

Environmental design and the perception of safety

An adjusted model for railway stations

Master thesis

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Colophon

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Abstract

Safety and the perception of safety have been an important topic on the political agenda for a long time. Recently, with the dismissal of the railway police and violent incidents towards the staff of NS in trains and at railway stations, in the Netherlands a discussion started with concern to safety and safety perception on railway stations. For several decades there has been scientific research on increasing safety and the perception on safety using spatial measures, called environmental design. This research investigated if and how the theory of environmental design can improve the perception of safety on railway stations, for the case study of the city of Groningen. This has been done using field observations and questionnaires on the three railway stations, along with an interview with the location manager from NS. It has been found that especially the three aspects 'activity support', having a clean and well maintained railway station during the day, and proper lighting after dark, are the most important aspects of environmental design for the perception of safety of users of the railway stations. The aspects 'physical barriers' and 'security at the entrance' are unimportant for the perception of safety on railway stations. With these adjustments, the theory of environmental design is applicable for creating a better perception of safety for users of the railway stations, although social influences and influences of the direct surrounding environment also have an important impact on the perception of safety on railway stations. With regard to this, a good cooperation between NS, ProRail, the police and the municipality is advisable.

Keywords: *environmental design; perception of safety; railway stations; spatial planning; travellers perception; Groningen*

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List of abbreviations

CCTV	Closed Circuit Television (camera security)
CPTED	Crime Prevention Through Environmental Design
EU	European Union
GIS	Geographic Information System
NS	Nederlandse Spoorwegen (passenger railway operator)
PKVW	Politiekeurmerk Veilig Wonen (police quality mark for safe homes)
SVOB	Stichting Veilig Ontwerp en Beheer (Dutch organisation of CPTED)
VOB	Veilig Ontwerp en Beheer (safe design and maintenance)

Chapter 1 - Introduction

Although safety has always been an important issue, in the last 15 years it increasingly got attention from political parties, also in the Netherlands. This was partly due to terrorist attacks and (political) murders in the first years of the 21st century. The Dutch prime minister Balkenende started the Safety Programme, which targeted to reduce crime and nuisance (Noije & Wittebrood, 2008). After Balkenende, the current Rutte cabinet also has a large focus on the safety concept (Breeman et al., 2011).

A discussion about the safety on railway stations started in the last years. Since 2013 the railway police has been lifted, for it was seen as a general police task to secure railway stations. In the years afterwards there was an increase of violence on railway stations and in trains, mostly towards conductors. Now the question is if the railway police should return, and what can be done to ensure the safety on railway stations. A first step to take can be to place -or if already there, close-entrance gates at the railway station (stichting maatschappij en veiligheid, 2015; npo, 2015; binnenlands bestuur, 2015; Van Steden & Mans, 2014).

The last decades, several instruments and guidelines have been developed to improve the safety and the perception of safety in the urban environment. This started in the United States, but is has been adopted in Europe and the Netherlands. Examples of such instruments and guidelines are the 'European standard for the reduction of crime and fear of crime by urban planning and building design' (ENV 14383-2) which resulted in the CEN/TR14383-2, the 'Safety Impact Assessment' and the Dutch PKVW (police label for living safely). These are all based on theories about designing the environment in such a way, that it can have a positive influence on lowering crime rates and the fear of crime. The theory mostly being used is CPTED which is an abbreviation for Crime Prevention Through Environmental Design (CCV, 2007; CCV, 2014; COST, 2014; Soomeren, 2002).

CPTED is used as a supporting theory for the development of safety guidelines. The theory also gives guidelines about intervening in the build environment to make it safer. For example: creating and/or maintaining sightlines to have a better view of the area. It is said that CPTED creates environments that are safer and at the same time also improve the perception of safety (Atlas, 2008). There is supporting literature for the positive influence of environmental design measures on crime rates, victimisation and the fear of crime. Especially the relation between environmental design and crime rates is strong (Cozens et al., 2005; Marzbali et al., 2012; Minnery & Lim, 2005). Although in general it seems to be true that environmental design can have a positive effect on crime rates and on the fear of crime, it is still uncertain how the different components of environmental design work. For example, is the creation of sightlines more important for safety issues than a clean environment, and how big is the impact of the different aspects on the safety level and the perception of safety? It is also unknown if different situations or areas require different types of measures, and thus in which situation a certain measure is more or less important. (Cozens et al., 2005).

