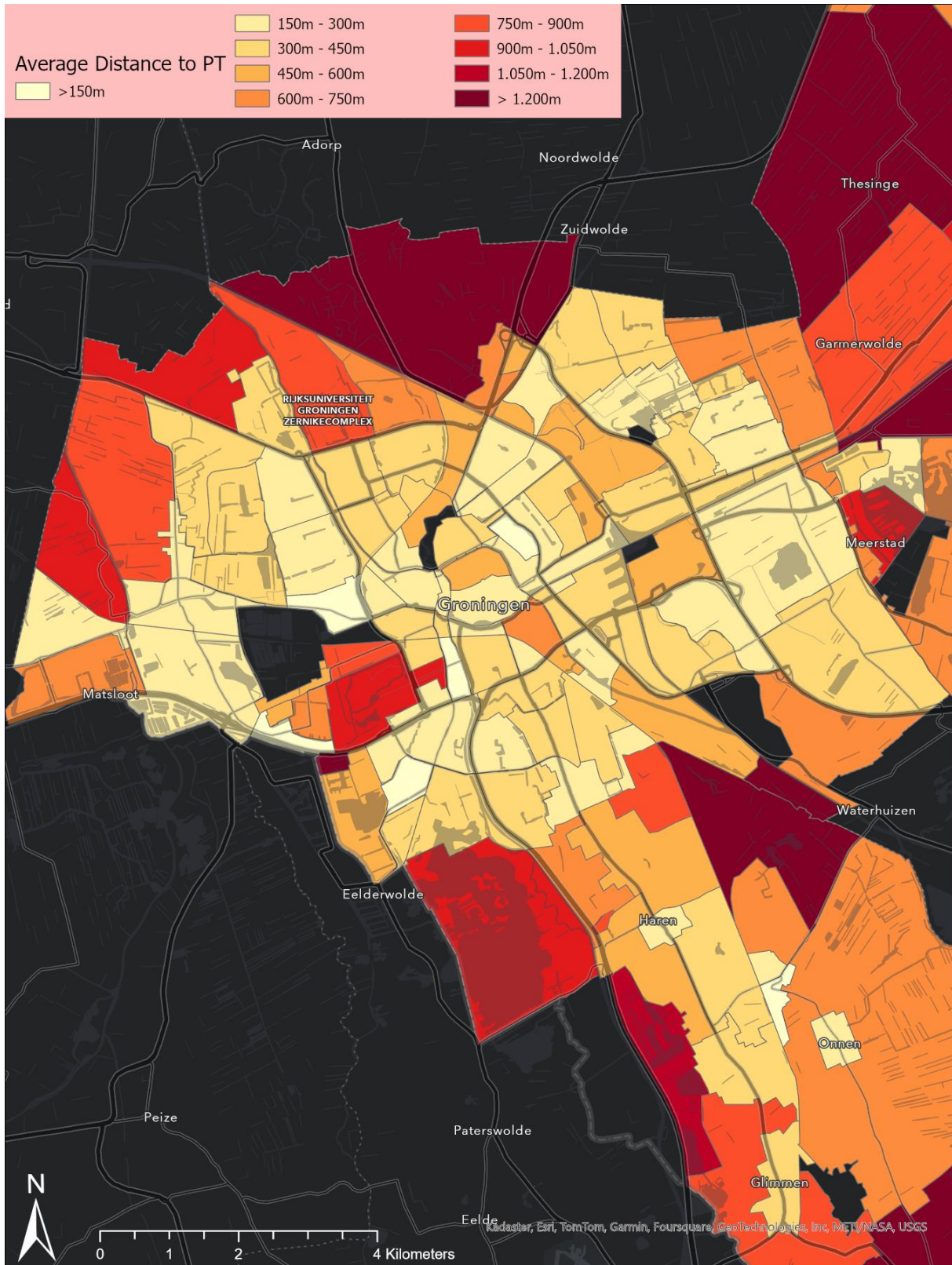


Figure 3, the average distance between houses and the nearest public transportation stop per neighbourhood in the Municipality of Groningen, own work.



Interviews

Views on connectedness

The first objective of these interviews was to find out what connectedness entails for each interviewee. Following the literature, there was no clear definition to be noted down. Similarly to earlier findings, descriptions came down to literal and physical connections in space through robust road and public transportation networks and social connections among residents. Also, urban planning was highlighted as an important aspect, particularly ensuring that homes are well-connected and that neighbourhoods foster multiple connections among people and facilities and are accessible to everyone.

