
Exploding poison-train or safest way of transportation ever?

A research to the difference in perspective of risk regarding the transportation of hazmat by train between citizens and planners in Eindhoven.



Master thesis
Utrecht University
Faculty of Geosciences
Spatial Planning

Utrecht, 2nd of July, 2021
Lieneke Stoop – 5861950

Supervisor Utrecht University: Dr. Francesca Pilo'
Supervisor Internship RIVM: Dr. Ir. Jeroen Neuvel



Utrecht University



Rijksoverheid
Rijksinstituut voor Volksgezondheid
en Milieu
Ministerie van Volksgezondheid,
Welzijn en Sport

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Summary

The Netherlands has an extensive railway network that is used for transporting persons, goods, and hazardous materials (from here: hazmat). Often, these trains have to cross densely populated cities and city centres. Especially for the transportation of hazmat, this brings some risk for the citizens living in the surrounding areas of the railway. Therefore, technical experts and governmental planners create rules, regulations, and protective measures to decrease the risk to an acceptable level. This acceptable level, determined by the experts and planners, is based on an objective notion of the risk. Factors that form the objective notion of risk are incident probability, population exposure, and vulnerability (Slovic, 2010; Bagheri, Verma & Verter, 2014; Covello & Merkhofer, 1993). What is missing knowledge about transporting hazmat by train in the Netherlands is information about the citizens' perspective on risk. This is a problem because according to many social scientists the perception of risk is subjective and can differ between citizens and governments (Slovic, 2010; Wachinger, Renn, Begg & Kuhlicke, 2013). This could lead to a discrepancy between citizens and governments about the (sort of) protective measures, or the citizens might not accept the transport of hazmat at all (Wachinger, Renn, Begg & Kuhlicke, 2013). The purpose of this research is to investigate this gap between citizens and planners and is therefore structured around the following question: *What is the perspective of both citizens living near railway-transportation routes and planners on the risk linked to the transportation of hazmat and the policy around it?* To answer this question, a case study in Eindhoven is executed, a city in the southern half of the Netherlands where relatively many trains with hazmat cross the city centre. During this case study, a document analysis is executed and semi-structured interviews with citizens and planners are conducted. The interviews were based on topics that came up during the literature review: social trust, experience, cognitive and affective risk interpretation, ethics, mitigation and prevention, and risk governance. The results lead to four conclusions: 1) in the Netherlands there is an influential national policy, called the Basisnet, that determines most policy about the transportation of hazmat in general. 2) citizens focus more on affective elements when calculating the risk and they tend to dramatize the consequences of an accident, while planners use more cognitive elements when calculating the risk and the consequences of an accident. 3) citizens experience on a daily basis many other inconveniences from the train passing their houses at a close distance, such as noise pollution and vibrations. These inconveniences are considered as a bigger problem than the risk regarding the transportation of hazmat. And 4) both citizens and planners are frustrated about the finished, but unused Betuweroute. The research ends with two recommendations for future policy: 1) integrate the affective contribution of citizens through formalised participation. And 2) create an integral decision-making process in which the national government, the municipalities, representing their citizens, and ProRail make decisions together.

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On the next 60 pages, I wrote my master thesis for the study Spatial Planning at Utrecht University. It marks the end of 5 years of studying and learning about myself in various contexts.

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Lieneke Stoop

Utrecht, 2nd of July, 2021.



1. Introduction

The Netherlands is a small country with over 17 million people living in 355 municipalities (CBS, 2020). Across the country, there are 7.000 kilometres of railway (ProRail, n.d.a). The railway is first of all mainly used for public transport. Besides, the railway network is used for the transportation of goods across the Netherlands and the rest of Europe. And thirdly, the railway network is used to transport hazardous materials such as chloride across the country (ProRail, n.d. b). This last function of the railway network brings some risk of accidents for the citizens living nearby the railway. And this is not about some individual houses that were built next to these transportation routes of hazardous material (from here: hazmat). In the Netherlands, these routes go straight through cities with thousands of people living close to the railway (Van Dijk, 2019). Therefore, measures must be, and are, taken in the Netherlands to protect the citizens living near railway-transportations routes of dangerous substances against accidents involving these substances.

Spatial planners from the government together with the technical experts of transportation of hazmat monitor this risk closely. Based on their knowledge and research about the risk, protection measures are taken. Also, in scientific literature, the analysis of risk and the recommendation of measures is mainly done from the technical and/or governmental perspective (Batarliene, 2020; Procházka, Hošková-Mayerová & Procházková, 2020). The main current understanding of taking measures to protect citizens against accidents with hazmat is to objectively investigate the risk and to come up with the ultimate protection measures and rules and regulations for the areas in the danger zones. The reason for this is that citizens do not have the technical knowledge to form a correct “objective” judgement of risk (Gregory & Miller, 1998). Before elaborating on this, it is needed to clarify what is viewed as ‘the risk’. This provides some insights into how the ‘objective perspective of risks’ is formed.

In general, the dominant view of risk is “the chance of injury, damage or loss” (Webster, 1983). The (negative) consequences of an event are assumed to happen in ways that can be measured by objective risk assessment (Slovic, 2010). The scientific definition of ‘the risks’ of transporting hazmat in general commonly consists of two elements: the probability of an undesirable event and the consequences of such an event (Bagheri, Verma & Verter, 2014; Covello & Merkhofer, 1993). When measuring the risk, it would be best to combine these two elements and calculate ‘The Risk’ in a quantitative way. However, due to the absence of detailed data on both elements, the measuring of risks is split into two elements (Bagheri, Verma & Verter, 2014; Abkowitz, Lepofsky & Cheng, 1992). The first way of measuring the risk of transporting hazmat is based on *incident probability*. This approach focuses only on the probability an accident happens. It is therefore only suitable for hazmat transports with a small danger zone (Bagheri, Verma & Verter, 2014; Abkowitz, Lepofsky & Cheng, 1992). The second strategy to measure the risk is based on *population exposure*. Here, the focus is on the maximum number of people exposed to the consequences of an accident with hazmat. This kind of risk measurement is suitable for estimating the required emergency response capability. Moreover, it is stated that this kind of risk measurement is suitable for estimating the risks as perceived by the public. (Bagheri, Verma & Verter, 2014; Batta & Siu, 1988).



Parameters that are mostly used to measure the risks of transporting hazmat by train are:

- Train derailment
- Point of derailment
- Number of railcars derailed
- Number of derailed railcars releasing
- Population exposure

The authors of the publication *Science for Disaster Risk Management 2017: Knowing better and losing less* write about the definition of risk in general and they add a third element to the two mentioned above: *vulnerability* (Poljansek, Marin Ferrer, De Groeve & Clark, 2017). This third element of risk is about “how the exposure at risk is vulnerable to an adverse event of that kind” (Poljansek et al., 2017, p. 40). They give the example of an earthquake: an earthquake in an area where people are familiar with earthquakes, and thus are prepared for them, causes less damage than an unexpected (smaller) earthquake in a poorly prepared area.

Thus, according to these authors, the objective risk is the combination between incident probability, population exposure, and vulnerability. However, many social scientists reject this notion of the objective risk (Slovic, 2010; Wachinger, Renn, Begg & Kuhlicke, 2013). They argue that risk is always something subjective. In their views, risk is not something that ‘exists out there’ and that can be measured, independent of cultures and the psychology of people. They state that people invented the concept of risk to understand and deal with uncertainties and dangers that come across (Slovic, 2010). This perception of risk is about “the process of collecting, selecting, and interpreting signals about uncertain impacts of events, activities, or technologies” (Wachinger, Renn, Begg & Kuhlicke, 2013, p. 1049). The perception of risk is therefore different from the objective notion of risk. In the literature review of this thesis, the topic of the perception of risk is discussed in more detail. First, the exact problem definition and the research questions that form the start of the research are presented in the next paragraphs.

1.1. Problem definition & Research questions

From the previous part, it is clear that there is already important knowledge about the objective risk. There exists, however, a knowledge gap about the perspective of the citizens living in areas nearby the transporting hazmat by train in the Netherlands. How do they view /perceive and experience the risk of accidents and how would they like to be protected? Whereas the technical part of safety measures is well investigated, the citizens' perspective on the measures against risks of transporting hazmat by train still forms a knowledge gap. This is a problem, because, as mentioned above, the perception of risk is subjective and can differ between citizens and governments. This could lead to a discrepancy between citizens and governments about the (sort of) protective measures, or the citizens might not accept the transportation of hazmat at all (Wachinger, Renn, Begg & Kuhlicke, 2013). Besides, citizens might have experiences and ideas planners can learn from. Moreover, ethical questions about factors like the process of decision-making, money, fairness of distribution of risks, underlying principles, and questions about minimalizing damage or maximalising utility are all factors that contribute to how people judge risks and subsequently how planners design protective

measures (Van Eeten et al., 2012). Therefore, knowing the perspective of citizens on these measures is essential for designing planning measures that protect the citizens against accidents and that create a grounded feeling of trust among the citizens.

The purpose of this research is to investigate the gap between the citizens' perspective on the risk of accidents with hazmat transported by train and the planners' perspective and how this difference influences the planning policy around the measures against accidents. The research is structured along the following main question:

What is the perspective of both citizens living near railway-transportation routes and planners on the risk linked to the transportation of hazmat and the policy around it?

The empirical part of the research consists of a case study of two neighbourhoods in Eindhoven, a city in the Netherlands that deals with many transports of hazmat by train. The neighbourhoods are called Tongelre and Strijp S.

The main question is subdivided into the following sub questions:

1. *What is the policy of transporting hazmat through Tongelre and Strijp S and what is the role of citizens in it?*
2. *What are the tensions and similarities in the vision of citizens and planners about risk, regarding the transportation of hazmat by train?*
3. *What are the implications of the different views of citizens and planners for the policy around transporting hazmat by train?*

The goal of the first sub question is to explore the context of transporting hazmat in general in the Netherlands. A framework about the current national and local policy is created and the role of citizens in this is researched. The second sub question aims to identify the gap that might exist between citizens and planners regarding their views on risk. The third sub question brings the results of sub question 1 and 2 together, and it explores how the current and future policy around the transportation of hazmat by train can be influenced by the differences in view of citizens and planners. In the next paragraphs, the relevance of these questions is explained.

1.2. Relevance

The research is scientifically relevant because it tries to fill in the knowledge gap of the perspective of citizens on the risk of transporting hazmat by train and the measures that are taken to protect them. Besides, the research complements earlier studies. Multiple quantitative studies have researched risk perception of people, also focussing on the risk perception of citizens (Ten Doeschot & Van Noort, 2019; Van Eeten et al., 2012; De Jonge, 2014; Slovic, 2010). However, in the Netherlands, little qualitative research is conducted to find out the reasons why citizens view risks different than planners or experts (Zonneveld, 2021). This research provides more in-depth knowledge about what people drive to judge the risks differently in comparison with the experts.

The societal relevance of the research is to gain more knowledge of the expectations/wishes of the citizens about the measurements against accidents with hazmat. Their local knowledge and experiences are valuable and might bring up unknown insights about the perception of risk around transporting hazmat by train through city centres. Besides, when the citizens can give their opinion and get involved in the research about risk and transportation of hazmat, more support is created for the safety measurements and the risks that need to be taken.

The thesis continues with chapter 2, which gives an overview of the scientific literature about the topics that are relevant for this research. This literature review leads to a conceptual framework, presented in chapter 3, that is used as a starting point for the empirical research. Thereafter, the methods used in the research are described and justified in chapter 4. In chapter 5, the results of the empirical research are presented, following the structure made by the sub questions. These results and answers to the sub questions lead to a conclusionary chapter 6, in which the main question is answered, and the discussion of the research is presented.

2. Literature Review

In the literature review, existing research on risk management in spatial planning and the interpretation of risk is reviewed. In the first paragraphs, the role of the disaster management cycle in spatial planning is presented. For many years, this has formed the most important concept in risk management, and still, it is the basis for the current risk management policies. After that, the change in strategy of reducing the hazards of potential risk after the 2000s is described. From then on, a fundamental shift in coping with disasters and the belonging risks is responsible for a change in the risk management in spatial planning. Hence, also some words are written about the concept of resilience and the so-called *risk governance cycle* (Fleischhauer, 2008). The first half of the literature review ends with a description of citizen science: an upcoming phenomenon that forms the bridge between the concept of disaster management and the concept of the perception of risk.

The second half of the literature review discusses qualitative and subjective approaches and perspectives to risk. To clarify the definition of the interpretation of risk, elements contributing to the interpretation of risk are reviewed. Second, the way the interpretation of risk might influence the acceptance of risk is discussed. It is important to make this connection because, according to the literature, there are also differences between citizens and planners regarding the acceptance of risk. Finally, the difference between the cognitive and affective interpretation of risk and the difference between planners and citizens is highlighted.

The literature review results in the presentation of the conceptual framework (Chapter 3) that follows the discussion of the scientific literature underneath and that will serve as a guideline for the empirical part of this research.

2.1. Planning and risk management

As described above, the first half of the literature review delves into theories about the risk management in general and the risk management in spatial planning.

2.1.1. Disaster management cycle

When discussing risk, disasters and policy, the theory about the disaster management cycle is one of the first to come up in the scientific discussion (Fleischhauer, 2008; Mejri, Menoni, Matias & Aminoltaheri, 2017). The cycle of disaster management visualises the different phases of risk management. The phases are prevention and mitigation, preparation, response and recovery (see figure 2.1). The first two phases are those before a disaster happens. During the prevention and mitigation phase, actors try to reduce the impact of a disaster by implementing all different kinds of measures and by optimising land use planning. During the preparation phase, actors get ready for impact. They organise rescue plans, resource plans, deployment plans and insurances. After a disaster has happened, the phase of response starts. During this third phase, the rescuing of people is started, spreading as much information as possible and executing damage mitigation. During the fourth phase, recovery, the direct impacts of the disaster are over and there is started with rebuilding and reconstruction

(Fleischhauer, 2008). The four phases should be seen as a closed-loop: by learning from experiences with disasters, the mitigation and preparation can be adjusted and therefore the risk management will become more effective (Sapountzaki, Wanczura, Casertano, Greiving, Xanthopoulos & Ferrara, 2011).

Figure 2.1: Disaster Management Cycle



Source: Kelly (2020)

As the name of the concept already tells, the disaster management cycle is developed to provide a framework for managers on how to deal with risks. In this approach, the role of the citizens is limited. It is, so to say, a top-down policy instrument. However, it is not a blueprint-instrument that is used the same way in all disciplines. Underneath, it is explained how the disaster management cycle can be applied to risk management in spatial planning.

For many years, the focus of planning in risk management was on the prevention phase and on the direct response phase after an incident happened (Mejri et al., 2017; Sapountzaki et al., 2011). The main goal of risk management during the prevention phase was to reduce the potential loss as much as possible. Or in other words: to reduce the risks as much as possible. This can either be done by reducing the exposure to the hazard using technical measures, for example by creating rules about building. The other option is to reduce the vulnerability of the people living in the exposure-zone (Poljansek et al., 2017; Lu & Stead, 2013; Sapountzaki et al., 2011). The first strategy is focused on controlling the environment and creating hazard-resistant designs. Characteristic of this strategy is that it is focussed on the technical part of risk-reducing and that it is therefore also executed by technical experts. The conception of risk is seen as a sectoral problem that needs to be solved by the people that know most about it, i.e., the experts.

The second strategy focuses on the modification of the vulnerability, or more precisely the reduction of vulnerability. Often this is also seen as increasing the resilience of an area (Poljansek et al., 2017; Lu & Stead, 2013). According to this view, community preparedness, forecasting, and warning systems are essential for reducing the risk. In contrary to the first strategy, here the measures are mainly undertaken by civil protection agencies that represent

the citizens (Sapountzaki et al., 2011). The first notion of the term resilience describing this strategy of coping with risks in spatial planning came up in the 1990s (Mileti, 1999).

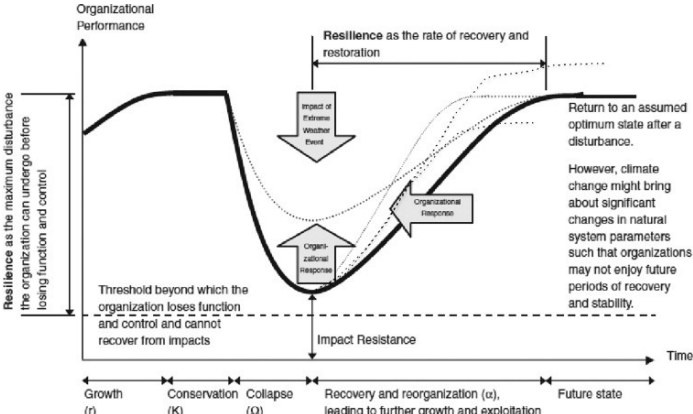
The two strategies of reducing the risk of potential hazards as much as possible are meant to be combined, but communication between the two seems hard because of differences in interests and historically fragmented public administrations (Sapountzaki et al., 2011). Concludingly we can say that until the 1990s the role of spatial planning in risk management was preventing disasters from happening by using the knowledge of experts and informing citizens of warning systems. The approach was sectoral, and the citizens only had a passive role in the way spatial planning dealt with risk management.

2.1.2. Risk management since the 2000s

A decade later, the scientific literature began to focus more on adaptation to disasters. Because it became clear that many incidents could never be prevented completely, the focus became more on policies to cope with inevitable disasters (Lu & Stead, 2013; Mejri et al., 2017). In the context of the Netherlands and her fight against the water, this paradigm shift is often expressed as the shift from ‘keeping feet dry’ to ‘living with water’. This also means the resilience of areas became more important. Therefore, the term resilience is discussed first, before moving on to the policies of spatial planning regarding risk management.

The simple, broadly supported definition of resilience is the capability to deal with or absorb disturbances, while still remaining functional (Holling, 1987; Holling, 2001; Taşan-Kok, Stead & Lu, 2013). A characteristic that is often associated with resilience is the ability to learn from incidents in order to become more resistant to change (Lu & Stead, 2013). Therefore, resilience is two-sided: on the one hand, it is about minimalizing the risks, on the other hand, it is about being able to undertake actions to deal with disturbances when they have happened. A concept that is considered to represent the term resilience is that of the adaptive cycle (Folke, 2006; Walker, Holling, Carpenter & Kinzig, 2004; Lu & Stead, 2013). This is a cycle of four phases, quite similar to the disaster management cycle, that a system (for example an ecosystem, society or economy) passes: growth and exploitation, conservation, collapse or release and renewal and reorganisation (see figure 2.2.). The phases can slowly change into each other, but this can also happen with rapid shocks.