The theories concerning environmental design state that the idea of environmental design can be applied anywhere. However, every place has its own characteristics, function, geographic context, history and culture. This makes the situation context-dependent, and excludes the theory of environmental design to be universal and thus a total objective one (Flyvbjerg, 2001). How you design a particular area depends on what you want to do with that area. Living areas require different design interventions than for example parking areas. In literature, studies tend to focus on specific areas, such as parks, living areas, malls or bus stops (McKay, 2015; Cozens et al., 2005).

Studies on environmental design have been mainly conducted on neighbourhood-level in residential areas. Other public areas have been less investigated, such as parks or squares. There are also areas that have been barely investigated, as for example station areas. Besides an analysis of Cozens et al. (2003) concerning railway stations in England, there are almost no scientific studies about these area types. There have been general guidelines developed regarding these areas by SVOB (the Dutch organisation concerning CPTED), but these are not clearly based on detailed investigations (SVOB, 2015b). In the Netherlands, the owner of the railway stations (ProRail) together with the passenger railway operator (NS) pay close attention to the creation of safe and secure railway stations to make sure that passengers have a safe journey. This is for example visible by the yearly investments done by the passenger railway operator NS regarding this topic (NS, 2015a) and the special attention given to this topic by ProRail by keeping track of the perception of safety of the passengers by conducting seasonal questionnaires (ProRail, 2015).

The insights of environmental design have not been used for the design of railway stations in the Netherlands. It thus seems interesting to investigate how environmental design can contribute to the safety feeling of train passengers on railway stations, as a contribution to the discussion on how to create safer railway stations, and how to use environmental design with regard to railway stations.

1.2 Research objective and research questions

To investigate how environmental design can contribute to the safety feeling of passengers on railway stations, a case study has been conducted in the city of Groningen. It has been analysed what, with regard to theory, can be done to create a better feeling of safety by changing aspects in the environment. From the theory it is not clear which aspects of this theory are relevant in different functional areas. For that reason it was investigated which aspects of environmental design passengers consider important and which not.

The city of Groningen has three railway stations, which differ a lot from each other. The main railway station, Groningen Railway Station, is a big station with relatively many passengers, which is situated in a historical setting. The Northern Railway Station is a small railway station which is located on an overpass in the middle of a residential area. This railway station is known for the bad scores on the safety perception of her users (ProRail, 2015). The third railway station, Groningen Europapark, is a newly renovated railway station located next to a business area with schools and a soccer stadium. This railway station is relatively small, but the newest designing methods have been used. Analyzing differing station areas result in interesting case studies; differences in environmental design can be distinguished and if there are other important factors -besides those included in the theory of environmental design- these can be easier shown. Another important item of these case studies is the decreasing crime rates in the city of Groningen, while at the same time unsafe feelings are increasing (CBS, 2014a). A third reason to choose for these railway stations, is because the station area of Groningen Railway Station was pointed out to be an example of 'good environmental design' (Luten 2011). Therefore it is interesting to investigate if users of this facility agree with these experts, and to compare the main railway station of Groningen with the other two stations in the city: Northern Railway Station and Groningen Europapark Railway Station.

The objective of this research is to analyse how environmental design can improve the perception of safety of users of the railway stations in the city of Groningen. The main question is:

"How can environmental design improve the perception of safety on railway stations in Groningen?"

The sub-questions are:

1. In what amount are the elements of environmental design present at the railway stations in Groningen?
2. What are the characteristics of environmental design of the places that are regarded to as being most unsafe on the railway stations in Groningen?
3. Which aspects of environmental design are most important for the perception of safety from users of the railway stations?
4. What are the differences of environmental design and the perception of safety between daytime and after dark?

1.3 Definitions

There are two definitions that are most important in this research.

Environmental design is a broad term, which can refer to sustainable planning, but also to the general planning that deals with the environment as it is design by humans, being architecture, urban planning, landscape planning, etcetera.

Perception of safety is separately distinguished, because people can have misperceptions about the actual chance of becoming a victim. Such misperceptions can be the result of heuristics (a conclusion not based on a deliberate analysis) and biases (perceptions are distorted and misleading). People can have an availability heuristic; they will perceive a phenomenon more common if it is easy for them to recall a similar event (e.g. if you saw an assault last week, you think it is more likely to happen again) (Steg et al., 2012).

