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Disconnected Areas:

Investigating the impact of diminished public transport in Peize
towards the city of Groningen



Source: <https://www.rover.nl/nieuws/29-dienstregeling/2169-ov-reiziger-jaren-terug-in-de-tijd-gezet>, 2022

Bachelor Thesis
University of Groningen
Spatial Planning and Design

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31-1-2024

Summary

While the world is witnessing the time-space compression, rural areas are facing a challenge connecting to urban sites. This study explores the possible consequences that a diminishing public transportation system on country sides has on the quality of life (QoL) of rural inhabitants. To address this research objective, a literature review was conducted alongside a Maptionnaire survey involving 120 participants. Literature and survey responses were analyzed using key words describing QoL; functionality, efficiency and affordability. The research revealed the following key findings: public transportation options for rural inhabitants are limited, this does not decrease their QoL, however, they often reported that the transportation situation could be improved by better public transportation options. Since the change in public transport is decided in a policy document, institutional injustice still stands. These findings contribute to research and policy plans by giving insight on opinions of the involved group of rural area inhabitants. This would be relevant for policymakers and urban planners involved in infrastructure planning. To advance this study, a longitudinal research design could be implemented or choosing different QoL factors.

Key words: Public transport, Quality of Life, Spatial injustice

Word count: 6546

Contents

- Summary 1
- 1. Introduction 3
 - 1.1 *Research problem*..... 3
 - 1.2 *Research structure*..... 4
- 2. Theoretical framework 5
 - 2.1 *Theories*..... 5
 - 2.2 *Public Transportation Structure*..... 6
 - 2.3 *Quality of life*..... 6
 - 2.4 *Spatial (in)justice* 7
 - 2.5 *Conceptual model*..... 7
- 3. Methodology 8
 - 3.1 *Research methods*..... 8
 - 3.2 *Discussion of the methods* 9
 - 3.3 *Ethics*..... 10
- 4. Results 11
 - 4.1 *Public transportation network Peize* 11
 - 4.2 *Quality of Life*..... 14
 - 4.2.1 *Functionality* 15
 - 4.2.2 *Efficiency* 16
 - 4.2.3 *Affordability*..... 16
 - 4.3 *Spatial (in)justice* 17
- 5. Discussion 18
- 6. Conclusion..... 19
- 8. Appendix 22
 - Appendix 1: Maptionnaire survey* 22

1. Introduction

In an era marked by urbanization and technological advancements, rural areas are seen as cultural heritage, natural beauty and community cohesion. Despite their distinctiveness, rural areas have faced and are facing their own challenges. These challenges occur from the geographical isolation and limited access to essential services and opportunities. One of the concerning challenges being the access and availability of public transportation infrastructure. The Dutch province of Groningen has lost 15% of bus stops in rural areas since 2018 (NOS, 2023). The village of Peize, located 10 kilometers from the city of Groningen, has lost 4 bus stops in the years between 2018 and 2023 (Pointer, 2023). As a result individuals from the rural areas could have lost access to urban areas and facilities.

The implications of diminishing public transport networks in rural areas are not only the decreasing accessibility towards urban areas, it can also have an effect on the overall quality of life (QoL) of the inhabitants (Setianto & Gamal, 2021). Research of Planbureau voor de leefomgeving (planbureau for living environment) (PBL, 2022) found that for individuals who are dependent on public transit, the accessibility to jobs and facilities are limited. With the declining public transport network, this accessibility decreased even more. Meaning that people from the rural areas are getting excluded from facilities and jobs moving further away. Rural area inhabitants rely on efficient, accessible public transportation as a lifeline to economic prosperity, healthcare, education, and social engagement. However, in recent years, rural areas worldwide have witnessed a decline in the availability and quality of public transportation options, leaving their residents grappling with a growing spatial injustice.

This research will address spatial injustice, a key concept in geography and urban planning studies. In particular transportation studies can benefit from this study, as the focus is on the impact of transportation changes and quality of life. The significance of this research can be seen in theoretical frameworks drawn from urban and rural mobility studies and the concept of spatial justice. In this study, institutional justice is of importance and will be explained later on. The spatial justice studies provide insight in understanding the unequal distribution of resources and opportunities based on geographical location. Prior literature and empirical evidence showed that access to public transportation is a fundamental issue of justice (Setianto & Gamal, 2021). This research will help identify and document existing disparities in public transport networks between rural and urban areas. It can shed light on the underlying causes and factors contributing to spatial injustice related to public transport. The outcomes can be helpful with sustainable planning and spatial justice.

This study aims to provide insight into these critical issues, via examining the relations between diminishing public transportation, QoL and spatial justice. By understanding these dynamics, it is possible to incorporate the knowledge in new development plans, making way for more equitable development in rural areas.

1.1 Research problem

The main purpose of this research is to bring more insight into the spatial injustice regarding the accessibility of public transportation and facilities in rural areas. Existing studies focused on accessibility towards public spaces and spatial injustices (Székely and Novotný, 2022), or QoL in regards to accessibility (Mattson et al., 2021). This study will bridge the gap of combining these factors, and using QoL in relation to public transport as an indicator for spatial injustice. To enhance QoL, accessibility and inclusion to a transport network and the city is crucial (Setianto & Gamal, 2021). This can be accomplished by distributive and or institutional spatial justice. The other way around you could say distributive and or institutional spatial

justice will lead to an enhanced QoL. However, this research explores if QoL has an influence on spatial justice. When there is a good QoL observed, does that mean there is spatial justice? And when there is a negative QoL measured, does that entail spatial injustice?

The central question regarding this purpose would be ‘How does the diminishing of an accessible public transportation structure contribute to spatial (in)justice as reflected in the overall quality of life of rural area inhabitants?’.