Figure 2.2.: The adaptive cycle



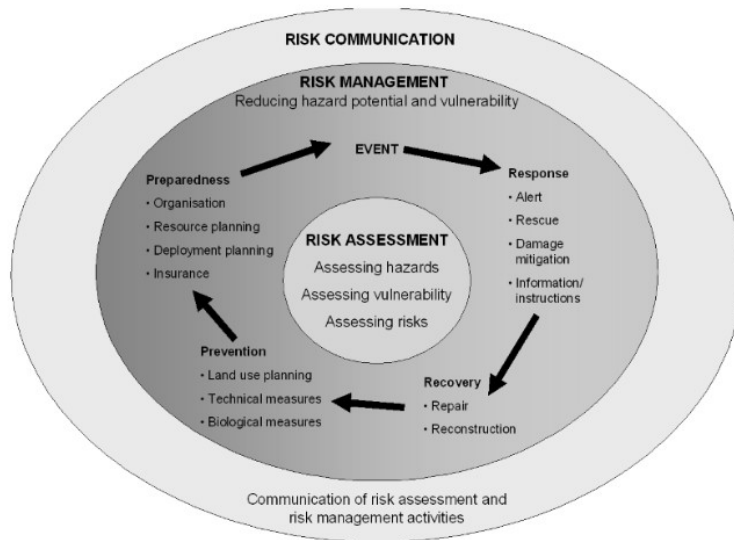
Source: Lu & Stead (2013)

In the literature, the concept of resilience is mainly discussed linked to natural disasters and climate change (Lu & Stead, 2013; Campbell, 2006; Hartmann & Driessen, 2017). However, spatial and urban planning is often not seen as a key component in these situations (Mejri et al., 2017). The general idea about coping with catastrophes is to just rebuild the physical area (Mejri et al., 2017; Vale & Campanella, 2005). In their book about the modern, resilient city Vale and Campanella give critique on this. According to them, rebuilding after an incident is never just about the physical aspects. The approach should change from this sectoral way of dealing with hazards to a more integral approach. Social and economic factors need to be integrated into the new plan to create a spatial plan that suits the use and functionality of the spaces and structures that are developed (Vale & Campanella, 2005). Spatial planners can therefore use an incident as a window of opportunity to readjust to pre-event vulnerability and level of risk in a positive way. Mejri et al. define the process of reconstruction after an incident as “a process integrating physical restoration of the built environment, to which spatial planners have to provide a substantial contribution, and boosting of social and economic activities to guarantee that what will be rebuilt will not be an empty shell deprived of its vital functioning core.” (Mejri et al., 2017, p. 46).

According to Jabareen (2013), many studies of urban resilience use the concept of resilience to simplify and overlook the complexities. In policy documents, the term is used with limited understanding. This complexity also became clear in a study by Hartmann & Driessen (2017) to flood risk management in Europe. It turned out to be quite challenging to implement the European plan in terms of governance: many actors are involved, the institutional context needed to be taken into account and the approach of the object of the flood risk management plan needed to change.

A point of discussion that is related to the above and that is mentioned multiple times in the scientific literature is that risk management, in general, is very complex because of the sectoral way in which it is organised (Sapountzaki et al., 2011; Jabareen, 2012; Hartmann & Driessen, 2017; Fleischhauer, 2008). Fleischhauer (2008) and Sapountzaki et al. (2011) therefore argue that the role of spatial planning in risk management is too small at this moment. In their view, spatial planning needs to play a bigger role in risk management in order to coordinate the sectoral issues of risks and safety and spatial planning in general. Spatial planning could be the binding actor between risk assessment, risk management and risk communication to the citizens (Fleischhauer, 2008). Fleischhauer, therefore, came up with the “risk governance cycle” (see figure 2.3). In this risk governance cycle, the complexity of risk management in spatial planning becomes visible.

Figure 2.3: The risk governance cycle



Source: Fleischhauer (2008)

Concludingly, we can say that the role of spatial planning in risk management has shifted from preventing risks from happening to adapting to the risks and finding ways to become more resilient in case incidents happen. What stands out is that the literature says very little about the role of the citizens. And that while often citizens are the ones that have to deal with the consequences of incidents. However, although it is not the main element of disaster management in spatial planning, a discussion about the role of citizens in managing risks is present. This is discussed in the next paragraph.

2.1.3. Citizen Science

It is a general trend in many disciplines that citizens are more and more involved in scientific studies (Paul et al., 2018). The reason for this is that the societal relevance of a research has become more important (Paul et al., 2018). The trend embraces not only just the participation of citizens in a passive way, but also the real engagement of citizens in a study in terms of analysing data and thinking about solutions. This phenomenon is called *citizen science*. The general definition of citizen science is as follows: “*the participation of nonprofessional scientists in research projects that involve data collection, interpretation, and analysis*”. (Paul et al., 2018, p. 2). Traditionally, citizen science was mainly used in biomedical studies, think for example of medical tests on humans (Paul et al., 2018; Buytaert et al., 2014). Citizens were also involved deeply in the developments of Geographic Information System (GIS) networks (Paul et al., 2018). In the discipline of risk management citizen science was not used at all for years, mainly because this discipline was viewed as being too technical for citizens to participate in (Paul et al., 2018). However, with the help of the internet, the media and mobile phones with apps, a change started. We see this for instance in the discipline of climate change. With these digital tools, citizens can collect data about the environment. These data can thereafter easily be

compared with data from all over the world (Buytaert et al., 2014; Huddart, Thompson, Woodward & Brooks, 2016). An example of this kind of citizen science in the Netherlands is the national bird counting in the garden. During this counting, every citizen that wants to be involved in the research needs to count all the birds in their garden for 30 minutes on one day at a specific weekend. You also need to provide some data about the species and your location. This gives the researchers an overview of the status of the bird species in the Netherlands (Vogelbescherming Nederland, 2021).

What we see now in the discipline of environmental studies and climate change is that citizens themselves are the most important stakeholder. They have to deal with the consequences of, for example, a flooding river. Therefore, they want to be part of the problem definition and the collection of relevant data (Buytaert et al., 2014; Huddart, Thompson, Woodward & Brooks, 2016). The degree to which citizens are involved in a scientific research is categorised into four levels (Paul et al., 2018): the first level is called 'crowdsourcing' and can be described as citizens as sensors. The second level is the distributed intelligence. On this level, citizens are used as basic interpreters. On the third level, participatory science, citizens also participate in the problem definition and data collection. The fourth level is called extreme citizen science. This means citizens collaborate in the problem definition, data collection and the data analysis. The fourth level is getting more and more popular, but unfortunately it is often not translated to real, usable knowledge for the people that are directly affected by environmental change (Harris, 2016). What becomes clear is that the coupling of risk management and citizen science is complex and that this acknowledges an effective risk governance, as visualised in the former named risk governance cycle. To make this risk governance effective, citizen science needs to be implemented in all phases of the disaster management cycle: in the pre-disaster phase, early signals can be picked up from citizens in order to prevent a disaster. During the in-disaster response phase, we can learn from the way citizens react to a disaster. And in the post-disaster recovery and adaption phase, citizens can participate in thinking about how the deal with the disaster next time (Paul et al., 2018).

Thus, the involvement of citizens becomes more important in risk management. Therefore, it is relevant to know how citizens view and interpretate risk and whether a difference exists between their view and the view of spatial planners and experts. The following part of the literature review, therefore, goes into the way risks are interpreted by people.

2.2. Risk

In the following paragraphs, the concept 'risk' is discussed to get a better understanding of the concept and to give an overview of what is already written about risks in current research. What became clear from the discussed literature in the introduction of this thesis is that in social sciences an objective notion of risk is rejected. Therefore, here the concepts of the interpretation of risk and the acceptance of risk are discussed. Furthermore, the objective risk and the subjective risk are placed in this discussion in relation to each other.

2.2.1. The interpretation of risk: experience & trust

What becomes clear from the literature is that an interpretation of risk is formed by many different factors and that it varies per person because of the uncertainties of risks and the emotional components of it (Slovic, 2010; Terpstra, 2011; Van Eeten et al., 2012). In general, the interpretation of risk is about “the process of collecting, selecting, and interpreting signals about uncertain impacts of events, activities, or technologies” (Wachinger, Renn, Begg & Kuhlicke, 2013, p. 1049). Two main elements that are essential for the formation of the interpretation of risk of citizens came up in the literature research: own experience and trust in scientific experts, authorities, and protective measures (Wachinger et al., 2013; Slovic, 1993; Slovic, 2010; Terpstra, 2011).

Experience

When talking about experience, the interpretation of risk is mainly influenced by *direct experience* of incidents (Wachinger et al., 2013; Slovic, 2010). When people experience a, for example, natural hazard themselves, the interpretation of risk most of the time increases. However, when it is about a very rare, seldomly happening natural hazard the perception of risk decreases because people think the chance that this will happen to them again is very small (Poljansek et al., 2017). This has also to do with the fact that humans have short memories regarding risks. Take for example the tsunamis in 2004 and 2011 in Thailand: although the risks were known, few people worried about tsunamis because they were rare and because none was filmed until 2004.

Terpstra acknowledges that this view of experience influencing the interpretation of risk negatively applies to natural hazards, especially to flood hazards (Terpstra, 2011). However, he points to the fact that studies in other fields show results that prove the other way around: peoples’ interpretation of risk decreased after experiencing a hazardous incident (Halpern-Felsher, Millstein, Ellen, Adler, Tschann & Biehl, 2001). Lindell and Perry (2004) explain this by the fact that people can also interpret their experience with a hazard as something they learnt from or are just happy with the fact they survived the hazard. Terpstra researched this hypothesis under citizens with flood hazard experience in the Netherlands. He found out that indeed positive feelings, although in a lower amount than negative feelings, can result from experiencing a flood hazard. These feelings do influence the interpretation of risk (Terpstra, 2011).

Trust

A second factor that is important for the interpretation of risk of citizens is trust in scientific experts and authorities and confidence in protective measures (Wachinger et al., 2013; Gregory & Miller, 1998; Terpstra, 2011). There are two reasons for this: first of all, natural disasters or accidents with transporting hazmat are situations that cannot be controlled by citizens themselves (Wachinger et al., 2013). They are dependent on the actions of experts and governments to protect them. Secondly, citizens do not have the technical knowledge to form a correct, cognitive perception of risk (Gregory & Miller, 1998; Terpstra, 2011).

Because of these two reasons, citizens need to estimate the risk based on the information they get from experts and governments. Trust in this information and the willingness of people to be dependent on this information from institutions responsible for making decisions about their safety and health is therefore crucial in forming a realistic perception of risk (Terpstra, 2011; Siegrist, Cvetkovich & Roth, 2000). Multiple studies showed that a high amount of this so-called *social trust* positively influences the interpretation of risk: people with much social trust view less risk and more benefits than people who do not have much trust in the institutions (Siegrist, Cvetkovich & Roth, 2000).

Characteristic of social trust is that it can be destroyed very easily, but it is difficult to rebuilt (Slovic, 1993; Slovic, 2010). Slovic (2010) identified four reasons why trust can be easily destroyed:

1. Negative events are more visible than positive events. A negative event is often quite visible and clear, for example, a car accident or human errors are clear events that are negative. A positive event is often less concrete, for example when you count one day without car accidents it is hard to tell how many positive events have happened.
2. Negative events weigh more than positive events. In his paper of 1993, Slovic shows that, even if both kinds of events are visible in the same amount, people tend to give more weight to the negative events.
3. Bad news tends to be more credible than good news. Slovic (2010) illustrates this with the example of animal studies: in general confidence in the validity of these studies is low. However, the trust in the validity of these studies for predicting health effects for humans increases significantly when a study has found that a chemical causes cancer in animals.
4. When distrust is initiated once, it tends to reinforce more distrust.

Thus, from the perspective of the citizens, the factors experience and social trust in authorities are important to form an interpretation of the risk of an activity. This interpretation of risk thereafter influences the acceptance of the risk, which is discussed below.

2.2.2. Risk acceptance: voluntary action, reasonability and blamability

Besides the interpretation of risk, but slightly connected to it, the concept of the 'acceptance of risk' is discussed broadly in the scientific literature. Theoretically, and viewed from a cognitive perspective, the risks are accepted when the benefits of a positive outcome are bigger than the disadvantages of a negative outcome combined with the chance that the negative scenario will happen (Zheng, Yu, Ma, Mi, & Jiao, 2021). Because citizens depend on institutions to get knowledge about risks and benefits, social trust is important to be able to make this decision about risks and benefits (Zheng et al., 2021; Slovic, 2010).

However, in reality, citizens' emotions have a big impact on determining whether people view the risks as acceptable or not (Zheng et al., 2021; Verhoeven & Duyvendak, 2016). Verhoeven and Duyvendak (2016) for instance name the example of fear: this is an emotion

that is hard to drive away with logical, cognitive arguments, but that influences the perception of risk, and therefore the acceptance of risk. Another example of an emotion that influences the acceptance of risk is that of fairness (Verhoeven & Duyvendak, 2016; Van Eeten et al., 2012). This is a big concept in the field of projects that fit the category 'Not In My Backyard'. When people feel they must take higher risks than other people, the acceptance of risk becomes lower, even if cognitively spoken the amount of risk is quite low.

In the report written by Van Eeten et al. (2012) three categories of factors that influence the perception of risks and whether we as citizens accept risks are described: voluntary action, reasonability and blamability.

To start with voluntary action: people find imposed risks less acceptable than risks assumed voluntarily. Interesting about this is that the question of whether it is an acceptable risk is not about the size of the risk but about the self-determination of facing the risk. Second, reasonability is about the question of fairness: is the amount of risk for me higher than the amount of risk other people face? Again, the perception of risk is not about the objective size of the risk. Thirdly, blamability. This is about the question of guilt regarding the risks we take. Damage caused by accident is valued as smaller damage compared to damage caused consciously, even though the actual damage is the same.

Van Eeten et al. (2012) mention that these three factors are not objective factors by themselves. They give as example the voluntary choice to drive a car and accept the risk that is involved with driving in traffic: people experience driving a car as a choice and therefore accept relatively high risks. However, our modern society is on a high level built around using cars, so for many people driving a car is necessary and therefore not a real voluntary choice. This example brings in the political factor of the perception of risk: the framing of the risk and situations influence the perception of risk.

2.2.3. Cognitive and affective elements: planners VS citizens

Following the previous paragraphs, it can be concluded that the interpretation of risk, and its acceptance, consist of cognitive and affective elements. What appears from multiple studies is that a discrepancy exists between how citizens balance these two sorts of elements in forming their interpretation of risk and how experts balance them (Slovic, 2010). Experts, on the one hand, form an interpretation of risk mainly based on cognitive elements. For example, the expected mortality or incident probability. Citizens, on the other hand, focus more on the affective elements such as equity, controllability, uncertainty, fear and maximum possible damage (Slovic, 2010). Thus, for example, someone who calculates the chance he gets involved in a car accident makes a cognitive perception of the risks. But the fear that he gets involved in an accident contributes to the affective part of his perception of the risks. These parts together form the perception of risk of this person regarding car accidents. Experts do not take this fear in the calculation of the risk, but only look at the cognitive calculation of the odds. This difference in the calculation of the risks and the risks people experience is visible in table 2.2.3., which is part of the paper of Slovic (2010):

Table 2.2.3

Table 2 - Ordering of perceived risks for 30 activities and technologies. The ordering is based on the geometric mean risk ratings within each group. Rank 1 represents the most risky activity or technology.

Rank Order		
1977 Laypersons		Experts
1	Nuclear power	20
2	Motor vehicles	1
3	Handguns	4
4	Smoking	2
↓		↓
17	Electric power (non-nuclear)	9
↓		↓
22	X-rays	7
↓		↓
30	Vaccinations	25

Slovic, 2010

What, for example, can be concluded from this table is that smoking is an activity that is seen as less risk by citizens in comparison to the experts. This discrepancy between experts and citizens is problematic. Because this can result in a situation where people do not take the risks of smoking very seriously and do not adjust their behaviour. On the other side, the table shows that nuclear power is seen as very dangerous by the citizens, but that is considered as quite low in risks by the experts. This can result in a situation where citizens are afraid of nuclear power and protest against it.

Poljansek et al. (2017) give a comparable example of driving cars or travelling by train: many more people die on the road than because of a train crash. However, when a train crashes, this often causes several deaths at once, instead of just one or two at a time. This might result in calls to spent money in order to improve the already quite safe railway, while the same amount of money could have helped save more lives if it was spent on the road network.

In the next chapter, the Conceptual Framework, it is explained how the theories described above contribute to and are used in the follow-up of this research.

3. Conceptual Framework & Research Questions

In the previous chapter, an overview of the scientific literature about spatial planning and risk management and the perception of risks is provided. In the figure below, the conceptual framework that is formed out of this literature is outlined. In this chapter, the relation between the conceptual framework and the research questions is presented.

As already introduced before, the central question of this thesis is: *What is the perspective of both citizens living near railway-transportation routes and planners on the risk linked to the transportation of hazmat and the policy around it?*

This main question is subdivided into the following sub questions:

1. *What is the policy of transporting hazmat through Tongelre and Strijp S and what is the role of citizens in it?*
2. *What are the tensions and similarities in the vision of citizens and planners about risk, regarding the transportation of hazmat by train?*
3. *What are the implications of the different views of citizens and planners for the policy around transporting hazmat by train?*

Thus, central in this research is the perspective of citizens and planners on risk and planning measures developed to protect them.

Sub question 1 goes into the policy of transportation hazmat in the Netherlands. What becomes clear from the literature reviews is that in risk management the *disaster management cycle* is a central concept. The focus of spatial planning in risk management was mainly on prevention and direct response and shifted through the years to adaption and coping with disasters. Overall, risk management remains very complex because of its sectoral identity and its integral consequences. Spatial planning could play a role in bringing some structure to this. This role for spatial planning in risk management is visualised in the risk governance cycle. Remarkable is that role citizens play in the traditional risk management policies is very small, despite citizens are often the ones that have to deal with the consequences of incidents. During the last years, this started to change. Slowly, but gradually, citizens get more and more involved in scientific and in governmental policy-making. The goal of sub question 1 is to research the situation in Tongelre and Strijp S, the case studies of this thesis.

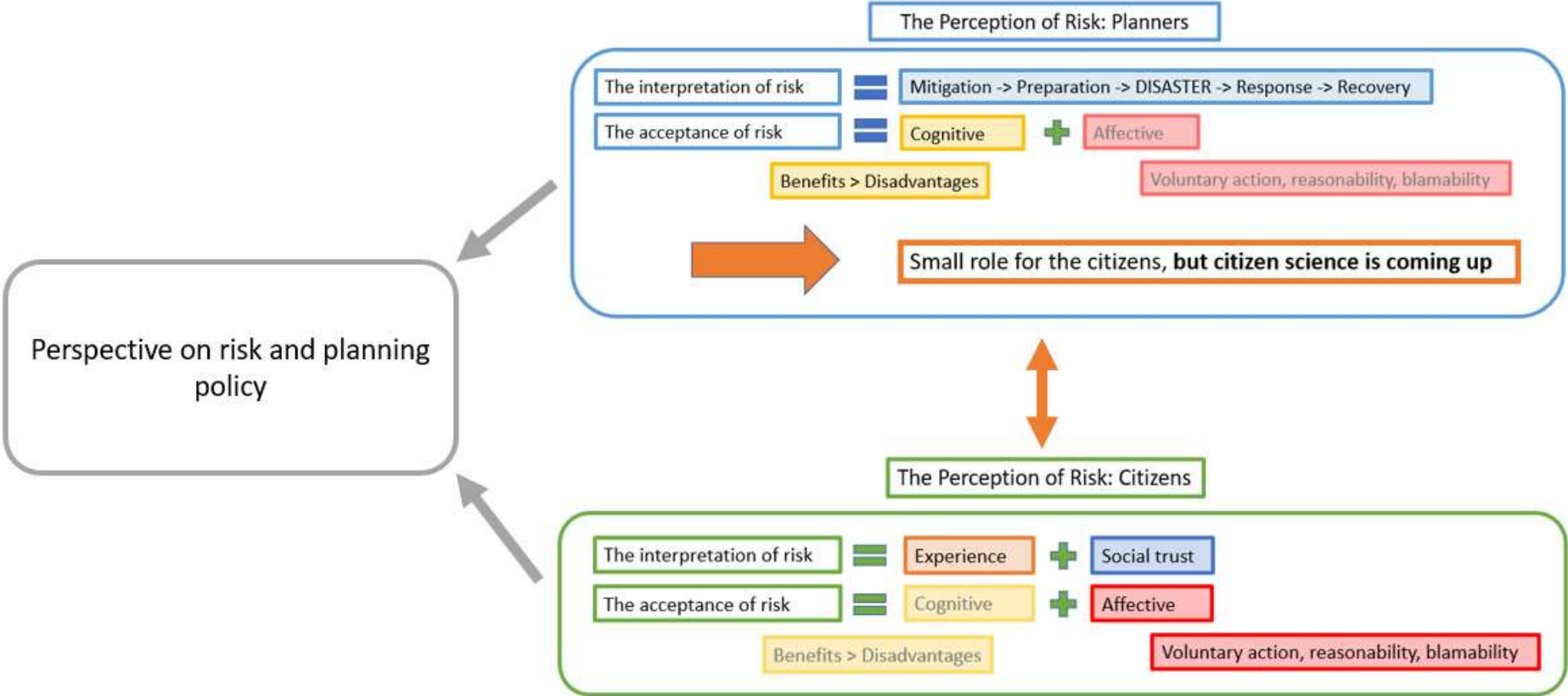
Sub question 2 is about the difference in perspective about risk of citizens and planners. As is presented in the literature review, scientists, governments and citizens are starting to realise how the citizens' perspective about risk might differ from the governmental perspective, and more importantly: how this can contribute to better risk management policies. Therefore, the literature review discusses what is already known about the citizens' and planners' perception of risks. The perception of risk consists of the elements *risk interpretation* and *risk acceptance*. Out of the literature review come up two factors that are the main factors determining how citizens interpretate the risk: own experience with incidents and social trust in authorities. Whether citizens accept the risk or not depends on their cognitive calculation of the risk plus the affective influences. This is in contrast with how

experts or spatial planners view the acceptance of risk: they only look at the cognitive part of calculating the risk. By asking sub question 2, this research explores if and how these differences in forming a perspective of risk regarding the transportation of hazmat by train show off in the case of Tongelre and Strijp S.

