

Dealing with the trade-off between safety and accessibility of regional infrastructure by means of spatial planning approaches: the case of the N34 road section in the municipality of Aa & Hunze

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Abstract

The N34 road section in the municipality of Aa & Hunze experiences daily traffic congestions and high relative and absolute numbers of traffic accidents compared to other N34 road sections. As the number of cars using this section increases over time, these situations of poor road safety and accessibility are expected to worsen. However, to date, no final plan for improving these factors of the N34 road section has been finalized and implemented. Therefore, this research aims to show if there is a pattern between the spatial planning approach, derived from the planning theory of De Roo, used by stakeholders in the planning process and whether or not there is a timely design of a final road design that, if implemented, improves the trade-off between safety and accessibility in the N34 case study. This is reached by conducting a comparative analysis in which data on different aspects, derived from media- and document analyses, of the N34 case and five national and international example cases in which problems of both road safety and accessibility has been solved, are compared. The results show that, in the N34 case, a scenario approach is used by the stakeholders in the planning process while in the other five cases the stakeholders used a more technical approach. This indicates that in the N34 case study, compared to the five other cases, there is more consultation with stakeholders, more consideration of stakeholders' interests in the planning process, more power for these stakeholders, and less discretion for project leaders. Since in all five cases both safety and accessibility improved, this study concludes that in the N34 case, the use of a more technical approach by the stakeholders in the planning process is more appropriate than the scenario approach currently used. This gives the Province of Drenthe more power in the decision-making process, as fewer stakeholders are involved and as a result requires less consultation in the planning process, saving time and consequently allowing a final road design to be finalised and implemented sooner and more effectively. However, as the N34 case study is only compared with five cases that all experienced safety and accessibility improvements and all used a more technical approach, and as no deepening interviews with N34 policy-makers were conducted, the results may lack validity. Future research should hence include interviews with policy-makers and analyse more than five cases, including some where no improvements were made and where stakeholders used less technical approaches.

Keywords: trade-off, accessibility, road safety, N34, Aa & Hunze, spatial planning approach, planning process, road design, comparative analysis.

Table of Contents

1. Introduction	6
2. Theoretical Framework	10
2.1 Planning Theory	10
2.2 Key Concepts of Infrastructure Planning	13
2.3 Integral trade-off between safety and accessibility	14
2.3.1 The relationship between traffic safety and accessibility	15
2.3.2 Factors relating to the trade-off between traffic safety and accessibility	18
2.4 Conceptual Model	20
2.5 Hypothesis	20
3. Methodology	21
3.1 Research Strategy	21
3.2 Methods of Data Collection	22
3.2.1 Media analysis	22
3.2.2 Document Analysis	23
3.2.3 Observations	24
3.2.4 Ethical Considerations	24
3.2.5 Literature Review	24
3.3 Methods of Data Analysis	25
3.3.1 Media and document analysis	25
3.3.2 Comparative Analysis	25
4. Analysis of Real-Life Infrastructure Problem Examples	27
4.1 Infrastructure Problems and Solutions in Western Countries	27
4.1.1 Infrastructure Projects in the Netherlands	27
4.1.2 Infrastructure Project involving Two Western Countries	29
4.1.3 Infrastructure Projects in other Western Countries	29
4.2 The N34 Infrastructure Problems in the Municipality Aa & Hunze	34
4.2.1 The Development History of the N34 Road Section in Aa & Hunze	34
4.2.2 The current N34 section in Aa & Hunze and its Trade-Off between Safety and Accessibility	35
4.2.3 Project development of the N34 Road Section in Aa & Hunze since 2011	36
4.2.4 The Current Status of the N34 Project in Aa & Hunze	38
4.2.5 Relating the N34 Project in Aa & Hunze to Theory	39
5. Comparative Analysis	40
5.1 Safety and Accessibility Improvements	40
5.2 The Planning Process	41

6. Conclusion and Discussion	43
7. Reflection	46
8. References	48
Appendix A: Overview of the Media Articles used in Section 4	54
A1: Media articles used in section 4.1: Infrastructure Problems and Solutions in Western Countries (analysis of the five national and international cases):.....	54
A2: Media articles used in section 4.2: The N34 Infrastructure Problem in the Municipality Aa & Hunze (analysis of the N34 case):.....	55
Appendix B: Overview of the Documents and Reports used in Section 4	57
B1: Documents and reports used in section 4.1: Infrastructure Problems and Solutions in Western Countries (analysis of the five national and international cases):	57
B2: Documents and reports used in section 4.2: The N34 Infrastructure Problem in the Municipality Aa & Hunze (analysis of the N34 case):.....	57
Appendix C: Protocol for the On-Site Observations	58

Tables & Figures

Table 1: Overview of the identification criteria to identify the spatial planning approach used by stakeholders in a planning process of a specific spatial planning case **Fout! Bladwijzer niet gedefinieerd.**

Table 2: Overview of the case studies and literature presented in section 2.3.1 ... **Fout! Bladwijzer niet gedefinieerd.**

Table 3: Analytical framework for the results of the media and document analysis presented in section 4.1 **Fout! Bladwijzer niet gedefinieerd.**

Table 4: Overview of the five infrastructure cases presented in section 4.1 **Fout! Bladwijzer niet gedefinieerd.**

Figure 1: Location of the Gieten traffic junction in the municipality of Aa & Hunze 6

Figure 2: Planning theory model of De Roo 10

Figure 3: Conceptual Model 20

Figure 4: The position in the planning theory model of De Roo of the spatial planning approach used by the stakeholder in the Sea-to-Sky Highway case 32

Figure 5: The road sections Gasselte-Gieten (A-B, opened in 1961) and Gieten-Anloo (B-C, opened in 1962)..... 34

Figure 6: The current Gieten traffic junction..... 35

Figure 7: The villages located around the Gieten traffic junction (red dot): Eext, Gieten and Gasselte37

Figure 8: The four current plans of the Province of Drenthe 38

Figure 9: Positions in De Roo's planning theory model of the spatial planning approaches used by the stakeholder(s) in the planning process of each case study (X= N34 case, 1= Vechtdalverbinding, 2= N261, 3= L558, 4= A590 & 5= Sea-to-Sky Highway) 42

1. Introduction

The Gieten traffic junction, located in the municipality of Aa & Hunze on the north-east side of the province of Drenthe, is an important junction of the N34 provincial road (Figure 1). This road connects two major cities in the north of the Netherlands: Emmen and Groningen. The traffic junction is also the point where the N34 provincial road and the N33 national road meet. This means that not only motorists on the N34, but also motorists turning off the N33 use it. However, the degree of accessibility of the Gieten traffic junction is insufficient for the 22.000 cars that use it daily (RTV Drenthe, 2019). Traffic jams on all four sides of the junction are therefore commonplace, especially in the morning, afternoon and evening rush hours (RTV Drenthe, 2019; Provincie Drenthe, 2024). In addition, the Gieten traffic junction and the two kilometers on the north and south sides of the junction experience high relative and absolute numbers of traffic accidents compared to other N34 road sections (Heeres et al., 2019). This indicates that the Gieten traffic junction and its immediate surroundings experience not only insufficient road accessibility, but also insufficient road safety. Consequently, the Gieten traffic junction is identified as a bottleneck for the N34 provincial road. As this bottleneck is located in the municipality of Aa & Hunze, the focus of this case study is on the N34 road section located in this municipality.

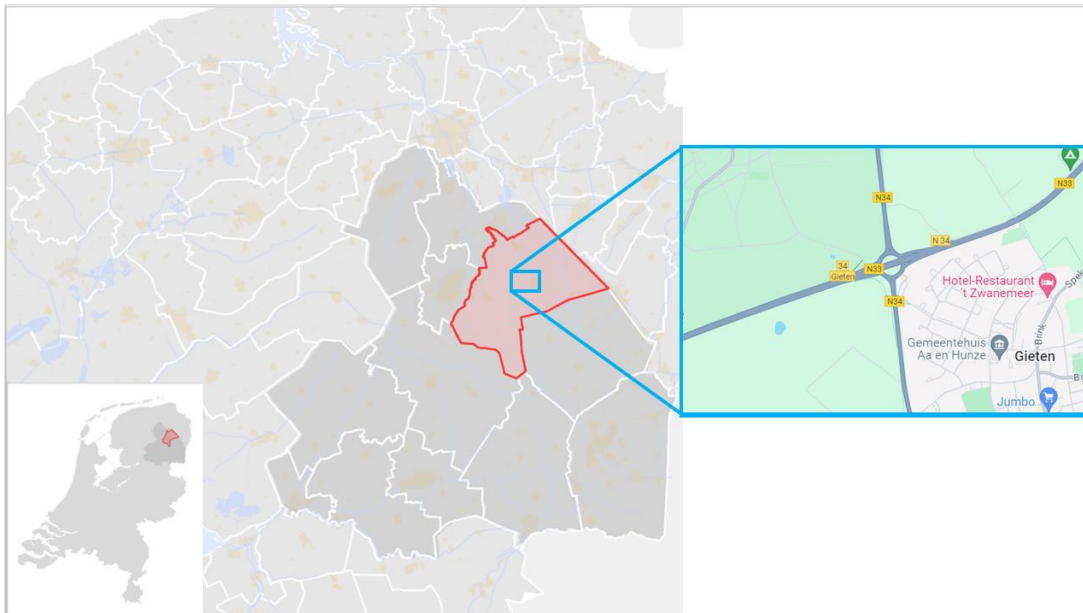


Figure 1: Location of the Gieten traffic junction in the municipality of Aa & Hunze (Sources: Wikipedia (2024) & Google Maps (2024a), adapted by the author)

The traffic jams caused by the insufficient accessibility of the Gieten traffic junction not only negatively affect businesses and people living and working in the immediate vicinity of the junction, but also have wider negative consequences. People living in other regions connected to the N34 but further away from the junction, such as Emmen and Groningen, may suffer negative (economic) consequences from the traffic jams. This is because traffic jams can cause students to arrive late at school, causing them to miss lectures or exams. In addition, it causes workers to arrive late to work, leading to production losses, and it also leads to income losses and extra costs for companies, especially in the transport sector (Falcocchio & Levinson, 2015). Overall, this can lead to an income drop for various businesses and individuals, potentially leading to economic stagnation. Moreover, the entire public transport in the northern Netherlands and the people who use it are negatively affected by the traffic situation of the N34 section in the municipality of Aa & Hunze. This is because there are no bus lanes around the

N34 near the junction, which means that buses also have to wait in traffic jams, causing delays (Provincie Drenthe, 2024).

In addition, several traffic accidents occur annually on this N34 road section due to the high traffic intensity and the unsafe nature of some single-lane sections. Not only does this further impede the flow and accessibility of the road section, several people have been seriously injured or even killed as a result of these accidents (Heeres et al., 2019). As described above, the Gieten traffic junction and the two kilometres of road on both the north and south sides of the junction experience higher relative and absolute numbers of traffic accidents compared to other N34 sections. After the Gieten traffic junction, the N34 section in the municipality of Aa & Hunze located next to the village of Gasselte experiences the most accidents (Heeres et al., 2019). This indicates a poor road safety record for the N34 road section in this municipality, especially at and near the Gieten traffic junction. For this reason, the N34's affectionate nickname, "Hunebed Highway" because of the prehistoric Hunebedden along the route, is increasingly renamed "death road" by the regional population (NOS, 2021).

Based on these descriptions of the N34 road section in the municipality of Aa & Hunze, there seems to be a tension and integral trade-off between road safety and accessibility, as both factors are interrelated and of insufficient level for this road section. In addition, the N34 in general and thus also the N34 road section in Aa & Hunze does not comply with provincial and national road safety policies (Heeres et al., 2019). To date, however, the plan for improving this N34 road section in terms of safety and accessibility has not yet been finalized and no final road design for improving these factors has been established, although several ideas have been put forward, such as fly-overs, doubling (parts of) the N34 or a combination of both (Provincie Drenthe, 2020).

This research aims to demonstrate if there is a pattern between the spatial planning approach used by stakeholders in the planning process and whether or not there is a timely design of a final road design that, if implemented, improves the trade-off between safety and accessibility of the N34 road section. In this study, a spatial planning approach is a specific working method in the planning process of a spatial planning case in which stakeholders follow specific guidelines to address and solve the spatial problems of that case. The research aim is reached by comparing five examples of national and international infrastructure projects, which experienced safety and accessibility problems, with the N34 case study as this will provide insights for the N34 case study and its related planning process on what does and does not work in seeking to improve infrastructure safety and accessibility. The five examples were selected on specific criteria and information about them has been collected and analyzed through both media and document analyses. After describing the five examples, the problems, solutions, effects of implementing the solutions on safety and accessibility, stakeholders involved and their roles, the planning process and the spatial planning approach identified for each case are compared with those of the N34 case through a comparative analysis. The spatial planning approach used for each of the five cases and the N34 case has been identified by relating and applying the aspects mentioned in the previous sentence to De Roo's planning theory and the identification criteria for spatial planning approaches, both discussed in the theoretical framework. Based on the results of the comparative analysis, conclusions are drawn about the most appropriate direction to take for the N34 project in terms of the spatial planning approach to be used by stakeholders in the planning process to affect the road design in such a way that it improves safety and accessibility faster and more effectively. If this direction is taken for the N34 project and road safety and accessibility is improved on the N34 road section in the municipality of Aa & Hunze, it is expected that the trade-off between safety and accessibility is better addressed on other N34 road sections as well. This potentially has several benefits for the entire region, including lower costs and higher income for people and businesses due to shorter travel times and lower risks of road accidents.

To date, little research has been done on using a planning process in which stakeholders adopt a spatial planning approach (technical, communicative or one that lies in between these approaches) that affects the road design for dealing with a trade-off between safety and accessibility in infrastructure. Therefore, this study adds to existing academic research by showing how using a planning process, based on an adjusted spatial planning approach in an infrastructure project, can affect the road design for dealing with a trade-off between safety and accessibility and improve both factors faster and more effectively. This will contribute to a better understanding in planning practice on how to deal with spatial planning situations where there is a tension between two interrelated factors. Moreover, this research potentially contributes to solving an existing social problem by drawing conclusions on which directions are more appropriate for an existing, real-life infrastructure project to follow in terms of the spatial planning approach used by the stakeholders in the planning process affecting the road design to improve road safety and accessibility. This is because the results and conclusions of this research help to increase and guide the knowledge of planning professionals working on the project, which may ultimately help them to more quickly and effectively determine a planning process, spatial planning approach and appropriate road design to improve safety and accessibility of the N34 road section. Consequently, an improved N34 road section will benefit society, as travelling on this section will generally be safer and less time-consuming. If the results of this study are generalized and applied to other national and international infrastructure projects to solve road safety and accessibility problems, society will benefit even more.

To reach the research aim, the following research question is proposed: “How can a planning process, based on an adjusted spatial planning approach, affect the road design for dealing with the trade-off between safety and accessibility of the N34 road section in the municipality of Aa & Hunze?”.

The sub-questions are divided as follows:

- How are spatial planning approach and planning process connected in theory and literature?
- What is the trade-off between infrastructure safety and accessibility in literature?
- How did the planning processes in other comparable, Western infrastructure projects look like, in which problems regarding the trade-off between safety and accessibility have been solved in the past?
- Why has the infrastructure problem of the N34 not been solved earlier?
- How does the planning process of the N34 project look like, including the stakeholders involved, their power and roles, and the spatial planning approach used?
- Which spatial planning approach to be used by the stakeholders in the planning process can be advised, to the project leaders of the N34 case, to solve the problems regarding safety and accessibility sooner and more effectively?

This thesis begins with a theoretical framework discussing De Roo’s planning theory, including the four spatial planning approaches referred to in this study, key concepts and the integral trade-off between safety and accessibility (De Roo & Porter, 2006). In addition, the conceptual model and hypothesis of this study are outlined in this section. Then, the methodology section discusses the research strategy, data collection methods and data analysis methods of this study. The analytical framework for the results of media and document analysis is also presented here. Then, in the results section, the results of the media and document analysis for both the five national and international example cases of infrastructure problems related to safety and accessibility and the N34 case study are discussed through the lens of the theory and literature discussed in the theoretical framework. In addition, this section presents the results of the comparative analysis between the five national and international case studies and the N34 case study based on the problems, solutions, effects of implementing the

solutions on safety and accessibility, stakeholders involved and their roles, the planning process and the spatial planning approach identified for each case study. Then, the conclusion and discussion section summarizes the main points, answers the research questions and draws conclusions on which direction is the most appropriate for the N34 project in terms of the spatial planning approach to be used by the stakeholders in the planning process to affect the road design in such a way that it improves safety and accessibility faster and more effectively. This section also discusses the possible implications of this study and refutes some rival explanations. Finally, the reflection section reflects on the process, the results and the strengths and weaknesses of this paper. This section also provides recommendations for future research.