To answer this question, it is first important to know what we understand under ‘public transportation structure’ and how the public transport network has changed overtime. Therefore, section 4.1 will focus on the question ‘What is the current state of public transportation infrastructure in rural areas, and how has it evolved over the years?’. Next to the public transport network, the QoL is an important concept to be clarified. Therefore, the question ‘What is Quality of life and how is the quality of life in rural areas’ will be explored in sections 2.2 and 4.2. To come to a conclusion, the before mentioned aspects will be combined. In this regard the last sub question that will be answered is stated as the following ‘How can quality of life influence the idea of spatial injustice?’.

1.2 Research structure

This thesis is divided in several parts. Firstly, a theoretical framework is laid out in section 2, here different concepts and theories of existing literature will be explored and explained. After the theoretical framework, in section 3 the methodology of this study will be explained. Here research methods, limitations and ethics will be discussed. Section 4 will provide results of the conducted research followed by a discussion of the outcomes. The findings of the thesis will be summarized in conclusion section 6, where in addition further research recommendations are proposed.

2. Theoretical framework

2.1 Theories

When talking about distances between urban settlements and smaller villages, a relevant theory to keep in mind is the central place theory of Christaller (1933). His theory describes the willingness to travel a certain distance towards urban areas and facilities on a time dependent basis. It entails that the larger city has a market region, this is the region where the smaller villages are able to reach the center. In order for the smaller towns to reach the center, the willingness distance is calculated. For this study the distances could change because of the diminishing public transport, making the distance to reach the facilities too far or more difficult to reach. This is reflected in the transportation principle. Which involves ‘the minimization of the length of roads connecting central places’. Figure 1 shows a visualization of the central place theory.

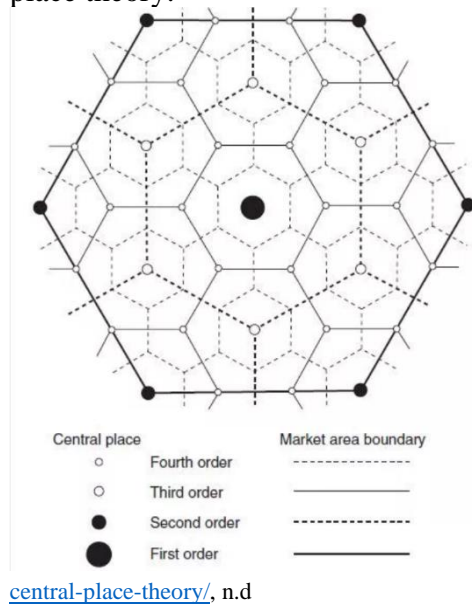


Figure 1: Central place theory, source: <https://geography.name/classical-central-place-theory/>, n.d

Furthermore, studies (Barthélemy, 2011; Boccaletti et al., 2006; Lämmer et al., 2006) based on transportation showed the importance of network theory. A network is a group formed from parts that are connected together. A network consists of linkages (edges) and nodes (vertex) (see Figure 2). Linkages are known as transportation lines and have a hierarchy in importance. Nodes are described as transport centers, this is a point of intersection or connection within a network. Networks have the tendency to grow over time, nodes wish to connect themselves to hubs with the most connections. Competitive fitness, that is nodes' intrinsic ability to attract links in the network, explains how networks evolve. The state of the network can be measured in complexity and connectivity. State refers to the current development phase of a network. Complexity can be expressed through the ratio of edges (linkages) to vertices (nodes), e/v . Connectivity describes how much a network is connected relative to how much it could be connected, the formula is the following: $e/(3v-6)$. The different phases are 1 (start), 2 (serious extension) and 3 (mature network). The development of a network can be done top-down or bottom-up. In a top-down process, politicians and planners decide on the basis of rational arguments to expand the network. Bottom-up refers to the expansion of the network through demand.

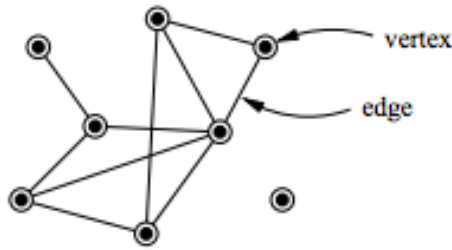


Figure 2: Visualization of a network, source: David Condrey, n.d

In addition to these theories, several concepts need clarification to answer the research question. In the main question three main concepts are already stated. These being public transportation structure, quality of life (QoL) and spatial (in)justice.

2.2 Public Transportation Structure

Public transportation structure refers to the physical infrastructure and facilities that support and enable public transportation services within a city or region. It has different components such as transit stations and stops. These are the places where individuals board or disembark. In this study stops are the most important component, since it is concerning the diminishing bus stops. Public transportation structures are crucial in spatial planning, since they play a role in reducing congestion, improving air quality and, most important for this research, enhancing mobility. Public transport modes could be trains, trams, metros or the bus. This study will focus on the bus in particular. However, it is important to note that there are different ways of commuting also without public transportation. A public transportation structure is of importance since it gives individuals accessibility towards, for example, facilities. Facilities are predominantly clustered in city centers, creating accessibility issues for rural inhabitants. Accessibility pertains to the ease which individuals can access or acquire public services. It can be defined as a gauge of relative proximity or nearness between the starting point and the intended destination (Setianto & Gamal, 2021).

The accessibility towards public transportation networks and thus facilities, influences the QoL. This is due to the fact that the indicators to measure the QoL are closely related to accessibility. The lack of a public transportation system can lead to exclusion of participation in (social) activities (Mobiliteitsarmoede, 2018) which can lead to a decrease in QoL.