Interviewees described connectedness as a multifaceted concept, encompassing the ease with which different groups of people can find and interact with one another, emphasising its physical, social, and other dimensions. Interviewee 3, working for the housing corporation, underscored the importance of minimising barriers between residents and organisations, ensuring that especially those from lower-income backgrounds or with specific domestic challenges can access social contacts and support when necessary. The corporation aims to provide comprehensive information and maintain a physical presence in well-connected locations to facilitate easy visits from tenants. They underlined that connectedness is about living together as a community, sharing the same amenities and concealing the differences in terms of personal wealth, societal status and possible problems within the mixed group of tenants they have to form a societal bond within the neighbourhoods.

Diverse perspectives on the accessibility and social integration facilitated by public transportation in new Dutch housing developments were mentioned. Interviewees emphasised the extent to which new neighbourhoods are reachable by public transportation and how effectively destinations can be accessed from these neighbourhoods so that people can reach shops, commute to work or visit their social contacts elsewhere in town. They noted that accessibility is inherently a spatial concept, underscoring the importance of strategically placing TOD and essential public facilities in the most accessible locations rather than retrofitting accessibility to predetermined spots.

Connectedness was also framed as enabling daily activities and movements, ensuring people can live, work, and travel efficiently within a system that maximises connectivity. The OV bureau's vision is to achieve 100% coverage of its operating area from 06:00 to 00:00 as its vision for connectedness. They recognise that while coverage quality, quantity, and frequency vary by location, the goal is to have as many residents as possible living close to transit stops, aligning with the principles of TOD. Continuing that line, the researcher introduced his perspective, which links connectedness closely with traffic engineering and economic efficiency. To him, connectedness appears as part of the degree of connection within transportation systems, highlighting a more analytical and objective view on trips and offering distinctive outlines for evaluation.

These interviews show a similar result to the literature review. There is no broad consensus on a definition of connectedness, indicated by the given explanations ranging from objective and measurable spatial characteristics to objective features like sense and feeling.



Responsibilities of the involved parties concerning mobility in relation to housing developments

The development of new housing areas in Groningen involves a complex interplay of responsibilities among various stakeholders, including municipal, provincial, and national governments, project developers, housing corporations, and the OV bureau. The municipality plays a central role in orchestrating these efforts, ensuring that new developments are well-connected to public transportation and other essential amenities.

Central to the process, the municipality holds the critical authority to determine the locations of new housing projects. Housing developers can bring forward locations that they are interested in, but the municipality has to give its approval. This decision-making power allows them to strategically place developments in areas where they can leverage existing infrastructure or where new investments in connectivity can be justified. Such decisions are essential to aligning housing projects with broader urban planning and mobility goals.

Developing substantial infrastructure, such as a new train station, requires significant investment and coordination across multiple levels of government. The municipality must present compelling plans to both provincial and national governments to secure their support and funding. While mobility vision documents can outline these ambitions, they do not guarantee success without the backing of higher governmental levels.

Municipal desires are critical in shaping housing developments. Project teams for developments such as at the Suikerzijde, Stadshavens, and Meerstad developments usually consist of various stakeholders, such as multiple housing developers and/or corporations, each responsible for a different target but with the mutual objective of successfully finishing the project. They consult with the municipality to discuss connectivity requirements. These discussions determine the specifics of public transportation infrastructure, such as the placement of bus stops and cycling highways, and address the financial responsibilities of each party involved. By acting as a coordinator in spatial planning projects, the municipality ensures that all stakeholders collaborate effectively to integrate transportation needs into the development plans.

As public transportation experts, the OV bureau plays a crucial role in planning and optimising public transportation services. They participate in meetings with the municipality and province, propose new bus lines, and work with the municipality to align these proposals with existing road infrastructure. The bureau also focuses on maximising bus ridership to ensure the financial feasibility of the bus lines by making bus lines faster, rerouting to focus on higher-density areas around the stops, and increasing the quality of the amenities around the bus stops.

Project developers, such as Dura Vermeer, collaborate with municipalities to discuss and plan access roads and the public transportation network, contributing to amenities beyond the immediate neighbourhood. However, their influence on the exact placement of public transportation infrastructure is limited; they can propose ideas, but implementation is the municipality's responsibility. Developers also need to adhere to the rules and regulations set by the local municipality, for instance that new neighbourhoods are inclusive and accessible. This entails designing spaces that are not only physically accessible to all residents, including those with disabilities, but also socially inclusive. They aim to create environments where residents from diverse backgrounds can thrive, providing amenities like affordable housing, public spaces for social interaction, and accessible routes for pedestrians and cyclists.



Housing corporations cannot demand specific infrastructure, but they emphasise the importance of easy access to social contacts and services and other desires from their tenants, who are often from lower-income backgrounds. They aim to maintain a physical presence in well-connected locations to assist their residents where needed, ensuring that their developments are integrated into the larger urban fabric and offer easy access to essential services and social opportunities.