Environmental Design with regard to safety and the perception of safety, can be explained with the definition from the theory CPTED. Atlas (2008) formulates it as a theory that states that *"...the appropriate design and application of the built and surrounding environment can improve the quality of life by deterring crime and reducing the fear of crime."* (Atlas, 2008; p. 53).

1.4 Thesis structure

In the following pages, first the relevant theories regarding environmental design and its effect on safety perceptions will be discussed. Based on these theories, a conceptual framework has been constructed which was the leading tool in the execution of this research. Chapter three explains how the research has been conducted and chapter four will outline the results of this research. The final chapter, chapter five, concludes this research and gives recommendations.

Chapter 2 - Theoretical framework

Research about the relation between environmental aspects and its influence on human beings and human wellbeing started around the 1950s. This was the beginning of the birth of a new study area within the psychology, the environmental psychology. Within environmental psychology research was done with regard to the relation between humans and their environment, which also led to studies concerning safety and feelings of safety (Steg et al., 2012). This chapter will first discuss some general theories within the environmental psychology with regard to the interaction between humans and their environment. Then, the development of theories with regard to crime, safety and environmental design will be outlined, which are based on the general theories of environmental psychology. From this, the most important and relevant theories for this study will be discussed, which in the end will be put into a conceptual model which has been the guideline in this research.

2.1 The interaction between humans and their environment

There are some theories within environmental psychology that form the basis for theories of environmental design such as Defensible Space and CPTED. In the following sections, these theories will be explained. This section will explain the most relevant theories with regard to the interactions between humans and their environment, concerning the perception of safety. This includes theories concerning the importance of the behaviour of other people, maintenance, landscape beauty and social control. These theories explain the thoughts and ideas that form the basis of the theories of environmental design, which will be explained in sections 2.2 and 2.3.

2.1.1 Goal framing

A first theory in environmental psychology is that of environmental cues and goal framing. Cues in the environment can trigger people to obtain a certain goal. Three general, overarching goals can be distinguished: hedonic, gain and normative goals. Hedonic goals are goals that make you feel better and happier, like eating chocolate or having a nice cup of coffee while waiting on the train. Gain goals are goals that want to increase a person's own resources, such as money or status. Normative goals are about social norms, rules, and 'doing the right thing' (Steg et al., 2012). Research has shown that cues in the environment can trigger certain goals. So can strong normative cues (e.g. the presence of a police officer, a church, or the presence of other people that are behaving correctly) trigger normative goals, which makes people behave more appropriate (Steg et al., 2012; Keizer et al., 2008). Other cues in the environment can trigger hedonic and gain goals (e.g. seeing a nice car or dress may trigger you to buy it). Triggering hedonic or gain goals can however lower normative goals. So can a person, if he/she really wants to gain something, become impatient and behave not according to the norm, maybe even steal something. Also, researchers found that the cues in the environment that show disrespect of norms, also trigger other people to have lower normative goals. For example, if you see that other people litter, you are more likely to do so yourself. However, researchers also found that the disrespect of one norm can have a negative effect on a total different norm. So did researchers notice that the presence of graffiti on a wall where this was clearly not allowed, made other people behave less normative than if there was no graffiti. In the graffiti situation, people littered a lot more than in the non-graffiti situation. This phenomenon is called the cross-norm inhibition effect (Keizer et al., 2008; Keizer et al., 2011). Disrespect of norms can increase

crime rates and the fear of crime (Steg et al., 2012). The scheme in figure 1 shows the relations between different environmental cues and its influence on normative behaviour. A theory that is closely related to this, is the broken window theory.