2.3 Quality of life

In this study QoL is an evaluator to decide whether or not there is a case of spatial injustice. QoL can be defined, following the oxford dictionary, as, 'the standard of health, comfort, and happiness experienced by an individual or group'. Assessing the QoL, emerges as a predominant instrument for assessing, planning and managing policy-making and development strategies (Li & Weng, 2007; Turkoglu, 2015). There are abundant studies concerning the development of indicators of QoL. These metrics are frequently employed to assess livability and sustainability of urban environments or to examine past land use next to development strategies (Wann-Ming, 2019). Depending on what is being studied the indicators can vary. Mattson et al. (2021) used social, physical/climate, functional and safety as dimensions and indicators, when QoL regarding the ease of travel and community QoL. Under functional the research understood for example the ease of travel and available jobs. The functional indicator will also be used in this study. Wesz et al. (2023) have defined this indicator as urban mobility. They also note that indicators can be subjective as well as objective. In addition, time efficiency and affordability will be indicators for the QoL in this study. Efficiency includes frequency as

well as punctuality. A high frequency of public transport services is fairly important in public transport plans. Studies (Nielsen and Lange, 2008) showed that the demand for high frequency public transport is high, especially when public transport policy plans try to compete with car use. Affordability concerns the travel costs, money- and timewise. In their report ‘het belang van openbaar vervoer’ (the importance of public transport) published in 2009, CPB and KiM (Centraal PlanBureau and Kennisinstituut voor Mobiliteitsbeleid), concluded that a better public transport system leads to limited use of cars (limited costs of e.g diesel) which in its place leads to less parking costs. The formula: Waiting time + in vehicle time + Transfer time makes up the travel costs timewise (Lin et al., 2021). In this study it is expected that individuals want to minimize the costs.

Where Mattson et al. (2021) used QoL in regards to ease of travel, this study will measure QoL in regards to accessible public transport networks. Public service facilities play a crucial role in enhancing the overall QoL. Evaluating the distribution of these facilities relies on assessing their accessibility and equitable availability. The majority of facilities are concentrated in the city center, posing accessibility challenges for residents in outlying areas. To rectify this disparity and achieve spatial justice, it is imperative to ensure accessibility to such facilities across various locations (Setianto & Gamal, 2021).

2.4 Spatial (in)justice

Different authors as Piazzoni et al. (2022), Moroni (2020) and Feitosa et al. (2023), have used the concept of spatial injustice, or in different terms such as spatial inequities or design justice, in varied studies. Spatial justice entails ‘the fair and equitable distribution in space of socially valued resources and opportunities to use them’, as Soja (2010) described. Moroni (2020) adds to this that spatial justice serves as a reflection of spatial conditions within an institutional context, institutional (in)justice. This entails that the spatial consequences are a result of basic institutions. That means that justice or injustice is the result of institutions since these ‘constrain or encourage, penalize or reward, possible human actions and interactions’. Young (2003) pointed this out by stating that operations of many institutions constrain or enable groups. And thus some groups (in this study the rural inhabitants) are faced with a limited set of options (in this study limited accessibility to public transport).

2.5 Conceptual model

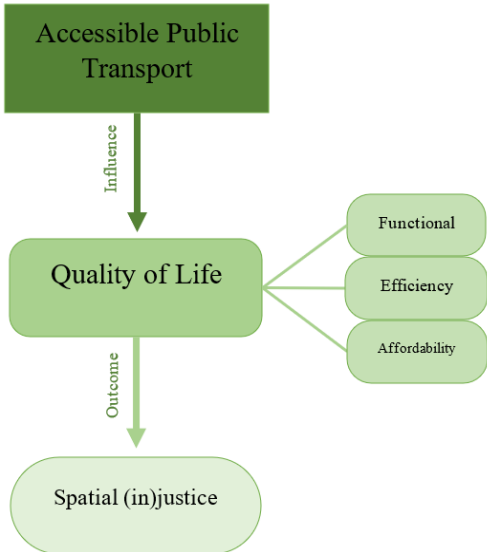


Figure 3: Conceptual model, source: Author

In the model above the main concepts are shown in relation to one and other. The study will investigate the influence of accessible public transport on QoL. QoL is constituted by three factors (functional, time efficiency and affordability) that relate to public transport. The QoL is the evaluator for the outcome of spatial injustice or justice, depending on what kind of influence (negative or positive) the influence of the decreasing public transport network has.

A critical starting point of this study is that the diminishing public transport network implies that there is a lack of public transportation in rural areas. Since objectively speaking an uneven distribution of accessibility towards facilities in the city center is spatial injustice, the hypothesis would be that since there is a diminishing public transport network in rural areas, rural inhabitants encounter spatial injustice. In addition, an assumption of this study is that facilities are important for the preservation of QoL. Together this would then lead to the hypothesis that the QoL of rural inhabitants would decrease when the transport network decreases, since the accessibility towards facilities is declining.

3. Methodology

3.1 Research methods

To get an answer to the central question '*How does the diminishing of an accessible public transportation structure contribute to spatial (in)justice as reflected in the overall quality of life of rural area inhabitants?*', primary and secondary data collection will be needed. Primary data collection can be helpful in answering the second and third sub-questions: '*What is quality of life and what are the factors influencing the quality of life related to public transport?*' and '*How can quality of life influence the idea of spatial injustice?*'. Secondary data is needed to answer the first sub-question: '*What is the current state of public transportation infrastructure in rural areas, and how has it evolved over the years?*'.

For this study the defined research area is Peize. Peize is a village which counts around 4000 inhabitants and is located 10 kilometers south of Groningen city. The village is dependent on the city of Groningen for varied amenities such as, different leisure activities, work, high schools and the university. In the last couple of years the village of Peize has lost 4 bus stops (Wolddijk, Centrum, Schoolstraat, Korvemaker) and connections of public transport in the direction of Groningen and back. The inhabitants of Peize are left with one stop (P+R Peize) which is located at the edge of the village. This makes Peize a relevant case study for the subject of spatial injustice and diminished public transportation.