2. Theoretical Framework

2.1 Planning Theory

Given the research aim in section 1, a planning theory model of De Roo is used (De Roo & Porter, 2006). This theory explains four spatial planning approaches on which projects dealing with planning problems can base their planning process on to arrive at a final design. These four approaches help determining which type of spatial planning approach is the most appropriate to base the planning process on to arrive at the most suitable road design for dealing with the trade-off between the two factors in the infrastructure problem presented in this study. This study assumes that spatial planning approaches are an epistemological way of considering developments in planning which can be applied to planning processes of infrastructure projects in the real world.

De Roo recognises that in planning theory, four specific approaches to planning are identified as the basis of the model: technical approach, scenario approach, actor consulting and communicative approach (De Roo & Porter, 2006). The technical (A) and communicative approaches (C) are respectively at the left and right ends of the model, while the scenario approach (B) and actor consulting (D) are located towards the middle (Figure 2).

In addition, two different sides in the model are identified. The left, dark-grey side represents an object-oriented focus of planning which focuses on the content and goals whereas the right, light-grey side represents an inter-subject oriented focus which focuses on the interaction between actors (Figure 2). This suggests that the technical and scenario approaches focus more on the content and goals of a planning project, while the communicative approach and actor consultation focus more on the interaction between different actors in the planning process (De Roo & Porter, 2006).

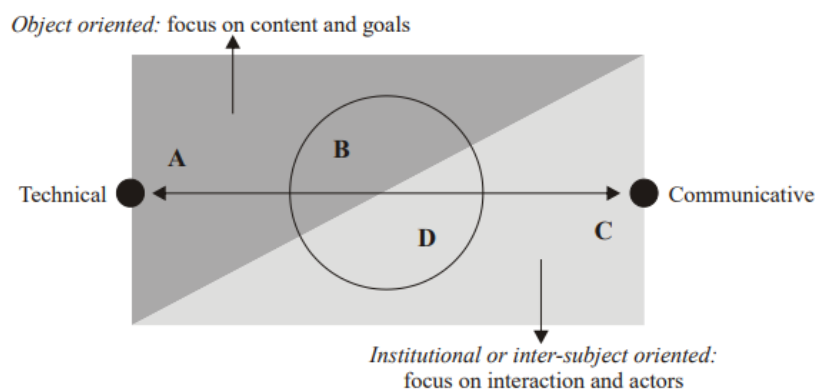


Figure 2: Planning theory model of De Roo (De Roo & Porter, 2006)

As the scenario approach (B) and actor consulting (D) are located somewhere in between the technical and communicative approaches, the latter two approaches are discussed first. At the left extremity of the model, the technical approach (A) is located and on the opposite extremity the communicative approach is located (C).

The technical approach focuses most of all approaches on the content and goal(s) of a planning situation. It seeks to maximise goal(s) and functionalism by means of blue-print planning (De Roo, 2010). Therefore, it is considered to be useful for simple planning issues in which solutions are drawn based on facts (De Roo & Porter, 2006). This makes that in this approach “certainty and control are present, due to the direct relationship between cause and effect, making it fairly easy for a single actor – normally the national government or the local authority – to decide how to plan and act” (De Roo & Porter, 2006, p.111). As a single actor can determine the decisions to be taken in the planning process with this approach, this technical approach is considered top-down. However, a critical attitude

towards this approach has emerged over the years as some scholars (Burby, 2003; Healey, 1992) claim that using a technical approach in planning will lead to disappointing results of planning processes and will lead to failing of the planning process if key information is missing (De Roo, 2010; De Roo & Porter, 2006).

On the contrary of the model, the communicative approach to planning focuses strongly on the actors and the interaction between those actors. The central idea of this approach is that all different actors involved in a planning project should engage in conversations in order to reach “consensus and commitment about the nature of the issues, how actions to tackle the issues can be taken, and by whom” (De Roo & Porter, 2006, p.112). As the focus is on interaction between different actors, network planning emerges. This network planning is organized bottom-up and makes the communicative approach suitable for highly complex planning issues. As a result, this approach is considered uncertain, as it requires equal consideration of the interests and values of all different actors. Since an action plan is produced based on the discussions among and agreements between the actors, an optimal process but not a maximum result is reached when applying this approach (De Roo & Porter, 2006; De Roo, 2010). As well as with the technical approach, this communicative approach also encounters criticisms as critics argue that this approach is “weak in explaining power relations in planning, due to a reliance on ‘power-free’ communicative ideals á la Habermas” (Westin, 2022, p.133). This reliance on ‘power-free’ communicative ideals is usually not feasible, as in reality there are often power differences between stakeholders, which is also demonstrated in this study. Moreover, other critics argue that by using a communicative approach, existing power relations are reinforced rather than transformed, meaning that ‘power-free’ communicative ideals can never be achieved as power differentials are increased when this approach is used (Purcell, 2009).

Only focussing on these two extremes for dealing with the trade-off between safety and accessibility in infrastructure is not enough. This is because these approaches are the “idealised types of planning, designed to handle issues rarely found in reality” meaning that a planning process cannot be based on these approaches to affect the road design, for dealing with the trade-off between safety and accessibility, for every infrastructure-related planning problem (De Roo & Porter, 2006, p.111; Van der Valk, 1999). Since the technical and communicative approaches are positioned at the left and right ends of the model, there are also planning approaches that are somewhere in between these extremes. These ‘in-between’ approaches always contain aspects of both the technical and communicative approach. Since the vast majority of problems cannot be solved by using a planning process that is purely based on a technical or communicative approach, almost all planning approaches used in planning processes to solve planning problems contain a combination of object-oriented and inter-subject-oriented aspects (De Roo & Porter, 2006). However, the degree to which the planning approach contains aspects of both the technical or communicative approach depends on its position in the model (De Roo, 2010). The two ‘in-between’ approaches in De Roo’s planning theory model that stakeholders can potentially use in planning processes to affect the road design for dealing with the trade-off between road safety and accessibility, are the scenario approach (B) and actor-consulting (D).

The scenario approach aims to provide, based on predefined issues, several scenarios for solving a planning problem. The most useful scenario for solving a problem is chosen by the stakeholders involved in the planning process and converted into a plan that is implemented. This approach is positioned close to the middle of the model but on the dark grey side which means that this approach is more focussed on the content and goals and thus still takes the planning problem as predefined (Figure 2) (De Roo & Porter, 2006). However, because De Roo did not place it relatively close to the technical extreme of the model, this approach also includes some communicative aspects. This is because the scenario approach tries to respond to the weakness of the technical approach that if key

information is missing when using this planning approach, the process will fail (De Roo & Porter, 2006). Compared to the technical approach, this approach thus accepts that various routes in the planning process, instead of one route, leads to an outcome and this outcome is context-dependent even though there is a predefined problem. This also makes this approach using tactical progress reports instead of blueprint plans. Furthermore, a scenario approach does not accept uncertainty but “it is a response to the lack of certainty in planning” (De Roo & Porter, 2006, p.111). Since the scenario approach is situated, by De Roo, around the centre of the model (Figure 2), it is useful for complex planning issues which are issues that are neither completely certain nor completely uncertain, which are between order and chaos, and in which there is a varying balance between an object-oriented focus and an inter-subject oriented focus (De Roo & Porter, 2006).

The final approach present in the planning theory model is actor consulting. The aim of this approach is “to address the subjective nature of planning issues, to create a common understanding among actors, and to unravel underlying mechanisms that determine the actions of actors” (De Roo & Porter, 2006, p.137). Central in this approach are the desired, potential and actual contributions of the actors in the planning process. These will help planning authorities to better deal with the uncertainty created by the influences of the many present actors in the planning process. This will lead to more acceptable, certain, thoughtful and realistic planning outcomes. In addition, the approach helps fine-tuning the dynamic relationships between the stakeholders, parties and decision-makers involved which further helps tackling uncertainties (De Roo & Porter, 2006). This approach is, just as the scenario approach, close to the middle of the model and thus useful for complex planning issues. However, in contrast to the scenario approach, actor consulting is positioned on the light grey side of the model which means that this approach is more focussed on actors and interactions (Figure 2). The approach helps these actors understand the different aspects that emerge in the planning process, regarding their own actions or those of others (De Roo & Porter, 2006).

In real life, criteria are used to roughly identify which of these four approaches stakeholders are using in a planning process of a specific spatial planning case. One criterion for this is the number of stakeholders involved in decision-making. When a technical approach is used in a case, one stakeholder makes all decisions and when a communicative approach is used, a large number of stakeholders jointly make decisions (De Roo & Porter, 2006). This means that the number of stakeholders involved in decision-making decreases when using a more technical approach and increases when using a more communicative approach. The degree of influence the involved stakeholders have on the final plan is also important here. This is because in a communicative approach, all different stakeholder interests are considered equally, whereas in a transition to a more technical approach, these interests are increasingly less considered and incorporated into the final plan. This also depends on the number of opportunities stakeholders have to share their views and interests about the project, because the more communicative the approach in a planning process is, the more opportunities stakeholders to share their interests. When moving to a technical approach, stakeholders are given fewer and fewer opportunities to share their interests. This also means that when a technical approach is used, the one stakeholder making the decisions has complete control over the planning process, as other stakeholders are not given the opportunity to have a say in the plan. This degree of control decreases when moving on to the communicative approach (De Roo & Porter, 2006). Since stakeholders have the most opportunities to share their interests in a plan when a communicative approach is used, the focus of using this approach is on seeking consensus on a final plan based on shared interests and interactions between stakeholders. With an increasingly technical approach, the stakeholders focus increasingly on content and achieving goals and less on interactions and shared interests between stakeholders (De Roo & Porter, 2006).

Moreover, with a technical approach, one stakeholder makes all decisions and thus there will be one final blueprint plan in which fixed goals are aimed for and a maximum result is achieved (De Roo, 2003). However, with a communicative approach network planning is coming into play. This means that stakeholders involved in the planning process become influential in managing the spatial planning process (De Roo, 2003). This also means that a plan is adjusted repeatedly based on the different views and interests of the stakeholders involved and that the final plan is based on an optimal process rather than a maximum outcome and on balancing different stakeholder interests. In both communicative and technical approaches, only one plan is presented that is either fixed (technical approach) or modified until a balanced final plan is achieved (communicative approach). In a scenario approach, however, multiple plans are presented initially and the most useful plan is selected and partially modified by the stakeholders into a final plan (De Roo & Porter, 2006). Other identification criteria, such as the time required to complete a planning process, are not included in this list because they do not always reflect the spatial planning approach used. Taking the time criterion as an example, the size of a project also plays a major role in the time it takes to complete the planning process, meaning that the general perception that using a more communicative approach in the planning process requires more time to complete it than using a more technical approach does not always apply. This is because a process of a small-scale project using a more communicative approach may be completed earlier than a large-scale project using a more technical approach.

Identification Criteria

1. Number of stakeholders involved in decision-making
2. The degree of influence of the stakeholders on decision-making
3. The number of opportunities that stakeholders have to share their views and interests
4. The degree of control the stakeholders have over the planning process
5. The focus of the planning process
6. The number of plans submitted
7. The number of times a submitted plan is modified

Table 1: Overview of the identification criteria to identify the spatial planning approach used by stakeholders in a planning process of a specific spatial planning case

These discussed criteria are summarised in Table 1 and, together with De Roo's theory, will help identify the spatial planning approaches used in the planning processes of the five national and international cases and in the N34 case study discussed in section 4. Table 4 summarises the spatial planning approaches identified in the planning processes of the national and international cases presented in section 4.1. Section 4.2.5 discusses which spatial planning approach has been identified in the N34 case study.

2.2 Key Concepts of Infrastructure Planning

Next to the spatial planning approaches explained by using De Roo's planning theory model the concepts "safety", "accessibility", "stakeholders" and "power" constitute the relevant concepts of this research. To become more familiar with these concepts in order to better understand this study and its results, these four concepts will be defined:

This study focuses on an infrastructure problem and therefore the concepts of safety and accessibility apply to traffic. Hence, these concepts are considered road/traffic safety and road/transport accessibility. In this context, safety is a measure of the number of traffic accidents/incidents occurring on a road (Teodorović & Janić, 2017). As a result, improving safety refers to taking measures in such a way that improvements are made regarding the maintenance, management and control of a road in order to minimize the number of traffic accidents/incidents and consequently the number of injuries

and deaths (Teodorović & Janić, 2017). Accessibility in infrastructure, on the other hand, refers to the ease with which drivers can reach a destination such as public services and job locations (Farber & Fu, 2017). When the level of accessibility is high, often at central locations according to Ewing & Dumbaugh (2009), the traffic flow is better and thus will a destination be easier to reach in terms of e.g. time, effort and costs. In a situation of low accessibility, the opposite is true. Accordingly, the level of accessibility can have an impact on several aspects such as economic and social ones (Farber & Fu, 2017).

Individuals, groups or organizations that are related to a spatial planning project, e.g. if they live nearby, are not by definition stakeholders in that project. However, once they start to have an interest in the project and its outcomes, are affected by it or try to affect the project and its outcomes themselves, they become stakeholders (Heiden & Saia, 2021; Doloi, 2012). These stakeholders can be both supportive towards the project and its goals or oppose it. To tackle this dichotomy, these stakeholders, commonly with different interests, can often engage in a project and work together in order to reach common goals (Heiden & Saia, 2021). If stakeholders are not allowed to engage in a project to reach common goals, this can generate stakeholder actions against the project (Vuorinen & Martinsuo, 2018).

The goals that stakeholders reach depends on the power differences between the different stakeholders engaging in the project. Power, in this context, refers to the capability to change the definition of the planning situation and to influence the behaviour of other engaging stakeholders (Wynn et al., 2021). This means that the more power a stakeholder has, compared to other stakeholders in the project, the more this stakeholder can change the planning situation to his interests and the more he can influence other stakeholders' interests to his interest. These power differences during stakeholder engagement will ultimately also influence which spatial planning approach will be identified in a planning process based on De Roo's planning theory and on the identification criteria of spatial planning approaches (section 2.1 & Table 1). In this way, these power differences also affect the road design for dealing with the trade-off between road safety and accessibility.

2.3 Integral trade-off between safety and accessibility

In infrastructure, safety and accessibility are interrelated: a change in the level of safety or accessibility, for example due to changes in road design, often causes an inverse change in the level of the other. This means that the factors of safety and accessibility are interconnected in such a way that improving the level of one factor often comes at the expense of the level of the other. In this study, this is referred to as an integral trade-off. However, as both factors are important for a well-functioning infrastructure, they need to be balanced to some extent. Therefore, improvements in the level of one of the factors may not come at the expense of the level of the other. In other words, in case an increase in the level of one factor causes a reduction in the level of the other, the reducing factor may not be reduced to below a certain minimum standard as this will cause problems and disruptions. A change in one of the factors must therefore be limited to a certain maximum in order for the other factor not to exceed its maximum change. This balance ensures that both factors remain effective, keeping the infrastructure functioning well.

In infrastructure planning, this trade-off causes choices to be made and questions to be answered: Which of the two factors is considered most important and is thus prioritised over the other in the trade-off? Does the improvement of one of the factors lead to the improvement of a whole infrastructure problem? Or does the improvement of this factor cause the other to become inadequate in the infrastructure situation? This section 2.3 discusses the relationship and the trade-off between safety and accessibility which is summarized in Table 2. Moreover, factors associated with this relationship are discussed.