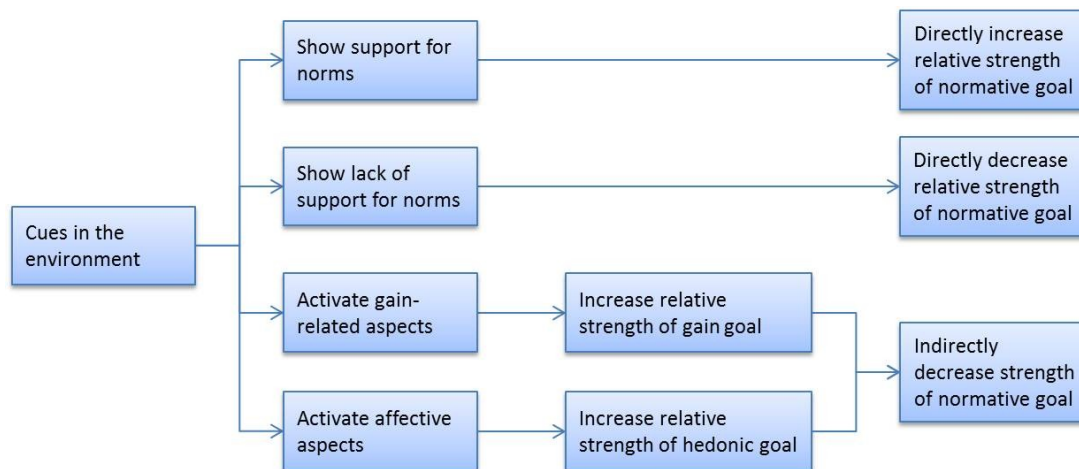


Figure 1: The effect of different cues in the environment on the normative goal (Steg et al., 2012)

2.1.2 Broken window theory

The broken window theory was developed by Wilson and Kelling in 1982. The theory states that small signs of degradation, such as a broken window or graffiti, lead to the impression of low authority and a low level of social awareness. This can create an environment attractive to offenders and can thus create criminal problems (Wilson & Kelling, 1982). This theory led to the so called zero tolerance policy, where there was no tolerance for such small crimes. The policies were made to tackle small crimes to prevent bigger ones, mostly by letting more police officers patrol the streets. However, critics stated that crime cannot be resolved by only more police officers, and that such strict policies may even cause aggression (Sherry, 2014; Kim & Shin, 2014). Apart from such policies, statistics do show a correlation between physical decay and the perception of safety (CBS, 2014c). This seems to be in confirmation with the broken window theory. The broken window theory thus shows that the lack of support for social norms results in the decrease of the normative goal of other people, as was also found by Keizer et al. (2008). Nowadays, this theory is used creating neat and clean environments, not only by removing or preventing graffiti, but also by making sure the tiles on the sidewalk are laying straight. There are also developments of 'everything-proof objects', objects that would be resistant to all sorts of misuse. In England they developed for example benches that are 'anti-homeless', 'anti-graffiti' and 'anti-vandalism' (Weburbanist, 2014).

2.1.3 Subjective risk perception of risk

Another theory within the environmental psychology is that of environmental risks. A simple formula for risk is: risk = chance x effect. However, people are not always capable of making such a rational analysis. Heuristics, biases, values and emotions can change the subjective risk perception drastically. This means for example, that if the impact of a risk would be really severe, you perceive the risk as much higher than it really is (e.g. the fear of crashing down with an airplane). This theory matches with the differences between actual crime rates and the fear of crime people can have. People can be more afraid on a railway station, if they heard that a week ago a traveller was assaulted in that area (Steg et al., 2012; Sjöberg et al., 2004).

2.1.4 Landscape preferences and universal aesthetic qualities

A landscape that people perceive as beautiful, or easy to understand, also positively influences the perception of safety (Song & Schwartz, 2009). In literature there is a discussion about measuring the level of beauty of a landscape. This is related to the difference between subjectivism and objectivism: is the beauty of an object in the object itself or in the eye of the beholder (Meinig, 1976). From this discussion, models have been developed based both on the subjective approach and on the objective approach (Daniel & Vining, 1983). There are theories that explain landscape preferences as something we were born with or as something we learned. An examples is the habitat theory, that states that people prefer savannah-like environments because based on the evolution theory the early homo sapiens used to live there (Orians, 1980).

Another example is the “prospect refuge theory” from Appleton. Appleton’s theory states that people prefer situations with as well prospect (overview) as refuge (protection), what would increase our chance of survival, what would cause an evolutionary advantage. This is also based on the evolutionary approach, stating that people are both hunter and prey. So people needed a good prospect of the area, but also the ability to hide, both increasing chances of survival. People would and still will feel most safe if they can see but not be seen. However, this is also positive for an offender, which also seeks to see but cannot be seen. So, people would actually feel most safe if their prospect is high (to see) and the refuge for a possible offender is low (few places an offender can hide) (Appleton, 1975; Fisher & Nasar, 1992; Jorgensen et al., 2012). An addition to this theory is the possibility to escape. An example used is an elevator: although the prospect is high and there is a lack of refuge for the offender, there is no possibility to escape (Fisher & Nasar, 1992).