Sub question 3 researches how the results of sub questions 1 and 2 influence the current and future policy around transporting hazmat by train in the Netherlands. It therefore closes the circle between sub questions 1, 2 and 3. Besides, this way, the results found around sub question 2 get the right weight and importance.

Underneath, the visualisation of the conceptual framework is presented. The grey arrows visualise that the perception of risk and of the risk management executed by the government eventually determine the perspective of citizens and planners on risks and on the policy around transportation of hazmat by train. The orange arrow visualises the differences described in the literature review between citizens and planners in forming their perception of risk.

Figure 3.1: Conceptual Framework



Source: own source

The next chapter explains the methodology used to answer the research questions and presents how the insights gained through the literature research fit into this research to the perception of risk of transporting hazmat by train.

4. Methodology

In this chapter, the methodology used for this research is described. First, the general methodological approach is described (4.1). Thereafter, the choice for the case studies of Tongelre and Strijp S is explained and justified (4.2). After that, the data collection (4.3) and data analysis (4.4) are discussed. The chapter ends with the operationalisation of the conceptual framework (4.5).

4.1. Methodological approach

This research is set up to contribute to a better understanding of the gap between the citizens' perspective on planning measures against accidents with hazmat transported by train and the planners' perspective. The research is structured along the following main question: *What is the perspective of both citizens living near railway-transportation routes and planners on the risk linked to the transportation of hazmat and the policy around it?*

The main question thus focuses on figuring out the difference in perspective between citizens and planners. A difference in perspective is not something that can be measured with numbers or hard data. The nature of *perspective* is that this differs for people and that also the interpretation of a perspective gives some room for different nuances. This research therefore can be seen as an interpretivist research (Bryman, 2016).

In line with interpretivist characteristic of the research, the research uses a constructionist ontology. This means that the social phenomena that are researched constantly change and are constructed by the changing society we live in (Bryman, 2016). As became clear from the literature review, the perspective of planners and citizens on risk and planning measures is something that depends heavily on context and environment. It therefore is a social challenge where is not mutually agreed upon one scientifically based, linear and optimal solution for everyone (Bryman, 2016).

These interpretivist characteristics and the constructionist ontology approach result in the usage of qualitative research methods (Bryman, 2016). This research strategy fits best because it "embodies a view of social reality as a constantly shifting emergent property of individuals' creation" (Bryman, 2016, p. 36).

4.2. Case study design: Tongelre and Strijp S

The empirical part of the research consists of an embedded single case design. The units of analysis are Tongelre and Strijp S, two neighbourhoods in the city of Eindhoven. In the following paragraphs, the argumentation for choosing the used research method is set out. Thereafter, the motivation for choosing these two specific cases is provided.

Yin (2009, p. 2-3) writes the following about case studies: *"As a research endeavor, the case study contributes uniquely to our knowledge of individual, organizational, social, and political phenomena. Not surprisingly, the case study has been a common research strategy in psychology, sociology, political science, business, social work, and planning (Yin, 1983). Case studies are even found*

in economics (...). In all of these situations, the distinctive need for case studies arises out of the desire to understand complex social phenomena."

The social phenomena of figuring out perspectives of citizens and planners therefore fits well with a case study design. When specialising the case study design in more detail various factors determine which cases are suitable for the research, such as representativity, accessibility and variety (Yin, 2009). For this research, a single case study design is created that serves a revelatory purpose (Yin, 2009). Not much qualitative research is conducted in the Netherlands to the perspective of citizens on the transportation of hazmat by train. Therefore, delving into the details of a case that has much experience with this transportation can bring up worthwhile new information (Bryman, 2016). By executing a case study research design, the contextual factors can be taken into account when analysing the results (Bryman, 2016).

4.2.1. Why Tongelre and Strijp S?

Important for the choice of the case is the demand that the case can serve as a *representative* case (Yin, 2009), or, as Bryman (2016) would call it, an *exemplifying* case. This requires that the case can be seen as an example of a broader category of cities in the Netherlands where trains transporting hazmat ride through the city centre.

This need for representativity resulted in the selection of Tongelre and Strijp S (both neighbourhoods in Eindhoven) as the two cases for this research. Eindhoven is situated in the south of the Netherlands, alongside the Brabantroute. This is a transportation route for hazmat by train. The Brabantroute goes straight through the neighbourhoods Tongelre and Strijp S.

The first reason why the neighbourhood of Tongelre is chosen is because Tongelre is a densely populated neighbourhood, comparable with many other Dutch neighbourhoods, where the houses are built close to the railway. These houses were already built long before the transportation of hazmat by train was on the current level. It therefore represents the situation of multiple bigger and smaller cities and towns that are situated alongside one of the transportation routes of hazmat.

The second reason why Tongelre is chosen as the unit of analysis of this research is because the trains form a lively subject of discussion among the citizens (Burg, 2019; Boon, 2019). People experience much inconvenience from the transports and want them to stop. The municipality of Eindhoven has done some adjustments to the houses to reduce the inconveniences such as noise pollution and vibrations, but not all citizens think they have done enough (Boon, 2019). In the next chapter, the case of Tongelre is described in detail.

The reason Strijp S is added as a second unit of analysis of the research is because Strijp S is a neighbourhood alongside the railway that the municipality is planning to develop (Eindhoven, 2020). In contrary to Tongelre, in Strijp S do not live many citizens yet. The area mainly provides room to small businesses at the moment. Therefore, view problems exist for planners considering the rules and regulations around the transportation of hazmat through the neighbourhood alongside houses. However, the municipality is planning to build houses in Strijp S. It is interesting to compare Tongelre with Strijp S because when the houses in Tongelre were built, not as much transport of hazmat by train existed as there is nowadays.

Moreover, the rules of transporting hazmat and the risk this brings for the citizens living alongside the railway were different than they are nowadays. In Strijp S, they planned to build houses in the area, but they already know this brings risks and inconveniences for the citizens that will be living here. For the research, it is relevant to research how this makes a difference in the way planners look at the risks and at the perspective of future citizens.

4.2.2. Limits of case study research

Above, the choice for conducting a case study is justified, however, some limitations of conducting case study research exist that need to be named. The biggest, and most named limitation of case study research is that results will always be influenced by the context of the case (Flyvbjerg, 2006). Therefore, the results can not be copied and pasted directly to other cities in the Netherlands. This is also not the goal of the research. It is meant to provide more insights into the difference in interpreting risk between citizens and planners. In reviewing the results this should be the main focus, taking the context into account. Therefore, the pros outweigh the cons of conducting a case study research as the method to answer the main question of the research. Underneath the methods that are used to collect the qualitative data from the cases are described.

4.3. Data collection

In line with the embedded single case design, two qualitative measures to conduct the empirical data are used: a document study and semi-structured interviews. In the following paragraphs, the motivation for using these methods is provided.

4.3.1. Document study

Executing a document study can be defined as *“a systematic procedure for reviewing or evaluating documents – both printed and electronic”* (Bowen, 2009). The goal is to gain more information about a subject and to systematically develop empirical knowledge out of existing documents with images or text (Bowen, 2009; Bryman, 2016). A document analysis can be used for the purpose of triangulation (Bowen, 2009): the researcher is able to compare the results from document study with the results of the semi-structured interviews. The credibility of the results of the paper therefore increases. Besides, conducting a document study gives the researcher an overview of the context of the cases, as well of the current context as of the historical context of the cases (Bowen, 2009). Next to that, a document study might bring up questions and unclarities that need to be asked to respondents. It therefore prepares the researcher for the semi-structured interviews (Bowen, 2009; Bryman, 2016).

Limits and opportunities document analysis

Analysing documents has both advantages and disadvantages (Bowen, 2009; Yin, 2009). To start with the disadvantages: first of all, documents are written for other purposes than doing research. This means that often they contain not enough details to answer the research question. Second, documents may not always be (completely) accessible. Thirdly, if the

researchers do not have a complete overview of all the documents relevant to analyse, biased selectivity of information arises, which influences the results.

However, the advantages of conducting a document study outweigh the cons: firstly, a document analysis is very cost-effective, secondly, documents are stable sources that are not influenced by the research process of the researchers. Thirdly, documents that include names, details of the case and references give very exact information about the subject. And finally, executing a document study allows the researcher to obtain a very broad view of the subject (Bowen, 2009).

Because of these advantages, the strategy of analysing documents is very suitable for this research. It enables the researcher to delve into the background of the transportation of hazmat in general, by train, and focus on the context of the Netherlands. It also helps the researcher to be more familiar with the rather technical part of transporting hazmat and with the jurisdictional part. Documents that are analysed are the following:

- Documents that provide insights into the national rules and regulations of transporting hazmat in the Netherlands.
- Documents that provide insights into the national and local rules and regulations of building around railways that are used for transporting hazmat.
- Documents that provide insights into the spatial situation of Tongelre and Strijp S.
- (Local) news articles that provide insights into the way local citizens feel about the transportations.

4.3.2. Semi-structured interviews

Complementary to the document study semi-structured interviews are conducted with citizens and planners. Only by using qualitative techniques, the views, interpretations, and opinions of people can be researched (Bryman, 2016; Bogner & Menz, 2009). A structured topic list provides a guideline for the interviewer but keeps enough room for the respondent to react to questions and elaborate on topics (Bryman, 2016; Mason, 2018). Especially with a topic like risk and impactful accidents, high emotions among the respondents may be triggered. Therefore, it is wished to leave some room for the respondent (Bryman, 2016). This way, topics that result from the literature review can be discussed as well as topics that are broad up by the respondents themselves. It has to be taken into account that there is a role for the social dimension in this kind of interviews (Bogner & Menz, 2009). People can think differently about the topics and the results can be influenced by external factors. Therefore, the responses must be seen in the light of the context of the respondent. In chapter 5, the context is sketched in as much detail as possible.

Because this research aims to explore the gap between citizens and planners, interviews are conducted with respondents from both actor groups. This way, the differences in views and interpretations between citizens and planners can be distinguished. The main general selection criterium for respondents belonging to the actor group of citizens was that they live in the zone around the railway that would potentially experience harm from an accident with

a train transporting hazmat. In the spatial plan of the neighbourhood Tongelre and Strijp S, this zone is the area within 200 meters of the railway (Eindhoven, 2019; Eindhoven, 2017). For this research 7 citizens are interviewed. The main general selection criterium for respondents belonging to the actor group of planners was that they are involved in the planning of spatial planning measures that are meant to protect citizens from harm when an accident with a train transporting hazmat happens. These are people from the municipality of Eindhoven and from the Veiligheidsregio Brabant-Zuidoost (from here VRBZO). This is the organisation that keeps an eye on the integral safety of a specific area. The Netherlands is subdivided into 25 of these safety regions. By using these selection criteria, the respondents most relevant for this research are interviewed. For this research 6 planners are interviewed. Underneath the complete list of respondents:

Citizens:

1. Citizen 1	April 16 th , 2021	By phone
2. Citizen 2	April 30 th , 2021	In real life
3. Citizen 3	April 30 th , 2021	In real life
4. Citizen 4	April 30 th , 2021	In real life
5. Citizen 5	April 30 th , 2021	In real life
6. Citizen 6	April 30 th , 2021	In real life
7. Citizen 7	May 10 th , 2021	By phone

Planners:

8. Municipality of Eindhoven 1	May 3 rd , 2021	Videocall
9. Municipality of Eindhoven 2	May 3 rd , 2021	Videocall
10. Municipality of Eindhoven 3	April 19 th , 2021	By phone
11. ProRail	May 20 th , 2021	Videocall
12. Researcher case studies	March 11 th , 2021	By phone
13. VRBZO	May 3 rd , 2021	Videocall

Respondents were contacted via contact persons at multiple organisations: the municipality of Eindhoven, the VRBZO, neighbourhood association 't Oude Raadhuis, multiple Facebook groups, and via the RIVM. These contact persons brought the researcher in contact with both the planners that are in charge of the rules and regulations around the railway and the spatial developments around it in Eindhoven, and the citizens living in Tongelre. From there the tactic of *snowballing* is executed. By asking respondents for other persons that should be interviewed for this research other interviewees are contacted. Citizens were contacted by posting calls on social media and by putting flyers at the neighbourhood associating from Tongelre: 't Oude Raadhuis. It was not possible to interview citizens from Strijp S, because this is a situation that is yet to be realised.

Due to COVID-19 restrictions, most interviews were conducted via videocalls or by phone. Some interviews with citizens living in Tongelre were conducted outside or in the neighbourhood association building.

Limits semi-structured interviews

The method of using semi-structured interviews provides more in-depth knowledge about how people view the risks and the planning measures, but it does not give us hard, statistical data about how people think about this. Moreover, this way of collecting data from respondents is more difficult to replicate because the questions are not set in stone. Therefore, every step of the methodology that is used is described in detail. Above that, the transcripts and recordings of the interviews can be viewed on request.

Besides, a factor that needs to be taken into account in this research in general, is that the ride of trains through the city centre all kind of inconveniences for the citizens. Think for example of noise pollution and vibration when a train pass. These factors are not specific to the transportation of hazmat, but are a big concern for citizens (Burger, 2019; Boon, 2019). This might draw the attention away from the fear people might have for the risk of transporting hazmat. Therefore, the interviewer needs to be aware of these factors and needs to keep the interviews on topic.

4.4. Data analysis

The interviews are recorded, with permission of the respondents. The transcripts from the interviews are analysed thematically by using codes. Firstly, these codes were created by reading the transcripts and looking for similar subjects, so-called 'open coding' (Boeije, 2016). The goal was to gain more insight into the obtained data and to get a first overview. The second round of coding consisted of 'axial coding'. This means codes found during the first round of coding were compared and coordinating codes were created (Boeije, 2016) The third round of coding followed from the concepts from the conceptual framework (see above), the so-called 'selective coding'. During this phase, the most important themes were discovered (Boeije, 2016). By doing this, the results were analysed in a structured and scientifically responsible way (Bryman, 2016). The themes provide a better insight into the difference in perspective between citizens and planners. The software program NVivo helped with coding the transcripts in a structured and clear way. The codes used for analysing the interviews are presented in appendix 7.3.

Directly after each interview, the transcripts were written. By doing this, a better understanding of the information provided in the interviews is gathered already during the data collection. This helps the interviewer to jump in during the following interviews.

4.5. Validity and reliability

This research is based on qualitative empirical research technics. This means that the results cannot be seen as hard, independent results that can be taken out of their context. Moreover, this is also not the approach of this research. With the research it is meant to get a better insight

into how citizens and planners differ in their interpretation of risks and planning measures. In order to find answers to this question, the research started with a general and broad literature review. After that, two local cases in the Netherlands were viewed closer. Afterwards, concluding remarks that zoom out and tell us something about the bigger picture were made. Therefore, the external validity of the research is secured.

When doing qualitative interviews, a danger of misinterpretation or colouring answers of respondents because of ideological or political views of the interviewer always exists (Bryman, 2016; Bogner & Menz, 2009). A completely neutral interviewer does not exist. To prevent the research from not being reliable, a comprehensive description of the research methods used in this research is provided. Moreover, all the interviews are recorded, and the recordings and transcripts are available on request. This makes this research as transparent as possible. Above this, the interviewer checked multiple times during the interview whether she understood the respondent correctly by summarising his or her answers and checked if this was the correct interpretation of what is said. Additionally, the respondents all have gotten the chance to read the result-chapter of the thesis on forehand and to comment if they saw any flaws or misinterpretations of their sayings.

4.6. Operationalisation

In this paragraph, the abstract concepts visualised in the Conceptual Framework (see chapter 3) are operationalised. Bryman (2016, p. 161) describes this as “devising measures of concepts”. It means the concepts are translated into terms that can be researched. Underneath the concepts are pointed out. Thereafter, they are translated into interview topics.

Risk management & spatial planning

The role of planners is to create a spatial design in which also social and economic factors are implemented (Fleischhauer, 2008). In the case of transporting hazmat by train, this means that the interpretation of citizens living alongside the railway is an important factor in designing the living environment alongside the railway. In this research one of the goals is to find out how citizens and planners view the role of spatial planning in reducing the risk for citizens when transporting hazmat by train.

Experience

Fortunately, not many direct experiences of accidents with trains that transport hazmat exist, but there are a few examples of accidents with trains (some with, some without hazmat) that make people aware of the possible danger (De Jonge, 2014; Bogdanovic, 2020). An example is the derailment of a train that transported acrylonitrile in 2013 in Belgium. After the accident, toxic gasses spread out through the environment and caused much harm to the health of citizens. One person even died. The train came from the Netherlands, so also over here many people began to worry (De Jonge, 2014).

Social trust

Social trust is important for the interpretation of risk of activities of which citizens do not have the technical knowledge of (Wachinger et al., 2013; Gregory & Miller, 1998; Terpstra, 2011). The transportation of hazmat by train is something citizens do not have (enough) technical knowledge of. Therefore, social trust in authorities is important for the interpretation of the risk involved in transporting hazmat by train.

Risk acceptance

Cognitively, the risk is accepted when the benefits of a positive outcome are bigger than the disadvantages of a negative outcome combined with the chance that the negative scenario will happen (Van Eeten et al., 2012). However, emotions play a big role. These are determined by voluntary action, reasonability and blamability (Van Eeten et al., 2012). Translated to the risk acceptance of citizens living near railway transportation routes of hazmat the questions would be as follows:

- Was there a choice in the policy of transportation of hazmat and the protective measures that are meant to protect us?
- Is the distribution of the risks even among all possible routes?
- Is there done everything possible to protect the citizens / relieve the citizens of the risks?

This results in the situation where the citizens' interpretation of risks is mainly determined by the former three questions (affective elements) and that the planners' interpretation of the risks is based on cognitive elements.