The approach to public transportation varies by development. Suikerzijde is the largest new housing development in Groningen, located at the former Suikerunie terrain. Here, sugar beets were processed in an enormous factory. Now that the factory had moved to another place, a vast empty space was left, which subsequently was designated for housing development. Suikerzijde has a primary focus on being connected to the rest of the city via public transportation and cycling routes. Public transportation was prioritised early in the Suikerzijde development discussions, reflecting a proactive stance towards future connectivity.

Conversely, at Stadshavens, another large housing development site in Groningen, but this time already within a semi-urban area, existing public transportation was initially deemed sufficient. However, the anticipated addition of 2400 households at Stadshavens necessitates a re-evaluation of public transportation provisions to ensure future connectivity, the interviewees from the OV bureau and municipality stated, as the current bus lines running along the area might not be sufficient anymore by then. This illustrates the dynamic nature of planning and the need to adapt transportation strategies to evolving urban development realities.

Policy and funding

The Mobility Fund expansion, valued at €7.5 billion, is designed to enhance local infrastructure and improve the connectivity of new neighbourhoods across the Netherlands. This strategic allocation of funds has shown significant variation in how different projects are supported. For instance, Suikerzijde's new station is set to receive €95 million in mobility-related funding, highlighting its priority due to its anticipated high impact on local transportation needs. In contrast, projects like Stadshavens receive less support, reflecting fewer direct mobility implications. Historically, public transportation funds were predominantly directed towards Randstad due to its dense population and higher passenger volumes. However, there is now a concerted effort to ensure a more equitable distribution of funds across all Dutch regions, including Groningen.

The funding process for infrastructure projects is lengthy, involving feasibility studies, plan evaluations, and securing financial commitments at each stage. The intricate planning and significant interest in large-scale projects contribute to the lengthy timelines observed. With its robust mobility policy, the municipality of Groningen exemplifies proactive and strategic planning by maintaining a ready list of potential mobility projects, ensuring they are prepared to take advantage of available funds as soon as they become accessible. Multiple interviewees have acknowledged this strategy, and it is becoming a more common practice in the Netherlands.

The municipality collaborates closely with national and other local governments to align housing and mobility plans. When a region for housing development is decided on the national level, the municipality of Groningen is ready for it. A recurring issue highlighted in the interviews is the timing of public transportation implementation in new neighbourhoods. When public transportation, such as buses, is introduced only after residents have settled, car ownership is already high, reducing the



likelihood of public transport usage. This is because people have travel habits, and once those are in place, it is very unlikely that they will change again soon.

"Er is vaak een hele grote schok nodig om nieuwe reisgewoonten te creëren, en een hele belangrijke schok in je leven is een verhuizing, naar zo'n nieuwbouwlocatie bijvoorbeeld."

[Usually, a big shock is needed for people to change their travel behaviour, and an important shock is moving to a new home, such as this new housing development.]

Interviewee 8

Securing funding is often characterised by political manoeuvring, involving strategically placed applications and inflating initial funding requests to buffer against potential reductions. The first round of Mobility Fund allocations was rapidly deployed into tangible projects, underscoring the fund's critical role in driving infrastructure development. However, the extent to which policy changes can influence development projects largely depends on their stage of progress. Once permits are granted, ongoing projects become less susceptible to policy shifts. Political dynamics also significantly influence funding decisions, with bodies like the OV bureau's board composition reflecting the outcomes of local elections, which can shift priorities and strategies.

Despite the substantial funding available, significant challenges persist. For example, the high costs associated with centralised parking facilities, especially underground ones, pose formidable obstacles to project realisation. The financial burden of constructing underground parking is substantial, often consuming a large portion of project budgets and potentially deterring other critical infrastructure development. As most housing developments are done by and paid for by private housing companies that need to make a profit, this could make or break their business case. A more nuanced analysis is needed to understand the trade-offs involved and how these costs influence overall project feasibility and prioritisation.

Moreover, housing corporations frequently feel excluded from funding discussions, arguing that their involvement could be crucial in securing additional subsidies. Their input could potentially streamline processes and align funding applications with broader housing and infrastructure goals. The OV bureau faces the ongoing challenge of balancing fund allocation to meet its dual objectives of enhancing urban accessibility while also ensuring connectivity in rural areas. This balancing act is crucial in achieving a cohesive and equitable transportation network across diverse regions.

Developments and implementation

The development and implementation of housing projects in Groningen demonstrates a nuanced approach to integrating public transportation and infrastructure. The primary focus has been on existing infrastructure capacities, such as roads, public transportation, and the power grid, to accommodate new housing developments. This strategy aims to optimise the resources that are currently already partially used and minimise the need for extensive new constructions.

Decision-making in the development of high-quality public transportation lines is notoriously slow, often taking up to two decades from the first idea to the realisation. This extensive timeline allows for thorough consideration and planning. Interviewee 2 mentioned as an example the concept of 'koppelkansen' (coupled chances), where infrastructure maintenance (e.g., sewerage) is aligned with broader road redesigns, optimising both time and resources.