2.3.1 The relationship between traffic safety and accessibility

According to Kristoffersson et al. (2024), local stakeholders perceived lowering the speed limit to promote road safety as a threat on major roads with a lack of directional separation of traffic in Sweden. This is because although traffic safety on the roads increased due to the speed limit reduction, it leads to a reduction in accessibility, indicating an integral trade-off between the concepts. As a result, “there is a need to balance traffic safety goals and accessibility goals” (Kristoffersson et al., 2024, p.2). However, speed limit reduction does not always lead to a reduction in accessibility, as it can also increase accessibility by reducing road congestion. This is argued by Gressai et al. (2021) in their study on the effects of speed limit reduction on traffic parameters such as traffic congestion and capacity in Hungary. Similarly to Kristoffersson et al. (2024), Svensson et al. (2013) also conducted a study on speed limits in Sweden. In this study, there is again a tension between safety and accessibility indicated as local and regional actors have conflicting interests about whether the speed limit should be increased to improve accessibility and economic growth or decreased to promote traffic safety (Svensson et al., 2013). They found that the commitment to higher speeds and resistance to lowering speed limits by the most powerful and influential actors was stronger. This suggests that, in this case, accessibility is prioritized in the regional arena over traffic safety, opposing policy efforts to promote national traffic safety as higher speed limits are expected to cause a higher rate of traffic accidents (Svensson et al., 2013). In an opposite perspective to Kristoffersson et al. (2024), Svensson et al. (2013) thus found that an increase in accessibility decreases road safety.

Other studies that focused on different geographical locations found similar results on the trade-off between safety and accessibility. Dumbaugh & Rae (2009) argued, in their study on the relationship between community design and traffic safety in the United States, that the tension between speed and access reduces the traffic safety. Applying an access management strategy is mentioned as one of the solutions to solve this tension as this strategy reduces the access and with that the number of crashes (Dumbaugh & Rae, 2009). Just as Kristoffersson et al. (2024), this implies that a reduction in accessibility results in higher levels of traffic safety. Gaca & Kieć (2012) executed a study on the impact of access control, road accessibility and road surroundings development on traffic safety in Poland and took an opposite perspective to Dumbaugh & Rae (2009). They found that an increase in the density of both intersections and access points, which are indicated as main variables describing accessibility, leads to an increase in the number of traffic accidents (Gaca & Kieć, 2012). This means their findings are consistent with those of Svensson et al. (2013) as they also found that an increase in road accessibility results in a decrease in traffic safety. The results of the papers described above thus show that there is an inverse relationship between traffic safety and accessibility in some cases. This means that when the level of one factor increases, the other decreases and the other way around.

Nonetheless, there are also situations where there is no inverse relationship between road safety and accessibility. This is showed by Ewing & Dumbaugh (2009) in their paper on the relationship between the built environment, determining mobility and road accessibility, and traffic safety in the United States. Based on the so-called “Vehicle Miles Travelled (VMT)” with regard to destination accessibility, they found that areas with high accessibility have significantly lower rates of traffic injuries and fatalities. This is because areas with high accessibility have a higher density of persons, jobs and houses which leads to both a lower VMT per capita and lower average traffic speeds declining the traffic fatality rate (Ewing & Dumbaugh, 2009). In other words, a higher level of accessibility leads to increases in traffic safety. Najaf et al. (2018) found similar results in their study on the impact of urban form characteristics, which is the physical configuration affecting transportation, on traffic safety. Increasing the accessibility in the urban form was mentioned as one of the crucial elements to create higher levels of safety in the traffic environment (Najaf et al., 2018). However, a study on the effect of traffic congestion on road accidents in the United Kingdom by Wang et al. (2013) found opposite results to

these studies. They found that roads with high levels of traffic congestions, indicating low levels of accessibility, are experiencing more accidents in which drivers are killed or seriously injured (Wang et al., 2013). This finding is in line with the study of Kononov et al. (2008), who found that in the United States the number of traffic accidents in which drivers are killed or injured increase with congestion. In both cases, decreasing levels of accessibility, caused by traffic congestions, thus decreases the level of traffic safety. In these cases there is no longer a trade-off between safety and accessibility as the level of both factors increase or decrease at the same time. However, since these situations could possibly happen in infrastructure situations they are considered important to include in this section.

It is also possible that in the trade-off between safety and accessibility, an increase or decrease in the level of one factor does not lead to a change in the other. Choi & Ewing (2021) show this in their study on the effect of street network design on congestion levels and road safety in neighbourhoods in the United States. They found that neighbourhoods with better network patterns, i.e. those with denser and more connected networks, have lower levels of congestion, indicating higher levels of accessibility. Even though these denser and better connected neighbourhoods have lower congestion levels, crash rates do not increase or decrease. This indicates that the level of road safety remains the same despite the increase in accessibility (Choi & Ewing, 2021). In addition, Choi & Ewing (2021) found that the decrease in congestion in denser and more connected neighbourhoods leads some drivers to drive at higher speeds during rush hour. Although their driving speeds are higher, they again found no evidence of higher crash rates in these better-connected neighbourhoods.

Based on the discussed literature presented in this section, Table 2 provides a systematic overview summarizing the literature discussed and their results. This table summarises for each paper mentioned in this section the author(s), the title of the study, the situation of the study location including any changes that took place during the study and the effects of the situation or change on both road safety and accessibility. For both road safety and accessibility, "+" indicates an increase in the level of the factor, "0" indicates no change, "-" indicates a decrease in the level of the factor and "UNKNOWN" indicates that the effects on safety and/or accessibility have not been included in the study and are therefore unknown.

Author(s)	Title of the study	Situation (incl. changes)	Effect on safety	Effect on accessibility
Kristofferson et al. (2023)	<i>Traffic safety versus accessibility: Investigating resistance against speed limit reductions</i>	Speed limit reduction	+	-
Gressai et al. (2024)	<i>Investigating the impacts of urban speed limit reduction through microscopic traffic simulation</i>	Speed limit reduction	UNKNOWN	+
Svensson et al. (2013)	<i>The politics of speed – local and regional actors' views on speed limits, traffic safety and mobility in Sweden</i>	Speed limit increase	-	+
Dumbaugh & Rae (2009)	<i>Safe Urban Form: Revisiting the Relationship Between Community Design and Traffic Safety</i>	Changing community design by applying an access management strategy	+	-
Gaca & Kieć (2012)	<i>Quantification of impacts of road accessibility and selected factors of road surroundings development on road traffic safety</i>	Increase in the density/number of both intersections and access points	-	+
Ewing & Dumbaugh (2009)	<i>The Built Environment and Traffic Safety: A Review of Empirical Evidence</i>	High density of persons, jobs and houses leads to both a lower VMT (Vehicle Miles Travelled) per capita and lower average traffic speeds	+	+
Najaf et al. (2018)	<i>City-level urban form and traffic safety: A structural equation modelling analysis of direct and indirect effects</i>	Improving urban form	+	+
Wang et al. (2013)	<i>A spatio-temporal analysis of the impact of congestion on traffic safety on major roads in the UK</i>	Road with high levels of traffic congestion	-	-
Kononov et al. (2008)	<i>Relationships between Safety and Both Congestion and Number of Lanes on Urban Freeways</i>	Traffic congestions	-	-
Choi & Ewing (2021)	<i>Effect of street network design on traffic congestion and traffic safety</i>	Neighbourhoods with good network patterns, i.e. those with denser and more connected networks	0	+

Table 2: Overview of the case studies and literature presented in section 2.3.1

2.3.2 Factors relating to the trade-off between traffic safety and accessibility

The trade-off between traffic safety and accessibility is influenced by several factors related to infrastructure planning. Not only the road design, its physical elements and traffic regulations have an important influence on both aspects, the available budget of an infrastructure project and the several views, interests and powers of the stakeholders involved also play an important role here.

The traffic regulations that apply on a certain road are affecting the traffic safety and accessibility. One of the regulations that has a major influence on this and that is predominantly discussed in literature is the maximum speed. Kristoffersson et al. (2024) and Svensson et al. (2013) both discussed this aspect in their papers on the effect of adapting the speed limit on both factors in Sweden. Whereas Kristoffersson et al. (2024) concluded that lowering the maximum speed enhances traffic safety and reduces the accessibility, Svensson et al. (2013) concluded the opposite when increasing the maximum speed. Nitzsche & Tucharaktschiew (2013) found similar results as Kristoffersson et al. (2024) in their study on the efficiency of speed limits: reducing speed limits leads to a reduction in accident costs but it has several negative economic effects such as lower labour supply and income. Based on the definition of accessibility by Farber & Fu (2017) used in this study, these economic “costs” of reducing the speed limits implies a reduction in accessibility. However, since the reduction in speed limits lowers the accident costs, the physical impact of a road accident is assumed to be lower (Nitzsche & Tucharaktschiew, 2013). This means that the number of deaths and injuries of traffic accidents are reduced by the speed limits, referring to an increase in traffic safety. So in terms of speed there often seems to be a real trade-off between the factors as by an increase of one factor, due to a change in the speed limit, the other decreases.

The spatial design of roads and its surroundings are widely known for influencing the trade-off between traffic safety and accessibility (Choi & Ewing, 2021). The focus here is on elements that are present at arterial roadways and not roads in general because the study focuses on these arterial roadways. Dumbaugh & Rae (2009) discuss several spatial design elements such as the width and straightness of roads, the presence of commercial and retail locations surrounding arterial roadways and roundabouts that are affecting safety and accessibility. Wider and straighter roads reduce the number of crashes as they lengthen the sight distance for drivers which makes them better identifying and responding to hazards and thus improves the traffic safety (Dumbaugh & Rae, 2009). However, this lengthening of the sight distance makes drivers to travel at higher speeds which in turn does increase accessibility but offsets the improvement in safety (Aschenbrenner & Biehl, 1994). In addition, commercial and retail locations located along arterial roadways, such as provincial roads, and connected with these roadways makes these locations highly accessible. Although these locations are highly accessible, this connection between roadways and the commercial and retail locations increases the number of accidents as lower-speed drivers turning into and out the driveways are coming into conflict with the higher-speed through-moving traffic (Dumbaugh & Rae, 2009). On the other hand, disconnecting these roadways with the commercial and retail locations improves the traffic safety but reduces the accessibility. Roundabouts also have proven to be effective on improving traffic safety. Roundabouts also appear to be helpful for balancing the trade-off between traffic safety and accessibility (Dumbaugh & Rae, 2009).

Moreover, the higher the number of intersections present on a road, the higher the number of traffic accidents (Gaca & Kieć, 2012). However, intersections are indicated as main variables describing accessibility (Gaca & Kieć, 2012). This means that a higher number of intersections increases the accessibility even though it reduces the traffic safety. A final physical element important to mention are crash barriers. According to Carlsson (2009), crash barriers are one of the most effective methods of protecting motorists from injuries or fatalities which enhance traffic safety. This is because they prevent vehicles from leaving the roadway after a crash and by that from facing hazardous elements

such as water and fixed objects (Ren & Vesenjok, 2005). In addition, crash barriers located in the middle of the road, between two lanes with opposite directions, prevent vehicles from reaching the opposite side of the road causing an even bigger crash (Antonson et al., 2013). Furthermore, at roads where crash barriers were established, the driving speeds also increased slightly (Antonson et al., 2013). This is again beneficial for the accessibility, however, the safety benefits of crash barriers are, in this way, partially offset (Aschenbrenner & Biehl, 1994).

Infrastructure projects in which a road design is implemented or in which a road is maintained involves costs. Therefore, the budget available for an infrastructure project also affects the trade-off between safety and accessibility. A lack of budget can have “serious consequences such as user costs associated with reduced functionality of roadway systems” (Nishijima & Faber, 2009, p.41). In other words, the motorists using the infrastructure can experience deficient safety and accessibility conditions due to the poor functioning and/or maintenance of the roadway system caused by the lack of budget. These deficient conditions can be applicable to both safety and accessibility, however, it is also possible that due to the lack of budget one of the factors is prioritized over the other and thus invested in with the available money. In this way, there is a trade-off between safety and accessibility, based on the available budget, in which it is determined which of these two factors is considered most important to improve or maintain. In reality, decision-makers often “request more budget than the expected costs in order to ensure successful management of the project” (Nishijima & Faber, 2009, p.42). As the “optimal budgets are consistent with the adverse consequences of possible insufficient budgets” (Nishijima & Faber, 2009, p.47), it means that if there is sufficient budget available, the roadway systems will experience an increased functionality which can provide both safety and accessibility benefits.

Decisions on infrastructure projects, road designs and how the available budget is spent also involve stakeholder engagement. The engaging stakeholders all have their own interests in a project that can be quite different from stakeholder to stakeholder (Doloi, 2012). This means that the one stakeholder may prioritize the safety outcomes of an infrastructure project whereas the other may prioritize the accessibility outcomes. A final decision on an infrastructure project is often based on those interests of the engaging stakeholders. However, if their interests are conflicting and they seek to preserve their established interests, power will be used by the stakeholders to reach a final decision (Ninan et al., 2019). As some stakeholders have more power than others in a project, there are power differences between the stakeholders what makes that the final outcome is not going to be an equal balance between the conflicting interests of all stakeholders. This is because the level of power a stakeholder has determines the amount of influence a stakeholder has on a project. The most powerful stakeholders are the most influential on the decision-making in the project (Doloi, 2012). This is because when a powerful stakeholder makes a decision that influences the project, sometimes “the projects could do little more than adapt to the situation” (Vuorinen & Martinsuo, 2018, p.10). As a result, such unequal power distributions in infrastructure projects also influence the trade-off between safety and accessibility. This is because if the most powerful stakeholders prefer, for example, the road safety to be largely improved, this is likely to be the main focus of the project which may come at the expense of the accessibility.

There are more factors affecting the trade-off between traffic safety and accessibility such as the rational behaviour of individuals, their driving skills and the quality of vehicles. However, as this study relates to spatial planning, the concepts discussed in this section are considered the most relevant.

The planning theory of De Roo, the key concepts of this research and the integral trade-off between safety and accessibility, including an overview of the findings of papers discussing this trade-off, have been introduced in this section 2. These aspects and the relationships between them are visualised in the conceptual model of section 2.4.

2.4 Conceptual Model

The conceptual model of this study is presented as follows (Figure 3):

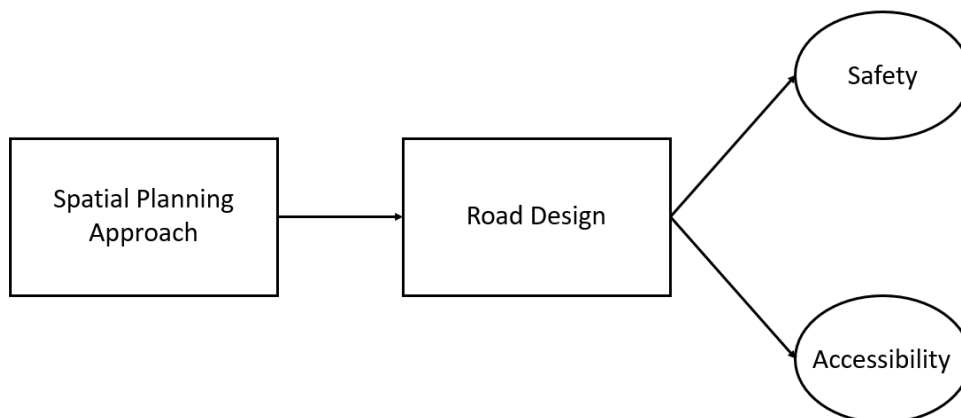


Figure 3: Conceptual Model (made by author, 2024)

This conceptual model shows that there is a relationship between a spatial planning approach and a road design. This means that the outcome of the road design is influenced by the choice of the spatial planning approach that stakeholders use in a planning process. In this way, a spatial planning approach also has an indirect effect on the trade-off between safety and accessibility, as the outcome of the road design determines how this trade-off is dealt with and thus how safety and accessibility are weighed against each other. The method for operationalising the relationship between spatial planning approach and road design is discussed in the methodology section (section 3).

2.5 Hypothesis

Based on the conceptual model (Figure 3), this research is expected to show that, by guiding a planning process, a spatial planning approach affects the road design and that the road design affects the trade-off between safety and accessibility.

3. Methodology

3.1 Research Strategy

Based on the research questions, a case study research strategy was chosen in this study to reach the research aim presented in section 1. The central case study is dealing with the trade-off between safety and accessibility of provincial roads. The N34 provincial road section in the municipality of Aa & Hunze will serve as the unit of analysis of this research. The case study approach is used to examine this contemporary phenomenon in a real-life context to gain a multidimensional, in-depth understanding of it (Yin, 2003; Crowe et al., 2011). Although the unit of analysis in this case study has a specific and unique context and location, it is considered a typical case as the findings of this study are not only applicable to the N34 road section in the municipality of Aa & Hunze, but the findings can also be generalised and then replicated by stakeholders in other similar planning project to solve safety and accessibility problems (Crowe et al., 2011).