Hazard, exposure, vulnerability & resilience

In the literature review, the concepts of hazard, exposure, vulnerability, and resilience are discussed. For this research, it is important to make a concrete distinction between these concepts. *Hazard* used in this research to define the source of the danger. In this case, the hazardous materials that are transported by train. *Exposure* is seen as the area that is harmed if an accident with the hazardous material happens. It differs per material and per accident how big the exposure area is. *Vulnerability* is defined as the extent to which people are capable of protecting or saving themselves from the hazard. This can either way literally mean how individuals can protect their selves or their houses from an accident with hazmat. However, it can also be seen more broadly: when a municipality decides to place a protecting wall between the railway and the houses, the vulnerability is decreased too. *Resilience* is seen as a positive definition of vulnerability.

Underneath, the operationalisation is translated into optional questions for the semi-structured interviews (Table 4.6.1.). The complete topic list is available on request.

Table 4.6.1.: Theoretical concepts translated into interview-topics

Concepts	Indicators	Interview-questions
Affective calculation of risk	Fear	How do you (citizen & planner) feel when thinking about the possibility of an accident?
Cognitive calculation of risk	Statistical chance it really happens	How big do you (citizen & planner) estimate the change an accident will happen?
Experience	Direct or indirect experience with an accident	Have you (citizen) ever witnessed an accident yourself? Do you (citizen) know people who have experienced an accident? To what extent is the possibility of an accident a lively subject among neighbours?
Social trust	Communication	How do you consider the communication between the municipality and the citizens? What do you know about the policy around transporting hazmat? Where did you get this information? Which kind of information do you get from the municipality? Are you satisfied with this information? Do you like to know more? On which aspects? What do you think about the policy around transporting hazmat?
Voluntary action	Choice	Did you (citizen) have a choice in the policy of transportation of hazmat

		<p>and the protective measures that are meant to protect you?</p> <p>Would you like to have a choice?</p> <p>If you had the possibility, what would you do?</p>
Reasonability	Distribution	<p>What do you (citizens & planners) think of the distribution of the transportations over de different routes?</p> <p>What would you (citizen & planner) see as the most optimal distribution?</p> <p>What factors do you consider when overthinking this?</p>
Blamability	Every possible is done	<p>Do you (citizen & planner) think there is done everything possible to reduce the risk?</p>
Citizen science	Participation of citizens	<p>What is the input of citizens in the policy about transporting hazmat?</p> <p>To what extent do you (citizen & planner) feel the wishes of the citizens are heard in the debate?</p>

Source: own source

5. Results

In Chapter 5, the data assembled by the document analysis, news article analysis, and the semi-structured interviews are discussed. The chapter is structured around the sub questions. The results presented in chapter 5.1 help to answer sub question 1: *What is the policy of transporting hazmat through Tongelre and Strijp S and what is the role of citizens in it?* This question helps to structure the research in a way that first more background information of the cases of Tongelre and Eindhoven is obtained. The question is also relevant to ask because it helps us learn more about the current policy regarding the transportation of hazmat by train.

Chapter 5.2 goes into sub question 2: *What are the tensions and similarities in the vision of citizens and planners about risk, regarding the transportation of hazmat by train?* The results of this research question lead to an overview of the current views of citizens in Tongelre and planners in Eindhoven and from ProRail. It helps the research to focus and to identify the gap that might exist between citizens and planners regarding their views on risk.

In chapter 5.3, the results around sub question 3 are discussed: *What are the implications of the different views of citizens and planners for the policy around transporting hazmat by train?* This question brings together the results of sub question 1 and 2 and describes how the current and future policy around the transportation of hazmat by train might be influenced by the differences in view of citizens and planners.

Because the interviews were conducted in Dutch, all quotes are translated from Dutch to English. The original quotes and the English translation can be found in the Appendix (7.2).

5.1. Policy and the role of citizens

Chapter 5.1 presents the situation of the transportation of hazmat by train in Tongelre and Strijp S. Central in this chapter is sub question 1:

What is the policy of transporting hazmat through Tongelre and Strijp S and what is the role of citizens in it?

To provide an answer to this question, first, the national policy of transporting hazmat by train in the Netherlands is discussed (5.1.1). This provides a better insight into the contextual rules and regulations the transportation of hazmat is fitted in. It is important to know the contextual rules and regulations because they influence the transportation of hazmat in the Netherlands in general. After that, the case of Tongelre and Strijp S and the citizens' role in the policy making around transporting hazmat are discussed (5.1.2). Thus, the research focuses on the context of these two neighbourhoods in Eindhoven in order to explain the local rules and regulations, and the policy concerning the transportation of hazmat through Tongelre and Strijp S. These first two parts of chapter 5.1 result in a concluding third part (5.1.3) where the results are analysed and combines. This leads to an answer to sub question 1.

5.1.1. National policy transporting hazmat in the Netherlands

In Europe, general rules and regulations about the safe transportation of hazmat are implemented. In the Netherlands, the more specific national rules and regulations of transporting hazmat in the Netherlands are written down in the “*Wet Basisnet*” (Law Base network). The Basisnet is a national network of main roads, waterways, and railways in the Netherlands that are appointed for transporting hazmat. The Basisnet is implemented since April 2015. The goal of the Basisnet is to create a balance between transportation of hazmat on to one hand, and spatial development on the other side. This balance is found by implementing so-called risk-ceilings on the railway. These risk-ceilings set rules for the maximum amount of risk that is taken by transporting hazmat by train. Besides, the Basisnet set rules for the buildings that are built next to the railway. When the risk on the railway is higher, the buildings need to be built farther away from the railway. Municipalities themselves need to justify their choices in this. These choices depend on the type and the number of the buildings that are situated alongside the transportation routes. A house for example, where people are present during day and night, leads to a higher risk of, potentially, dying than an office where people are only present during the day and are awake. Or another example: a rest home for the elderly increases the risk of potentially dying more than an office, because elderly people cannot save themselves. The Basisnet creates a framework of building opportunities and restrictions for municipalities of cities that are situated alongside a transportation route. It therefore influences spatial planning. The Basisnet is created in order to balance the transport of hazmat, safety around it, and spatial planning (Rijksoverheid, n.d.; InfoMil, n.d. a).

Dependent on the level of the risk, the Basisnet provides rules that determine the distance between the infrastructure route and the building. This distance may vary per part of the transport route, depending on the type and number of the buildings alongside the route. For example, offices are allowed to be built closer to the railway than houses or rest homes for the elderly. Regardless of the context of the route, the risk of people dying because of an accident with transporting hazmat may not exceed 1 in a million years (InfoMil, n.d. a).

Thus, the allowed amount of risk caused by the transportation of hazmat is first of all determined by the type of buildings alongside the route. Besides, the level of risk depends on the substances that are transported. The substances that are transported by train via the Basisnet Spoor (base network railway) are classified into categories: A (flammable gasses), B2 (toxic gasses), B3 (chloride), C3 (flammable fluids), D3 (acrylonitrile), and D4 (toxic fluids). The rules of transporting this hazmat by train are determined by the maximum amount of risk (risk-ceiling). Therefore, the rules do not determine the maximum number of trains or wagons. As Van der Vlies and Berrevoets (2017) explain: 1 euro is 100 cents, but also 10 times 10 cents or 2 times 50 cents. The same counts for wagons with hazmat: 100 wagons category A and 100 wagons category C3 might have a lower risk-ceiling than 800 wagons category A and 1200 wagons category C3 (Van der Vlies & Berrevoets, 2017). The risk-ceiling is also determined by the safety of the section of the trail and the technical condition of the materials. This means that if the safety of the transport increases because of safety measures, more hazmat can be transported without crossing the risk-ceiling (Van der Vlies & Berrevoets, 2017). Besides the risk-ceilings, the national government also made agreements with the transporter

about safely assembling trains. E.g.: wagons with flammable gasses should not be directly connected to wagons with flammable fluids (Rijksoverheid, 2012).

The rules written down in the Basisnet Spoor thus determine the situation on the railway itself and determine the individual risk, based on characteristics of the direct surrounding of the railway. The municipalities are responsible for regulating new developments near the railway through land use planning and regulations. They determine what activities are allowed near the railway, how many buildings may be built, what kind of buildings these could be, and which safety requirements should be considered. All, of course, below the risk-ceiling of that specific part of the railway.

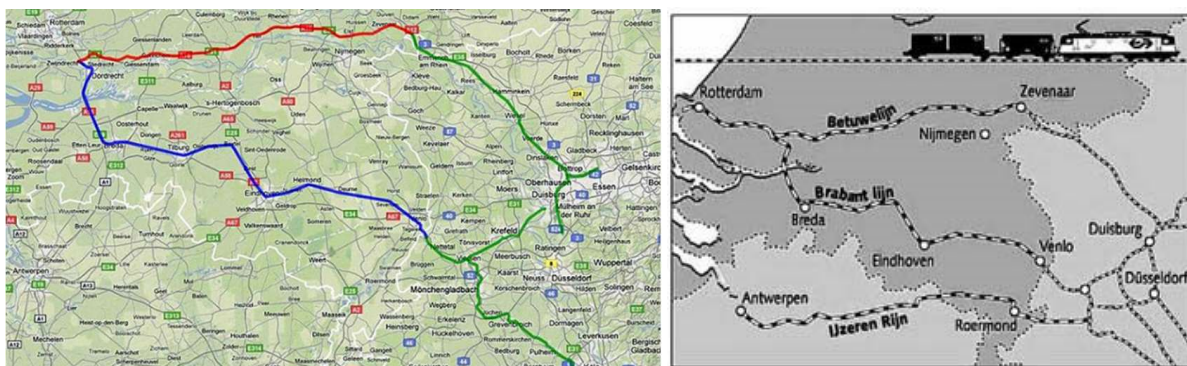
What becomes clear from the text above is that strict rules and regulations for the transportation of hazmat exist. In order to keep the risk low, a framework of risk-ceilings that marks the boundaries of what is possible for the transports of hazmat is created. These risk-ceilings are calculated using calculation methods based on various variables. However, as a respondent from ProRail made clear, these calculation methods seem to be somewhat random. He explains that in order to calculate risk, you need data from earlier incidents, however, in the Netherlands there has not been a big incident in the last 100 years. Therefore, the models used to calculate the risk are based on data from the USA from 50 years ago. It therefore can be questioned how relevant those risk-calculations are for the Dutch train networks nowadays (Personal communication ProRail, May 20th, 2021). However, documents from the RIVM show that the calculation methods are actualised during the years (Uijt de Haag et al., 2019). Later on, more critics on the Basisnet and her risk-ceilings is outlined.

What we can say is that, in this national policy, the cognitive elements of risk calculation, as discussed in the literature review, are strongly visible. The interpretation of risk is namely based on calculations of the possibility of a (deadly) accident, and this can be checked (Slovic, 2010). The norms that come out of this calculation result in risk-ceilings for the whole railway network of the Basisnet Spoor. The norms are set by the government. At this moment, the norms are set as risk acceptability criteria defined as the probability that a person on a particular location dies per year due to the transportation of hazmat by train, assuming that the person is permanently present and unprotected e.g., through buildings. If these chances of dying are below 10^{-6} , the individual risk is viewed as acceptable. Individual risk contours can be plotted on a map. The national policy states that the risk of transporting hazmat by train is acceptable, and that safety is guaranteed, if the individual risk contours stay below the risk-ceiling of 10^{-6} that is plotted as the maximum individual risk that is acceptable on a particular location. Therefore, risk-ceilings of, for example, 10^{-7} or 10^{-8} , are not implemented in order to guarantee safety (this is what the risk-ceiling of 10^{-6} is for). These lower risk-ceilings give municipalities clarity about the situation of the railway, which they need to keep in mind when making spatial development plan. Each year it is evaluated if the risk-ceilings are crossed over. What stands out of the evaluations of the last years is that the risk-ceilings are crossed over often: more transportation of hazmat alongside specific trails of the Basisnet was realised than was expected (InfoMil, n.d. b). This has mainly happened because of construction processes on the Betuweroute and because the German parties do not always want to travel via the Betuweroute (Personal communication municipality of

Eindhoven, ProRail, May 2021). It is expected that these risk-ceilings will be crossed over again in the coming years. However, it is also concluded that the safety norms (individual risk contour of 10^{-6}) were not crossed over. This means there are no parts of the trails where the risk of a deadly accident for the people present in the buildings alongside the track has been higher than 1 time in a million years (InfoMil, n.d. b; Basisnet Kernboodschap, 2019).

What stands out from the evaluation of the risk-ceilings is that the risk-ceilings that are crossed over most are the ones alongside the so-called *Brabantroute* (See figure 5.1, blue line). The Brabantroute is the railway that connects Rotterdam, Vlissingen and Antwerp with the German Ruhr area (Province of Noord-Brabant, n.d.). It is therefore an important transportation route that is used heavily. The province of North-Brabant wants to decrease the amount of transportation of hazmat by train because the Brabantroute goes right through big, densely populated cities such as Tilburg and Eindhoven (Boerma & Bogdanovic, 2020). For Eindhoven, these transports are a problem because the city wants to develop the railway area and build houses over there (Municipality of Eindhoven, 2020). The possibilities for development at this moment are small because of the existing risk-ceiling and the liveability of the area around the railway. In the spatial planning vision of Eindhoven, the municipality states that they expect the pressure on the railway network through Eindhoven to decrease when the Betuweroute will be used again (Municipality of Eindhoven, 2020). This will give them more opportunities to develop the railway area.

Figure 5.1: The Brabantroute (blue line) & the Betuweroute (red line). The green line is the trail in Germany (see also the map on the right).



Source: left: Province of Noord-Brabant (n.d.). Right: Samuëls (2015).

5.1.2. Eindhoven: Tongelre and Strijp S

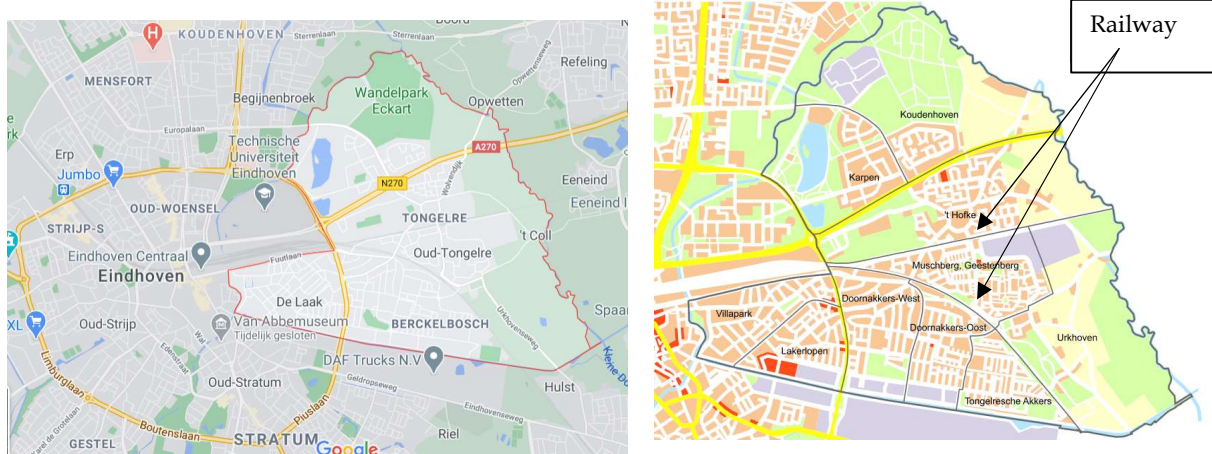
In addition to the strict national policy that is described above, a local policy around transporting hazmat by train exists. To be able to answer the question about the policy of transporting hazmat through Tongelre and Strijp S and what the role of citizens is in here, the characteristics of the two neighbourhoods are described first.

Tongelre

Tongelre is a neighbourhood on the east side of Eindhoven (see figure 5.2). Around the 19th century, during the Industrial Revolution, the railway was built for transporting goods and

people started to travel from their houses to the industrial workplaces in Eindhoven. This led to increasing pressure on the traffic routes and housing shortage in Eindhoven. In order to solve the housing shortage and to reduce the travel time, many worker-houses were built between the roads and railway. This development determined the spatial division of the neighbourhood (Eindhoven, 2020b).

Figure 5.2: Left: Tongelre. Right: close up from Tongelre, northern railway is Eindhoven-Venlo, southern railway is Eindhoven-Roermond.



Source: Left: Google Maps, 25th of March, 2021. Right: Eindhoven (2020,b)

In Tongelre live around 21,500 people (CBS, 2020). The variables *income*, *employment*, *people with a migration background*, and *house-worth* differ much in the neighbourhood. Some parts score quite above the national average and some parts far below. Two railway tracks that are used for transporting hazmat cross the neighbourhood: the track between Eindhoven and Venlo and the track between Eindhoven and Roermond. In between these two tracks in Tongelre live around 2,200 people (CBS, 2020). The crossing over of the risk-ceiling is certainly not the only inconvenience of transporting hazmat the citizens experience (Burg, 2019; Boon, 2019; Eindhoven, 2020a; Boerma, & Bogdanovic, 2020; Personal communication Citizens 1-7, April 2021) The trains in general makes citizens experience vibrations and noise pollution during day and night. These are quite clear and concrete inconveniences, which may drive away the attention from the overcrossing of the risk-ceiling. However, from a study conducted by i&o Research, it appeared that citizens are also worried about their safety and the risk they are exposed to (Ten Doeschot & Van Noort, 2019; Burg, 2019).

The municipality of Eindhoven did take action in, for example, the Hofstraat (see figure 5.3) in order to decrease the harmful effects of noise pollution by renovating the houses by isolating the houses (Boon, 2019). The municipality also focussed on reducing the noticeable vibrations. This was a process the citizens were involved in too. Ideas were collected from citizens and information was provided for the citizens. When analysing local news articles, it seems that most citizens are happy with the renovation of their houses. Their energy bill became lower because of the isolation and the noise pollution decreased (Boon, 2019; Municipality of Eindhoven, 2020). Although, the worries about accidents with hazmat are still present (Boon, 2019). During the renovation, no additional safety measures were implemented.

Figure 5.3: Situation of the Hofstraat in Tongelre: houses build next to the railway between Eindhoven and Venlo



Source: Google Maps, 25th of March, 2021.