Infill development is prioritised in well-connected areas, such as near train stations or in city centres. While these locations are advantageous due to existing public transportation links, continuous improvements in connectedness are necessary to fully capitalise on these developments. It is critical that space is allocated for all forms of mobility and parking by adding them to the drawing board already in the early planning stages to ensure comprehensive infrastructure support.

The case of the Meerstad neighbourhood highlights the evolution of PT's importance within the city planning department over time. Originally designed with a car-centric layout, the municipality has since recognised the necessity for improved public transportation connections in and to Meerstad. Figures 1 and 3 show how the different parts of the neighbourhood have these different PT characteristics. The neighbourhood's reliance on limited bus lines underscores the challenges of retrofitting public transportation in car-focused areas like Meerstad.

Developments like Suikerzijde are set to emphasise robust public transportation connectivity, likely including a train station, to reduce car dependency. Until rail infrastructure is established, interim solutions like enhanced bus services will be critical to combat a car-minded population. Similarly, the STOMP principle is gaining traction, emphasising the integration of health, sustainability, and resilience into urban planning.

Parking emerges as the main issue in new housing developments, especially for housing corporation tenants who rely heavily on cars due to irregular work hours and non-standard working locations, which are badly served by public transportation - or not at all. This highlights the need for public transportation services that operate beyond typical hours and locations to serve these residents better. Moreover, innovative public transportation networks that facilitate direct neighbourhood-to-neighbourhood travel, bypassing central hubs, are suggested to enhance social connectedness by interviewee 6. Challenges in collaborative development are evident at Stadshavens, where multiple stakeholders complicate decision-making. In contrast, the municipality's sole ownership of land at Suikerzijde simplifies the planning and discussion processes.

Improvements in public transportation have demonstrable benefits, as seen with the mobility contract for the University Medical Center Groningen (UMCG). Interviewee 3 emphasises this contract as a prime example that significantly reduces city traffic by removing several hundred cars from inner-city roads each day. Similar benefits are noted in Roden, where fewer but better-equipped bus stops have increased ridership despite requiring longer initial travel distances for some residents. Although fewer stops are left in this kind of villages, the ridership satisfaction has increased thanks to the shorter overall travel time and the increased quality of the waiting facilities.

Mobility and accessibility

The interview findings underscore the significant emphasis on integrating public transportation in new housing developments within Groningen, particularly in the Suikerzijde and Stadshavens areas. The municipality's strategic vision focuses on the early establishment of public transportation services in new developments. This early integration aims to influence residents' mobility habits, ideally reducing car dependence. Especially the researcher underscored that moving can be a pivotal moment in changing these habits.

In both developments, one of the main plans is to remove public parking spaces on streets and replace them with limited volumes in parking garages, under or above the ground. This approach, combined with high housing density, stresses the critical need for robust public transportation



connectivity. High connectedness is essential for both projects since they encourage future residents to rely on PT, reducing the need for private cars. The new Suikerzijde station is also set to become a mobility hub, playing a crucial role in the broader public transportation network. Although the train station will not be available in the initial years, the area will be served by two major bus lines – one running north-south and the other east-west – ensuring interim connectivity.

For the Stadshavens development, the limited presence of facilities necessitates strong links to adjacent neighbourhoods. Despite the absence of new bus lines, the existing lines will improve by adding high-quality stops to enhance accessibility. This aligns with the shift in policy away from buses penetrating deeply into neighbourhoods. Instead, more direct routes are preferred, resulting in faster travel times, increased capacity, and financial savings that can be reinvested in improving stops and services. This can be seen in Roden, where a bus route was recently streamlined, saving time and freeing up resources and improving the traveller's satisfaction. Although the need for appropriate last-mile solutions was mentioned in several interviews, and increasing the average distance to PT stops could worsen this challenge, no universal ready-to-implement solutions are on hand.

An important observation from the interviews is the difference in perspectives from stakeholders and interviewees on the proximity of public transportation stops. One of the housing corporation representatives highlighted the feeling that an 8-minute walk to a public transportation stop is excessive, advocating for a 4-to-5-minute walk to be the maximum to ensure public transportation is a more attractive option than cars, whereas the municipality and especially the OV bureau are backing the process of stretching the bus lines for quicker transportation times. This means that where previously some bus lines were designed to have stops on just about every corner of a village or neighbourhood and, therefore, were easily accessible, currently a process is going on where these bus lines take more direct routes and have fewer stops along the way, decreasing the catchment area but decreasing transportation times as well.