This study combines the research methods media analysis, document analysis and comparative analysis with a literature review on the topic and on the specific case to answer the main research question. The media and document analysis are conducted to collect data from media articles, published reports and documents on cases of national and international infrastructure problems, other than the N34, where both safety and accessibility needed to be improved and where there was a trade-off between these factors. The criteria on which these cases have been selected are discussed in section 3.2.1. Once the data on these cases were collected, they have also been analysed through both media and document analyses. The main results of these analyses on the problems, solutions, stakeholders involved and their roles, the planning process and the impacts of problem solving on both safety and accessibility in these infrastructure cases are presented in section 4.1. Subsequently, for each of the national and international infrastructure case studies presented in 4.1, these aspects have been related to the descriptions of the four spatial planning approaches included in De Roo's planning theory and to the identification criteria for these approaches (Table 1), both described in section 2.1, to identify which spatial planning approach has been used by the stakeholders in the planning process of each case study (De Roo & Porter, 2006). The spatial planning approach identified for each case may either be one of the four approaches discussed in section 2.1, or an approach that is somewhere 'in between' two of these approaches. The results presented in section 4.1, including the identified spatial planning approach used by the stakeholders in the planning process of each case, are summarized using the analytical framework presented in Table 3.

Case + Location	Problem(s)	Stakeholders involved in Planning Process	Spatial Planning Approach <i>(identified by relating the results of the media and document analyses (section 4.1) to the planning theory and identification criteria (section 2.1))</i>	Solution(s)	Effect on Safety	Effect on Accessibility

Table 3: Analytical framework for the results of the media and document analysis presented in section 4.1

Moreover, both a media and document analysis have been conducted on the N34 infrastructure case in the municipality of Aa & Hunze itself to gather data from media articles, published reports and

documents on this case as well. This data was also analysed by using a media and document analysis. The focus of this analysis was on filtering out key information about the current situation of the N34 section in Aa & Hunze, its trade-off between road safety and accessibility, the development history of the N34 section and the current status of the project to improve the safety and accessibility of this road section. Since the Gieten traffic junction is located in the middle of this road section and the safety and accessibility situation at this location is particularly poor, the traffic junction plays a prominent role in the media and document analysis and in section 4.2 where the main results derived from the analysis have been presented. As with the other examples of national and international infrastructure problems, by relating the results (section 4.2) to the four spatial planning approaches discussed by De Roo & Porter (2006) and the criteria for identifying which planning approach has been used in a specific case (section 2.1 & Table 1), the spatial planning approach used by the stakeholders in the planning process of the N34 project has been identified.

The results of the media and document analyses presented in the sections 4.1 and 4.2 have been compared in section 5 through a comparative analysis. In this way, the results of the selected, previously solved national and international infrastructure problems, including the solutions to these problems, the associated planning process and spatial planning approach used, the stakeholders involved and the effects of problem-solving on both safety and accessibility for each case are compared to these aspects of the N34 project allowing the identification of differences and similarities. Based on these identified differences and similarities, conclusions are drawn in section 6 on the most suitable direction the N34 project can take in terms of the spatial planning approach to be used by the stakeholders in the planning process to affect road design in such a way that it improves safety and accessibility more quickly and effectively.

3.2 Methods of Data Collection

The data in this study are collected through three methods of data collection: media analysis, document analysis and observations. Based on this data collected, the analytical framework of Table 3 could be fully completed in a verifiable and reproducible manner using the 27 sources available in Appendices A1 and B1. This means that sufficient data was collected using these three methods and that other methods of data collection, such as interviews, were not necessary. In addition, a literature review on the topic has been conducted to collect additional information:

3.2.1 Media analysis

A media analysis has been conducted to collect data from published articles in the media on the problems, solutions, stakeholders involved and their roles, planning processes, and on the effects of implementing the solutions on both safety and accessibility of concrete national and international examples of infrastructure problems requiring a trade-off between safety and accessibility. The same has been done for the N34 case, however, no final solution has been presented so far for this case. Therefore, both the solutions and the effects of implementing the solutions on both safety and accessibility are not included for the N34 project. For the case examples of national and international infrastructure problems, the Google search engine has been used in which combinations of keywords have been entered, in both Dutch and English, regarding infrastructure problems involving safety and accessibility, its solutions, stakeholders involved and the planning process. These combinations of keywords have been entered to find information to construct an overview of specific national or international infrastructure cases involving safety and accessibility problems which are suitable for comparison with the N34 project. To select information suitable for comparison with the N34 project, in the Google search engine, only examples of infrastructure cases were selected that met the following criteria: the cases had to be similar to the N34 in terms of road type (provincial road), trade-off between safety and accessibility, and the goal of improving both road factors. In addition, only real-life

infrastructure projects implemented in a Western country were selected. In order for these project examples to be selected, they had to be completed at the time of writing this article and the results and associated planning process, including the roles of the stakeholders involved and the spatial planning approach used, had to be known or identifiable.

After collecting media articles on infrastructure projects based on the criteria described in the previous paragraph, a total of five examples of infrastructure projects that matched these criteria were selected: the Vechtdalverbinding and the N261 provincial road in the Netherlands, the L558 that connects Germany and the Netherlands, the A590 in the United Kingdom and the Sea-to-Sky highway in Canada (section 4.1). A total of two national, two international and one case with both national and international components were thus selected. Despite the fact that only five cases were selected in this study, it provides insights into the most suitable direction the N34 case study can take in terms of the spatial planning approach to be used by the stakeholders in the planning process to affect the road design in such a way that it improves safety and accessibility faster and more effectively. Therefore, the total of five case studies is considered sufficient. In the collection of the media articles on these five cases were articles that were published by national, regional and even local media, such as by 1Achterhoek and De Gelderlander. Based on these collected media articles, an analysis (section 3.3.1) has been carried out to select the data from these collected sources that are useful for presentation in section 4.1.

Furthermore, media articles about the N34 case in the municipality of Aa & Hunze were collected using the Google search engine. The focus of this search was on media items that wrote about its history, current situation, about the safety and accessibility situation of this N34 section and on the current status of the N34 project. Accordingly, these topics were entered in the Google search engine and linked to the N34 by entering e.g. “history of the N34” and “current situation of the N34”. This resulted in a collection of mainly regional media articles from, for example, RTV Drenthe. In addition, some articles from local media about the case were also collected. The data from these collected articles were once again analysed (section 3.3.1) and, if deemed relevant, presented in section 4.2. An overview of all media articles used in section 4 to write the analysis for both the national and international cases and the N34 case is provided in Appendix A.

3.2.2 Document Analysis

After the data collection by means of the media analysis, a document analysis has been carried out to collect additional data from published documents and reports on the five examples of national and international infrastructure problems, their solutions, planning processes, stakeholders involved, their roles and the effects of implementing the solutions on both safety and accessibility of these cases. In addition, additional data on the N34 project from reports and documents on the problem, stakeholders involved and planning process has been collected as well. As with the media analysis, the Google search engine has been used and the same combinations of keywords has been entered to find the reports and documents. However, since the five national and international cases with infrastructure problems were already selected by means of the media analysis, the combinations of keywords entered in the Google search engine has been supplemented by entering the specific case e.g. by adding “Vechtdalverbinding” or “Sea-to-Sky Highway” next to the combination of keywords. In this way, documents and reports on the five cases have been collected, in particular from national and regional authorities such as from the British Highways Agency and the Provinces of Overijssel and Noord-Brabant. These collected documents and reports has also been included in the analysis (section 3.3.1) to select data useful for the presentation of the results in section 4.1.

For the N34 project, the Google search engine has also been used to collect documents and reports. Just as in the media analysis, topics about which information had to be found, such as history and

current situation, were entered in the search bar after which “N34” was added to make the search more specific. Besides the media articles collected through the media analysis, this also resulted in a collection of reports and documents published mainly by the Province of Drenthe. The data included in the collected documents and reports have been analysed (section 3.3.1) and, if deemed relevant, presented in section 4.2. Appendix B lists all the documents and reports included in section 4 that contributed to the writing of the analysis for both the national and international cases and the N34 case study.

3.2.3 Observations

For the N34 case study, on-site observations have been carried out to monitor the safety and accessibility situation of the N34 road section. These observations were made by driving over the Gieten traffic junction and its adjacent roads, on the north and south sides, during the morning rush hour, evening rush hour, afternoon rush hour and mid-morning and afternoon. By making observations while driving, the safety and accessibility events such as traffic flows, traffic congestions and dangerous traffic situations have been observed and experienced. In addition, other motorists' driving behaviour was observed, especially when entering the Gieten traffic junction. A full protocol for the observations including objectives, times and subjects of observation is provided in Appendix C.

As the collected findings from the observations correspond to the collected data from the media and document analysis, the findings from the observations are considered part of the data from the media articles, documents and reports. Accordingly, the findings from the observations were not analysed separately, as this would give the same results as the results from the media and document analysis (section 3.3.1 & section 4.2). Nevertheless, the observations confirmed that what is written in the media articles, reports and documents about the N34 case, as far as observed, corresponds to reality.

3.2.4 Ethical Considerations

This research uses publicly available documents and articles from reliable and acknowledged national and regional media and from government organisations. These media and government organisations have to follow ethical regulations when writing their documents and articles, otherwise they are not allowed to publish them. Since all the documents and articles used in this study were openly published by these media and government organisations, it is assumed that these publications comply with ethical considerations and that the data used in this study are thus ethically correct. No interviews were conducted in this study, which means that other ethical considerations are limited.

The author of this study is a commuter who frequently travels between Emmen and Groningen, using the N34 road section and Gieten traffic junction on a regular basis. For this reason, the author is highly interested in dealing with the trade-off between safety and accessibility as quickly and effectively as possible, as this will make his journeys less time-consuming and safer as well.

3.2.5 Literature Review

In the literature review of this study, existing academic articles on theory and the subject have been reviewed and the main findings of some of these articles were summarised (sections 2.1, 2.3 & Table 2). These results of the literature review of this study were applied to the results of the media and document analysis (section 4) to identify the spatial planning approach from theory used by the stakeholders in the planning process of each case presented. In addition, in the comparative analysis between the examples of national and international infrastructure problems and the N34 case study (section 5), findings from the literature review were related to and applied to this comparison. This was possible because both the findings of the literature review and the results of the media analysis address the trade-off between safety and accessibility in infrastructure and focus on a Western context only.

3.3 Methods of Data Analysis

In this study, the data collected from media articles, documents and reports have been analysed through a media and document analysis, which were also used to collect the data, and through a comparative analysis.

3.3.1 Media and document analysis

Both media and document analysis are not only data collection methods as described in section 3.2, the data collected from different media articles, documents and reports can also be evaluated and interpreted through a media and document analysis (Misirlis & Vlachopoulou, 2018). In other words, by using media and document analysis, not only are data collected, but the data collected are also analysed. The focus of these analyses is on data included in the articles, documents and reports that describe the problems regarding safety and accessibility for each national and international infrastructure case. In addition, the analyses focusses on the solutions implemented in each case to tackle the problems. As such, the analyses also focussed on selecting information on the final results and the impacts on safety and accessibility after implementing the solutions. In addition, for each of the five cases, it has been analysed how the planning process was structured throughout the project, which stakeholders were involved and what role(s) each stakeholder had in the planning process. This analysis is important to identify the spatial planning approach used in the planning process of each case.

The complementary and overlapping data from the different sources were combined for each case and used to describe each of the five different national and international examples of infrastructure problems and projects individually based on the aforementioned aspects: problems, solutions, stakeholders involved and their roles, planning process and the ultimate impact of implementing the project on safety and accessibility (section 4.1). Based on these aspects, the five cases described in section 4.1 are further summarized by using Table 3 (section 3.1) as an analytical framework. In this analytical framework, it has also been identified which spatial planning approach is used by the stakeholders in the planning process of each of the five cases by relating these aspects of each case to De Roo's theory on spatial planning approaches and the identification criteria for these approaches (section 2.1 & Table 1) (De Roo & Porter, 2006). The completed analytical framework of Table 3 can be found in section 4.1 labelled as Table 4.

Furthermore, the collected data from media articles, documents and reports about the N34 road section in the municipality of Aa & Hunze, which correspond with the results of the on-site observations, have been analysed. This analysis focused on selecting and categorising data based on the history of the N34 road section and its previous developments. In addition, data on the current safety and accessibility situation and on the current status of the development project of the N34 section including the Gieten traffic junction were selected. Based on the analysis findings on these individual categories, section 4.2 describes the history, previous developments, current situation of the N34 road section in terms of safety and accessibility and the current status of the project. As for the other five cases, for this case it has also been identified which spatial planning approach is used by the stakeholders in the planning process (section 4.2.5), by relating the analysis findings to De Roo's theory on spatial planning approaches and the identification criteria for these approaches (section 2.1 & Table 1) (De Roo & Porter, 2006).

3.3.2 Comparative Analysis

After describing both the national and international examples of infrastructure problems and the N34 case study, a comparative analysis has been conducted. In this comparative analysis, the five national and international cases (section 4.1) have been compared with the N34 case study (section 4.2). More specifically, the combination of conditions, i.e. the combination of planning process, stakeholders

involved and their roles, of the five cases that led to specific solutions for the identified problems and outcomes for both safety and accessibility have been compared with these conditions of the N34 case study and its outcomes so far (Hanckel et al., 2021). In addition, the identified spatial planning approaches in the planning process of each of the five cases have been compared with the spatial planning approach identified for the planning process of the N34 case. In this way, similarities, differences and patterns between the cases in terms of planning process, stakeholders involved and their roles, solutions to the problems, spatial planning approaches used, and effects of implementing the solutions on both safety and accessibility can be identified which will provide valuable insights into what does and does not work in developing safety and accessibility in infrastructure. The results of this comparative analysis are presented in section 5 to which the results of the literature review have been applied.

In this study, the identified spatial planning approach in combination with the road design and outcomes for safety and accessibility are especially important for each case. This is because the goal of each case is to reach an road design through which both safety and accessibility are improved which is influenced by and depends on the spatial planning approach that is used in the planning process of case. This means that when using a different spatial planning approach for the same case, the outcomes of the road design and thus of the safety and accessibility will be different. Based on the differences and similarities between the five cases and the N34 case in terms of the combination between the used spatial planning approach, the associated road design and outcomes for road safety and accessibility, conclusions are been drawn in section 6. These conclusions are drawn on the most appropriate direction the N34 project can take in terms of the spatial planning approach to be used by the stakeholders in the planning process to affect the road design in such a way that it improves safety and accessibility faster and more effectively. Since conclusions could be drawn on these aspects, this means that using a total of five cases to compare with the N34 case is considered sufficient in this study.

As the five cases, just as the N34 case, all meet the criteria discussed in section 3.2.1, this can provide valuable insights into which planning process, spatial planning approach and road design could potentially work for the N34 project. However, as all national and international cases presented in section 4.1 are context- and location-specific, the usefulness of adopting the planning processes, spatial planning approaches and road design elements of the cases that experienced safety and accessibility improvements is not guaranteed for the N34 case study. Nevertheless, these solutions, planning processes and approaches, including the involvement of stakeholders and their roles, which led to improvements in both road safety and accessibility, can be adopted by the N34 case as a guideline for how the N34 project can be executed to achieve a prosperous and successful outcome.

4. Analysis of Real-Life Infrastructure Problem Examples

4.1 Infrastructure Problems and Solutions in Western Countries

Both in the Netherlands and other Western countries, there are several infrastructure problems that are highlighted in the literature and media. This section presents the analysis of five such infrastructure problems that met the criteria discussed in section 3.2.1: the Vechtdalverbinding and the N261 provincial road in the Netherlands, the L558 between Germany and the Netherlands, the A590 in the United Kingdom and the Sea-to-Sky highway in Canada. As the analysis of these five cases leads to valuable insights and conclusions for the N34 case in terms of the planning process, spatial planning approach and road design to improve safety and accessibility, a total of five cases is considered sufficient in this study. These five cases with infrastructure problems are presented respectively in this section including several aspects such as their solutions and their associated planning process, including the stakeholders and their roles. These aspects and the effects of implementing the solutions on safety and accessibility are summarized in Table 4. In this table, the spatial planning approach used by the stakeholders in the planning process of each case is included as well which has been identified by relating the aspects summarized in Table 4 to De Roo's planning theory, including the four spatial planning approaches, and to the identification criteria for spatial planning approaches (section 2.1 & Table 1) (De Roo & Porter, 2006). The spatial planning approaches that can be identified for each case are the actor-consulting, technical, communicative and scenario approaches, discussed in section 2.1, or an approach that is somewhere in between two of these approaches.