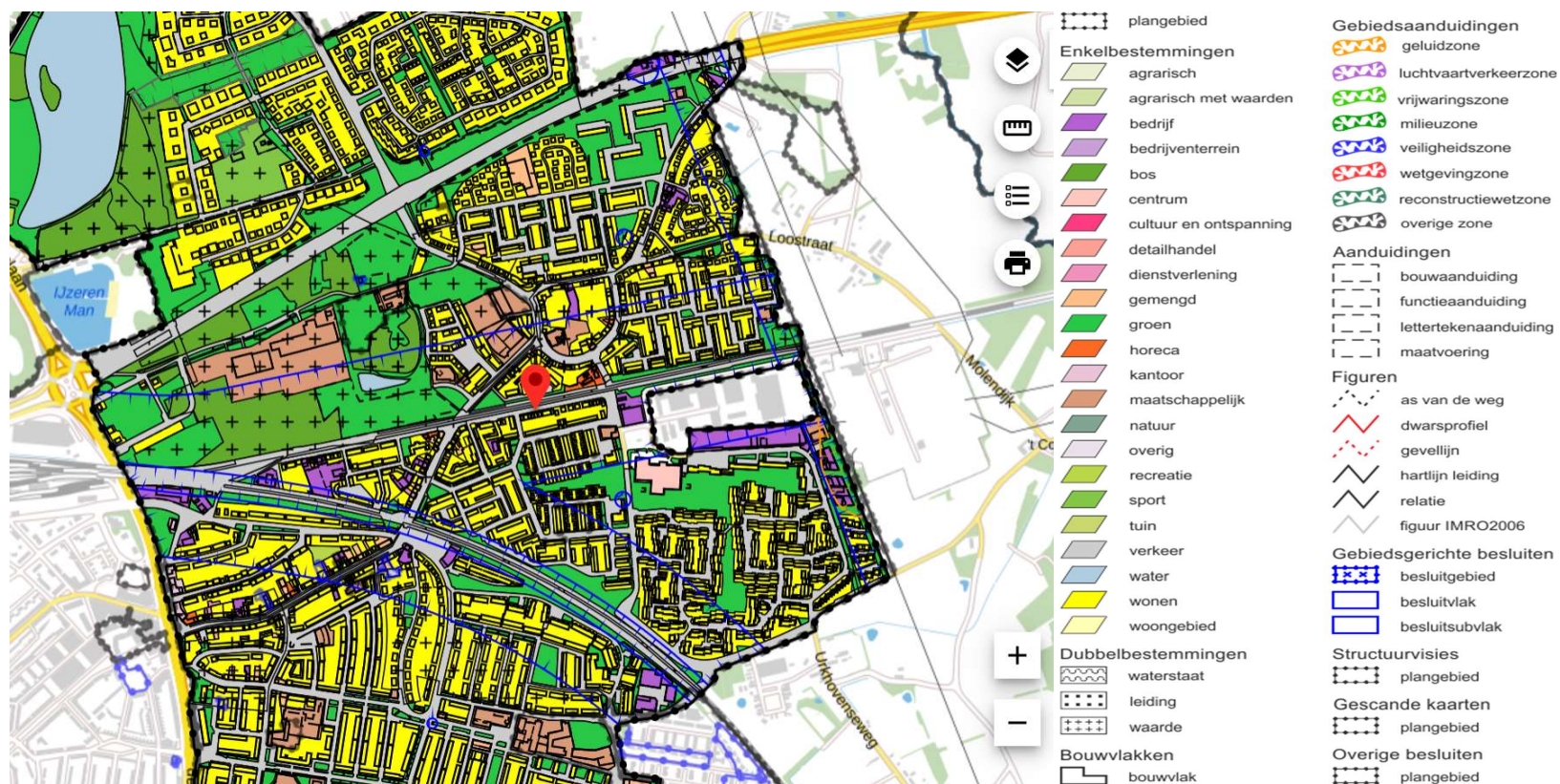
Measures taken at a local level in order to reduce the risk

Thus, in order to provide inside into the risk of transporting hazmat by train, the national government set up the Basisnet Spoor that contains rules and regulations for the content of the trains and the distribution of the wagons. Moreover, the municipality of Eindhoven did implement measures in order to decrease the inconveniences of noise pollution and vibrations. However, the question that needs to be answered in analysing the case of Tongelre in Eindhoven is: what are the spatial measures the government took to protect the citizens against accidents with hazmat transported by train? And is there a role for the citizens in this policy? It is important to ask this latter question because from the conceptual framework it appears that citizens and experts such as planners may think differently about the concept of risk and planning measures (Slovic, 2010). Therefore, citizens would be able to add some points to the discussion about transporting hazmat that planners might oversee.

The first step that is taken in order to answer these questions is to take a look at the spatial development plan of Tongelre. The municipality made a specific development plan for the area of Tongelre outside the beltway. The plan was last updated in 2019 (Eindhoven, 2019). The map underneath is a visual of the research area (Figure 5.4). The red pin marks the earlier named Hofstraat. The street is alongside the northern railway track between Eindhoven and Venlo. The southern railway track is between Eindhoven and Roermond. As you can see on the map, a safety zone of 200 meters around the railway tracks is created (the blue line, in the legenda marked as 'veiligheidszone'). This marks the research area. Within this zone, it is necessary to pay extra attention to the risks of transporting hazmat by train. This means for example that it is not allowed to construct buildings within this zone that are used by people that are not self-reliant, such as children, the elderly, or people that need medical attention (Eindhoven, 2019). The leading rule for this area is that the city council needs to justify the so-called *group-risk* they take. By doing this, they need to balance the importance of the wished spatial development and the risk a group of people dies due to an incident with the transportation of hazmat (Eindhoven, 2019). What factors and calculation methods are used exactly to make this balance, does not become clear. However, a new national policy is being made to make this clearer and more transparent in the coming years. It is definitely a point of attention among the various levels of the Dutch government (RIVM, 2021). What becomes clear from the map is that quite some houses (yellow) are situated within the safety zone of 200 meters. Moreover, a substantial part of these houses is even within the safety zone of the northern and the southern railway track. This means, that the people living in these houses

live within 200 meters of both railway tracks. These people do experience the general inconveniences such as noise pollution and vibrations more intense because trains pass their houses on two sides. The municipality has three criteria for the spatial development of the neighbourhood Tongelre: the whole area needs to stay reachable; the present fire extinguishing water needs to meet the 'fire extinguishing water and reachability rules'; and on the terrain of the TU Eindhoven the fire-brigade and the regional *Veiligheidsregio* realised a station that has a 24-hour crew in order to reach the area quicker (Eindhoven, 2019). The spatial development plan of Tongelre, in which these measures are described, has been published for citizens to give them the opportunity to react to the plan before it was implemented. These reactions did not go into the topic of safety and transport of hazmat by train (Van den Baar & Peppelenbos, 2019). There will be elaborated on this at the end of this chapter. First, the situation in Strijp S is described.

Figure 5.4: Visualisation of the spatial development plan of Tongelre

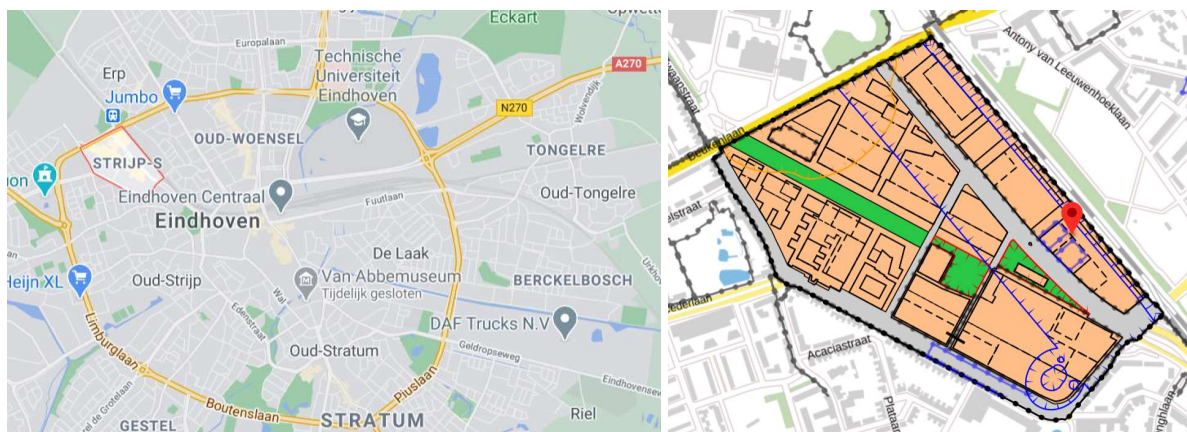


Source: Eindhoven (2019)

Strijp S

The situation in the neighbourhood Strijp S is completely different because almost no citizens live here (see figure 5.5). Strijp S is a neighbourhood situated in the western part of Eindhoven within the beltway. On the east side, the neighbourhood is bordered by the railway between Eindhoven and Den Bosch. This is also part of the Brabantroute and thus used for transporting hazmat. As you can see on the visualisation of the spatial development plan of Strijp S (see figure 5.5), the function of the buildings nowadays is mixed usage (orange). It mainly consists of small businesses. The municipality of Eindhoven is planning to build houses in this area and to develop Strijp S into a creative neighbourhood where different functions are executed next to each other (Eindhoven, 2020; Eindhoven, 2017). Thus, although not many citizens live in this area now, this is going to happen in the future. This brings up some safety challenges in order to be able to build houses in this neighbourhood. At this moment, no people live in the safety zone of 200 meters from the railway, but if this changes, the rules of transporting hazmat will influence the possibilities for building houses close to the railway. The balancing between the need to build houses on the one side and creating a safe living environment on the other side is something the municipality of Eindhoven, and many other municipalities too, struggles with (Personal communication municipality of Eindhoven 2, May 3rd, 2021). However, finding a good balance is essential for the citizens that (will) live in these neighbourhoods. Because the citizens have to deal with the daily inconveniences of the trains, and with the risk of the transportation of hazmat by train. This is the reason why the voice of the citizens is important in the debate around transporting hazmat by train. The next part will go into that.

Figure 5.5. Left: location of Strijp S. Right: spatial development plan Strijp S



Source: left: Google Maps, 1st of April, 2021. Right: Eindhoven (2017).

The role of the citizens

In the previous sections, the national policy around transporting hazmat is presented and the current situation in Tongelre and Strijp S is described. It becomes clear that because of the two railway tracks, the citizens have to deal a lot with trains in general. Therefore, this would be a characteristic situation where the literature on *citizen science* can be useful. Because the citizens experience the inconveniences of the trains every day, they can be considered as experience-experts. It would be useful to consider them as *citizen scientists* (Paul et al., 2018). The

involvement of citizens in the creation of policy would also fit with the increasing participation of citizens in spatial planning (Paul et al., 2018).

Despite this general trend of citizens getting more involved in the policy around spatial planning, in Tongelre and Strijp S, citizens are not formally participating in the process of policy making around the railway tracks. Where in other areas, such as creating a healthy, safe or green neighbourhood, a formal invitation from the municipality to citizens to participate existed (Municipality of Eindhoven, 2020), this is not the case for the topic of trains passing Eindhoven. This phenomenon is not atypical, and also not unlogic. As is discussed in the literature, topics like transporting hazmat and risk-calculation are considered big, complex and technical issues (Sapountzaki et al., 2011; Jabareen, 2012; Hartmann & Driessen, 2017; Fleischhauer, 2008). Citizens are often not considered to have enough technical and political expertise to participate well in the process of policy making around transporting hazmat (Sapountzaki et al., 2011). Moreover, transporting hazmat by train concerns European and national policy that is formed way above the influence of citizens living in a neighbourhood of one of the dozens of municipalities the trains cross. Besides, powerful actors are involved in the discussion, such as ProRail and, of course, the companies that need the hazmat that is transported by train. In Strijp S exists the additional difficulty of the fact that citizens do not live in the neighbourhood yet. It is extra difficult to reach out to future citizens.

However, according to the discussed risk governance cycle, a role for citizens should be present in making policy concerning risk full activities because it can improve the communication between spatial planning, governmental institutions, and citizens (Fleischhauer, 2008; Mejri, Menoni, Matias & Aminoltaheri, 2017). For many years, the citizens of Tongelre did not have a clear, formal organisation they could go to with their opinions and concerns about the trains driving through the neighbourhood. However, around 7 years ago, a group of citizens with a strong opinion about the trains was formed. This group came together to talk with each other and with the government about the inconveniences they experience due to the trains (Personal communication Citizen 1, 2 and 5, April 2021). These discussions were centred around the noise pollution and vibrations they experience. The group was quite active and for some time even met once a week. They talked to the municipality of Eindhoven, ProRail, and even went up to The Hague to talk with the State Secretary for Transport and Water Management. Their main goal was to find solutions for the inconveniences they experienced as citizens living very close to the railway. First, they focused on noise pollution. Later, also the vibrations caused by the trains became a big issue (Personal communication Citizen 1-6, April 2021). They thought that by contacting the municipality of Eindhoven as a group, they could show the governmental institutions their everyday-inconveniences and come to solutions together (Personal communication citizen 1, 2, 5 and 7 April, 2021). The professionalism of the group became clear out of the frequency they met (every week), but also out of the knowledge they gained about the subject. Citizen 2 named the example of the vibrations:

At the time, I worked a lot in construction, including railroad construction, especially stations. So, those people who were very involved with vibrations there, those engineers, I knew them very well. So, during the lunch break I would tell them what was going on with us. Well, then they just took a large whiteboard

(...). And there I got a folder, boom, ready. And then there was a whole catalogue in it, and it contained all the solutions, with prices per meter.

Personal communication Citizen 2
30th of April, 2021

As this quote suggests, the idea that citizens know very little about the subject is not completely true in Tongelre. However, in the case of Tongelre, the citizens felt their actions around fighting their daily inconveniences had not much influence. Therefore, after some time, the developments slowly stopped, and the group fell apart. Citizens 2 and 5 say this was because at the time they lost hope to be heard truly (Personal communication Citizen 2 and 5, April 2021).

Interestingly enough, since January 2021, the municipality of Eindhoven has asked this group of citizens to come back together again and to talk another time with the municipality and with ProRail about their situation. This indicates the new municipal agents in the new government are planning to get the citizens again more involved in the process around transporting hazmat. For the citizens, the main subject of discussion stays the inconveniences they experience from the vibrations caused by the train (Personal communication Citizens 1-7, April 2021). They also mention that they do not immediately have much faith in the developments around the communication with the municipality. According to the citizens, it stays unclear what this participation entails. Citizens 2 and 5 say during the interview that they first would like to see how much impact their words have in the conversations (Personal communication citizen 2 and 5, April 2021). They still feel like this is just a 'gesture for the audience' from the municipality in order to be able to say they let citizens participate. The municipality of Eindhoven on the other hand state they are interested in the citizens' view. The municipality wants to talk with, and listen to the citizens and wants to fight for their wishes on the higher political levels. However, because of the complexity of the subject and because of the long-term run of the decision-making, the people representing the municipality citizens talk to shift multiple times through the years. These factors make a structural citizen-participation process difficult. Moreover, as already described above, the citizens did not make use of the opportunity to react on the parts about external safety of the spatial development plan of Tongelre in 2019 (Eindhoven, 2019). This also suggests that the citizens are not actively occupied with the policy about external safety.

5.1.3. Strict rules, small role for citizens

Chapter 5.1 was centred around sub question 1: *What is the policy of transporting hazmat through Tongelre and Strijp S and what is the role of citizens in it?*

In conclusion, it can be said that the national policy around transporting hazmat, by trucks, by boats, or by trains, is dominating. The Basisnet sets strict rules and regulations around the transportation and the risk that is involved in this. As is already described in the literature review, the national policy made by governmental planners and policy makers is often based on objective risk calculations. The national policy is therefore based on a cognitive interpretation of the risk (Slovic, 2010). From the text above this also seems to be true for the



transportation of hazmat in the Netherlands as well. The municipality of Eindhoven has very little influence on the policy around transporting hazmat by train. Their area of influence, so to speak, is limited to the development of the areas next to the railway. For the policy about the rules and regulations of transporting hazmat and the development rules of the areas alongside the railway tracks, the municipality depends on the national policy.

To understand these findings, it is good to look back at the *disaster management cycle*, discussed in the literature review. When fitting in the policy around transporting hazmat in the disaster management cycle, we can say that the national policy strategy is mainly focussed on the *prevention phase* of accidents happening with transporting hazmat (Fleischhauer, 2008; Mejri, Menoni, Matias & Aminoltaheri, 2017). The implementation of the Basisnet is meant to decrease the risk of getting an accident as much as possible by setting up rules about risk-ceilings and combinations of hazmat in one train. On the other hand, the results show that the municipality has more influence on the policy that is made for the response-phase of the disaster management cycle. The municipality created rules about reachability and fire extinguishing water and stays in direct contact with the *Veiligheidsregio*. Besides, the municipality can influence the prevention-phase by creating the most optimal spatial plan for the areas around the railway tracks (Fleischhauer, 2008). This reduces the vulnerability of the people living in these areas.

The role of the citizens in the policy around transporting hazmat is small: the citizens are very focussed on the decrease of the hazard itself, the source of the risk, namely the trains riding by. However, they have little influence on the trains riding by. They do have more opportunities in influencing the exposure and vulnerability they have, for example by demanding a debate about extra safety measures. However, their main frustration is that they experience many daily inconveniences due to the trains and that very few changes have been in that, despite their high efforts made with the group of citizens. This is mainly because of the high level the decisions are made and because of the fact that no organised institutional space for the citizens to go to is present. Moreover, because of the distributed responsibility of safety measures among multiple governmental levels and institutions, it is hard for citizens to “break through the lines”, so to speak. The municipality of Eindhoven is trying to get the group of citizens back together, but as written above, the municipality itself is also a smaller actor in the policy making.

5.2. Citizens VS Planners: Comparing the visions about risk

In chapter 5.2 the results considering the interpretation of risk of transporting hazmat by train are presented. Central in this chapter is the following sub question:

What are the tensions and similarities in the vision of citizens and planners about risk, regarding the transportation of hazmat by train?

This question is important because it provides an overview of the gap between citizens and planners regarding their views on the transportation of hazmat by train. The first part (5.2.1) of the chapter goes into the difference of view regarding the risk and the risk-ceilings. In these paragraphs, it becomes clear what citizens and planners think of the risk of the transports with hazmat through cities. The second part (5.2.2) describes the difference in view of the consequences of a (possible) accident between citizens and planners. It becomes clear that both groups have completely different expectations of the consequences of an accident. This is relevant for the research because it therefore also influences the interpretation and the acceptance of risk. In the third part (5.2.3) conclusions from the first two parts are drawn and sub question 2 is answered.

The results are constructed by using themes extracted from the interview results and the results found in the various documents that are analysed.

5.2.1. The “calculation” of the risk: emotional VS rational

In the previous chapter, it is already described that the risk-ceilings along the Brabantroute are the ones that are crossed over most. Thus, although rules for the maximum amount of risk that may be taken exist, they are not enforced strictly. In the following paragraphs, the different points of view from citizens and planners regarding the calculation of the risk are discussed. This difference is relevant for this research because it shows the tensions in the vision of citizens and planners regarding the transportation of hazmat by train.

Among citizens, the crossing over of the risk-ceilings brings up strong emotions, also fuelled by (local) news articles. When searching for news articles about the Brabantroute, this is the first and foremost point all articles make. The articles have (sub) headings¹ like *Sometimes even 5 times more* (Tromp, 2020), *Why does the government not intervene?* (Boerma & Bogdanovic, 2020), *Many more trains* (Van de Ven, 2020) and *Very wrong* (Burg, 2019). These are only a few of the dozens of articles around this subject. And not only local news articles pay attention to this subject, also on national news sites, the topic gets attention (NOS, 2021). The local newspaper *Brabants Dagblad* even made a complete summer series of 6 articles during the summer of 2020 about the trains transporting hazmat through the province of North-Brabant. This makes clear that the subject is lively apparent among journalists and citizens. In these 6 articles, various subjects around the transportation of hazmat by train through the province of North-Brabant are discussed. For example, in the first article, the derailment of a train transporting hazmat in 2013 in Belgium is described (Bogdanovic, 2020). This derailment of 5 wagons filled with acrylic resin resulted in a fire in the ditch alongside the railway of 300

¹ Translated from Dutch to English

metres long. Toxic smog caused health problems for the people living nearby and toxic water entered the houses via the sewage system in a radius of 1 kilometre. The accident caused the death of one person, one dead dog, and 400 people who had to go to the hospital with breathing issues. The first article of the summer series asks the question what if this would have happened a few kilometres earlier? For example, in a big city like Eindhoven. In the literature review, the influence of *experience* with an accident on the interpretation of risk is discussed. This accident in Belgium in 2013 can also be seen as a form of *indirect experience* with an accident (Wachinger et al., 2013; Slovic, 2010). The train that derailed came from the Netherlands. By describing the accident again in 2020 in the first article of the summer series, the experience is getting up in the mind of citizens living in North-Brabant. It therefore influences people's mindset about the trains transporting hazmat (Personal communication Citizen 1, 2, 3 & 4, April 2021). In this first article, also a critical finger is pointed to the Ministry. The title of the article² is *Poison-trains, a danger for Brabant? 'Ministry does not seem to care about its own agreements'*. This title shows the frustration about the crossing over of the risk-ceilings, which is, as named before, the biggest problem alongside the Brabantroute. This terminology of 'poison-trains' is criticised by the respondents of the municipality of Eindhoven (Personal communication Municipality of Eindhoven 1 & 2, May 3rd, 2021). They state that by using this strong term, a wrong perception of the trains transporting hazmat is created. This research needs to be aware of the fact that citizens often speak of the 'poison-trains' that could explode and ruin a whole city, while planners see the trains as the safest way of transporting hazmat. This is a difference in view that influences the whole debate around transporting hazmat.