Evaluation and future perspectives

The KiM consistently integrates data with interviews and literature research to provide comprehensive evaluations relevant to travellers, civilians, government, and businesses. Their analyses indicate that public transportation levels will unlikely return to pre-COVID-19 levels within the next five years (Hamersma & Moorsma, 2023). Therefore, investment in infrastructure must be cautiously approached to avoid inefficiencies when demand is low.

Policy advisors from the municipality of Groningen annually report on their activities and update the city council on project statuses. The evaluation includes policy indicators such as public transportation cleanliness and traveller satisfaction, assessing whether goals have been met. This systematic policy cycle ensures continuous assessment and the formulation of new policies as previous ones reach completion.

In the upcoming years, particularly within the next decade, several significant developments are anticipated:

- Suikerzijde neighbourhood: The first houses in the Suikerzijde neighbourhood are expected to be completed within five years, with the area taking shape and public transportation infrastructure becoming active. Although the station in Suikerzijde is not expected within this decade, it may be established in ten to fifteen years. Meanwhile, complementary to the bus lines, a dedicated cycling road will connect the new neighbourhood to other parts of the city.



- Parking and Mobility Hubs: The municipality is expected to remain strict in assigning parking spaces in new housing developments despite potential resistance from residents. Groningen aims to increase mobility hubs to address parking issues, similar to practices in the Randstad region, complementing the existing seven well-used Park & Rides. On-street parking will gradually be phased out in favour of green streets designed for delivery and pick-up rather than parking.
- Bus Lines and Alternatives: Future bus services will likely feature faster routes with fewer stops, replacing slower, unprofitable lines that wind through neighbourhoods. Although some residents may need to travel further to reach bus stops, the enhanced amenities at these stops, such as bike parking and improved waiting areas, will mitigate this inconvenience. Alternatives like hub taxis and enhanced biking or scootering options may be developed to supplement traditional bus services.

The municipality's central consideration when evaluating its mobility policies is the quality of life in Groningen. One of the key factors is ensuring the city remains an attractive place to live and move through. It is good to notice that setting indicators like these, which can be determined and then followed over time, is an objective way of assessing the performance of planning institutions and interventions.

There are many visions for the future, but certainty is lacking. From the positive standpoints and ideas, an often-heard thing is hope for the success of integrating Mobility as a Service solutions with PT, enhancing the accessibility of public transportation stops through various forms of mobility. Examples are the introduction of shared steps or a last-mile solution such as a hubtaxi, especially for elderly people. However, challenges to achieving these mobility and housing goals include slow planning processes, the nitrogen crisis, increased interest rates, and rising construction costs, all of which contribute to unfeasible projects. Nonetheless, there is cautious optimism as conditions appear to be gradually improving.

Recommendations for the future

During the interviews, some specific ideas, goals, and challenges that should be addressed in the future were mentioned. The first one addressed the sometimes seemingly endless planning processes, as the building itself does not have to be the problem; it is the process that needs to get up to speed. Following Minister De Jonge's argument, by reducing the possibility of raising objections at the Council of State, planning procedures are likely to take much shorter. However, residents, neighbours, and others who might want to object to plans still need to be heard throughout the process.

Furthermore, housing corporations could contribute much more to the financial side of area development when they are notified of the possibilities for subsidies and the tasks bound to those subsidies. This could result in more projects being financially feasible while deemed not upfront. The tension within development teams of multiple stakeholders is one of the reasons why many of these developments are not going smooth, missing out on possible quality in the end.



Conclusion

Throughout this paper, the critical role of urban connectedness in creating sustainable and liveable cities has been explored. This study focused on assessing the impact of recent legislative changes on the connectedness of new Dutch neighbourhoods to public transportation, with a specific emphasis on the city of Groningen. Using a combination of Geographic Information System (GIS) analysis and stakeholder interviews, valuable insights into the multifaceted nature of urban connectedness and the challenges and opportunities presented by recent policy shifts were gained.

The research highlights that urban connectedness extends beyond mere physical proximity to public transportation. It encompasses social dimensions and accessibility to essential services, demonstrating the complexity of this concept in urban planning. In Groningen, this has manifested in nuanced approaches to urban development, as seen in projects like Suikerzijde and Stadshavens, which prioritize the early integration of public transportation infrastructure.

The impact of recent legislation, and most notably the expansion of the Mobility Fund, is evident in Groningen's evolving urban planning strategies. The €7.5 billion initiative has enabled more ambitious projects, some even in the short term, such as the new Suikerzijde station, marking a tangible shift towards prioritizing public transportation over designing for car usage in new developments. However, the findings also underscore the significant time lag that usually is present between policy implementation and observable changes in the urban landscape. The intricate nature of urban planning, involving multiple stakeholders and lengthy approval processes, suggests that the full impact of these legislative changes may not be fully realized for several years.