Kaplan and Kaplan (1989) developed the famous preference matrix. They state that people, based on an evolutionary approach, find the ability of exploration and understanding very important. They distinguished two dimensions, the immediate and the inferred dimension. When put in a matrix, this gives four different landscape characteristics that would all contribute to a preferable landscape: coherence, complexity, legibility and mystery (see table 1). Coherence is about the easiness to understand the surroundings immediately, complexity is about the visual richness, legibility means the understanding of what lies before you and how you can find your way; mystery means the promise of new things to discover in what lies ahead. They also found that mystery was the best predictor of landscape preferences. However, the preference matrix of Kaplan and Kaplan is focussed more general on natural, non-urban settings. There are also theories that focus more on urban settings and architecture.

		Informational variables	
Level of interpretation		<u>Understanding</u>	<u>Exploration</u>
	<u>Immediate</u>	Coherence orderly, ‘hangs together’, repeated elements, regions	Complexity Richness, intricate, number of different elements
	<u>Inferred</u>	Legibility Finding one’s way there and back, distinctiveness	Mystery Promise of new but related information

Table 1: The preference matrix (Kaplan et al., 1989)

2.1.5 Urban landscape preferences and universal aesthetic qualities

The perceptual fluency theory is a theory that is more critical towards preference theories based on evolutionary approaches. The perceptual fluency theory states that it is not (merely) an evolutionary viewpoint that makes us like a particular landscape more than the other, it is the perceptual fluency. Perceptual fluency means, that we like objects more if they are easy to process (such as symmetric objects). The longer it takes to understand and process an object or situation, the more we dislike it and the higher the risk perception and vice versa (Song & Schwartz, 2009), which is similar to Kaplan's legibility (table 1). However, people tend to process natural environments faster than urban, even though natural environments are often said to be very complex. The perceptual fluency theory states, that it is the repetition of the same structure that can be found in nature, which makes it easy to process and thus more attractive and less risky. This internal repetition and self-similar patterns are called fractals (see figure 2). This taken, fractal structures can create a more attractive environment. However, such structures are barely seen in urban settings, them being mostly part of natural ones, although it can be plausible. Especially gothic architecture and Hindu temples makes use of these fractals (figure 3), what makes people tend to like such buildings (Joye, 2007).

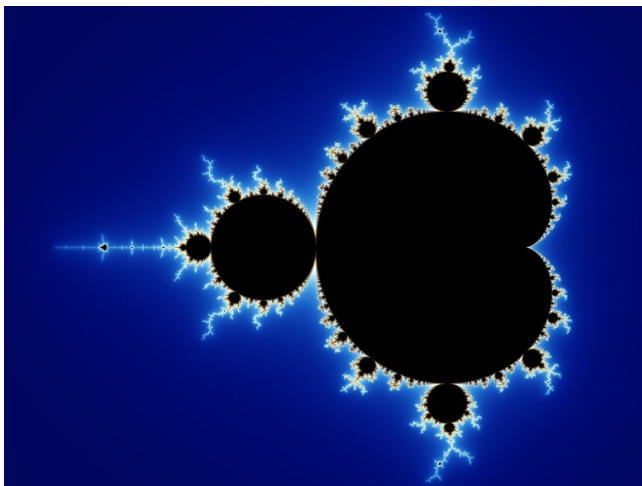


Figure 2: A typical fractal pattern



Figure 3: Hindu temple Kandariya (source: Mannix, 2000)

Research shows that natural settings can have a positive influence on the wellbeing of people, in a better way than urban settings. This is also linked to the perceptual fluency theory, where natural settings can be more easily understood and thus gives the body the opportunity to restore (Joye, 2007). Green spaces in an urban environment are thus very important for the well-being of people. If these places are well maintained, they are also positive for the feeling of safety, for people conclude that someone is taking care of that place (Nasar & Fisher, 1993). However, recent studies show that this is not only true for natural settings, but that sometimes also the built environment can have a positive effect on the well-being of humans, reducing stress and improving peoples mood. Buildings as for example museums, places that are seen as pleasant, fascinating and that are being well-cared for (Packer, 2008). Also mixed environments can have a positive effect, such as the inclusion of green spaces or water within the built environment (Karmanov & Hamel, 2008).