When analysing the first article of the summer series, it also becomes clear that they represent a lack of *trust* in the national government that exists among citizens when it goes about the transportation of hazmat by train. In the literature review, it is already discussed that this trust is very important for a realistic interpretation and acceptance of the risk (Wachinger et al., 2013; Gregory & Miller, 1998; Terpstra, 2011). Besides, because of the fact the Ministry crosses her own risk-ceilings, citizens also get the feeling their problems are not taken seriously by the government (Personal communication Citizen 2, 4, 5 and 7, April 2021). This again contributes to the distrust that exists among citizens regarding the government.

During the interviews with citizens living in Tongelre, it became clear that the citizens themselves do not think in terms of crossing over risk-ceilings. They focus more on the actual number of trains that is coming over the railway. Citizen 2 mentions that in two years the number of wagons increased from 2400 to 8600. The fact that two railway tracks cross Tongelre is the main reason for this:

De Betuweroute needed to close. It was needed to create an alternative route. But in addition, there were created many other routes to relieve the alternative Betuweroute. However, we already have the railway track between Venlo and Maastricht... We have two routes coming from Rotterdam. So, for us, it does not matter at all which alternative route they take.

Personal Communication Citizen 2
30th of April, 2021

² Translated from Dutch to English

Besides the fact that the number of trains crossing Tongelre is increasing, citizens also mention their frustration that this happens without the government notifying them (Personal communication citizen 2, 5, 6 and 7, April 2021). For them, the increasing number of trains leads to all kinds of extra inconveniences. For example, more noise pollution, more vibrations, and less time between the trains to cross the railway passages (Personal communication citizens 1, 2, 3, 4 and 5, April 2021). Citizen 7 even said that all the information he gets about the trains is from the local newspapers. Whether this is true or not, the fact that citizens have this feeling creates a gap between citizens and planners. As concluded above, the newspapers tend to draw a rather dramatic picture of the situation, while this is not the most realistic scenario.

It is this more realistic, rational scenario, where for example 'only' a small leak in a wagon arises, that planners tend to focus on when they calculate the risk of the transportation of hazmat by train. In the previous chapter, it has become clear that the national government has a big influence in the making of policy around risk-calculation with developing the risk-ceilings. However, the municipality stays responsible for the safety of her own area. In Eindhoven, the municipality has a long learning history in implementing external safety and risk-calculations in their spatial plans in general. In 2004, the reconstruction of the shopping centre Piazza Centre, nearby the railway tracks, led to the need for additional safety measures. These developments formed a wake-up call for the municipality: the external safety needed to be better implemented in spatial development plans. Therefore, in 2009, the municipality of Eindhoven created the *Visie Externe Veiligheid* (Vision External Safety, from now VEV). The VEV was created because the city of Eindhoven wanted to develop sustainably by using the scarce building ground of the city in the most optimal way. At the same time, the municipality wanted to increase the safety of the city by reducing the risks (Municipality of Eindhoven, 2009). In the VEV the municipality explained what they mean with external safety: *external safety is about risks from the outside that can affect citizens beyond their control* (Municipality of Eindhoven, 2009, p. 3). They give the example of an accident due to storage, usage, or transport of hazmat. The norm that is used for external safety is the chance of 10^{-6} (one in a million) that a person per year dies due to an external safety problem. To give some comparison: the chance that one person dies per year when driving a car is 1: 5,700 and the chance one person dies per year when walking outside is 1: 54,000. Thus, the norm for external safety is quite high. Respondent of the Municipality of Eindhoven 2 said the following about this:

We have had a great deal of safety policy for many years. We also have our own vision. And we also have our own 'rules of the game' about how we deal with safety in that area. So, it is not that we come up with that ourselves, we have very strict rules for that.

Personal communication Municipality of Eindhoven 2
3rd of May, 2021

This quote shows that the municipality of Eindhoven has a quite rational approach to calculating the risk and executing spatial planning with risk. The strict rules determine their opportunities for spatial development. This is in contrast with the more emotional view on the risk of the citizens, fuelled by the fear of an accident, as explained above. This difference is in line with the cognitive and affective calculation of risk, as described in the literature review

(Slovic, 2010). The planners tend to focus more on the cognitive elements when calculating the risk and the citizens focus more on the affective elements that contribute to their perception of risk.

Besides the emotional fear and anger about the crossing over of the risk-ceilings, citizens are also worried that the risk will become even higher in the future because of the increasing transportation of hazmat and the increasing number of trains crossing their houses (Boerma & Bogdanovic, 2020; Personal communication citizen 1, 5 and 6, April 2021). This is also something Citizen 1 mentioned during the interview. He said that sometimes he hears people talking about a third railway crossing Tongelre. When talking about this, an agitated tone came into his voice:

If that is true, I think they will need to shut down some houses to make room in the neighbourhood. I do not know how they are planning to do that, but in that case the best option for me would be to just get a bag with money and leave to another neighbourhood.

Personal communication Citizen 1
16th of April, 2021

What becomes clear from this quote is that Citizen 1 is frustrated about the developments around the transportation of hazmat through Tongelre. It also shows that the fear for the consequences of an accident will increase that much if a third railway is planned that he will leave the neighbourhood. This gives an insight into the emotions that citizens living in Tongelre feel when talking about the railway. However, the ideas and views on the consequences of a possible accident differ between citizens and planners. Therefore, the next paragraphs discuss the views on the consequences of accidents with trains transporting hazmat.

5.2.2. The consequences of an accident: huge explosions?

Besides the different perception in calculating the risk between citizens and planners, another difference that was brought up during the interviews is the expectations of the consequences of an accident. Or in other words: a difference in the perception of what the risk could be. This difference is relevant to highlight because it helps to explain the difference in the risk-perception of both citizens and planners.

When analysing the citizens' expectations regarding the consequences of a possible accident, two uttermost views come up. On the one end of the spectrum, many citizens do not view the trains that transport hazmat as their biggest problem (Personal communication Citizen 1-6, April 2021). A big part of the interviews consisted of citizens talking about the inconveniences they experience from the trains crossing Tongelre in general. Citizens experience mainly noise pollution and vibrations from the trains. Citizen 3 mentions that she feels the vibrations of the trains, while she lives on the 8th floor (Personal communication Citizen 3, April 30th, 2021). The group of citizens that came together 7 years ago every week was mainly discussing these kinds of inconveniences with the municipality. The citizens explain this by the fact that these are things they experience every day and night. The chance

that the citizens will ever experience an accident with trains transporting hazmat is viewed by them as very small. Especially the vibrations are causing the most inconvenience for the citizens living close to the railway (Personal communication Citizens 1-6, April 2021). The inconvenience of the transportation of hazmat in particular per train is not that big for the citizens. Citizen 5 explains it as follows:

Because you normally do not suffer from it. And that one time it happens, well yes, those people are no longer bothered by it. They only need to be buried into the ground.

Personal communication Citizen 5
30th of April, 2021

Citizens 2 and 4 also underline that the citizens of Tongelre just do not want to think about the possible consequences. The dominating idea the citizens have is that they cannot help it anyway if an accident happens. They just ignore the risk of the transportation hazmat. Citizen 5 adds that they like to spend their energy better in discussing the inconveniences of the vibrations with the municipality. They have the feeling there is more to win in that discussion. Besides, they do acknowledge the need of transporting hazmat. Only, they would like to see this being transported via the previously discussed Betuweroute (Personal communication Citizens 1-6, April 2021).

The other uttermost view on the other end of the spectrum is the extreme fear of an accident. In the second article of the previous named summer series of the *Brabants Dagblad* (Bogdanovic, 2020) a scenario of an accident with a train transporting hazmat on the Central Station of Tilburg, a city close to Eindhoven, is sketched³:

A man buys a face mask from the AKO at the station in Tilburg, checks in and takes the escalator up. The Intercity train will arrive in ten minutes and will take him to Den Bosch. A train transporting goods passes by. Just as the last wagons have passed the platform, they derail with a deafening creak. Then the explosion: a fireball of 80 meters shoots in all directions. The man burns alive; as well as all those waiting on the platform.

The scenario sketched above has not happened. It is the fantasy of Bogdanovic, the author of the article, that brought this story up. However, in big lines, it is what citizens had in mind when they were asked to describe their feelings and opinions of transporting hazmat by train through densely populated cities (Personal communication citizens 1, 2, 5 and 6, April 2021). Although no one ever actually experienced an accident, the fear for it is real. This is an interesting finding. Because apparently, without any direct experience with such an accident as described in the news article, citizens still fear this kind of heavy consequences. Citizen 1 describes it as follows:

³ Translated from Dutch to English

In a city like Eindhoven, and I assume that it [the transport] also goes through Tilburg because it comes from Rotterdam, there are a number of points that I think: if something happens there... then there will die very many fellows.

Personal communication Citizen 1
16th of April, 2021

Thus, although Citizen 1 has no indirect or direct experience with an accident with a train transporting hazmat, he is quite worried when thinking of the possible consequences. Citizen 2 also mentions again the fact that Tongelre is situated between two railway tracks. He says that when an accident happens, the 2,200 citizens living between de railway tracks are locked into the area, also unreachable for emergency services (Personal communication citizen 2, April 30th, 2021).

The overlapping concept in both extreme citizens' views is 'fear'. The first group of citizens is that afraid of the consequences of an accident that they just do not want to think about it. The second group of citizens is fearing a big disaster that means the end for a whole neighbourhood. As pointed out before, the citizens tend to focus on the hazard itself, which they can not change, instead of focussing on their exposure and vulnerability, which they perhaps can change. This shows that citizens do not see how smart spatial designs could help them in creating a safer living environment. Therefore, they are not interested in participating in this. However, if we look back at the previously described accident that happened in Belgium in 2013, which is seen as the heaviest accident in years with a train transporting hazmat, we can conclude that that accident was not that deadly as the story made up by Bogdanovic. Of course, many people suffered from breathing issues and one person even died, but the fear of an accident that ruins a whole city does not seem to be realistic. News articles that start with such a scenario, however, increase these feelings of fear. This line of reasoning is also something the municipality of Eindhoven and ProRail recognize. When they talk with citizens, they hear citizens talking about deadly explosions and *giftreinen* (poison-trains). They stress the fact that this is not a realistic view of possible incidents that can happen, but it is hard to get these images out of people's heads (Personal communication ProRail, May 20th, 2021). When talking about accidents, or incidents, planners have much smaller incidents in mind than citizens have. The respondent of ProRail explains this as follows:

We actually see an incident as a deviation from the standard situation. So, an incident does not mean that dangerous substances have been released, that there is a dangerous situation, but that there is a deviation (...): the train is delayed, a train has a breakdown, gates do not go up or down, someone is walking his dog along the track, there are swans on the track. These are all incidents. Another example: a truck that has been hit on the railway track, that is also an incident, right? So, it really is from almost nothing to the biggest, but an incident is a deviation from the planned situation. So, an incident sometimes is explained in the media as a train that has exploded. But well, fortunately that never happened.

Personal communication ProRail
20th of May, 2021



This quote shows perfectly how the terminology around accidents and incidents differs between citizens and planners. This difference also influences the debate around the perception of risk. Because when citizens talk about accidents and risk, they talk about a huge explosion, while planners talk about much smaller incidents. Besides, when planners make decisions about transporting hazmat by train and calculating risk, they always need to make an integral decision (Personal communication Municipality of Eindhoven 1 & 2, VRBZO & ProRail, May 2021). Respondent 2 of the Municipality of Eindhoven clarified during the interview that, besides the numerical calculation of the risk, the municipality always makes an integral decision about the developments of the areas close to the railway (Personal communication Municipality of Eindhoven 2, May 3rd, 2021). This is also something the respondent from the VRBZO agreed upon on. It is the job of the VRBZO to calculate and to predict the effects of an accident. The municipality also takes into account the chance such an accident happens. Respondent 1 of the Municipality of Eindhoven gives the following example:

The chance that a train derails during a PSV match in such a way that it ends up exactly on the main stand of the PSV-stadium, because the Philips stadium is next to the track, [is very small]. So, we decide not to move the Philips stadium.

Personal communication Municipality of Eindhoven 1
3rd of May, 2021

The example of the respondent is an extreme one, but it shows the reasoning that planners make when calculating the risk of any event that could bring citizens in danger. Besides the reasoning of effects and chances, the municipality also makes an integral decision with other factors, of which the building houses is the most important one. From the Residence Deal (*Woondeal*) that is made up in 2017, the municipality of Eindhoven needs to build 15,000 houses in the period between 2019 and 2023 and up to 25,000 extra houses before 2040. 10,000 of these houses need to be built within the zone close to the railway tracks. This need for houses brings the municipality in a difficult balance between providing enough houses and taking care of her responsibility of creating a safe living environment:

Well, the special thing that is happening now is that the government is not discussing at the right level. Because on the one hand, they say to the municipality to build, build, build. (...). So, that is not something we decide, but the Ministry of Home Affairs wants this. So, we say we will do this, and we make agreements about it, we are going to organize it properly. And on the other hand, we also see that the Ministry of Transport, Public Works and Water Management says yes, we have to transport goods. And then we say yes, we understand that, that is the field of tension. And then you have the Ministry of Security and Administration, perhaps also the Ministry of Economic Affairs with Brainport. But they don't talk to each other. Actually, you would like to have a vision at national level in which you clearly agree on how you are going to organize this in the Netherlands. Because if we don't agree on that... it will not happen automatically. That is not done and that is just a shame, because then you think damn...

Personal communication Municipality of Eindhoven 2
3rd of May, 2021

This quote makes clear that there is a tension between the need to build houses and the need to create a safe living environment. Moreover, it shows that another big part of integral decision making is focused on the collaboration between various governmental levels and private companies, such as environmental services, safety regions, municipalities, provinces, and the national government. All these actors make the process of integral decision-making even harder. Especially when also international actors get involved. This is the case when talking about the Betuweroute. Besides the fear citizens have for the consequences of an accident, the main emotion that comes up during the interviews is frustration and incomprehension about the fact that the Betuweroute is not used. As visualised in chapter 5.1, the Betuweroute is a railway track that connects Rotterdam with Germany. It is specifically constructed for transporting goods and hazmat by train. The part of the Betuweroute in the Netherlands is developed, and it does not cross big city centres. The goal was to be able to use this route instead of the Brabantroute in 2022/2023. However, due to slow processes in Germany, this will take another 6 or 7 years (Source). This is frustrating, as well for Dutch planners as Dutch citizens (Personal communication Municipality of Eindhoven 1 & citizens 1-7, April-May, 2021). Besides, the Brabantroute is shorter and therefore cheaper for the transporters to use.

During the interviews, it became clear that this is a subject that lives strongly under the citizens of Tongelre. The citizens all admit the economic and practical reasons for not using the Betuweroute, but they do think it is not explainable to just let all those trains ride through big cities like Eindhoven until the Betuweroute is completely finished (Personal communication citizen 1-7, April 2021). Citizen 5 compares it with people using a toll road:

There have been comparisons with building a highway for which you have to pay toll. (...) When there is also a sufficient way next to the new highway, then half of the users will probably say "yes, the highway is beautiful indeed".... And the others just go over the old road, because why would I pay toll?

Personal communication Citizen 5

30th of April, 2021

Also in the summer series, an article is spent on the Betuweroute (Bogdanovic, 2020). The frustrations about the modern railway track that is not used become clear from this text too. The unfinished Betuweroute is also something planners are frustrated about too (Personal communication Municipality of Eindhoven 2 & ProRail, May 2021).

As described before, the railway track and the policy about transporting hazmat over it is mainly national policy. The municipality of Eindhoven can do little to increase the safety on the railway tracks itself. The measures the municipality can take are focused on development areas around the railway tracks, as described above. Besides, the municipality undertakes measures in the form of spreading information among the citizens that live close to the railway about the risk and what to do when an incident happens. The municipality does this by spreading flyers among citizens. Besides, a website is set up where more information can be found. The website is called www.ophetjuistespoor.nl. This information is meant to let citizens know what they can do when something odd happens.

The paragraphs above show the tensions between citizens and planners in their perspective of the possible consequences of an accident and how to deal with them. In the following part of this chapter, the overall conclusions of chapter 5.2 are presented.

5.2.3. Citizens VS Planners: feelings vs numbers

Chapter 5.2 was centred around sub question 2: *What are the tensions and similarities in the vision of citizens and planners about risk, regarding the transportation of hazmat by train?*

In conclusion, it can be said that the first tension visible between citizens and planners is the difference in affective and cognitive interpretation of risk. As already stated in the literature review, this difference is quite common. What becomes clear from the (local) news articles on the one hand, and especially from the summer series written by Bogdanovic, is that the subject of transporting hazmat by train brings up mostly negative emotions among citizens. Also, in the news articles emotions like fear and incomprehension are fuelled. Although, the articles might not show the most realistic scenario. Above this, the citizens see numbers that show that the risk-ceilings are crossed over, which frustrates them even more. On the other hand, planners make a more rational perception of risk and construct the planning measures to decrease the risk as much as possible from this starting point. They also make a more integral decision when they decide about planning measures in where they take into account also other factors like housing and spatial development of the city centre. This results in a discrepancy between the citizens' view and the planners' view. It is important to highlight this discrepancy because, according to the interview results, this makes the citizens feel let down. Moreover, the citizens feel that the governmental institutions do not tell the complete truth about the risk and the possible causes of an accident. This results in a lack of trust in the governmental institutions. This is a problem because from the conceptual model it results that trust is very difficult to rebuild once it is lost.

A second tension between citizens and planners is the communication between the two groups. The citizens do not feel taken seriously in the discussion about the trains. This counts as well for the transportation of hazmat as for the daily inconveniences they experience. Especially for the latter subject, the active group of citizens has spoken with the municipality for many years. In the meantime, they see different faces over the years, due to elections, people switching jobs, etcetera. Every time a new face comes in, the citizens have the feeling they have to start the discussion all over again.

A third important result that came up during the interviews and the policy document analysis is the tension in difference in what citizens and planners view as an 'accident with a train transporting hazmat'. Planners have a different perception of 'an accident' than citizens: citizens have in mind they will die immediately when an accident takes place, while planners also view small leaks or even just delays or problems with exchanges as an incident. This is something they want to prepare citizens for. This means, most citizens just do not want to think about the possibilities of an accident, while it might be good if they know what to do if a small incident happens and if they know that most incidents do not relate to the fact the train is transporting hazmat. And if they would think about possible safety measures they would

like to have in their neighbourhood. The discrepancy also influences the acceptance of risk of the citizens, while the risk they have might be bigger in their minds than it is in reality.