First it is important to study and visualize the changes in the public transport network. By doing so, there will be a clear understanding which bus stops are removed and which one is still there. An overview is needed to understand which changes the inhabitants went through and to get an image of what the connection to the city of Groningen looked like before and now. This will help answer the first sub-question '*What is the current state of public transportation infrastructure in rural areas, and how has it evolved over the years?*'. With the use of GIS, visualizations will be made. The method that will be used for this part, is a mix of primary and secondary data. Secondary data is needed for different analyzes in GIS. The layer of road networks and the public transport of the Netherlands layer are being downloaded from the ESRI database. These layers need to be adapted to fit the case study area and symbology. Next to this the layer of the situation before will be made and thus is primary data. For understanding why and how the public transportation has changed, municipality documents will be analyzed. The examination of this secondary data will give an understanding on the decisions of change. The

focus while analyzing will be on different keywords such as public transport, bus stops, functionality, efficiency, affordability, process and opinions. This will help getting a clear and relevant overview relating to the changes that will be shown in the maps.

After an overview of changes made in public transportation in Peize, the research moves on to studying QoL and the relation with spatial injustice. The questions *'What is Quality of life and what are the factors influencing the quality of life related to public transport?'* and *'How can Quality of Life influence the idea of spatial injustice?'*, will, as well as the first question, be answered by a mix of methods. To begin, secondary data will be analyzed for a literature review to get an understanding on QoL and which elements could influence this. This information, next to the information obtained by the municipality documents, will be input for a survey. To collect primary data, Maptionnaire will be used. Maptionnaire is a platform that enables local insights and GIS-backed decisions. The survey will give insight on how inhabitants of Peize think about the diminishing public transport in their area. With a mixture of quantitative and qualitative questions, the primary data will provide quantitative data and basic demographics together with more in-depth insights. The Maptionnaire survey was distributed through publishing a link on the local website. In this way the survey is targeted at only the target audience, the inhabitants of Peize. The answers of the participants should help answer the questions on how the diminishing public transport affects the QoL in regards to the factors functionality, efficiency and affordability. The survey can be found in the appendix.

Table 1 visualizes a summary of the methodology that was used.

3.2 Discussion of the methods

Although Peize is a perfect example of an area which suffers from diminishing public transport, a case study can limit the outcome. With a comparative study, or multiple case studies a broader result will substantiate the outcome. It is important to note that it is not one story that fits all, what is true for Peize might not be true for another village which undergoes the same situation of diminishing public transportation. Next to this, the amount of participants can influence the outcome. With the aim of 80 respondents and the result of 120, which is enough for statistical tests, it is by far not everyone in the village that has filled in the survey. In addition, there are no interviews conducted. Interviews could be of value in this research. Interviews with infrastructure planning experts could give a different dimension to the issue. For this study varied factors are chosen to measure QoL and thus spatial injustice. These factors can depend on choices and insights in how to best cover QoL and may also change over time. At last, this research is focusing on the removed buses and bus stops, however it does not take the ability of private transport into account. This could be done in further research. Besides these limitations, this research with a case study of Peize, is an important first step in this field. This study enables a start for further research since it gives the first insights on the situation of diminishing public transportation in rural areas in relation to QoL.

Table 1: Overview methods

	Instrument	Why	How
Primary data	Maptionnaire	<ul style="list-style-type: none"> ➤ Location based survey ➤ Opinions inhabitants Peize ➤ Maps ➤ Charts 	<ul style="list-style-type: none"> ➤ Published online ditispeize.nl ➤ Networking
	GIS	<ul style="list-style-type: none"> ➤ Visualization 	<ul style="list-style-type: none"> ➤ Data
Secondary data	Municipality documents - Timetable changes - Traffic and Transport plan	<ul style="list-style-type: none"> ➤ See how and why there were changes made 	<ul style="list-style-type: none"> ➤ Review on keywords

3.3 Ethics

As the survey concerns, amongst other things, the location of bus stop and the proximity to one, the data can be sensitive. To make sure privacy is ensured, no address will be asked in the survey. Rather a method of marking areas is used; the participant can mark areas which could be close to them or sensitive (working place or school). By marking a bigger area, there is no risk in giving private address information. In addition inhabitants can choose themselves if they want to participate or not, the survey is voluntary. To ensure protected privacy, questions about names will not be asked. The age of the participant is relevant, however, since no name will be asked the privacy impact is limited. The data will be stored and analyzed in Excel, the raw data is only accessible to the researcher, only after analyzing and generalizing the data is shown to second and third parties and thus precludes that identifiable information is shared.

4. Results

4.1 Public transportation network Peize

Relating to the bus service in the case study of Peize, it was found that in the last years 4 bus stops and a bus line were removed. To visualize this change, Figure 4 and Figure 5 show the differences between the status of the public transportation network in Peize in 2023 and the before removal situation. Figure 5 shows the current service area of the bus stop anno 2023. Figure 4 shows the service area before different bus stops were removed and canceled. The service area threshold is set at 400 meters, this an acceptable walking distance of approximately 5 minutes. In the current situation the village of Peize has only one option to take the bus, at bus stop P+R Peize. In the situation before 2023, the inhabitants of Peize had access to five different bus stops (P+R Peize, Wolddijk, Centrum, Schoolstraat, Korvemaker), making the service area of the bus significantly bigger. This means that in the current situation of 2023, the amount of inhabitants who can easily reach a bus stop is remarkably lower than before.