4.1.1 Infrastructure Projects in the Netherlands

In the province of Overijssel, the Netherlands, three connected roads (N340, N377 and N48) that make up the "Vechtdalverbinding" have been improved on behalf of the province in recent years and will be further improved in the coming years. According to the Provincie Overijssel (2024b), this was necessary as the large number of motorists using these roads daily led to traffic congestion during rush hour. Besides the fact that this project improved the traffic flow and accessibility of these roads, road safety was also improved (Provincie Overijssel, 2024b; Koninklijke BAM Groep, 2022). The road safety was improved by replacing some dangerous intersections through the construction of roundabouts, flyovers and by creating a new road section that dips under the existing intersection. This also improved accessibility. In addition, some of the remaining intersections will be modified, by implementing new elements such as traffic lights and road barriers that contribute to improving road safety (Provincie Overijssel, 2024b). Moreover, some sections of these roads have been doubled, so that some sections now have two times two lanes, improving accessibility. Some sections of these roads have also been widened and provided with a separation between the two roads going in opposite directions to enhance road safety. On some road sections of the Vechtdalverbinding, the speed limit has also been lowered which contributes to improving safety (Provincie Overijssel, 2024a). However, the effect of lowering the speed limit on the accessibility of the Vechtdalverbinding is unknown. This is because, in theory, lowering the speed limit, on the one hand, could reduce accessibility through lower driving speeds (Kristoffersson et al., 2024), while, on the other hand, it could also improve accessibility by reducing road congestion (Gressai et al., 2021).

The Vechtdalverbinding consists of two provincial roads, the N340 and N377, and one national road, the N48. Although a national road is part of this project, the Province of Overijssel is in control and in charge of this project and not the national government (Boschman, 2022). Over the years and during the planning process, the Province has been open to participation, conflicting interests and opinions of residents, interest groups and municipalities (Boerboom, 2022). Even now, the Province still consults with these actors on the design of certain parts of the Vechtdalverbinding (Provincie Overijssel, 2024a). In 2009, however, it was the Provincial Council itself that came up with a concrete plan to improve this Vechtdalverbinding (Boerboom, 2022). Although several parties from the Provincial Council and other

stakeholders were critical of this plan and the costs involved, a provincial land-use plan was adopted by the Provincial Council in 2012. This was also the moment when the national government became involved in the project anyway, as the State Council decided that from then on, all appeals against the land-use plan would be rejected (Boerboom, 2022). After the budget for this project was set in 2017, the final provincial land-use plan on the project was made, but it was slightly modified based on the various views and opinions of stakeholders that were included (Provincie Overijssel, 2018). In 2018 a contractor was chosen who worked out the final design of the plan in 2019 after which construction of the project started in 2020 (Boerboom, 2022). The project was completed by the end of 2023, which has resulted in the roads N340, N377 and N48 being safer and more accessible (Provincie Overijssel, 2024b; Koninklijke BAM Groep, 2022).

Similar to the Vechtdalverbinding, the N261 provincial road connecting Waalwijk with Tilburg in the province of Noord-Brabant has also been improved in terms of safety and accessibility. This provincial road is connected to the A59 national highway, making it an important road for traffic heading south to the city of Tilburg and to national attractions such as De Efteling. As with the Vechtdalverbinding, the N261 is subject to congestion, in this case caused by the increase in the number of users of this road. Not only did this result in poor accessibility, the road safety of this road was also inadequate (Provincie Noord-Brabant, 2005). Hence, the aim of the Province of Noord-Brabant was to solve the road safety and accessibility problems to promote regional connectivity. This goal was achieved by replacing five intersections on this road with fly-overs, as this prevents the formation of traffic jams, which improves accessibility and also safety, as these fly-overs reduce the risk of car accidents (Provincie Noord-Brabant, 2005). One of these fly-overs also contains a roundabout. According to Dumbaugh & Rae (2009), this can help balance the trade-off between road safety and accessibility. In addition, the speed limit has been lowered for the entire N261. This generally improves safety, but accessibility can both decrease due to lower driving speeds or increase due to a reduction in road congestion (Kristoffersson et al., 2024; Gressai et al., 2021). However, regardless of the effect of lowering the speed limit on accessibility, by providing the entire road with two times two lanes, accessibility is generally improved for this road, alongside safety (IPCON, 2016). Although the costs of this plan were much higher than the alternatives, the safety and accessibility benefits were considered so great by the Province of Noord-Brabant that it was implemented in 2012 anyway (Provincie Noord-Brabant, 2005). This investment was right in retrospect, as the N261 generally became safer and more accessible after the completion of the project in 2015 (Provincie Noord-Brabant, 2015; Koninklijke BAM Groep, 2015; Van Hest, 2015).

As the N261 is a provincial road, the Province owns the road and therefore had control over the project (Van Hest, 2015). Consequently, the Province came up with the plan and design for improving the N261. Although the Province had already prepared the plan and design, they also consulted with some parties, including several municipalities. The aims of these consultations were to further develop the design, to discuss action points and to discuss the possibilities of improving this road (Provincie Noord-Brabant, 2007). In this way, these interested parties had the opportunity to have a say in the project by sharing their views. These views were taken into account when designing a zoning plan. Ultimately, a zoning plan was presented by the province against which stakeholders and local residents could appeal. After no further appeals were eventually lodged, the zoning plan was finalised by the province and ready for implementation (BRO, 2011). Although an information evening was organised for residents and these residents were given the opportunity to appeal the zoning plan, no further evidence was found that they actually had much say in the project (BRO, 2011).

4.1.2 Infrastructure Project Involving Two Western Countries

An infrastructure problem involving the Netherlands with another Western country is that of Landesstraße 558 (L558) in Germany, just across the border with the Netherlands. The L558 is a provincial road that is connected to the N319 provincial road in the Netherlands, linking the German town of Oeding with the Dutch town of Winterswijk. This makes the L558 an important connection between Germany and the Netherlands. However, this connection runs through the centre of the Oeding, causing the L558 to be heavily congested just before the border crossing with the Netherlands (1Achterhoek, 2023). As a result, there is a lot of traffic congestion on this road, making accessibility deficient. In addition, the heavy use of this road in the centre of Oeding creates unsafe traffic situations resulting in a lack of road safety here too (1Achterhoek, 2023). Consequently, in 1994, the first studies were conducted and plans were made to develop a new bypass south of Oeding to replace the current road crossing in the centre of Oeding (De Gelderlander, 2019). This bypass will lead to an increase in road safety in Oeding and it will lead to an increase in accessibility from Germany to the Netherlands and in Oeding itself (Gemeente Winterswijk, 2019a). The plan has thus existed for decades but has not been implemented until now for various reasons related to the spatial planning approach used by the stakeholders in the planning process. This is because using this approach in the planning process has, among other things, ensured that the various stakeholders in both countries have had the opportunity to oppose the bypass, which they consequently did in large numbers leading to delays in the project (1Achterhoek, 2023; Kits, 2019). Among these opponents are residents who feel that the new bypass will be built too close to their houses (Esselink, 2017).

Since the German government takes the initiative in this project and pays for it in full, the municipality of Südlohn, the district administration of Münster and the German state of Nordrhein-Westfalen came up with a zoning plan (Gemeente Winterswijk, 2019b; 1Achterhoek, 2023). As this project has been ongoing for some time, this zoning plan has already been submitted to the municipality of Winterswijk in the past (1Achterhoek, 2023). The municipality of Winterswijk will process this "old" zoning plan and come up with a newer zoning plan. This newer zoning plan will be published by the municipality and residents and other interested parties are given the opportunity to respond to this plan and express their views. Their responses are then considered and, if deemed valuable, implemented in the final zoning plan for the part of the bypass located in the Netherlands (1Achterhoek, 2023). A similar procedure applies on the German side of the border. The plans of the municipality of Südlohn, the district administration of Münster and the German state of Nordrhein-Westfalen were presented to local residents and stakeholders for inspection. The various objections and views of these parties were considered and partly incorporated into an adjusted zoning plan. This L558 zoning plan is currently nearing completion in Germany, after which it will be implemented (1Achterhoek, 2023; Kits, 2019). This means that the bypass will be built, leading to an improvement in both road safety and accessibility in Oeding itself and to an improvement in accessibility on the road from Germany to the Netherlands.

4.1.3 Infrastructure Projects in other Western Countries

The A590 road project in the UK is the first fully international example presented in this section. The A590 is a trunk road located on the western side of central UK and is comparable to a Dutch provincial road, even though the road classification is slightly different in the UK. The A590 previously ran through the villages of High and Low Newton, but the traffic density was so high that congestion and road accidents were common (Highways Agency, 2014). This means there was a lack of accessibility and safety at the A590. So to improve both safety and accessibility, the A590 High and Low Newton bypass plan was created by the Highways Agency. The aim of this plan was to build a new bypass, with a dual carriageway on both halves of the road, located 300 metres west of the villages (Highways Agency, 2014). Construction of this bypass began in 2006 and the project was completed in 2008. The construction of this bypass proved to be a success, as both the accessibility and safety of the A590 and

in the villages of High and Low Newton were greatly improved by the project (Highways Agency, 2014). This was highlighted by the regional newspaper NW Mail (2018a), as they stated that the number of accidents had decreased by 80 per cent and the estimated travel time for that section of the A590 had decreased by an average of 2 minutes and 25 seconds. In addition, five years after its opening in 2008, an evaluation of the bypass was carried out by the Highways Agency (2014). This evaluation showed that the new A590, compared to the old one, reduced travel time by several minutes and significantly reduced the number of collisions in general, as well as the number of serious and fatal collisions. This indicates an improvement in both accessibility and safety of the road.

Although the A590 is a trunk road, similar to the Dutch provincial road, the UK government came up with the first idea for a bypass in 1976. After some local investigations in 1993, the project was approved by the Secretary of State for Transport in 1994. Despite this approval it took almost another decade before the project was added to the government's agenda in 2003 (Highways Agency, 2014). The project was commissioned by the Highways Agency, a company that builds and maintains roads for the national government. Together with some contractors and designers, the Highways Agency ensured that environmental and social improvements to the construction were included from the beginning of the project (Highways Agency, 2014). A detailed design of the new A590 was prepared in late 2005 and presented in January 2006, and from then on, the project team started working with other parties, such as landowners and businesses affected by the project, but only for small things like planting trees on their properties. In 2006, construction of the bypass began and many local residents and contractors were employed on the construction site (Highways Agency, 2014). In general, the bypass construction was supported by local residents and businesses around High and Low Newton because of the safety, health, social and accessibility benefits it would bring (NW Mail, 2018b; Highways Agency, 2014). This is evidenced by the fact that local residents and businesses called the Highway Agency to a closed-door meeting in 2004 to explain them why they had not yet started construction (Gazette News Desk, 2004). However, some local residents protested against the project because they feared that replacing the A590 with the construction of the bypass would isolate their villages and their local amenities (NW Mail, 2018b; Highways Agency, 2014).

The final project discussed in this section is the Sea-to-Sky highway project in Canada. The Sea-to-Sky highway is a provincial highway (Highway 99) in southwestern Canada in the province of British Columbia and is connected to the city of Vancouver. The Sea-to-Sky highway project aimed to improve the safety, reliability and capacity of this road by straightening and widening it and by implementing other design measures. These measures were designed to reduce hazards and shorten travel times for this road, meaning that both safety and accessibility would be improved (Infrastructure BC, 2005). After the completion of this project in 2009, the number of accidents decreased and both road capacity and traffic speed increased, implying both safety and accessibility improvements to this road (Mott MacDonald, n.d.; Hernandez, 2020).

Since the Sea-to-Sky highway is a provincial highway in the province of British Columbia, the Ministry of Transportation (MoT) of British Columbia was the initiator of this project. The MoT formed a public-private partnership with S2S Transportation Group using a Design Build Finance Operate (DBFO) model (Infrastructure BC, 2005). This means that S2S was responsible for the design, construction, financing and operation of the project. The MoT supervised and monitored the project to ensure that the standards in the contract were met (Infrastructure BC, 2005). The S2S Transportation Group consists of several companies, each with its own specialism, meaning that, for example, the design company was responsible for the design and the construction company for the construction of the project (Infrastructure BC, 2005). Despite a number of protests against this project by activists and residents, mainly aimed at protecting the environment and ecosystem, citizens were not involved in this project.

Also not by means of the protests, as these were not heeded by the project developers (CBC News, 2006; Hernandez, 2020).

Based on the analytical framework of Table 3, Table 4 provides a systematic overview of the five infrastructure problems discussed in this section. This table summarises the infrastructure problems regarding safety and accessibility, their solutions and the stakeholders involved based on the descriptions for each of these five cases in this section. Moreover, the effects of implementing the solutions after project completion on both road safety and accessibility are also included in the table. For both road safety and accessibility, "+" indicates an improvement in the factor, "0" indicates no change and "-" indicates a reduction in the level of the factor. In addition, for each of the five cases, the spatial planning approach used by the stakeholders in their planning process is identified. This was done by relating the results on the aspects in Table 4 to the identification criteria for spatial planning approaches (Table 1) and to De Roo's planning theory, including the four spatial planning approaches, discussed in section 2.1. For the use of the identification criteria, it means that if the number of stakeholders involved is low, if stakeholders' interests are not always fully considered and partially ignored, if stakeholders have relatively few opportunities to share their interests, if only one stakeholder or group has much control over the decisions that are made, and if a plan is hardly modified over time, it is determined that the spatial planning approach used by the stakeholders in the planning process of a case is approaching a rather technical approach. If the opposite is true, the spatial planning approach used by the stakeholders in the planning process of a case approaches a communicative approach. The identified spatial planning approach for each case can be one of the four approaches, actor-consulting, technical approach, communicative approach or scenario approach, discussed in section 2.1, but it can also be an approach that is somewhere in between two of these approaches.

To demonstrate how this identification of a spatial planning approach used by stakeholders in the planning process operates in a real case, the Sea-to-Sky Highway in Canada is taken as an example. The Ministry of Transport of British Columbia (MoT) was the only stakeholder involved in this project, as the other identified stakeholder, the S2S Transportation Group, was only the executor of the project. Moreover, other potential stakeholders such as citizens were not involved in the project, meaning they had no opportunity to share their views and interests. This also means that the only stakeholder, the MoT, has complete influence and control over the decision-making and planning process. Furthermore, the focus of the planning process was on achieving goals and no plans were submitted to the public for feedback because the S2S Transportation Group designed the new Sea-to-Sky Highway according to the standards set by the MoT in their shared contract. Based on the application of the discussed aspects of this case to the De Roo's planning theory and the identification criteria specified in Table 1 and the previous paragraph, it was found that a technical approach was used in this case by the sole stakeholder in the planning process (Figure 4 & Table 4). The spatial planning approaches used by stakeholders in the planning processes of the other four cases presented in this section and in Table 4 were identified in the same way.