In contrast to natural settings, it seems that in architecture complexity is less preferred. Complexity in a building is still important, but more complexity does not mean more appreciation.. Studies with regard to architecture showed that the relation between complexity and appreciation

takes a U-shape. Very low and very high forms of complexity are not preferred, but average levels are. However, very complex buildings are not that common (Imamoglu, 2000).

Herzog & Gale (1996) also tested the build environment on Kaplan's & Kaplan's preference matrix (1989). They tested older versus newer buildings, in natural and non-natural settings. They concluded that older buildings were preferred over new ones, but only if the older buildings were well maintained. They also found that 'complexity' and 'mystery' from the preference matrix were predictive factors in the preference of architecture. Also, buildings in natural settings were appreciated more than in non-natural settings, also as long as the natural setting was well-maintained and cared for. For the natural setting of buildings, they found that the 'complexity', 'mystery' and 'coherence' from the preference matrix were predictive factors. Overall it can thus be said that people prefer older buildings in natural settings, as long as both the buildings and nature are well maintained. If they are neglected, people prefer newer buildings over older ones. Coherence, complexity and mystery of the natural setting and the building seems at least partly an explanation for these preferences. In a latter study, Herzog & Shier (2000) also found that people prefer complex buildings, and buildings with entrances that are visible.

2.1.6 Social control

A research about eye images showed that people behave better and more according to the rules if they are being watched or think they are being watched by others (Ernest-Jones et al., 2011). This increases when the number of surrounding people is higher. But, if the number of people gets really high, it decreases again. This is similar to Jane Jacobs 'eyes on the street'. Jane Jacobs expressed her disapproval of the planning of the cities and public spaces at that current time in her book 'The death and life of great American cities'. She pleaded for more social control and 'eyes on the street' by mixing functions on district level and building houses with windows towards the street. According to her, this would result in a safer environment (Jacobs, 1961; Luten, 2011; Atlas, 2008; Cozens, 2008). This also results in the avoidance of anonymous spaces, where there are no 'eyes on the street' or windows facing the sidewalk (Atlas, 2008; Cozens, 2008; Jacobs, 1961; Luten, 2011). This is also important in criminology. If, for instance, houses are far away from the streets or have a blind wall towards the street, there are less 'eyes on the streets'. And if less people are watching the streets, the opportunity for offenders to conduct a crime without being watched is bigger and thus the chance for such a crime to happen also increases. A study in the Dutch cities of Gouda and Alkmaar shows for example that people living in streets further away from busy main roads are more likely to become a victim of a burglary (Lopez & Van Nes, 2007).

The mentioned theories within environmental psychology are also visible within the theories concerning environmental design. The development of these theories will be explained in the next section.

2.2 Environmental design and safety – a historical overview

In history, there have been many literature reviews concerning crime rates, the fear of crime and creating an environment to influence these two. Building against crime already started in the Middle Ages, by building defensive walls and digging moats. In the 19th century people like Guerry (1833) and Mayhew (1851) started to describe the spatial patterns of criminality. This was rather descriptive and from the perspective of the offender (Luten, 2011; Sherry, 2014; Lopez & Van Nes, 2007). In the following decades researchers started to describe the perspective of the victim, and the influence of

the environment on their perception of safety. The most important developments were in the second half of the 20th century. Important researchers were Jane Jacobs, Elisabeth Wood, C. Ray Jeffery, Oscar Newman and Timothy Crowe (Luten, 2011; Cozens, 2008).

Jane Jacobs pleaded for more social control and 'eyes on the street'. Windows facing the street, mixed function and a clear distinction between public and private spaces, should make an area more safe (Jacobs, 1961; Luten, 2011). It is said that with Jacobs insights, a paradigm shift was created in urban planning (Matthias, 2009).