The GIS analysis revealed no notable linear patterns in the relationship between housing age and proximity to public transportation. Nevertheless, older neighbourhoods, particularly those developed before 1980, generally seem to have better access to public transportation. This highlights the importance of integrating transit planning early in new developments to achieve optimal connectedness. Conversely, retrofitting newer, more car-centric developments like Meerstad with effective public transportation solutions remains a significant challenge.

Stakeholder interviews revealed a shift in planning philosophies, with increasing emphasis on the STOMP principle (prioritizing walking, cycling, and public transport over private car use) and the concept of the 15-minute city. These approaches aim to foster more sustainable, accessible, and vibrant urban environments. However, implementation faces hurdles, including balancing diverse stakeholder interests, securing funding, and navigating bureaucratic processes.

Recent strategies in public transportation planning indicate a trend towards fewer but higher-quality bus stops, complemented by enhanced cycling infrastructure and potential last-mile solutions. This aims to balance efficiency with accessibility, though it may pose challenges for residents with mobility limitations. Moreover, regional differences in connectedness were observed within the Groningen region. While Groningen's city centre generally exhibits high levels of connectedness, peripheral areas and newer developments often struggle to achieve similar integration with public transportation networks. This calls for tailored urban planning approaches that consider local context and existing infrastructure.



Looking to the future, several trends are poised to shape the connectedness of new neighbourhoods in Groningen and beyond. The increased use of mobility hubs, the gradual phasing out of on-street parking, and the integration of MaaS solutions present significant opportunities for enhancing urban connectedness. However, these developments also bring challenges, particularly in ensuring equitable access among various social layers and age groups and adapting to evolving mobility behaviours.

These findings have broader implications for urban planning policies and practices beyond Groningen. They underscore the importance of proactive planning, early integration of public transportation in new developments, and flexible approaches that can adapt to evolving urban needs and technologies. Collaborative efforts involving diverse stakeholders are crucial to successful urban planning processes.

This study acknowledges its limitations. As a case study focused on Groningen, this may limit the generalizability of the findings to other urban contexts. Additionally, the long-term impacts of these new developments on residents' mobility behaviours and overall urban connectedness remain to be seen. Future research would benefit from longitudinal studies tracking the evolution of connectedness in new neighbourhoods over time, as well as comparative studies across different Dutch cities to provide further insights into the varying impacts of national legislation on local urban development practices. Besides that, the absence of an interviewee from the province is a point of attention and improvement.

For the GIS analysis, two noteworthy details about the data are that the 'distance to PT' variable was calculated in a straight line and did not take roads, property ownership and other externalities into account. Furthermore, the calculations are based on the current situation. Reflecting on the mentioned change in the bus route through Roden, this generally led to a lower calculated distance value than when the situation was reviewed several years ago. Therefore, this variable should be critically reviewed in future research.

In conclusion, fostering urban connectedness through sustainable planning practices like Transit-Oriented Development and the 15-minute city is not merely an option but a necessity for modern cities. As demonstrated by the Dutch government's housing agenda and Groningen's evolving urban landscape, achieving these goals requires a commitment to reimagining urban spaces in ways that prioritize accessibility, inclusivity, and environmental stewardship. By continuing to innovate and collaborate, we can build cities that are not only more connected but also more resilient and vibrant, ensuring a higher quality of life for all residents now and in the future.



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Appendix 1: Interview guide

1. Could you tell me about your background, study and role and functions at your current job?
2. How would you describe and measure 'connectedness'? There are a lot of synonyms like 'accessibility' and 'transit oriented development', but I am looking for the explanation of the concept rather than synonyms.
3. In the most recent coalition agreement, 7,5 billion euros are pledged to go to creating and improving the connectedness of new neighbourhoods, how substantial is this figure compared to the money that was already meant to be spend with this goal in mind before this extra money was announced?
4. Is there already a measurable effect caused by this new legislation? And how long does it usually take for new policies to show some result in the real world?
5. How does local policy emerge or follow as a result of this kind of national legislation?
6. What are the key factors when evaluating policy?
7. The NOVEX-housing developments will likely receive most of the funds, but to what extent would there be regional differences in the application of this legislation?
8. What is your expectation of the current situation compared to the situation in 2030 with respect to the connectedness of housing? Both regarding new developments as well as the current housing stock.



Appendix 2: Snippet of an interview transcript

Thijs: Dankjewel, hartelijk bedankt dat u de moeite neemt voor het interview.

Koen: Ja leuk, zeg maar je hoor.

T: Helemaal goed. Ik zag dat je beleidsmedewerker mobiliteit bent, wat houdt dat precies in?