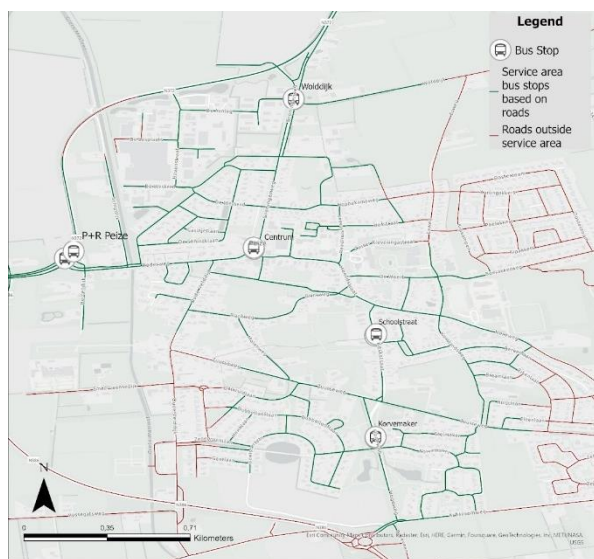


Figure 4: Bus stops and service area before removal, source: Author

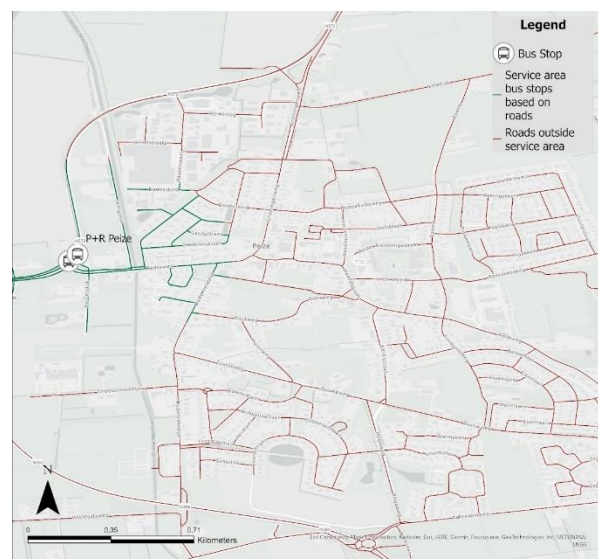


Figure 5: Bus stops and service area after removal (2023), source: Author

In addition Figure 6 and Figure 7 show the differences in complete network over the years. Figure 6 shows the current state of the network, with one node (bus stop P+R Peize) and one edge (Busroute). Figure 7 shows the state of the network before various bus stops were removed and routes were canceled. The previous situation (Figure 7) has 5 nodes (bus stop P+R Peize, Wolddijk, Centrum, Schoolstraat and Korvemaker) and multiple edges as a result of multiple bus routes and bus stops.



Figure 6: Network 2023 situation, source: Author



Figure 7: Network before situation, source: Author

The reason for this change in the public transportation structure is not stated in municipality documents. However, in the document of ‘definitive main routes’ (Definitieve hooflijnen, 2021), it is noted that the removal of the bus stops and route saves the municipality of Noordenveld 155.000 euros. This would be a legitimate reason for the municipality to cancel the bus. Nevertheless, in the ‘Traffic and Transportation plan’ (Gemeentelijk verkeers- en vervoersplan, 2015) Noordenveld states that they want an improvement of accessibility towards public transport and the public transport system itself. In the document the municipality states that ‘optimization of bus routes through the municipality’ (Gemeentelijk verkeers- en vervoersplan, 2015, p35) and that ‘the public transport bureau strives towards a robust and future proof network’ (Gemeentelijk verkeers- en vervoersplan, 2015, p40). This is contradictory when looking at the situation maps from before removal and 2023. Neglecting the knowledge obtained from the municipality documents and just by looking at the different maps, a conclusion could be the opposite of what the municipality intends to be doing, namely a deoptimized bus route which is not robust nor future proof. This being said, the OV-Bureau gives a disclaimer that they need to make choices to cope with the financial pressure (Gemeentelijk verkeers- en vervoersplan, 2015, p40). This disclaimer would lead to an assumption that the removed bus line through Peize was not important enough. Nonetheless, another goal of Noordenveld is that the cities (in this case Groningen) as well as rural areas (in this case Peize) are accessible (through public transport) (Gemeentelijk verkeers- en vervoersplan, 2015, p40). The outcome of the diminished public transport system and this statement are contradictory. The Traffic and Transport plan ends with stating the main goal: ‘focussing on the maintaining and improvement of the (economic) accessibility, and the increasing of the traffic safety and the (living) environment (Gemeentelijk verkeers- en vervoersplan, 2015, p58). This goal again is contradictory to the results on the map, where one could say that the maintaining and improvement of accessibility has failed due to the fact that bus stops and lines are removed. This would mean that the one factor explaining the change in the public transportation network is the municipality saving money. Even though it is nothing like said in municipality plans.

The participants in the case study were also asked what they think the ideal situation would be for the public transportation network. This is visualized in Figures 8, 9 and 10. It can be seen

that the inhabitants mostly choose locations that were originally already a bus stop or a bus route.