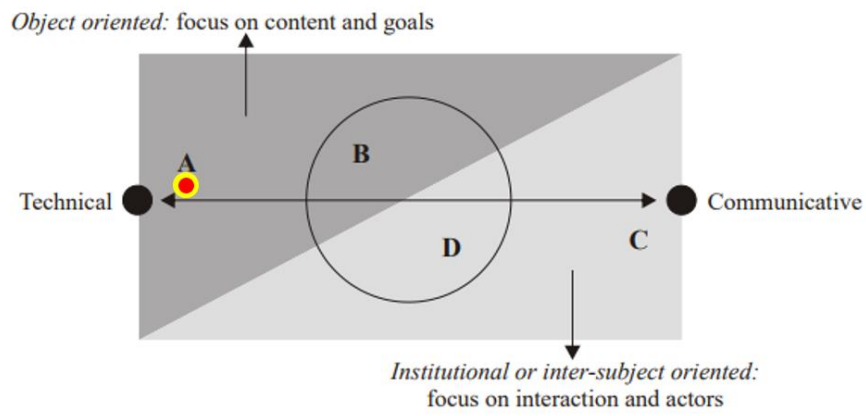


Figure 4: The position in the planning theory model of De Roo of the spatial planning approach used by the stakeholder in the Sea-to-Sky Highway case (red dot) (De Roo & Porter, 2006, adapted by the author)

Case + Location	Problem(s)	Stakeholders involved in Planning Process	Spatial Planning Approach <i>(identified by relating the results of the media and document analyses (section 4.1) to the planning theory and identification criteria (section 2.1))</i>	Solution(s)	Effect on Safety	Effect on Accessibility
<i>Vechtdalverbinding (N340, N377 & N48), Overijssel, the Netherlands</i>	- Frequent traffic congestions during rush hour - Poor road safety	Province of Overijssel, Local Residents, Interest Groups, Municipalities, National Government	Somewhat more Technical than the Scenario Approach (slightly to the left of B in Figure 2)	- Replacing dangerous intersections by constructing roundabouts, fly-overs & road sections dipping under these intersections -Modifying intersections by implementing new elements such as traffic lights and road barriers - Widening and doubling road sections - Severing roads that go in opposite direction -Lowering the speed limit on some sections	+	+
<i>N261 Waalwijk-Tilburg, Noord-Brabant, the Netherlands</i>	-Frequent traffic congestions -Inadequate road safety	Province of Noord-Brabant, Interest Groups, Municipalities, Local Residents	Approach roughly in between the Technical and Scenario Approach	-Replacing five intersections with traffic lights by constructing fly-overs -Lowering the speed limit for entire N261 -Doubling the entire N261	+	+
<i>Landesstraße 558 Oeding (Germany) – Winterswijk (the Netherlands)</i>	-Heavy traffic congestion in front of border crossing -Unsafe traffic situations	German Government, Municipality of Südlohn, District Administration of Münster, German State of Nordrhein-Westfalen, Municipality of Winterswijk, Interest Groups, Local Residents	Somewhat more Technical than the Scenario Approach (slightly to the left of B in Figure 2)	- Construction of a new bypass south of Oeding to prevent L558 from crossing the centre of Oeding	+	+
<i>A590 High and Low Newton, United Kingdom</i>	-Frequent traffic congestion -Regular road accidents	UK Government, Secretary of State for Transport, Highways Agency, Local Landowners, Local Businesses	Approach roughly in between the Technical and Scenario Approach	-Construction of a new bypass, with a dual carriageway on both halves of the road, located on the west of the villages High and Low Newton	+	+
<i>Sea-to-Sky highway (Highway 99), British Columbia, Canada</i>	-Poor accessibility -Poor road safety	Ministry of Transportation of British Columbia, S2S Transportation Group	Technical Approach	-Straightening and widening the highway -Implementing design measures to reduce hazards and shorten travel times	+	+

Table 4: Overview of the five infrastructure cases presented in section 4.1

4.2 The N34 Infrastructure Problems in the Municipality Aa & Hunze

After five examples of national and international infrastructure problems have been provided in section 4.1, in this section, the infrastructure problems of the N34 road section in the municipality of Aa & Hunze are presented. As discussed in the introduction, the N34 road section located in this municipality is struggling with both safety and accessibility problems (Heeres et al., 2019; Provincie Drenthe, 2024; RTV Drenthe, 2019). Especially around the Gieten traffic junction, these problems are commonplace. So far, the safety and accessibility problems are still present in this road section. Based on media articles, documents and reports published by local media, regional media and regional authorities, this section will discuss why these problems have not been solved by showing the development history of the N34 section in Aa & Hunze, by describing the current situation of this road section and its trade-off between safety and accessibility and by showing how work is currently underway to improve this N34 road section.

4.2.1 The Development History of the N34 Road Section in Aa & Hunze

After the road section between Gasselte and Gieten was opened to traffic in 1961, the road section between Gieten and Anloo was opened to traffic on 9 April 1962 (Figure 5) (Rijkswaterstaat, 1962). This meant that most of the current N34 in the municipality of Aa & Hunze was opened at that time. Moreover, with the opening of the road section between Gieten and Anloo in 1962, the Gieten traffic junction was also opened (Beek, 2017). At the time, the Gieten traffic junction was a single-level roundabout where the current N33 and N34 met. Over the years, however, it became clear that the level of road safety and accessibility was increasingly inadequate for the number of vehicles passing this junction (RTV Drenthe, 2008).

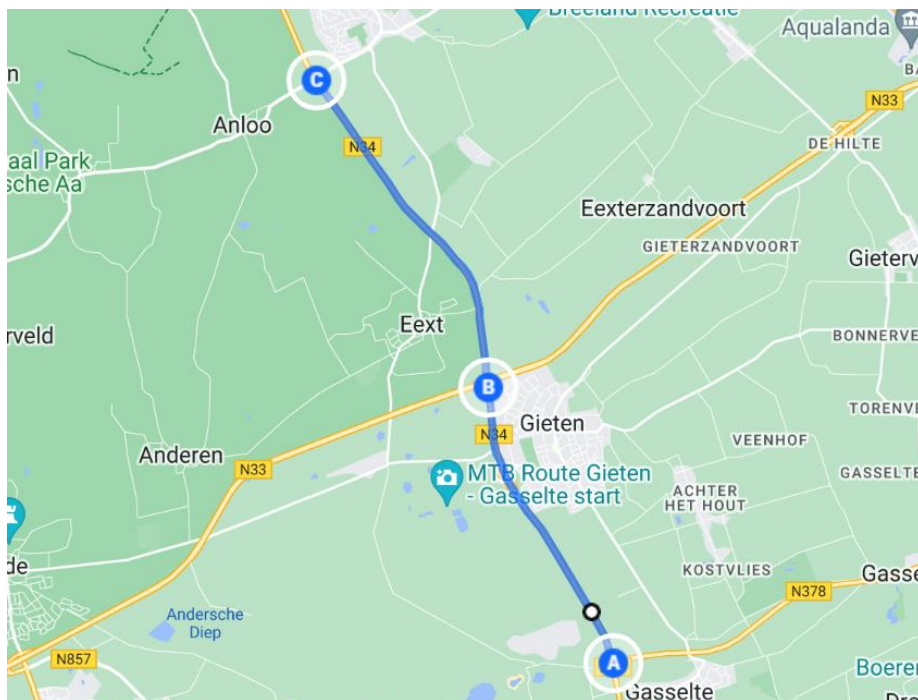


Figure 5: The road sections Gasselte-Gieten (A-B, opened in 1961) and Gieten-Anloo (B-C, opened in 1962) (Source: Google My Maps, 2024)

On 1 January 2007, the Provinces of Drenthe and Overijssel became owners of the N34 after the national government transferred this road to them. From then on, the N34 was no longer a national road, but officially became a provincial road (Beek, 2017). Although the Province of Drenthe became the owner of the N34 road section in the municipality of Aa & Hunze, the national government gave money to the Province to finance the reconstruction of the road into a multi-level motorway (Deur

Drenthe, 2012). With this reconstruction, the national government and the Province of Drenthe wanted to increase the safety and accessibility of the N34 (RTV Drenthe, 2008). Consequently, the Province of Drenthe did not hesitate when it became the owner of the N34 and, in cooperation with the municipalities of Aa & Hunze and Borger-Odoorn, immediately started the planning process for this reconstruction in April 2007 (Deur Drenthe, 2012; RTV Drenthe, 2008). In Aa & Hunze, two new fly-over junctions were constructed at the Gieten traffic junction and in Gasselte. At the Gieten traffic junction, this fly-over was realised by routing the N33 underneath the N34 roundabout. In addition, on the southeast side of the Gieten traffic junction, a public transport hub was constructed after which the new Gieten traffic junction was opened in 2011 (Beek, 2017) After completing the reconstruction, the biggest bottlenecks had been removed. However, further reconstruction is necessary to further improve the N34 section in the municipality of Aa & Hunze (Deur Drenthe, 2012).

4.2.2 The current N34 section in Aa & Hunze and its Trade-Off between Safety and Accessibility

The Gieten traffic junction forms the current centre of the N34 section in the municipality of Aa & Hunze. This traffic junction is formed by a large roundabout lying across the N33, the road that runs perpendicular to the N34 (Figure 6). The roundabout is thus also connected to the N33, which means that not only users of the N34 use this roundabout, but also motorists turning off the N33. As a result, the number of motorists using this roundabout is so high that there are daily traffic jams on the parts of the N34 leading to it, especially around rush hour (RTV Drenthe, 2019). These daily traffic jams indicate situations of poor traffic flow which means that the accessibility of this N34 road section is lacking at certain times, especially around the Gieten traffic junction.



Figure 6: The current Gieten traffic junction (Source: RTV Drenthe, 2023b, adapted by the author)

Moreover, the N34 road section in the municipality of Aa & Hunze has high absolute and relative numbers of car accidents compared to N34 road sections in other municipalities, partly due to high traffic intensities and unsafe road segments (Heeres et al., 2019). The Gieten traffic junction experiences the most accidents, followed by the part of this N34 section located next to the village of Gasselte (Heeres et al., 2019). However, not only at the Gieten traffic junction, but also the two kilometers on the north and south sides of the junction experience relatively high numbers of traffic accidents (Heeres et al., 2019). This indicates that the road safety of this N34 road section is also poor, especially near the Gieten traffic junction.

Both safety and accessibility are thus insufficient for the N34 road section in the municipality of Aa & Hunze. Therefore, the province took the initiative to improve both factors for this road section (Provincie Drenthe, 2024). Especially at the Gieten traffic junction and its immediate surroundings, most car accidents and traffic jams take place. This indicates an even lower level of safety and accessibility for this part of the N34 road section. Since most accidents take place on this least accessible part of the road section, this shows that road safety and accessibility are related. This is in line with what Wang et al. (2013) and Kononov et al. (2008) found in infrastructure case studies other than the N34, as they found that traffic congestion not only reduced accessibility but also road safety, as roads with congestion show a higher number of car accidents.

4.2.3 Project development of the N34 Road Section in Aa & Hunze since 2011

After completing the construction of the current N34 road section in the municipality of Aa & Hunze in 2011, the road still showed safety and accessibility deficiencies. This applies in particular to the segment at and immediately around the Gieten traffic junction. As a result, the N34 does not comply with the provincial and national road safety policies (Heeres et al., 2019). Moreover, the number of vehicles using this junction is expected to increase over time, which is expected to cause even greater safety and accessibility problems (Heeres et al., 2019). Consequently, the Province of Drenthe is working on developing various traffic measures for the N34 to improve road safety and accessibility in the long term (Provincie Drenthe, 2024).

So far, no final plan has been implemented to carry out these improvements, although several plans have been designed and presented by the Province of Drenthe. Most of these plans focus on both improving the Gieten traffic junction and partially doubling the N34 (Vinkenvleugel, 2023a). Options proposed for the traffic junction included a cloverleaf on the existing roundabout, a fly-over over the roundabout and a 'shifted fly-over' on the left side of the junction (Vinkenvleugel, 2020). These three options have different costs: for example, a fly-over is cheaper than a 'shifted fly-over'. However, a fixed budget of €90 million is available for these improvements (Vinkenvleugel, 2023a). This means that depending on which option is chosen, a different part of the budget remains that can be invested in partially doubling the N34 (Vinkenvleugel, 2023a). So, if a more expensive option is chosen, less money remains for doubling certain parts of the N34 section, meaning a shorter distance can be doubled. Inflation in recent years also plays an important role in this funding, as over time less and less can be renovated and improved with the available budget of €90 million as all materials become more expensive (Vinkenvleugel, 2023b). Moreover, according to Drenthe's deputy for traffic and transport, Nelleke Vederlaar, it is not realistic to allocate additional money for the plans, which means that the budget of €90 million is fixed (Guit, 2023).

As a result, the cloverleaf option on the existing roundabout was already rejected, as in 2022, the price of the cloverleaf was estimated at €93 million. This already exceeds the budget by €3 million, and by the time the project is implemented, the price is expected to be even higher due to inflation (Vinkenvleugel, 2023b). Although most plans aimed at both partially doubling the N34 and improving the Gieten traffic junction, plans were also made by the Province of Drenthe to only partially double the N34 and to leave the traffic junction as it is now. However, again due to inflation, only 6 kilometres of road could be doubled instead of 12, which is why the Province of Drenthe also dismissed this plan (Guit, 2023).

The Province of Drenthe therefore wants to use one of the fly-over options to make the N34 safer and more accessible (Guit, 2023). However, no decision has yet been taken on which of the two fly-over options will be adopted. The reason for this is not financial, as with the options of the cloverleaf and only partial doubling of the N34, but has to do with the opinions and interests of representatives and residents of the villages around the Gieten traffic junction: Eext, Gieten and Gasselte (Figure 7).

Although the representatives and residents all think that the Gieten junction is in need of improvement, they have slightly different opinions about which type of fly-over is appropriate to use in this case (RTV Drenthe, 2023a). The fly-over over the junction is preferred by the representative and residents of Eext as they are against the 'shifted fly-over' because it will cause visual and noise pollution for them (RTV Drenthe, 2023a). In contrast, some Gieten residents fear that the fly-over over the Gieten traffic junction will cause noise pollution for them. In general, however, the majority of the Gieten inhabitants, like the inhabitants of Eext, prefer the fly-over option over the Gieten traffic junction (De Schakel, 2023).

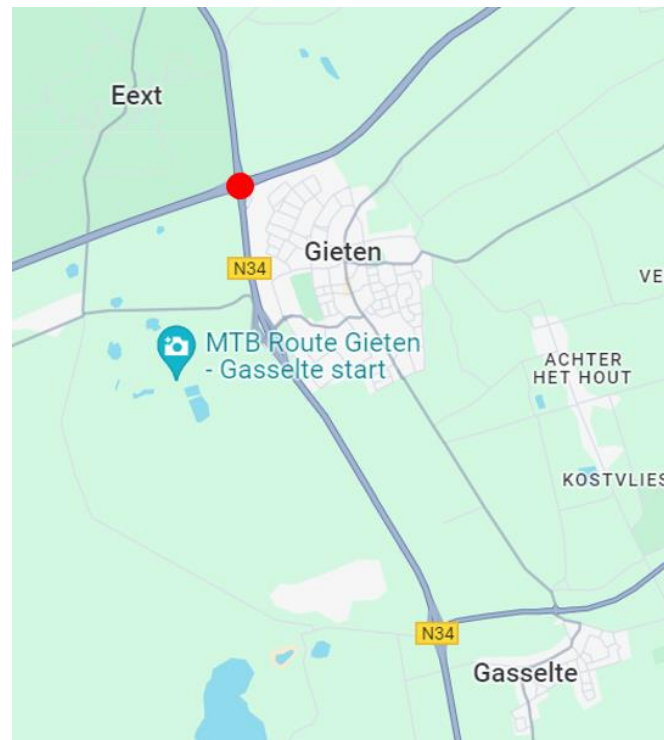


Figure 7: The villages located around the Gieten traffic junction (red dot): Eext, Gieten and Gasselte (Source: Google Maps, 2024b, adapted by the author)

For the two proposed fly-over options, an environmental impact assessment is being carried out. The environmental impact assessment looks at the likely impacts of the two options on both the natural and living environment (De Schakel, 2023). This is beneficial as the results of this assessment are incorporated into the final design, ensuring that the residents of both Eext, who oppose the 'shifted fly-over', and some residents of Gieten, who oppose the 'normal' fly-over, will not experience severe disruption to their living environment as a result of the implementation of the chosen fly-over.

For both the 'shifted fly-over' and the fly-over over the Gieten traffic junction, it is also being considered by the stakeholders whether or not a partial doubling of the N34 on either side of the new fly-over is necessary (RTV Drenthe, 2023a). Again, there are different interests on this partial doubling of the N34. On the one hand, the representative of Gasselte argues that the partial doubling of the N34 is "unnecessary and a waste of money" because there is no evidence that the partial doubling around the Gieten traffic junction improves accessibility (RTV Drenthe, 2023a). This is supported by several left-wing political parties, such as SP, Partij voor de Dieren and GroenLinks, represented in the Provincial Council of Drenthe who add that the partial doubling is harmful for nature and the living environment (Vinkenvleugel, 2023c). On the other hand, other political parties represented in the Provincial Council of Drenthe, such as PVD and VVD, are convinced that the partial doubling of the N34 has to be realised in the final road design to help dealing with the trade-off between safety and accessibility of the N34

in the municipality of Aa & Hunze, even if this requires borrowing money from the national government (Vinkenvleugel, 2023c).