K: Ik ben beleidsadviseur bij de directie stadsontwikkeling. Stadsontwikkeling zit vooral hier, aan de Zuiderdiep. En binnen stadsontwikkeling hebben we verschillende programma's, waaronder mobiliteit. Daarnaast nog wonen, ruimtelijke economie, leefkwaliteit en energie. En ik zit dan in het programma mobiliteit. En daar zitten we met een stuk of vijftien beleidsadviseurs, en wij werken aan de beleidsvorming en ook aan de beleidsuitvoering op het gebied van hoe wij ons door de stad bewegen. Dus collega's die doen dat op het gebied van parkeren bijvoorbeeld. Op het gebied van lopen, fietsen, op het gebied van verkeerslichten. Zeg maar dus op allerlei verschillende velden wordt er aan beleid gewerkt. Ik doe dat voornamelijk op het gebied van openbaar vervoer, en ook een stukje mobiliteitshubs. Dus knooppunten waar verschillende vormen vervoer samenkomen. Wij schrijven dus beleid, we zorgen ervoor dat het beleid wordt uitgevoerd in projecten en we adviseren ook ons bestuur; het college van burgemeester en wethouders, die adviseren wij. Zij zijn de bestuurders, het beleid voeren zij uit. Als er politieke vragen zijn of als er iets in de gemeenteraad ligt dan zijn wij degenen die daarover adviseren.

T: Dus jullie bedenken en schrijven beleid, is dan ook de evaluatie voor jullie? Of is dat dan weer voor een andere afdeling?

K: Nee, dat doen we eigenlijk ook, evaluaties. Sowieso wordt jaarlijks aan de gemeenteraad verantwoording afgelegd over wat we doen. Wat is de stand van zaken voor projecten. Er zijn ook wel beleidsindicatoren die we opstellen en dan het jaar erna gaan we kijken, hebben we die behaald of niet?

T: Moet ik dan denken aan percentages?

K: Ja, bijvoorbeeld op het gebied van openbaar vervoer, van hoe schoon is het openbaar vervoer? Wat is de reizigerstevredenheid? Wat was het doel, en is dat dan achteraf behaald? Dus dat zijn wel manieren van evalueren. En daarnaast heb je natuurlijk een hele beleidscyclus. Dus je stelt beleid op en dan ga je het uitvoeren, en op een gegeven moment heb je zoveel uitgevoerd dat er behoefte is aan nieuw beleid. Dan begint het hele riedeltje weer van vooraf aan.

T: Met dan jaarlijks tussendoor tussentijdse evaluaties?

K: Ja, dat kan. Het is maar net wat je kiest maar vaak is het wel dat je jaarlijks kijkt van wat heb je gedaan, en hoe zorg je ervoor dat sommige dingen die bijvoorbeeld nog niet goed gaan kunt gaan bijsturen? Zodat je zo wel verantwoording aflegt.

T: Klinkt goed. Wat is je vooropleiding geweest?

K: Ik heb ook aan de RUG gestudeerd. Ik heb eerst de sociale geografie en planologie gedaan, de bachelor. Ik ben in 2010 begonnen, dus ook al een hele tijd geleden. En toen heb ik EIP gedaan, dat is vast bekend.



Appendix 2: Research Data Management Plan

1. General	
1.1 Name & title of thesis	Assessing the Impact of Recent Legislation on the Connectedness of new Dutch Housing Developments to Public Transportation, a Groningen Case Study
1.2 (if applicable) Organisation. Provide details on the organisation where the research takes place if this applies (in case of an internship).	-
2 Data collection – the creation of data	
2.1. Which data formats or which sources are used in the project? For example: - theoretical research, using literature and publicly available resources - Survey Data - Field Data - Interviews	- literature and publicly available resources. - Interviews - GIS data from publicly available resources.
2.2 Methods of data collection What method(s) do you use for the collection of data. (Tick all boxes that apply)	<input type="checkbox"/> Structured individual interviews <input checked="" type="checkbox"/> Semi-structured individual interviews <input type="checkbox"/> Structured group interviews <input type="checkbox"/> Semi-structured group interviews <input type="checkbox"/> Observations <input type="checkbox"/> Survey(s) <input type="checkbox"/> Experiment(s) in real life (interventions) <input type="checkbox"/> Secondary analyses on existing data sets (if so: please also fill in 2.3) <input checked="" type="checkbox"/> Public sources (e.g. University Library) <input type="checkbox"/> Other (explain):
2.3. (If applicable): if you have selected 'Secondary analyses on existing datasets': who provides the data set?	<input type="checkbox"/> Data is supplied by the University of Groningen. <input type="checkbox"/> Data have been supplied by an external party. (Please mention the party here).
3 Storage, Sharing and Archiving	
3.1 Where will the (raw) data be stored during research? If you want to store research data, it is good practice to ask yourself some questions:	<input type="checkbox"/> X-drive of UG network <input type="checkbox"/> Y-drive of UG network <input type="checkbox"/> (Shared) UG Google Drive <input type="checkbox"/> Unishare