The most common similarity between citizens and planners regarding their vision about risk when transporting hazmat by train is their frustration about the much safer, but unfinished Betuweroute. Apart from the fact that the full usage of the Betuweroute would decrease the number of transportations of hazmat by train through the Brabantroute, it would also contribute to the decrease of the affective perception of risk. Namely, just the idea that a route especially built for transporting goods and hazmat release the pressure of the subject. In the next result chapter, the influence of the conclusions made above on the policy around transporting hazmat by train is discussed.

5.3. The implications for policies

In chapter 5.3 the consequences of the different views of citizens and planners regarding risk and accidents for the policy are discussed. Central in this chapter is sub question 2:

What are the implications of the different views of citizens and planners for the policy around transporting hazmat by train?

This question is relevant because it explains how the policy is, or could be, influenced by these different perspectives. In the following paragraphs (5.3.1), the integration of emotional and rational aspects of the perspective of risk in policy around transporting hazmat is presented. Thereafter, some critical notes from planners on the current national policy, the Basisnet, are described (5.3.2). This shines some light on the complexity of the current policy which is relevant for understanding its pros and cons. After that, the theoretical lens of Van Eeten, as described in the literature review, is used to understand the tensions between citizens and planners, and the implications these could have for the policy around the transportation of hazmat by train (5.3.2).

5.3.1. Affective and cognitive elements in policy

From the previous chapters, two main differences in view between citizens and planners according to the perception of risk came up. First of all, citizens tend to focus more on affective elements when estimating the risk, while planners tend to focus more on cognitive elements. Secondly, the citizens' perception of the risk of transporting hazmat by train is much more dramatic than the planners' perception of the consequences of a possible incident. From the interviews and from the policy document analysis, it becomes clear that the planners in Eindhoven are aware of this difference in perspective (Personal communication ProRail, Municipality of Eindhoven 2, May, 2021). They acknowledge that citizens are very worried about the trains. They also emphasize that these worries are not realistic and cannot be justified with the current situation. However, many citizens still feel these emotions and cannot be calmed (Citizens 1-6, April 2021). This often leads to anger and frustration from both sides and a heated discussion that does not lead to a constructive solution for both parties. However, the existence of emotions in a debate is not per definition a bad thing. As Eshuis, Klijn & Braun (2014) conclude from their research, affective elements such as emotions and strong feelings can add to rational decision making. These affective elements contribute namely to the valuation of the different options that exist when making policy. Without these emotions and feelings, it is much harder to determine what elements are more important than others (Eshuis, Klijn & Braun, 2014). Therefore, the participation of citizens in the debates about forming policy around the transportation of hazmat can contribute to better decision making. By asking the group of citizens in Tongelre to come back together, the municipality of Eindhoven is trying to realise this participation in a more formal way (Personal communication Municipality of Eindhoven 2 and 3, May 3rd, 2021).

Another way in which the emotions of the citizens around the trains in Tongelre get (more) attention in the policy around the transportation of hazmat is by informing them more (Personal communication ProRail, May 20th, 2021). During the interviews, the respondents

from the VRBZO, the municipality of Eindhoven, and ProRail mentioned that during the last years, the informing of citizens has gotten more attention (Personal communication Municipality of Eindhoven 1 & 2, VRBZO & ProRail, May 2021). By doing this, they want to make the citizens aware of the cognitively formed perspective of risk from planners, which is very small. Moreover, ProRail organises evenings for citizens where both citizens and planners can talk with each other (Personal communication ProRail, May 20th, 2021). These evenings are meant to listen to each others' worries and views. However, as the respondents from both the citizens' group as the planners' group acknowledge, often people from both sides do not feel heard. This makes to the implication of affective elements in planning policy around transporting hazmat by train a complex point of attention. Moreover, also planners are not happy with the current cognitively based policy. To show the complexity of this current policy, the next paragraphs present some critics from planners on the Basisnet.

5.3.2. The current policy revised: critics on Basisnet

As described in chapter 5.1, the Basisnet is the national policy regarding the transportation of hazmat by boat, over the road, or by train since 2015. It was meant to create clarity around the risk and the safety of people living near these transport routes by using risk-ceilings. However, as the respondent of ProRail mentions, the Basisnet does not work properly in practice. According to him, one of the problems of the Basisnet is the lack of a 'toolbox' with measures that can be used when a risk-ceiling is crossed over. He mentions that at this moment, we can monitor whether a risk-ceiling is crossed over or not, but that we do not have tools to solve this problem (Personal communication ProRail, May 20th, 2021). This means the rules that are set up in the Basisnet can only be checked and not be followed. This is also something the municipality of Eindhoven sees: they know the risk-ceilings in their city are crossed over. However, this is first of all national policy they can not adjust, and secondly, they have no tools to solve this problem (Personal communication municipality of Eindhoven 2, May 3rd, 2021).

The other big problem of the Basisnet the respondent from ProRail mentioned is the false promise of safety the Basisnet creates. He explains that the risk-ceilings are set up using the numbers of expected transportation of hazmat over a specific track. Therefore, the Basisnet is not a good instrument to calculate and monitor the concept of risk. It is an instrument that is set up to make agreements about the transport, but not about the risk specifically. For example, it was expected that very few trains transporting hazmat would ride between Amersfoort and Apeldoorn, so, the risk-ceiling on that railway track is low. However, the risk-ceiling on the tracks around Dordrecht are much higher:

If 2 trains with hazardous substances ride there [between Amersfoort and Apeldoorn] per year, you will exceed the risk-ceiling. If you have 2000 trains driving through Dordrecht, so 1000 times more, then you are still very far below the ceiling. But the situation at Dordrecht with 2000 trains is of course more dangerous than the situation between Amersfoort and Apeldoorn. So, I always try to look at it from the safety side, because that's important for us at ProRail. Safety is a very important aspect. And I think that Basisnet often misleads people.

Personal communication ProRail
20th of May, 2021



This quote shows that the risk-ceilings do not give us that much information about the risk. It just provides information about the expected amount of transport with hazmat. Therefore, this is also the most important critic on the national policy regarding the transportation of hazmat. Currently, the national government is busy thinking about other ways to deal with this problem and they are searching for ways to improve the Basisnet. This new form of the Basisnet is called the *Robuust Basisnet* (Personal communication Municipality of Eindhoven 2, May 3rd, 2021). The first initial research has been done to find improvements. However, it is a complex process that will take some years before it shows off results in practice.

This complexity is characteristic for the topic in itself: risk is hard to define and to score. As showed in the literature review, different theoretical justifications can be made regarding the risk that is taken when transporting hazmat (Van Eeten et al., 2012). In the following paragraphs, the different theoretical views are applied to the case of Eindhoven.

5.3.3. Risk acceptance and policy

In order to gain a better understanding of the tensions between citizens and planners and the implication these could have for the policy around transporting hazmat, the theoretical lens of Van Eeten et al. (2012) is used. As described in the literature review, this paper, among other things, exhibits three different categories of factors that influence the perception of risks and whether we as citizens accept risks are described: voluntary action, reasonability, and blamability. Voluntary action means that people find imposed risk less acceptable than risk assumed voluntarily. This is also something the respondent of ProRail names as a reason why citizens do not accept the risk of the transportation of hazmat by train:

And they have proven that. If you take a risk yourself, you accept a thousand times higher risk than if someone else puts that risk on you. I've thought about that myself and I think that's about right. If you think about cycling through the city, then cycling is about 1000 times more dangerous than if something could happen by train, but nobody worries about cycling to the city. But 200 cyclists die in traffic every year.

Personal communication ProRail
20th of May, 2021

What this quote of ProRail shows is that, although the transportation of hazmat by train is even safer than riding a bike through the city centre, citizens are still more worried about the trains than about cycling, just because they had no choice taking this specific, small, risk. Citizens indeed feel the same way. They do acknowledge that they chose to live close to the railway, however, the increased number of trains (in general and with hazmat) passing by feels as an imposed risk. The risk, and the inconveniences the citizens experience, are therefore less acceptable:

Citizen 5: You do live with the trains, I think.

Citizen 2: But those are things [the increased number of trains] that are simply pushed through.

Personal communication citizen 2 and 5
30th of April, 2021



This quote shows that citizens 2 and 5 do know they have to live with the trains, but that they regret the fact that they have no say in the changes of policy. This clearly refers to the lack of voluntary action, and it therefore is in line with the theory that people accept a smaller risk if it is imposed by others.

The second category of the acceptance of risk is reasonability. In the literature review, it is explained that risk is better accepted if it is just as big, or smaller, as the risk of someone else. It is, in other words, about the fairness of the distribution of risk. What becomes clear from the interviews is that citizens living in Tongelre feel they have an extra big disadvantage compared to citizens living alongside other railway tracks. This is first because the risk-ceilings of the Brabantroute are crossed over most. And secondly, because the Netherlands has built an alternative route, the Betuweroute, which is not fully used.

Citizen 2: Yes, and you build the Betuweroute for only one reason: you should no longer have those poison trains ride through all those cities.

Citizen 6: Yes, a fast line, no level crossings and stuff. And then we place it so that no accidents can happen. And then they say: well, then I have to pay a little too much, so I'll use this other track. Then I think, I lost track.

Personal communication citizen 2 and 6
30th of April, 2021

Especially the frustration about the Betuweroute not being used becomes clear from this quote. It is this option that could relieve the pressure from the Brabantroute, which would make the distribution of risk fairer. This is also something the respondents from the municipality of Eindhoven find difficult to explain and about which they are frustrated about too (Personal communication municipality of Eindhoven 2, May 3rd, 2021).

The third category of the acceptance of risk is blamability. This is about the question of guilt: is the damage caused by accident or on purpose? This topic is somewhat harder to research. There has not happened an accident yet with trains transporting hazmat in the Netherlands. Besides, the views regarding the blame differ. Citizens feel the government and ProRail do not do enough to reduce the risk citizens living alongside the railway have (Personal communication citizens 1-6, April 2021). However, the government and ProRail do say that transporting hazmat by train is the safest way of transporting hazmat, with very small risks (Personal communication municipality of Eindhoven 1-3, VRBZO, ProRail, May 2021).

The paragraphs above show that different ethical lenses can lead to different ways of accepting risk. These different ways of accepting risk can therefore also influence the policy around transporting hazmat by train. The choices that are made in creating policy depend on the ethical lens the policymakers use.

5.3.4. The *Robuust Basisnet*

In chapter 5.3 sub question 3 was the central question: *What are the implications of the different views of citizens and planners for the policy around transporting hazmat by train?* What becomes clear from the results above is, firstly, that the integration of affective elements in policy can lead to a more efficient process of policymaking. Besides, the planners in Eindhoven are paying more and more attention to the emotions of fear and anger citizens experience when the topic is about the transportation of hazmat by train. Moreover, the municipality of Eindhoven and ProRail inform citizens about the way the current, more cognitively based, risk policy is set up.

A second point that came up is that the current policy, centred around the Basisnet, is not the best policy regarding planners and citizens. The national government, therefore, is reviewing this policy and is making plans for the follow-up plans, called the *Robuust Basisnet*. In these plans, more attention to the wishes and needs from municipalities involved in the transportation of hazmat by train will be paid.

Thirdly, besides these plans for new national policy, the ethical question of judging 'the risk' always stays a bit of a grey area, and political choices. However, three categories of accepting risk exist. By influencing the voluntary choice, reasonability, and blamability, the acceptance of risk may increase. The choice for one of these three ethical lenses influences the policy around transporting hazmat by train as well.

6. Conclusion & Discussion

This research was set up to research the gap between citizens and planners regarding their view on the risk of transporting hazmat by train in the Netherlands. In fact, the safety measures that secure the risk of transporting hazmat, are already well investigated (Batarliene, 2020; Procházka, Hošková-Mayerová & Procházková, 2020). However, we still know very little of the perspective of citizens on the risk and the planning measures of transporting dangerous substances by train (Batarliene, 2020; Procházka, Hošková-Mayerová & Procházková, 2020). This is a problem because the perception of risk is subjective and can differ between citizens and planners. This could lead to a discrepancy between citizens and governments about the (sort of) protective measures, or the citizens might not accept the transportation of hazmat at all (Wachinger, Renn, Begg & Kuhlicke, 2013). The research focussed on the case study of two neighbourhoods in Eindhoven: Tongelre and Strijp S. Through these neighbourhoods, trains with hazmat ride close to the houses and buildings, which makes these neighbourhoods exemplifying cases for other Dutch cities. Moreover, Strijp S could represent the Dutch neighbourhoods that will be realised close to the railway in the future. Both citizens and planners participated in semi-structured interviews, mostly conducted online due to COVID-19. Besides, multiple (policy) documents and news articles about the situation in Eindhoven are analysed. The central question this research aimed to respond to is the following:

What is the perspective of both citizens living near railway-transportation routes and planners on the risk linked to the transportation of hazmat and the policy around it?

This central question was divided into three sub questions: 1) *What is the policy of transporting hazmat through Tongelre and Strijp S and what is the role of citizens in it?* 2) *What are the tensions and similarities in the vision of citizens and planners about risk, regarding the transportation of hazmat by train?* And 3) *What are the implications of the different views of citizens and planners for the policy around transporting hazmat by train?* These sub questions are analysed and answered in the previous result chapter. Underneath, the four most important conclusions regarding the main central question are pointed out:

First of all, what became clear during the research is that in the Netherlands there is an influential national policy, called the Basisnet, that determines most policy about the transportation of hazmat in general (Rijksoverheid, n.d.; InfoMil, n.d. a). This policy is based on the cognitive calculation of risk and chances of an accident happening. It is focused on the prevention of accidents and on the reduction of the risk as much as possible. The municipalities the trains cross do not have a big say in this policy. However, they are responsible for the safety of their area. Therefore, the municipality of Eindhoven influences the safety measures that are taken in her spatial area. These measures are on the one hand focussed on the response phase of the disaster management cycle (Fleischhauer, 2008). For example, make sure that there are enough flight paths, and that the area is reachable for ambulances and firefighters (Eindhoven, 2019). On the other hand, the municipality can influence the prevention phase by creating the most optimal spatial plan for the areas around the railway tracks (Fleischhauer, 2008). The citizens have little influence in the making of this policy. Although the citizens of Tongelre have combined their ideas via a citizen group, they

still have the feeling they do not get heard by the planners that make the policy. Besides, the measures about creating the most optimal spatial plan only can be implemented in newly build neighbourhoods. For Tongelre, this does not work. Moreover, citizens are not interested in these kinds of spatial determining measures. They 'just' want the inconveniences they experience to be reduced.

Secondly, in line with the theoretical framework, citizens indeed focus more on the affective elements when calculating the risk they experience from the transportation of hazmat by train alongside their houses (Slovic, 2010). This results in the expectation that whole cities could explode if an accident happens. This idea is also fuelled by the media (Bogdanovic, 2020). These affective elements of fear and anger the citizens experience are unrealistic, according to the planners from the municipality of Eindhoven and from ProRail. The cognitive elements they use in calculating the risk show that the chance of an accident that causes people to die is very small. The risk is much smaller than 'normal' things people do on a daily basis without thinking about the risk they take, such as driving a car or riding a bike through the city centre. This also lights up another prominent difference in perspective between citizens and planners: the perception of 'an accident'. Citizens think of *poison-trains* exploding and destroying complete cities when they are talking about the risk of transporting hazmat by train. Citizens do not think that smart spatial designs could realise a safer living environment. They believe, an accident with a train transporting hazmat will destroy their neighbourhood anyway. Therefore, some citizens are not even interested in participating in this specific topic of the transportation of hazmat. Planners, on the other side, have a much more downgraded view when they talk about 'accidents'. They also describe deviations from the normal situation as an incident. This is something, safety measures can help in reducing the risk. These measures are like the above-described rules for the distance between buildings and the railway, but also, regarding future neighbourhoods, about the rules for buildings themselves.

Thirdly, another, contrary but prominent, perspective of citizens is that they experience many other inconveniences from the train passing their houses at a close distance, such as noise pollution and vibrations. Because these inconveniences are experienced on a daily basis, this is a more prominent topic in the discussion about the trains than the risk attached to the transportation of hazmat. This is also the topic citizens want to discuss regarding the planning measures.

These first three conclusive results show the complexity of creating a safe way to transport hazmat by train. In the literature review, it came up that risk management, in general, is very complex because of the sectoral way in which it is organised (Sapountzaki et al., 2011; Jabareen, 2012; Hartmann & Driessen, 2017; Fleischhauer, 2008). According to the results of this research, this seems to be true for the transportation of hazmat by train in the Netherlands as well. Spatial planning might be the department that has the best overview of all technical and social consequences of policy around transporting hazmat. Therefore, as Fleischhauer (2008) suggested, spatial planning could be the binding department between risk assessment, risk management, and risk communication to the citizens. In practice, municipalities do use this integral approach when creating new neighbourhoods. For existing neighbourhoods, however, this seems to be much harder.

Fourthly, one similarity between citizens and planners that stands out of the results is their frustrations about the Betuweroute. Both groups think it is unexplainable, and unacceptable, that this finished transport route that does not cross big city centres cannot be used because of international issues. Citizens and planners both view that the usage of the Betuweroute as a transport route for goods and hazmat could save many inconveniences and risks for the citizens living alongside other railway routes that are used more now, as an alternative route for the closed Betuweroute.

Discussion of the results

In conclusion, this research makes clear that there is a difference in the perspective of citizens and planners regarding the risk of transporting hazmat by train. This difference is caused by two main factors: 1) the difference in using affective or cognitive elements in calculating the risk, and 2) the difference in experiencing the daily inconveniences or making the policy from a distance. In the following paragraphs, these two differences are analysed, making use of the conceptual framework (presented in chapter 3).

Starting with the first difference: in the conceptual framework, it is visualised that cognitive and affective elements contribute to a different perspective of risk. This research shows that this is also the case between citizens and planners in Eindhoven, regarding the transportation of hazmat by train. Moreover, the elements of voluntary action, reasonability, and blamability contributed to the difference between citizens and planners. However, when reading papers about policy-making, it becomes clear it cannot be true that citizens do not use cognitive elements at all in calculating the risk and that planners are not influenced by affective elements (Van Eeten et al., 2012). The results are clear enough to draw the conclusion that in general, this difference exists, but in practice, citizens, as well as planners, use both affective and cognitive elements in the formation of their perspective of risk. It is the difference in proportion that results in the conclusion that is mentioned above.

When reviewing the second difference, the difference in experiencing the daily inconveniences or making the policy from a distance, it becomes clear how influential spatial planning and risk management are in creating a perspective of risk. In this research it became clear that the people who make the policy have a completely different perspective of risk than the people who experience the daily inconveniences every day. In the conceptual framework, this is already visualised. In practice, the cases of Tongelre and Eindhoven show the importance of an integral risk governance cycle. This research shows that the complexity of the transportation of hazmat by train through cities asks for integral decision making: many actors and stakes are involved and there is never an optimal solution. Moreover, the results show that the need to have citizens actively involved in this risk governance cycle is enormous. This need starts with making the citizens themselves conscious of their value in contributing to the discussion of policymaking around the transportation of hazmat by train. The citizens living in Tongelre did already organise a citizens' working group, but this was more focussed on the daily inconveniences they experience from the trains in general. This year, the municipality of Eindhoven did actively ask the group to come back together and talk with them. This involvement of citizens and the fact that there is a discussion between citizens and planners can lead to a process in which the affective elements of the citizens' risk calculation

can be useful in creating more suitable policy around the transportation of hazmat through Eindhoven.

Both factors show the importance of citizens being involved in the discussion about transporting hazmat by train. In the next paragraphs, there is elaborated on this last conclusion.