In short, although various options for improving the safety and accessibility of the N34 in the municipality of Aa & Hunze have been proposed since 2011, no final plan has been made so far. This is because, besides the lack of budget which made the options cloverleaf and only doubling the road unfeasible, slightly conflicting interests of different parties have meant that no decision has yet been taken on which fly-over has to be built to solve the problem. In addition, due to the conflicting interests over whether or not to combine the fly-over options with a partial doubling of the N34, no decision has been taken on this either.

4.2.4 The Current Status of the N34 Project in Aa & Hunze

At the time of writing this study in 2024, no final decisions have been taken on implementing one of the following four current plans of the Province of Drenthe: 1) a fly-over over the Gieten traffic junction without doubling the N34; 2) a fly-over over the Gieten traffic junction in combination with doubling the N34 between Gasselte and Annen; 3) a 'shifted fly-over' on the west side of the Gieten traffic junction without doubling the N34; and 4) a 'shifted fly-over' on the west side of the Gieten traffic junction with partial doubling of the N34 (RTV Drenthe, 2023b). These four plans are visualised through Figure 8 in which the numbers 1 to 4 in the figure correspond to the above descriptions 1 to 4.



Figure 8: The four current plans of the Province of Drenthe (RTV Drenthe, 2023b, adapted by the author)

In 2023, these plans were presented by the province to the residents of the villages surrounding the project area. In addition, these residents were given the opportunity to give their opinions on these plans (RTV Drenthe, 2023b). In the beginning of 2024, these inputs and opinions of the residents have been included in the elaboration of the four plans in sketch designs. Furthermore, all four designs are

assessed and compared based on various criteria through an environmental impact assessment (RTV Drenthe, 2023b; De Schakel, 2023). In this way, the effects of each plan on the natural and living environment are determined. The results of the sketch designs that take residents' input and the environmental impact assessment into account will be resubmitted to the residents of the surrounding villages before the summer of 2024. These residents can then give their opinions on the plans again (De Schakel, 2023). In 2024, based on the environmental impact assessments, residents' input and a calculation of costs, the province will present which of the four plans is preferred (RTV Drenthe, 2023b; De Schakel, 2023). This preferred plan is then submitted to the Provincial Council of Drenthe, which will either agree or reject the plan in 2025 (RTV Drenthe, 2023b). If the Provincial Council of Drenthe agrees to the preferred plan, decisions on the final road design will be made in 2025/2026. If this final design is then adopted, implementation of the plan to improve the safety and accessibility of the N34 in the municipality of Aa & Hunze is expected to be realized in 2028/2029 (Provincie Drenthe, 2024).

4.2.5 Relating the N34 Project in Aa & Hunze to Theory

In this section, the current planning process of the N34 project in the municipality of Aa & Hunze, including the stakeholders involved, their roles and power, is related to De Roo's planning theory, including its four spatial planning approaches, and to the identification criteria for these approaches discussed in section 2.1 and Table 1 (De Roo & Porter, 2006). In this way, it is identified which spatial planning approach is being used by the stakeholders in the planning process of the N34 project:

The Province of Drenthe owns the N34 road section in the municipality of Aa & Hunze and has therefore taken the initiative to improve both traffic safety and accessibility by presenting potential traffic measures and plan designs. However, the Province of Drenthe will not decide solely on the plan to be implemented, as municipalities, representatives and residents of the villages surrounding the project area will have multiple opportunities to share their opinions and views on the plan designs. This means that the Province of Drenthe does not have full control over the planning process and decisions taken on the project. In addition, the political parties represented in the Provincial Council of Drenthe will get multiple chances to share their views on the different plan designs. The views and interests of all the different interest groups have been considered and some of them have been included in the elaboration of the plan designs. These elaborated plan designs are then resubmitted to the residents of the project area, at which point they can again share their views. Partly based on these residents' views, but not on all of them, the Province of Drenthe will present one preferred plan that will be submitted to the Provincial Council of Drenthe. The political parties represented in the Provincial Council will jointly approve or reject the preferred plan. If they approve, a final plan is formatted and decisions are taken on it, after which the plan can be implemented.

In short, by presenting four plan designs, different planning scenarios for solving the predefined safety and accessibility problems of the N34 road section in Aa & Hunze are offered by the Province of Drenthe. By taking the initiative in presenting several possible designs, the Province of Drenthe selects an object-oriented focus by concentrating on the content and goals. Stakeholders such as local residents, the Provincial Council and village representatives are given several opportunities to give their views and interests on the plan designs. This means that consultation is also included in the planning process and the province does not have complete control over the project. However, based partly, but not entirely on their views and interests, a preferred scenario will be selected by the province and eventually converted into a plan. Subsequently, this plan will be modified several times based on some interests and views of the stakeholders until a final plan is presented. Therefore, based on De Roo's theory and the criteria for identifying a spatial planning approach (Table 1) in section 2.1, the approach identified in the planning process of the N34 project in the municipality of Aa & Hunze most closely resembles the scenario approach (B in Figure 2).

5. Comparative Analysis

In this section, the dealing with the trade-off between safety and accessibility in the five national and international case studies (section 4.1) are compared with the dealing with this trade-off in the N34 case study (section 4.2) based on the following criteria: safety and accessibility improvements after implementation of the final road design, planning process, stakeholders involved and their power, and spatial planning approach. Through this comparison, similarities, differences and patterns between the five cases and the N34 case are identified, as the five cases faced road safety and accessibility problems and made efforts to improve them, while in the N34 case they are now facing these problems and are making efforts to improve them. Moreover, the five cases from section 4.1 all experienced an improvement in both road safety and accessibility after applying road design measures. Therefore, the findings of the comparative analysis can provide insights for the N34 case study and its related planning process on what does and does not work in seeking to improve infrastructure safety and accessibility. Subsequently, in section 6, these findings are used to draw conclusions on the most suitable direction the N34 project can take in terms of the spatial planning approach to be used by the stakeholders in the planning process to affect the road design in such a way that it improves safety and accessibility faster and more effectively.

5.1 Safety and Accessibility Improvements

In the five national and international case studies presented in section 4.1, various measures and solutions were implemented to increase the level of both road safety and accessibility. The implementation of these measures led to improvements in both factors in all five cases.

In the five national and international cases, different but also partly similar measures have been taken to improve road safety and accessibility. In two cases (Vechtdalverbinding and N261), dangerous intersections have been replaced by the construction of fly-overs, roundabouts or road sections that pass under the intersection. The replacement of these intersections led to a decrease in the number of accidents on these roads, meaning that road safety has increased as a result. In addition, accessibility has also improved in both cases. This is because with the construction of fly-overs and road sections that pass under the former intersection, cars no longer have to stop in front of the intersection, but can pass it directly. This usually improves both road safety and accessibility (Gaca & Kieć, 2012). Moreover, the construction of only roundabouts instead of intersections has been mentioned in the Vechtdalverbinding case as a good solution for improving road safety and accessibility.

Furthermore, straightening, widening and/or doubling an existing road contributed to increasing both road safety and accessibility in four of the five cases presented (Vechtdalverbinding, N261, A590 and Sea-to-Sky highway). This is because wider and straighter roads generally lead to a reduction in road accidents, thus improving road safety (Dumbaugh & Rae, 2009). However, this will generally encourage motorists to drive at higher speeds than before the road was widened and straightened. In this way, accessibility will increase, but the increase in road safety is partially offset (Aschenbrenner & Biehl, 1994). However, these two measures are not included in the N34 case study plans. In three cases (Vechtdalverbinding, N261 and A590), doubling the whole road or some road sections also contributed to improving safety and accessibility. Doubling the road sections just before and after the Gieten traffic junction is also included in some design plans for the N34 case study. When related to the three presented cases, doubling some road sections of the N34 near the Gieten traffic junction seems to be beneficial for motorists as this possibly improves both safety and accessibility.

In addition, in two of the cases presented (L558 and A590), a bypass was constructed that improved both road safety and accessibility. This is similar to the two plans of the 'shifted fly-over' in the N34 case, as this is a bypass in the form of a fly-over. In the N34 case, the implementation of the 'shifted fly-over' is expected to lead to a 75% decrease in traffic using the Gieten traffic junction (Vinkenvleugel,

2020). This means fewer cars driving on and around the traffic junction, reducing the likelihood of traffic jams. The construction of a bypass by means of a 'shifted fly-over' can hence, as presented in the two cases, improve the traffic flow on the N34 road section and lead to a decrease in the number of major accidents on that road section (Wang et al., 2013; Kononov et al., 2008).

Implementing the separation of roads going in opposite directions has helped improve safety and accessibility in one case (Vechtdalverbinding). This usually improves road safety because it prevents two opposing vehicles from colliding head-on or ending up on the wrong side of the road, which can lead to serious road accidents (Antonson et al., 2013). However, when a lane separation between the two opposing lanes is implemented, it will generally lead to a slight increase in driving speed (Antonson et al., 2013). Although this increases accessibility, it partly cancels out the improvement in road safety (Aschenbrenner & Biehl, 1994). The N34 plan designs currently does not include road separations.

In two cases (Vechtdalverbinding and N261), a reduction of the speed limit has been implemented for road sections or for the whole road. In both cases, this has contributed to improving road safety. However, the effects of speed limit reductions on accessibility are unknown in both cases. This is because, when introducing a speed limit reduction, accessibility can both decrease due to lower driving speeds and increase due to a reduction in road congestion (Kristofferson et al., 2024; Gressai et al., 2021). In the N34 project, none of the plan designs propose lowering the speed limit. Nevertheless, if the main objective is to improve safety, this could favour the N34 project. If the main objective is to improve accessibility, other measures to improve this factor lead to a higher certainty of success, as lowering the speed limit can both increase and decrease accessibility, as indicated in literature.

5.2 The Planning Process

When comparing the stakeholders involved in the planning process of the five national and international cases with the N34 case, generally, with the exception of the Sea-to-Sky Highway in Canada, the same types of stakeholders were involved. In all cases, a national, regional or provincial government came up with a plan to improve the safety and accessibility of an infrastructure situation. As with the N34, several municipalities were also involved in the planning process. In the Vechtdalverbinding, N261 and L558 cases, the municipalities involved helped the provincial or regional government to further develop the plan designs through consultation or design. Local residents and other interest groups also had a (minor) say in the plan designs of all cases, except for the Sea-to-Sky Highway case. In all other cases, in fact, local residents and people from other interested parties were given the opportunity to share their opinions and views on the project and the designed plan(s) or to cooperate with the project team. The opinions and views of these local residents and people from the interested groups were then (partially) considered in the final road design. Unlike the N34, both the A590 and the Sea-to-Sky highway projects involve two companies employed by the national or provincial government: the Highways Agency and the S2S Transportation Group. In the N34 case, no such companies are involved in the planning process.

While there are many similarities between the N34 case and some of the other cases in terms of the stakeholders involved and the object-oriented focus, the role and power of these stakeholders in the planning process makes the cases also somewhat different. In the N34 case study, the province presented several scenario plans, while in the other cases the provincial, regional or national government came up with only one draft plan to improve the safety and accessibility of a specific infrastructure. Although local residents and interest groups are given the opportunity to express their views on the plans, in the N34 case study, these stakeholders have more say in the project than in all other cases. This is because in all other projects involving local residents or interest groups, their opinions and views were collected and considered, but are only implemented in the new road design if they were deemed valuable. In the case of the N34, representatives and local residents have

somewhat opposing views on the plans presented, which is why so far no final decision has been taken on the plan to be implemented. In all other cases, the existence of opposing views between different stakeholders does not prevent a final decision from being taken.

Due to the different scenario plans presented in the N34 case and the object-oriented focus, but with many moments of consultation in it, this case study is characterised as a scenario approach (X in Figure 9). In the five other cases presented in this study, compared to the N34 case study, more technical approaches were used by the stakeholders in the planning process in which one plan rather than several scenarios were presented each time (1-5 in Figure 9). As a result, there are differences in the planning processes between the N34 cases and the other five cases, even though the identified spatial planning approaches of the five case studies and the identified approach of the N34 case study are all positioned on the object-oriented side of the model. In the Vechtdalverbinding and L558 cases, approaches were used that correspond well to the scenario approach, but with a small degree of the technical approach in it, which is why these approaches are slightly on the left side of the scenario approach, i.e. slightly closer to the technical approach (Figure 9). This is because local residents and stakeholders had quite a bit of say in the design of the final plan but only when their opinions and views were considered relevant. Therefore, compared to the N34 case study, not all of these stakeholders' opinions and views were taken into account, meaning that the planning process was completed much faster than in the N34 case study, as a decision on a final plan was made at some point, even though there were some conflicting interests. Moreover, in the N261 and A590 cases, a spatial planning approach was used by the stakeholders in the planning process that is approximately in between the technical and the scenario approach (Figure 9). This means that the approaches used in these cases were technical in nature, but with some minor consultation moments in them, as local residents and stakeholders generally did not have much, but only a minor say in the project. In the case of the Sea-to-Sky Highway in Canada, the spatial planning approach used by the only stakeholder in the planning process resembled a technical approach (Figure 9). This is because in this case, a provincial government agency came up with a plan that was directly implemented by a partner of this government and no other actors have been involved in the project to share their opinions and views on the project. This process thus had to a large degree a technical, top-down character, as one stakeholder came up with a plan, made decisions about it on its own and had the plan implemented without considering the opinions and views of other potential stakeholders (De Roo & Porter, 2006).

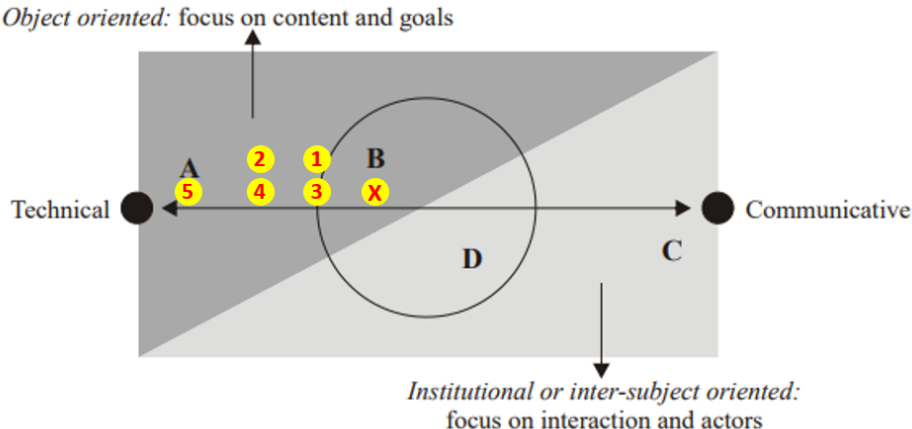


Figure 9: Positions in De Roo's planning theory model of the spatial planning approaches used by the stakeholder(s) in the planning process of each case study (X= N34 case, 1= Vechtdalverbinding, 2= N261, 3= L558, 4= A590 & 5= Sea-to-Sky Highway) (De Roo & Porter, 2006, adapted by the author)

6. Conclusion and Discussion

The N34 road section in the municipality of Aa & Hunze is a section of the N34 provincial road that connects two major cities in the north of the Netherlands: Groningen and Emmen. This road section faces daily traffic congestions and a high relative and absolute number of traffic accidents compared to other N34 road sections. These problems are expected to intensify as more and more motorists will use this road section in the future. To date, however, there is no final plan for improving this poor safety and accessibility situation of the N34 road section, although the planning process has been ongoing since 2011. Consequently, this research studied if there is a pattern between the spatial planning approach used by stakeholders in the planning process of the N34 project and whether or not there is a timely design of a final road design that, if implemented, improves the trade-off between safety and accessibility in the N34 case. This has been studied by comparing five Western regional infrastructure cases, including two Dutch ones, in which problems related to both safety and accessibility had already been solved, with the N34 project in the municipality of Aa & Hunze. In this comparison, the problems, solutions, planning processes including the stakeholders involved and their roles, and the effects of the implementation of the solutions on both safety and accessibility of the five cases have been compared with these aspects of the N34 case. Data on these aspects for the five cases and for the N34 case, insofar as available, were collected and analysed through both media and document analyses. Based on the results of the data analyses, for both the five cases and the N34 case, it has been identified which spatial planning approach the stakeholders have used in the planning process of each case by relating the findings on the above mentioned aspects to the descriptions of the four spatial planning approaches, included in the planning theory of De Roo, and to the identification criteria for spatial planning approaches discussed in section 2.1 and Table 1 (De Roo & Porter, 2006). After identifying the spatial planning approach used by the stakeholders in the planning processes of the five cases and the N34 case, a comparative analysis has been carried out. In this comparative analysis, all above mentioned aspects, including the spatial planning approach used by the stakeholders, for each of the five cases have been compared with these aspects of the N34 case:

The results of the comparative analysis show that in the N34 case, compared to the other five cases, the level of consultation with and between stakeholders is the highest meaning that stakeholders have more say in the N34 project than the stakeholders in the other five cases had. Moreover, in the N34 case, most views and interests of affected stakeholders are taken into account in the planning process, valuable or not, while in the other cases, only views and interests considered valuable are taken into account. Furthermore, in all five example cases, stakeholders used an approach in the planning process that was more technical than the scenario approach currently used by the stakeholders in the N34 project, with the approach used in the Sea-to-Sky Highway case study being an outlier, as it was found that a technical approach was used in that project (Figure 9). This confirms that, compared to the N34 case, in all five cases there was less consultation with stakeholders and less consideration of their views and interests, meaning that stakeholders had less say and power in these projects. Compared to the N34 project, this also means that the government agencies that managed the five projects made more decisions on the final road design on their own, so without always taking into account the views and interests of all stakeholders.