<ul style="list-style-type: none"> • How big is my dataset at the end of my research? • Do I want to collaborate on the data? • How confidential is my data? • How do I make sure I do not lose my data? <p>Need more information? Take a look at the site of the Digital Competence Centre (DCC) Feel free to contact the DCC for questions: dcc@rug.nl</p>	<input checked="" type="checkbox"/> Personal laptop or computer <input type="checkbox"/> External devices (USB, harddisk, NAS) <input checked="" type="checkbox"/> Other (explain): Personal OneDrive cloud storage.
<p>3.2 Where are you planning to store / archive the data after you have finished your research? Please explain where and for how long. Also explain who has access to these data NB do not use a personal UG network or google drive for archiving data!</p>	<input type="checkbox"/> X-drive of UG network <input type="checkbox"/> Y-drive of UG network <input type="checkbox"/> (Shared) UG Google Drive <input type="checkbox"/> Unishare <input type="checkbox"/> In a repository (i.e. DataverseNL) <input checked="" type="checkbox"/> Other (explain): After a successful completion of the master thesis, I will only keep the thesis itself (stored in my personal cloud storage), and I will delete all interview recordings and transcripts. <p>The retention period will be 0 years.</p>
<p>3.3 Sharing of data With whom will you be sharing data during your research?</p>	<input type="checkbox"/> University of Groningen <input type="checkbox"/> Universities or other parties in Europe <input type="checkbox"/> Universities or other parties outside Europe <input checked="" type="checkbox"/> I will not be sharing data

<p>4. Personal data</p>	
<p>4.1 Collecting personal data Will you be collecting personal data?</p> <p>If you are conducting research with personal data you have to comply to the General Data Privacy Regulation (GDPR). Please fill in the questions found in the appendix 3 on personal data.</p>	<p>Yes</p>
<p>If the answer to 4.1 is 'no', please skip the section below and proceed to section 5</p>	
<p>4.2 What kinds of categories of people are involved?</p> <p>Have you determined whether these people are vulnerable in any way (see FAQ)? If so, your supervisor will need to agree.</p>	<p>My research project involves:</p> <input checked="" type="checkbox"/> Adults (not vulnerable) ≥ 18 years <input type="checkbox"/> Minors < 16 years <input type="checkbox"/> Minors < 18 years <input type="checkbox"/> Patients



	<p><input type="checkbox"/> (other) vulnerable persons, namely (please provide an explanation what makes these persons vulnerable)</p> <p>(Please give a short description of the categories of research participants that you are going to involve in your research.)</p>
<p>4.3 Will participants be enlisted in the project without their knowledge and/or consent? (E.g., via covert observation of people in public places, or by using social media data.)</p>	<p>No</p>
<p>4.4 Categories of personal data that are processed.</p> <p>Mention all types of data that you systematically collect and store. If you use particular kinds of software, then check what the software is doing as well.</p> <p>Of course, always ask yourself if you need all categories of data for your project.</p>	<p><input type="checkbox"/> Name and address details <input type="checkbox"/> Telephone number <input type="checkbox"/> Email address <input type="checkbox"/> Nationality <input type="checkbox"/> IP-addresses and/or device type <input checked="" type="checkbox"/> Job information <input type="checkbox"/> Location data <input type="checkbox"/> Race or ethnicity <input type="checkbox"/> Political opinions <input type="checkbox"/> Physical or mental health <input type="checkbox"/> Information about a person's sex life or sexual orientation <input type="checkbox"/> Religious or philosophical beliefs <input type="checkbox"/> Membership of a trade union <input type="checkbox"/> Biometric information <input type="checkbox"/> Genetic information <input type="checkbox"/> Other (please explain below):</p>
<p>4.5 Technical/organisational measures</p> <p>Select which of the following security measures are used to protect personal data.</p>	<p><input type="checkbox"/> Pseudonymisation <input checked="" type="checkbox"/> Anonymisation <input type="checkbox"/> File encryption <input checked="" type="checkbox"/> Encryption of storage <input type="checkbox"/> Encryption of transport device <input type="checkbox"/> Restricted access rights <input type="checkbox"/> VPN <input checked="" type="checkbox"/> Regularly scheduled backups <input type="checkbox"/> Physical locks (rooms, drawers/file cabinets) <input type="checkbox"/> None of the above <input type="checkbox"/> Other (describe below):</p>
<p>4.6 Will any personal data be transferred to organisations within countries outside the</p>	<p>No</p>



<p>European Economic Area (EU, Norway, Iceland and Liechtenstein)?</p> <p>If the research takes places in a country outside the EU/EEA, then please also indicate this.</p>	
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5 – Final comments	
<p>Do you have any other information about the research data that was not addressed in this template that you think is useful to mention?</p>	-