6.1. Recommendations for future policy

The results of this research lead to two recommendations that can be made for future policy around the transportation of hazmat by train. First of all, it is needed to integrate the affective contribution of citizens through formalised participation. This formalised participation could be organised best by the municipality of Eindhoven. This is namely the governmental level the citizens are connected to most. From the conclusion of the research, it becomes clear that indeed a gap exists between the perspective of citizens and planners. It also becomes clear that this gap seems to exist because citizens and planners do not understand each others' views. This is probably because citizens and planners do not have to same experience with the risk. Citizens living alongside the railway experience 'side-inconveniences' of the trains every day. Planners only see the positive, cognitive data about accidents that rarely happen. In the end, both citizens and planners want the transportation of hazmat by train to be as safe as possible. To bring these views on the same line, it is recommended to organise a formalised participation option for the citizens living alongside the railway. For the past 8 years, a group of citizens living in Tongelre organised themselves. Last January, the municipality of Eindhoven asked the group to come back together to share their views again with the municipality. For the future, it would be good to formalise these citizens' participation in order to create a better understanding of each others' experiences with the trains and the transportation of hazmat. This has multiple pros: first of all, citizens feel taken more seriously when there is a formal invitation from the municipality to let them hear their views and opinions. Secondly, the municipality gets the chance to explain their views and opportunities to the citizens. For example, how they view the risk of an accident, or what their opportunities are to influence the national policy. This creates more comprehension between both groups. Thirdly, this way, the affective components citizens use in their calculation of risk get more attention by the municipality, and also the other way around: the calculation of the risk by citizens might be more based on cognitive elements instead of mostly affective elements when they know more about the view of planners. And fourthly, citizens get more conscious of the elements of transporting hazmat that they can influence. Until now, citizens focus on the hazard itself, which they can not change, but their exposure and vulnerability to the trains can be decreased by implementing safety measures. This is something citizens can have a say in, but which does not seem to be on top of their minds.

The second recommendation for future policy that leads from this research is to create a more integral decision-making process. The municipality of Eindhoven struggles with the tension between the national policy of transporting hazmat and the need of building houses. These struggles ask for an integral decision-making process in which the national government, the municipalities, representing their citizens, and ProRail make decisions together. This need

for integral decision-making is something the municipality of Eindhoven is fighting for, but eventually, the national government needs to initiate this. The realisation that the Basisnet is not the perfect form for this and also not for the guarantee of safe transportation of hazmat, has come. Therefore, the national government is in the middle of the process of making a renewed form of the Basisnet: the Robuust Basisnet. This is a perfect time to implement also a more integral decision making and more opportunities for local municipalities and citizens to get their views heard.

6.2. Methodological discussion and limitations

The intention of the researcher has always been to conduct a research that is scientifically relevant and constructed. Anything possible within the capability and the timeframe of the researcher is done to contribute to this. However, the methods used in the research cause some content for discussion. It is important to highlight these limitations in order to get a complete and honest overview of the research and the conclusions that are described above.

First of all, the choice for a case study in general has some pros and cons, which are already described in the methodology chapter. However, besides these general cons, the choice for the case study of Eindhoven also gives a contextualised view of reality. As explained, Eindhoven has to deal with an extreme number of trains transporting hazmat riding over the Brabantroute, compared to the rest of the Netherlands. This means the results of this research should put in the right light. In other Dutch cities, citizens probably experience fewer inconveniences and have fewer worries about the risk caused by the trains. Therefore, it is expected that the results of the same research in other cities will differ, especially on the emotional part: citizens probably have fewer strong emotions about the trains compared to citizens living in Eindhoven.

Secondly, the respondents belonging to the citizen group were reached via the neighbourhood association of Tongelre. This way, only active, interested citizens are interviewed. Due to a lack of time and negative reaction on other ways of reaching out to citizens, this was the only way to be able to interview citizens. However, these results do therefore not produce a general overview of the citizens' perspective. This was also not the main goal of the research.

The third methodological limitation of this research is that it is conducted during lockdown due to COVID-19. Therefore, most interviews are conducted via telephone or video calls. Thereby, it was more difficult to read the emotions of the respondents during the interviews. On the other side, this digital way of interviewing made it easier for the respondents, and for the researcher, to plan a meeting.

6.3. Recommendations for future research

This research has tried to gain more qualitative insights into the perspectives of citizens and planners regarding the risk of transporting hazmat by train. The conclusion described above shows that this research is a good starting point for a broader discussion in the future. The results also bring up the need for additional research on this topic. The first reason for this is

already named: this research is conducted in Eindhoven, a city alongside the Brabantroute. The scope of the research must be broadened in the future in order to research whether citizens living alongside other transportation routes, with fewer trains in general, have similar views and opinions. Moreover, scaling up the qualitative research to other cities will increase the generality of the results and will provide better insights for the making of the local and national policy around the transportation of hazmat.

Besides, a side that stays underexposed in this research is how to reach citizens that will live in future neighbourhoods. This research tried to cover this situation with the case of Strijp S. However, it seems quite difficult for a (local) government to reach future citizens and to find out their views and opinions. These views and opinions might be different from the perspective of citizens living in Tongelre, because the people that will live in future neighbourhoods have more options regarding the type of house and location. Here are opportunities for planners to create a spatial development plan that suits the future citizens very well. The municipality of Eindhoven does take care of the external safety in Strijp S, but it is hard to take the citizens' view into account because they do not live in the neighbourhood yet. The municipality might be able to extract the citizens' view from other, already existing neighbourhoods, such as Tongelre. It is interesting to look into this possibility. Especially because this becomes a more urgent problem while the need for more new build houses, specifically in the city centres close to the railways, is increasing throughout many Dutch cities. Therefore, this is a national problem that needs more attention.

Besides these more practical recommendations for future research, this thesis also brought up two more theoretical questions that need to be researched in the future.

Therefore, the third recommendation is about the question of whether, when the discussion of risk is about the transportation of hazmat by train, the citizens' view is purely focussed on the risk and spatial planning policy. During the research, it became clear that the focus of the citizens was for a big part on the general, daily inconveniences from the trains they experience. The citizens also are unhappy with the transport of hazmat. However, in many cases, the discussion starts with complaints about noise pollution and vibrations. Therefore, it is interesting to research what elements beyond spatial planning contribute to the perspective of risk from citizens. More research is needed on such cohesions.

The fourth, and last recommendation is about the integration of affective elements in policymaking in general. This research shows that affective elements play a big role in the calculation of risk for citizens, but these elements do not seem to be integrated with planning policies. However, as the results in chapter 5.3.1 show, affective elements can be very helpful in creating better, more effective policies. Therefore, the question of how emotions can be integrated into policymaking in general is relevant to ask. This creates the need for future research on this question that builds upon this thesis.

7. Appendix

The appendix consists of three parts. In appendix 7.1, the references used in this thesis are presented. In appendix 7.2, the translations of the quotes used in the result chapters are presented. In appendix 7.3, the codes used for analysing the interview results are presented.

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7.2. Translation quotes result chapter

Quote 5.1

At the time, I worked a lot in construction, including railroad construction, especially stations. So, those people who were very involved with vibrations there, those engineers, I knew them very well. So, during the lunch break I would tell them what was going on with us. Well, then they just took a large whiteboard (...). And there I got a folder, boom, ready. And then there was a whole catalogue in it, and it contained all the solutions, with prices per meter.

Personal communication Citizen 2

30th of April, 2021

Dutch:

Ik werkte toentertijd heel veel in de bouw, ook bij de bouw van spoorwegen. En dan met name stations. Dus die mensen die daar heel veel met trillingen bezig waren, die ingenieurs, ja die kende ik allemaal heel goed. Dus ik kreeg via die mannen... in de lunchpauze zei ik dan van nou dit is er bij ons aan de hand. Nou dan pakte zij zo'n groot whiteboard, dan moet je dit doen, dan moet je zo doen, dan moet je zus doen, dan moet je zo doen. En hier heb je een map, boem klaar. En dan lag er zo'n hele catalogus in en daar stonden alle oplossingen in met bedragen erin, per meter.

Quotes 5.2

De Betuweroute needed to close. It was needed to create an alternative route. But in addition, there were created many other routes to relieve the alternative Betuweroute. However, we already have the railway track between Venlo and Maastricht... We have two routes coming from Rotterdam. So, for us, it does not matter at all which alternative route they take.

Personal Communication Citizen 2

30th of April, 2021

Dutch:

De Betuwelijn moest sluiten. Er moest een alternatieve lijn gemaakt worden. Maar daarnaast zijn er ook heel veel andere routes gecreëerd om die alternatieve Betuweroute ook een beetje te ontlasten. Maar omdat wij hier die route hebben vanuit Venlo en Maastricht... Dus we hebben 2 routes die vanuit Rotterdam komen. Dus dat wil zeggen, als ze zeggen we laten een route zo komen en een andere route zo komen, dat maakt voor ons helemaal niet uit.

We have had a great deal of safety policy for many years. We also have our own vision. And we also have our own 'rules of the game' about how we deal with safety in that area. So, it is not that we come up with that ourselves, we have very strict rules for that.

Personal communication Municipality of Eindhoven 2

3rd of May, 2021

Dutch:

We hebben al jarenlang heel veel beleid rondom veiligheid. We hebben ook een eigen visie. En we hebben ook eigen spelregels over hoe we met de veiligheid in dat gebied om te gaan. Dus het is niet dat wij dat zelf bedenken, we hebben daar hele strenge spelregels voor.

If that is true, I think they will need to shut down some houses to make room in the neighbourhood. I do not know how they are planning to do that, but in that case the best option for me would be to just get a bag with money and leave to another neighbourhood.

Personal communication Citizen 1

16th of April, 2021

Dutch:

Maar een laatste ding van mijn kant: er wordt hier zelfs wel eens gesproken of er nog derde lijn moet komen, ehm, nah als dat zo is, Het is aan deze kant van Eindhoven zo smal dat ze dan naar mijn idee huizen moeten platgooien. Nou hoe ze dat gaan doen weet ik niet, Maar dat zal voor mij gewoon de beste optie zijn dat ze zeggen hier meneer heeft u een zakgeld en dan ga ik wel ergens anders heen.

Because you normally do not suffer from it. And that one time it happens, yes, those people are no longer bothered by it. They only need to be buried into the ground.

Personal communication citizen 5

30th of April, 2021

Dutch:

Omdat je daar normaal geen last van hebt. En die ene keer dat het gebeurt, ja die mensen hebben daar geen last meer van. Die hoeven alleen nog maar de grond in.

In a city like Eindhoven, and I assume that it [the transport] also goes through Tilburg because it comes from Rotterdam, there are a number of points that I think: if something happens there... then there will die very many fellows.

Personal communication Citizen 1

16th of April, 2021

Dutch:

Maar ja een stad als Eindhoven, en ik ga er dan ook wel vanuit dat het ook door Tilburg heen gaat, want het zal wel uit Rotterdam komen, ja daar liggen toch wel een aantal punten dat ik denk ja als daar iets gebeurt... Ja, dan gaat er en massa wat mensen hoor.

We actually see an incident as a deviation from the standard situation. So, an incident does not mean that dangerous substances have been released, that there is a dangerous situation, but that there is a deviation (...): the train is delayed, a train has a breakdown, gates do not go up or down, someone is walking his dog along the track, there are swans on the track. These are all incidents. Another example: a truck that has been hit on the railway track, that is also an incident, right? So, it really is from almost nothing to the biggest, but an incident is a deviation from the planned situation. So, an incident sometimes is explained in the media as a train that has exploded. But well, fortunately that never happened.

Personal communication ProRail

20th of May, 2021

Dutch:

Een incident zien wij eigenlijk als een afwijking van de standaard situatie. Dus een incident wil helemaal niet zeggen dat er eh, stoffen zijn vrijgekomen, dat er een gevaarlijke situatie, maar dat er een afwijking is (...): de trein is vertraagd, ergens staat een trein met pech, overwegbomen gaan niet naar boven of naar beneden, er loopt iemand met zijn hond uit te laten langs het spoor, er staan zwanen op het spoor. Dat zijn allemaal incidenten van klein tot groot. Ook een vrachtauto die is aangereden op het spoor, dat is ook een incident hè. Dus het is echt van bijna niks tot het meest grote, maar een incident is een afwijking van de geplande situatie. Dus dat wordt dan wel eens in de media uitgelegd van ja een incident betekent als inderdaad wat jij zegt, een trein die ontploft is. Nou dat hebben we gelukkig nog nooit gehad.

The chance that a train derails during a PSV match in such a way that it ends up exactly on the main stand of the PSV-stadium, because the Philips stadium is next to the track, [is very small]. So, we decide not to move the Philips stadium.

Personal communication Municipality of Eindhoven 1

3rd of May, 2021

Dutch

De kans dat er een trein precies tijdens een PSV-wedstrijd zodanig van het spoor afgaat dat die precies op de hoofdtribune terecht komt van het PSV-stadion, want het Philipsstadion ligt naast het spoor, daarmee besluiten we niet om het Philips stadion te verplaatsen.

Well, the special thing that is happening now is that the government is not discussing at the right level. Because on the one hand, they say to the municipality to build, build, build. (...). So, that is not something we decide, but the Ministry of Home Affairs wants this. So, we say we will do this, and we make agreements about it, we are going to organize it properly. And on the other hand, we also see that the Ministry of Transport, Public Works and Water Management says yes, we have to transport goods. And then we say yes, we understand that, that is the field of tension. And then you have the Ministry of Security and Administration, perhaps also the Ministry of Economic Affairs with Brainport. But they don't talk to each other. Actually, you would like to have a vision at national level in which you clearly agree on how you are going to organize this in the Netherlands. Because if we don't agree on that... it will not happen automatically. That is not done and that is just a shame, because then you think damn...

Personal communication Municipality of Eindhoven 2

3rd of May, 2021



Dutch:

Nou het bijzondere wat zich nu afspeelt is dat het Rijk niet de discussie voert op haar goede niveau. Want de gemeente wordt aan de ene kant gezegd bouwen, bouwen, bouwen. (...). Dat is niet iets wat wij beslissen, maar dat wil gewoon het ministerie van binnenlandse zaken wil dat heel graag. Dus wij zeggen dat gaan wij doen, en we maken daar afspraken over, we gaan dat goed organiseren. En aan de andere kant zien we ook dat het ministerie van verkeer en waterstaat zegt van ja we moeten vervoeren. En dan zeggen we van ja dat snappen we, dat is het spanningsveld. En dan zeggen we van praat dan met elkaar. En dan heb je nog het ministerie van veiligheid en bestuur erbij, misschien het ministerie van economische zaken met Brainport erbij. Maar die praten onderling niet met elkaar. Dus hoe kan je dan.... Want eigenlijk zou je een visieniveau op Rijksniveau willen hebben waarin je duidelijk afspreekt van ja hoe ga je dat organiseren in Nederland? Want als we daar niks over afspreken... het gaat niet vanzelf. En dat wordt dan niet gedaan en dat is gewoon heel jammer want dan denk je ja verdorie.

There have been comparisons with building a highway for which you have to pay toll. (...) When there is also a sufficient way next to the new highway, then half of the users will probably say "yes, the highway is beautiful indeed".... And the others just go over the old road, because why would I pay toll?

Personal communication Citizen 5

30th of April, 2021

Dutch:

Er zijn vergelijkingen geweest met de snelweg die je aanlegt, waar je voor moet betalen. (...) Daarnaast ligt ook een goeie weg. Ja dan zegt de helft waarschijnlijk ja, snelweg is ook mooi inderdaad.... En die anderen gaan gewoon over de oude weg, want waarom zou ik tol betalen?

Quotes 5.3

If 2 trains with hazardous substances ride there [between Amersfoort and Apeldoorn] per year, you will exceed the risk-ceiling. If you have 2000 trains driving through Dordrecht, so 1000 times more, then you are still very far below the ceiling. But the situation at Dordrecht with 2000 trains is of course more dangerous than the situation between Amersfoort Apeldoorn. So, I always try to look at it from the safety side, because that's important for us at ProRail. Safety is a very important aspect. And I think that Basisnet often misleads people.

Personal communication ProRail

20th of May, 2021

Dutch:

Als daar 2 treinen per jaar rijden met gevaarlijke stoffen overschrijd je tussen Amersfoort en Apeldoorn het plafond. En als je 2000 treinen hebt bij Dordrecht, dus 1000 keer zoveel, dan zit je nog enorm ver onder het plafond. Maar de situatie bij Dordrecht met 2000 treinen is natuurlijk gevaarlijker dan op het traject Amersfoort Apeldoorn. Dus ik probeer het altijd vanaf de veiligheidskant te bekijken, want die vinden wij bij ProRail belangrijk. Veiligheid is een zeer belangrijk aspect. En ik vind dat Basisnet juist mensen vaak op het verkeerde been zet.



And they have proven that. If you take a risk yourself, you accept a thousand times higher risk than if someone else puts that risk on you. I've thought about that myself and I think that's about right. If you think about cycling through the city, then cycling is about 1000 times more dangerous than if something could happen by train, but nobody worries about cycling to the city. But 200 cyclists die in traffic every year.

Personal communication ProRail

20th of May, 2021

Dutch:

En dat hebben ze ook wel eens aangetoond. Als jij zelf een risico neemt, dan accepteer jij een duizend keer hoger risico dan als een ander jou dat risico toedoet. Ik heb dat wel eens zelf zitten nadenken, ja dat klopt wel ongeveer. Als je denkt wat fietsen door de stad, dan is fietsen ongeveer 1000 keer gevaarlijker dan als er iets met de trein zou kunnen gebeuren, maar er is niemand die denkt van als ik naar de stad fiets, van levensgevaarlijk dit. Maar er komen wel 200 fietsers per jaar om h  in het verkeer.

Citizen 5: You do live with the trains, I think.

Citizen 2: But those are things [the increased number of trains] that are simply pushed through.

Personal communication citizen 2 and 5

30th of April, 2021

Dutch:

Bewoner 5: Je leeft hier wel met de trein vind ik.

Bewoner 2: Maar dat zijn dingen dat wordt dus gewoon doorgedrukt.

Citizen 2: Yes, and you build the Betuwelijn for only one reason: you should no longer have those poison trains ride through all those cities.

Citizen 6: Yes, a fast line, no level crossings and stuff. And then we place it so that no accidents can happen. And then they say: well, then I have to pay a little too much, so I'll use this other track. Then I think, I lost track.

Personal communication citizen 2 and 6

30th of April, 2021

Dutch:

Bewoner 2: Ja, en je bouwt de Betuwelijn maar met 1 reden: die giftreinen moet je niet meer door al die steden hebben.

Bewoner 6: Ja, een snelle lijn, geen overwegen en alles. En dan leggen we hem zo neer dat er geen ongelukken gebeuren. En dan zeggen zij ja dan moet ik iets te veel betalen, dan ga ik hier wel overheen. Dan denk ik, dan ben ik het spoor even bijster.

7.3. Codes used for analysing the interviews

Codes used for open coding:

- Noise pollution
- Vibrations
- Citizens' working group
- Betuweroute
- ProRail
- Fear
- Anger
- Poison trains
- Incidents
- Accidents
- Government
- Dangerous substances
- Distance between houses and railway
- Basisnet

Codes used for axial coding:

- General inconveniences
- Citizens' working group
- Frustrations about Betuweroute
- Accidents VS Incidents
- Communication between citizens and government
- Dangerous substances
- Distance between houses and railway
- Basisnet

Codes used for selective coding:

- General inconveniences
- Citizens' working group
- Common frustrations about the Betuweroute
- Emotions about the trains
- Accidents VS incidents
- Relation between citizens and planners
- Hazmat
- National policy VS local policy