Since in all five example cases, both safety and accessibility improved after implementing the final road design, this study concludes that the scenario approach currently used by the stakeholders in the planning process of the N34 case study has to be adjusted to a more technical approach in order to affect the road design in such a way that it deals more quickly and effectively with the trade-off between safety and accessibility of the N34 road section in the municipality of Aa & Hunze. This is because, by adopting a more technical approach, the Province of Drenthe has more control and power over future decisions to be made on the N34 project, as the province will take less account of the

broader stakeholders' interests and views when making decisions and increasingly prioritizes only those interests and views deemed relevant to the project. So if a stakeholder's opinion or interest does not seem relevant, the province will not include it in the planning process and the stakeholders who came up with it will no longer have power over the project. In this way, compared to when the scenario approach is continued, fewer different stakeholders are involved in the planning process and there are fewer opportunities for public participation. This also means that fewer different views and interests are considered and thus less consultation is required to make decisions on what is or is not included in the final road design, saving time during the planning process when stakeholders use a more technical approach. As a result, the N34 project comes up with a final road design sooner, which also ensures that it can be implemented earlier, leading to a reduction in congestion and traffic accidents sooner. In these times of inflation, when over time less and less can be built with the reserved, fixed budget of €90 million for the N34 project, this also means that a more technical approach will allow more to be built with the available budget. Moreover, although the planning process is not optimal when stakeholders use a more technical approach, the results that will be achieved in terms of safety and accessibility are expected to be better than when using a scenario approach as the focus is more on achieving the goals and less on reaching agreement among stakeholders. In other words, even though stakeholders are generally less satisfied with the planning process when a more technical approach is used, because their views and interests are less taken into account and they have less say in the project, the quality of both safety and accessibility of the N34 road section is expected to be at a higher level after implementation of a final road design that is based on a more technical approach.

Factors other than the differences in spatial planning approaches used by stakeholders in the planning process between the five case studies and the N34 case study may potentially explain why the trade-off between safety and accessibility was successfully dealt with in the five case studies but not in the N34 case. In the five example cases, there seems to be sufficient budget to implement the plans, while in the N34 case, the fixed budget of €90 million caused the option of constructing a cloverleaf at the Gieten traffic junction to be rejected. However, when the new Gieten traffic junction was constructed in 2011, it was already clear that improvements on and around that junction were necessary to further improve the safety and accessibility of the N34 road section. In 2011, the budget of €90 million was sufficient to implement all options, including the cloverleaf, but by 2022 the budget was insufficient to construct the cloverleaf due to inflation. Therefore, compared to the five cases, the lack of budget in the N34 case cannot be used to explain why the safety and accessibility of the N34 road section in the municipality of Aa & Hunze has not improved so far. This is because, if the planning process had not taken so long and the decision-making on a final road design had taken place in the years immediately after 2011, all options would have been realistic to implement with the available budget and the trade-off between safety and accessibility could have been successfully dealt with back then by, for example, constructing a cloverleaf. This again indicates that because of the spatial planning approach used by the stakeholders in the N34 case, the planning process took so long that good options to improve safety and accessibility had to be scrapped due to inflation.

Another potential explanation for the fact that the safety and accessibility of the five cases improved while that of the N34 has not, are the conflicting interests and resistances to the presented road designs of the N34 road section that prevented decisions on a final road design to be taken. Nevertheless, in some of the five cases presented, such as the A590 and Sea-to-Sky Highway, there have also been several protests and resistances to the proposed road designs. In these cases, despite the opposition, decisions on a final road design were taken by the project leaders, which were implemented in all cases improving both safety and accessibility. This is because these cases used a more technical approach compared to the N34, meaning that the opposing views were not or only partially taken into account when designing the final road design whereas in the N34 case the conflicting interests are taken into

account to a greater extent, which is why no decisions on the final road design have been made so far. Therefore, resistance to and conflicting interests on the road designs in itself does not explain why safety and accessibility improved in the five cases and not in the N34 case study. This, too, has to do with the differences in spatial planning approaches between the five cases and the N34 case study.

When the practical solutions in the road designs of the five cases are compared with the N34 case, conclusions can also be drawn as to which practical solutions could potentially be included in the final road design of the N34 case by the spatial planners working on the project. Based on the comparison, it seems beneficial to include one of the proposed fly-overs in the final design, as the presence of a fly-over usually improves both safety and accessibility. Moreover, it seems favourable to include the doubling of the N34 road section on both the north and south sides of the Gieten traffic junction in the final design, as doubling roads or road sections has been carried out in three of the five cases and has contributed to improving both safety and accessibility in all of them. Depending on the objectives of the N34 project and whether improving safety or accessibility is considered most important in the trade-off, other practical measures could possibly be included in the final road design. If accessibility is considered more important in the trade-off than safety, it seems beneficial to straighten and widen the N34 road section, and to construct a lane separation between the two opposing lanes. However, when safety is considered more important in the trade-off than accessibility, it is especially beneficial to reduce the speed limit. Straightening and widening the N34 and constructing a lane separation may also be beneficial for road safety, but the safety benefits are partially or completely negated by the fact that motorists' driving speed generally increases when these solutions are implemented. On the other hand, lowering the speed limit may also be beneficial for accessibility, as it may lead to less congestion, but it may also be unfavourable, as it lowers the average driving speed. The effects of implementing these practical measures on safety and accessibility thus need to be measured by researchers in the context of the N34 road section in the municipality of Aa & Hunze to determine whether they are useful to implement or not.

These results on the most appropriate spatial planning approach to be used by stakeholders in the planning process of the N34 project and the practical solutions to possibly implement can be used to inform the planners and leaders of the N34 project on which planning approach and practical solutions are most suitable to be used to achieve a final road design that deals with the trade-off between safety and accessibility sooner and more effectively. Once the spatial planning approach is used by the stakeholders in the planning process of the project and a final plan resulting from this approach is implemented, society will benefit from a quicker and better improved safety and accessibility situation of the N34 road section in the municipality of Aa & Hunze. In addition, the results of the practical solutions can be used by the planners and leaders of the N34 project as advice and suggestions to consider when designing the final plan, as these solutions show that they work in improving safety and accessibility problems in other infrastructure cases. Moreover, the results on the spatial planning approach to be used by the stakeholders in the planning process of the N34 case and the practical solutions discussed can be generalised and applied in other comparable infrastructure situations to solve safety and accessibility problems. In this way, people in other locations and contexts may also potentially benefit from quicker and better improved road safety and accessibility situations.

7. Reflection

When considering the strengths of this study, several important aspects stand out. The data from the media and document analyses are of high quality and reliable, as all data come from reliable local, regional and national media and government organisations. The appendices A and B of this study and Table 2 include all data sources used in the literature review and analysis of this study, making the analysis results verifiable. Moreover, as the N34 road section in the municipality of Aa & Hunze has been experiencing road safety and accessibility problems for more than a decade, the findings of this study have important implications for the development of the N34 planning process. As the developed planning process ultimately results in a better and faster completed final road design, the findings of this study also have important implications for the development of the safety and accessibility of this N34 road section. In this way, the findings benefit society, as motorists using this N34 road section will experience greater improvements in safety and accessibility sooner.

However, this study also has some limitations. Although comparing five case study examples with the N34 case study was sufficient to draw conclusions about the spatial planning approach that is most suitable for the stakeholders to use in the planning process of the N34 case, future research needs to compare the N34 case with more cases as this will make the results of this study more reliable. This is because as more cases are compared with the N34 case study, the results and conclusions of this study are based on more real-life infrastructure cases from different contexts, making them more generalisable. Besides comparing the N34 case with more than five case examples, future research needs to include interviews with policy-makers of the N34 project in this study. This will make the results and conclusions of this study more valid and less at risk of under- or overstating the relationship between spatial planning approach, planning process and road design for dealing with safety and accessibility trade-offs (Flyvbjerg, 2011). This will also increase the 'convergence of evidence' (Yin, 2014). Moreover, the ways in which spatial planning approaches are identified in the planning processes of all cases have not been described in detail for each case study. Thus, in future research, a roadmap needs to be included in the methodology section and applied in the results section to better explain how spatial planning approaches are identified for the planning process of each case. This will make the results more reproducible and the conclusions more verifiable.

In addition, each of the five example cases showed a positive effect on both safety and accessibility after implementation of the final road design. However, no cases were included in which there were negative effects of this implementation on safety and/or accessibility. Moreover, this study only included example cases in which a spatial planning approach with an object-oriented focus was identified. Hence, infrastructure case studies in which negative effects on safety and/or accessibility occurred after the implementation of the final road design and infrastructure case studies in which a spatial planning approach with an inter-subject focus, such as an actor-consulting or communicative approach, was used by stakeholders in the planning process need to be included in future research. This will make the results of the comparative analysis and the conclusions drawn from these results more reliable, as conclusions are now drawn from more different perspectives and contexts.

Finally, because the N34 road section in the municipality of Aa & Hunze is site- and context-specific, there is a risk that the conclusions drawn about possible practical solutions for the N34 project may not be appropriate for this case study. This is because what works in one case does not mean that it will work in another, similar case. Therefore, future research needs to investigate the effects of implementing the proposed practical solutions on both road safety and accessibility of this N34 road section. This has to be investigated by measuring for each of the proposed practical measures whether or not they have a positive effect on the road safety and/or accessibility of the N34 road section. This reduces the risk of implementing a practical measure that does not improve one or both factors.

All in all, the results appear convincing because of the high quality and reliability of the data collected. However, by incorporating and implementing the various points of interest mentioned in this section in future research, the results will become more convincing.

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Appendix A: Overview of the Media Articles used in Section 4

A1: Media articles used in section 4.1: Infrastructure Problems and Solutions in Western Countries (analysis of the five national and international cases):

Boschman, J. (2022). Hoe het Vechtdal met N340 en N377 na jaren steggelen 'nieuwe' verbindingen kreeg met de rest van het land. *De Stentor*, 04-12-2022.

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Redactie De Gelderlander (2019). *Plan voor rondweg om Oeding is opnieuw veranderd*. *De Gelderlander*, 02-09-2019.

A2: Media articles used in section 4.2: The N34 Infrastructure Problem in the Municipality Aa & Hunze (analysis of the N34 case):

De Schakel (2023). *Fly-over over verkeersplein Gieten lijkt voorkeursvariant*. Retrieved on 03-04-2024 from <https://www.schakel.info/nieuws/algemeen/69838/fly-over-over-verkeersplein-gieten-lijkt-voorkeursvariant>. Zuidlaren: De Schakel.

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Vinkenvleugel, S. (2023c). *Gemengde reacties op de halvering van de verdubbeling van de N34*. Retrieved on 03-04-2024 from <https://www.rtvdrenthe.nl/nieuws/15318773/gemengde-reacties-op-de-halvering-van-de-verdubbeling-van-de-n34>. Assen: RTV Drenthe.

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Vinkenvleugel, S. (2023a). *Knooppunt Gieten is niet drukker geworden, ook aantal ongelukken stabiel*. Retrieved on 02-04-2024 from <https://www.rtvdrenthe.nl/nieuws/15892744/knooppunt-gieten-is-niet-drukker-geworden-ook-aantal-ongelukken-stabiel>. Assen: RTV Drenthe.

Appendix B: Overview of the Documents and Reports used in Section 4

B1: Documents and reports used in section 4.1: Infrastructure Problems and Solutions in Western Countries (analysis of the five national and international cases):

Boerboom, J. (2022). *Weg van de weerstand: Biografie van de Vechtdal Verbinding*. Zwolle: WBOOKS.

BRO (2011). *Bestemmingsplan N261, Reconstructie Noord: Gemeente Waalwijk*. Boxtel: BRO.

Gemeente Winterswijk (2019b). *Ontwerpbestemmingsplan Rondweg Oeding, Kotten*. Gemeenteblad 2019 nr. 213027. Winterswijk: Gemeente Winterswijk.

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Highways Agency (2014). *A590 High and Low Newton Bypass: Five Years After Study*. Post Opening Project Evaluation. Guildford: Highways Agency.

Infrastructure BC (2005). *Achieving Value for Money: Sea-to-Sky Highway Improvement Project*. Project Report Sea-to-Sky Highway. Vancouver: Infrastructure BC.

Provincie Noord-Brabant (2005). *Projectbeslissing voor de provinciale weg N261, Tilburg-Waalwijk*. Project Beslissing 1151104. 's-Hertogenbosch: Provincie Noord-Brabant.

Provincie Overijssel (2018). *Besluit vaststelling Provinciaal Inpassingsplan N340/N48 Zwolle - Ommen, herziening 2017*. Provinciaal Blad 3006. Zwolle: Provincie Overijssel.

B2: Documents and reports used in section 4.2: The N34 Infrastructure Problem in the Municipality Aa & Hunze (analysis of the N34 case):

Beek, M. (2017). *Bestemmingsplan Reconstructie N34 aansluiting Klijndijk*. RB 10.220. Exloo: Gemeente Borger-Odoorn.

Heeres, N., Rozema, M., Praamstra, H., Horvath, F. & Bekink, J. (2019). *Verkeersonderzoek N34: Nut en noodzaak maatregelen N34*. Verkeersonderzoek N34 1. Assen: Provincie Drenthe.

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Appendix C: Protocol for the On-Site Observations

Observation Protocol: Gieten traffic junction (N34)

Objective:

Observing the road safety and accessibility (based on traffic flow and congestion) of the Gieten traffic junction and its adjacent roads which are part of the N34 road section in the municipality of Aa & Hunze.

Method:

Observation by driving over the Gieten traffic junction and adjacent roads to experience the road safety and accessibility of this N34 road section.

Observation days and times:

All observations have been conducted on weekdays at different times:

- 8:00 a.m. (morning rush hour)
- 10:00 a.m. (mid-morning)
- 12:00 p.m. (afternoon rush hour)
- 15:00 p.m. (mid-afternoon)
- 17:00 p.m. & 18:00 p.m. (evening rush hour)

Observation points:

1. Road safety

- Experiencing the sense of safety while driving at the Gieten traffic junction and the adjacent road sections of the N34
- Experiencing the sense of safety when entering the Gieten traffic junction
- Observing the driving behaviour of other motorists, both at the Gieten traffic junction and before and after entering it

2. Accessibility

- Traffic flow: experienced delays and number of times stopping/braking for Gieten traffic junction
- Traffic congestion: identify at what times of the day traffic congestion occurs and what causes it
- Experiencing the ease of entering the Gieten traffic junction

Results:

The results of the observations are consistent with the findings on the road safety and accessibility of the N34 road section in the municipality of Aa & Hunze, including Gieten traffic junction, derived from the media and document analyses. Therefore, the results are not presented any further here, but only in **section 4.2**. However, the results of the observations did confirm that what is written in media articles, documents and reports about the safety and accessibility of the N34 road section is also experienced in reality.