Figure 8: Bus stop locations chosen by respondents, source: Author

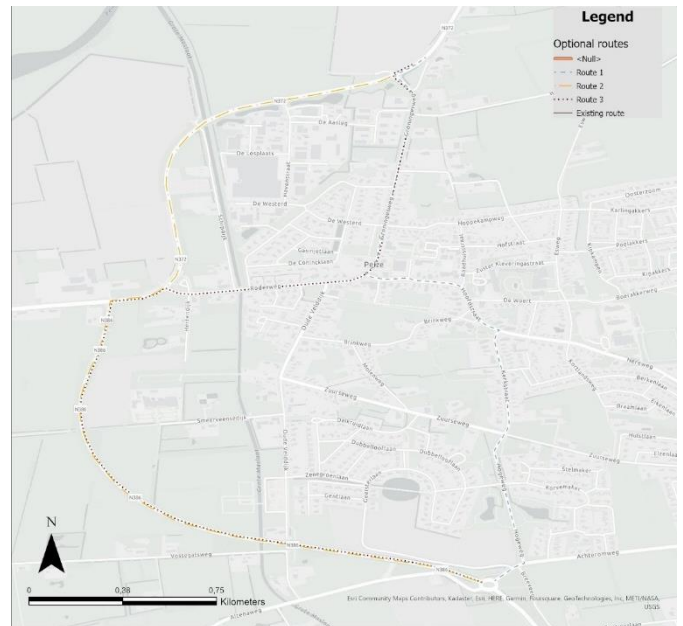


Figure 9: Bus routes chosen by respondents, source: Author

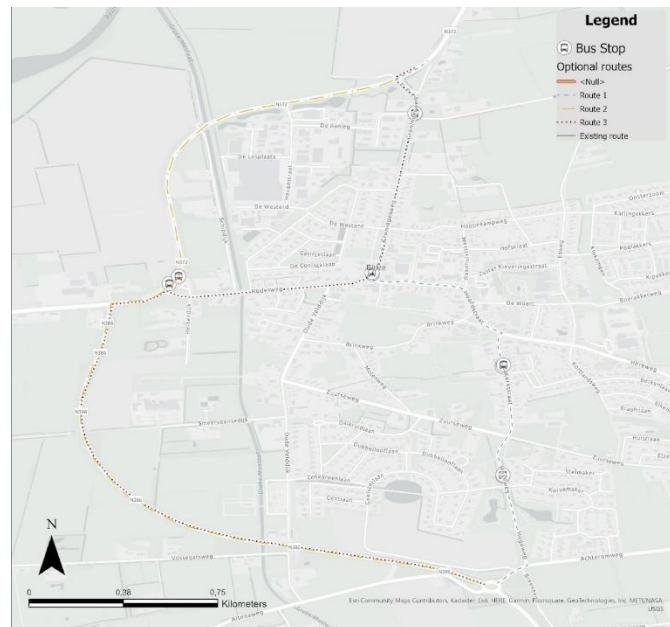


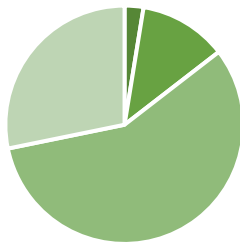
Figure 10: Network based on respondents, source: Author

4.2 Quality of Life

With an average age of 46, with a range of 15 years old to 91 years old, 120 individuals participated in the survey. Figures 11-14 show some general characteristics of the participants. It can be seen that the majority of the participants do make use of public transport, making the output reliable. However, it would have been more preferable to have more people using the bus, nevertheless, the survey also asks when individuals would prefer the bus over their own vehicle, making their answers still of value. In addition, it can be noted that there is variety in daily occupation, making the sample representable for inhabitants of Peize.

The participants were also asked to indicate their daily activity space, Figure 15 shows a visualization where inhabitants of Peize need to be in their daily lives and thus if the inhabitants travel. The map shows that the majority of inhabitants of Peize, need to be in a different location for their daily lives and thus it makes sense to ask about transportation.

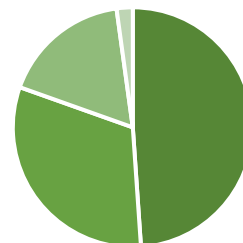
Daily occupation



■ High school student ■ Student ■ Working ■ Other (eg. Pension)

Figure 11 source: Author

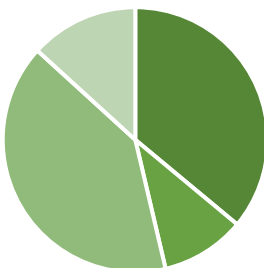
Trip to Groningen per week



■ 1 to 2 ■ 3 to 4 ■ 5 to 6 ■ 7 or more

Figure 12 source: Author

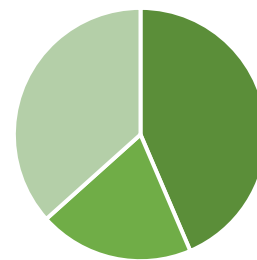
Reason for the trip



■ Work ■ School ■ Leisure activities ■ Health care

Figure 13 source: Author

Making use of public transport



■ Often ■ Sometimes ■ Never

Figure 14 source: Author

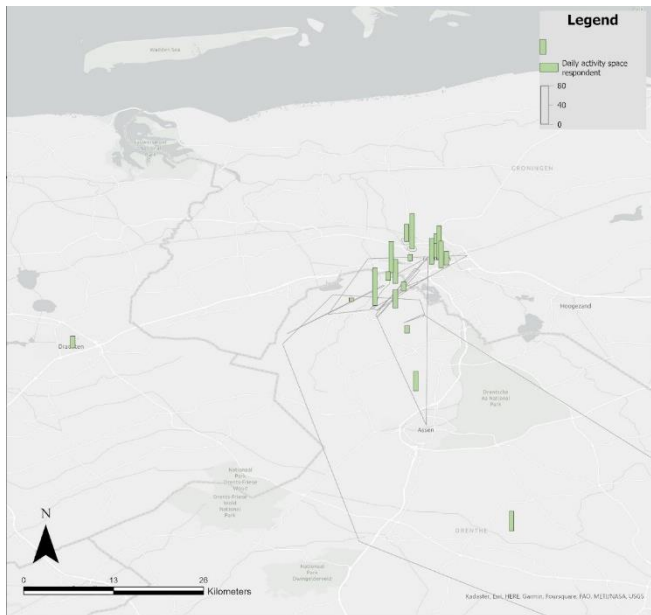


Figure 15: Daily activity space inhabitants of Peize, source: Author

4.2.1 Functionality

Regarding the factor of functionality, it can be noted that the majority of the inhabitants of Peize are satisfied. When asked to rate the overall functionality on a scale of one to five, the greater part of the participants responded with a four. Nevertheless, a fair amount rated the overall functionality with a three or less. In addition the rating of the bus route from Peize to Groningen on a scale of one to five, where one is not optimal and five is very optimal, can be seen that again the majority is satisfied. However, when asked if the public transport structure offers a sufficient range of routes to meet the travel needs, including commuting, running errands and leisure activities, the satisfaction decreased. The majority of ratings for this question (again on a scale one to five), is between two and four. This comparison is visible in Figure 16. In spite of these positive ratings, participants also had some marks for improvement,

'P+R Peize is located on the outside of Peize. Due to this I have to walk for a little bit. If the bus stop would be located more in the center, it would improve the functionality.'

As expected, one of the improvements that can be made following the inhabitants, is the addition of a bus stop in the center of Peize, as shown in the quote above.

A less expected emergent pattern is related to the bus making use of the bus lane.

'the bus lane needs to be extended, now in the mornings you spend a lot of the time in traffic jams.'

The bus is able to drive on a bus lane for most of the route Peize - Groningen. However, the bus lane ends approximately one kilometer before the end station. This raised answers of inhabitants such as the mentioned quote.

Several participants in addition had as a point of improvement the seating plan in the bus itself to make the travel more comfortable.

Q17 and Q18



Figure 16: Comparison Q17 and Q18, source: Author

4.2.2 Efficiency

Noordenveld themselves had diverse statements about efficiency. An example is providing bus stops with a Dynamic traveler information system. This system shows (digital, in real time), travel information such as the departure times and delays (Gemeentelijk verkeers- en vervoersplan, 2015, p42). It is found that, by far, the majority of the participants are satisfied with the punctuality of the bus. However, when asked if they experience significant delays, on a scale of never, sometimes and often, the majority answers with sometimes. Quotes as *'I chose my own car over the bus, because the total travel time with bus is way longer than if I go by car'* would be an explanation on why inhabitants in some cases prefer their own vehicle, instead of the bus, namely travel times and also delays were mentioned.

The municipality also aims to offer a regular bus service. When first questioned on the frequency of the bus, the greater part of respondents is satisfied. Nevertheless, when asked more in depth questions it turned out participants were not as satisfied as they initially might have thought. Answers as *'The bus should drive more frequently and more distributed throughout the day'*, show that the aim of a regular bus service is not achieved. Multiple answers of respondents were inline with too little busses available and not frequent enough.

4.2.3 Affordability

Concerning affordability, the results show that half of the inhabitants do not take affordability into account when choosing the preferred way of traveling. The other half is divided in a group who sometimes takes it into account and a group who always takes affordability into account. One third of the participants stated that the costs associated with public transportation are not reasonable and too high. They find the busses *'way too expensive to use'*. However, there are also certain inhabitants who chose the bus above other transport, for example, due to eliminating parking costs at the destination. Timewise, the same can be said as for efficiency, the travel time by bus is longer than by their own vehicle.

4.3 Spatial (in)justice

The opinions of spatial injustice in Peize are mixed. When directly asked if the participants feel like Peize is a case of spatial injustice, about half of the participants said yes and the other half said no. This mixture of opinions is also clear in the questions relating to the factors of QoL, as written above. The participants who are not satisfied with the new situation of public transport in Peize, are also the persons who think that there is a case of spatial injustice. An emergent pattern for the reasoning of these individuals is that the new situation excludes certain inhabitant groups, such as elderly or students. Next to this a recurring reasoning is the removed bus stops and routes.

Nevertheless, there are individuals who do not agree. Their reasoning is that the bus stops and route is removed for a reason. They have the opinion that the demand for public transport is not there, and therefore the supply is not there. However, it is important to note that the participants who support this argument, are in general in possession of a car or E-bike.

5. Discussion

In this research a Maptionnaire survey is used to determine the QoL of rural inhabitants. The factors to measure this are used as described by Mattson et al. (2021), Nielsen and Lange (2008) and CPB and KiM (2009). The survey is distributed over Peize and 120 individuals participated. This sample is more than sufficient to say something about the population of Peize. And thus making the results of the study representable for the case study.

It was found that the public transport network has changed. The state of the network in 2023 is equal to a complexity of 2 and connectivity of -1, were the state of the network before was equal to 1,2 and 0,67. This shows, following the theory of network complexity, that even though nodes and linkages are removed, the network still enhanced. This is also contradictory to the theory, since it states that networks enhance when they evolve. The change in the network was made by a top-down process. The consequences of the network are thus a result of basic institutions and thus are inline with institutional (in)justice as Moroni (2020) described. With the enhancement of the network, objectively speaking, the institution enabled groups, which is in line with the study of Young (2003). On the other hand answers to the Maptionnaire showed that inhabitants feel like some groups (elderly) are now excluded since the only bus stop is located outside of the village. This means the institution constrained a group, which is also in line with spatial institutional injustice studies of Young (2003).

Answers to the questionnaire showed that the limited access to public transport in the first instance does not impact the QoL of rural inhabitants. This result is not in line with the expectation of a decrease in QoL due to diminishing public transport (Setianto & Gamal, 2021), the normalization of car use and accessible other modes of transportation could be an explanation of this outcome.

However, the open questions show that inhabitants, contradictory to their first answers, find that there should be more accessible bus stops and a more frequent bus line to improve their QoL. This is in line with the research of Mattson et al. (2021) and Nielsen and Lange (2008). Next to this, the results show that participants do want to minimize their travel costs, money- as well as time wise. This overlaps with the study of Lin et al. (2021).

6. Conclusion

On the basis of a mixture of quantitative and qualitative research, it was examined if diminishing public transport has an impact on the QoL of rural inhabitants with a consequence of spatial injustice. Three factors influencing QoL were distinguished to determine if the QoL is substandard, notably these factors were functionality, efficiency and affordability. Before the research on QoL was conducted, the change in public transport network was examined.

The findings suggest that by the change of the public transport network, less people have access to the bus stops at the same time the network state itself is enhanced. This makes the network less robust and functional, contradictory to goals of the government. Nevertheless, results indicate that the QoL of rural inhabitants is not inadequate. Improvements could be made regarding the functionality and efficiency factors. The main point of improvement is the frequency of buses and the availability of bus stops. Since the QoL is not drastically low, there is no case of subjective spatial injustice. Nonetheless, institutional wise the case of spatial injustice still stands as a group of people is being excluded from the use of the bus due to the removal of bus stops.

These results do not fully overlap with existing research. Setianto and Gamal (2021) noted that the lack of public transport has a severe impact on accessibility of (social) activities, which impacts the QoL. In this study this is not the case. On the other hand, studies (Nielsen and Lange, 2008), show how important frequency is concerning public transportation, which is also reported in this research. This could be inspiration for planners and politicians to focus on while making transportation plans.

As an important next step, future research could explore the rate of QoL before the public transport network had changed, this study is limited to only knowing the QoL after the change. It could be that the QoL of inhabitants was even better before and thus would show a decrease in QoL. This would make for interesting additional research, in this regard a longitudinal research design on places where it is known where bus stops will be removed in the future could study the change in QoL.

Next to this, the role of different modes of transport next to only public transport. This study is limited to public transport, however, individuals do have access to a car which could mean public transport is not that important. On the other hand it could also be that there are more cars in rural areas due to the diminishing public transport. This would be interesting to do further research about. In addition, it would be useful to conduct the research with other factors influencing QoL, such as the environment.

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8. Appendix

Appendix 1: Maptionnaire survey

Survey Public transport Peize

This survey is to get insight on what inhabitants of Peize think about the public transport network in Peize. The answers will help answer the research question ‘*How does the diminishing of an accessible public transportation structure contribute to spatial (in)justice by influencing the overall quality of life of rural area inhabitants?*’. The direct answers will only be shown to the researcher, and no name is needed to fill in the survey. The survey is voluntary and will take about 5 to 10 minutes. By taking part in the survey, you are giving consent to participate in the research. The survey is divided into four sections. In the first section general questions will be asked, in the second questions regarding functionality will be asked, in the third question regarding efficiency and the last section will be questions about affordability. There will be open and closed questions. For the closed questions, you pick the answer most applicable to you. For the open ended question, you can give more elaboration by typing an answer. There is no right or wrong.

For more questions or concerns contact: m.p.de.jong.4@student.rug.nl

EXTRA EXPLANATION USING THE MAP:

For some of the question you are being asked to mark something on the map. If you are filling in this survey on the laptop, the map is open net to the questions. If you are using a mobile phone or tablet, the map will open as soon as you click on the question. You can click on the map and move it. By the questions in question, more explanation is given.

first part, general questions

1- What is your age?

2- How long have you lived in Peize?

3- What is you daily occupation

- student
- student with a side job
- employee
- different, namely

4- How often do you need to travel for your daily occupation?

- Never
- Sometimes
- Often

5- mark on the map you daily activity space, this can be done by clicking on different points on the map.

6- How often do you travel to the city of Groningen per week?

- 0-2
- 3-4
- 5-6
- 7

7- What are the reasons for the trip to Groningen? (multiple answers possible)

- work
- school
- leisure activities

- Healthcare
- 8- Do you own a car or ebike?
- yes, both
 - yes, car
 - yes, ebike
 - no
- 9- Do you use your own vehicle to travel to Groningen? (ebike and bike included)
- yes/no
- 10- Do you use public transport to travel to Groningen
- yes/no
- 11- How far away is the bus stop P+R Peize for you?
- 0-400m
 - 400m-1 km
 - 1km +
- 12- Are you aware that multiple bus stops in Peize have been removed (Groningerweg, Centrum, Korverweg, Kerkstraat)?
- yes/no
- 13- Did you made use of the removed bus stops?
- Yes, often
 - Yes, sometimes
 - No, never
- 14- Does the availability of bus stops limit your daily actions? (such as meeting up with friends, going shopping etc.) on a scale of 1 to 5, where 1 is not at all and 5 very much
- 1-5
- 15- Mark on the map where you would (re)place a bus stop in Peize, this can be done by clicking on the spot you wish to place a bus stop.

second part, functionality

- 16- Is the P+R Peize bus stop easily accessible for you?
- yes/no
- 17- Would you say that the bus route in the direction to Groningen is optimal? On a scale of 1 to 5, where 1 is not at all and 5 very much
- 1-5
- 18- Do you feel that public transportation services offer a sufficient range of routes to meet your travel needs, including commuting, running errands, and leisure activities? On a scale of 1 to 5, where 1 is not at all and 5 very much
- 1-5
- 19- Have you experienced any difficulties in accessing essential services (e.g., healthcare, education, employment) due to limited public transportation options?
- Often
 - Sometimes
 - Never
- 20- mark on the map how you feel like the bus route should be, this can be done by clicking on several points on the map to make a line.
- 21- Do you find buses comfortable and accommodating for your travel needs? On a scale of 1 to 5, where 1 is not at all and 5 very much
- 1-5
- 22- How often do you need to change your travel plans due to functionality of the public transport?
- Often

- Sometimes
- Never

23 - How would you rate the overall functionality and ease of travel using public transportation services in your area, with 1 being very difficult and 5 being very easy?

- scale 1-5

24- can you explain in short how the functionality of public transportation in direction of peize – groningen - peize, could be improved?

.....

end second part

third part, efficiency

25- Are you satisfied with the frequency of public transportation services in your area? On a scale of 1 to 5, where 1 is not at all and 5 very much

- 1-5

26- How satisfied are you with the punctuality of public transportation services in your area? On a scale of 1 to 5, where 1 is not at all and 5 very much

- scale 1-5

27- How often have you experienced significant delays or waiting times when using public transportation recently?

- Often
- Sometimes
- Never

28- How often do you prefer your own car or ebike over the bus? (if applicable, otherwise choose nvt)

- Often
- Sometimes
- Never

29- Why do you prefer your choice?

.....

30 – what should be improved for you to chose the bus over your own vehicle?

.....

end third part

begin fourth part, affordability

affordability

31- Are the costs associated with public transportation services reasonable for your budget?

- yes/no

32- How much money on average do you spend on public transport per week?

- 0-10
- 11-20
- 20+

33- How often do you use public transportation due to its affordability compared to other transportation options (e.g., personal vehicle, rideshare services)

- Often
- Sometimes
- Never

final open question

34- One of the policy goals of the municipality of Noordenved is '... aimed at maintaining or improving (economic) accessibility, increasing road safety and improving the (living) environment...'. Do you think this has been successful in your region?

- yes/no

35- what should be done to get to this goal?

.....

spatial injustice can be defined as: 'the fair and equitable distribution in space of socially valued resources and opportunities to use them'.

36- Do you feel that the diminishing of public transportation options contributes to spatial injustice in Peize? (Yes/No) b. Please explain how it contributes to spatial (in)justice.

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