Newman wrote in 1973 a book called 'Defensible space, crime prevention through urban design' (FEMA, 2008). His Defensible Space theory focused on the victim, explaining how neighbourhoods can better defend themselves against crime. His most important insight was that people should feel responsible for their living environment. This could be achieved by making them partly 'owner' of that space, giving them the ability to control their living environment. Changes in the physical environment should give residents the opportunity to increase the control of their own living area, and should also create an environment that is unattractive to possible offenders (Carrabine et al., 2008; Luten, 2011; Newman 1972; Newman, 1996). Newman distinguished four categories that would create a Defensible Space: territoriality, natural surveillance, image and milieu. Territoriality means that residents have the ability to create territories or boundaries. This gives the ability to control the area and thus to notice strangers and intruders. Natural surveillance means that there must be good circumstances to control the 'territories', for example by facing windows of houses towards the street. People must be able to observe what is going on in their neighbourhood. By image, Newman means that the area should not look vulnerable; it should not look isolated or abandoned, but well maintained. The category milieu suggest that the good quality of an area, thus having low crime rates, will also have a good effect on its surroundings and the people living in this area (Reynald & Elffers, 2009). In his last book (1996), Newman gave the example of the high apartment buildings as designed by Le Corbusier, and how these were an example of a bad design. He stated that these areas proofed unsafe, and that this was a result of a lack of defensible space. The grounds surrounding the apartment buildings were common ground, there was no sense of territoriality. Also, the apartment buildings were so big, natural surveillance was impossible. There were too many people using the building, so people could not know who actually lived there and who was an intruder (Newman, 1996). Although critics say Newmans ideas are vague and too simplistic, and researchers have used different explanations for the characteristics of Newman's theory (Mawby, 1977; Reynald & Elffers, 2009), Newman's ideas are still being used in the designs of buildings and neighbourhoods. However, this theory mostly focuses on residential areas, and not on areas with other functions.

Just before Newman presented his ideas, criminologist Ray Jeffery created the term 'Crime Prevention Through Environmental Design (hereinafter referred to as CPTED) in 1971. He was inspired by the work of Jacobs. With CPTED he gave a theoretical approach to prevent criminality, having some similarities with the Defensible Space theory from Newman, but including other fields of study. In contrast to Newman's work, Jeffery's CPTED got little attention in the 70s. Newman recognized the broader focus of Jeffery's CPTED, and included Jeffery's work into his own, calling it CPTED too. Newman gave Jeffery credits, and hereby also Jeffery's work got more attention. Newman's work however kept to be limited to residential areas, where Jeffery's CPTED was more broadly applicable (FEMA, 2008). In time, various versions of CPTED have been developed, based on the work of Jeffery. Crowe developed the most popular version of CPTED, which presented practical

and concrete steps in the private and public space to prevent crime and reduce the fear of crime (Luten, 2011; Cozens, 2008).

CPTED seems nowadays the most important theory with regard to environmental design and safety. The theory is being applied all over the world, also in Europe and the Netherlands, for the foundation and development of several guidelines with regard to safety by governments, the European Union, private organisations and scientists (CCV, 2007; CCV, 2014; COST, 2014; Soomeren, 2002). The English term for CPTED is 'Design Against Crime' (DCA) and the Dutch term is 'Veilig Ontwerp en Beheer' (VOB) (DAC, 2015; SVOB, 2015a; Luten, 2011).

2.3 CPTED

CPTED is a theory that gives practical solutions to create a safer environment, and also increases the perception of safety (Atlas, 2008; Cozens et al., 2005). There are several definitions and elaborations on CPTED. Cozens et al. (2005) reviewed the development of CPTED and distinguished a first and a second generation CPTED. The first generation contained merely physical factors; in the second generation, also psychological factors were included. The second generation CPTED was developed based on critics, saying that CPTED did not include psychological and social factors of offenders and victims, and researchers thus included socio-economic factors and demographic information. It also includes levels of residential participation in for example social control.

For the first generation of CPTED Cozens et al. (2005) described a distinction of six categories: territoriality, surveillance, access control, target hardening, image/maintenance and activity support (figure 4). These aspects are all in one way or another linked to theories from the environmental psychology as is described in section 2.1. Crowe and Cozens et al. (2005) state that territoriality functions as an 'umbrella', to which all other aspects are connected. Besides, all aspects are interconnected by themselves. Several studies have shown that all different aspects do indeed have an influence on the crime rates as well as the perception of safety, although there are also studies that cannot find such relations, or only for a view of the aspects (Cozens et al., 2005; Marzbali et al., 2012; Minnery & Lim, 2005).

2.3.1 Territoriality

Territoriality refers to the sense of ownership people have of an area, and also to the clearness for others who owns a specific place. If people feel responsible for a specific place, and also make clear to others that they take responsibility for it, unwanted use of these areas is being discouraged, for such use would be noticed. Demarcation of a territory can be done with the use of symbolic barriers and real barriers. Examples of symbolic barriers are signs, or the use of different colours on the road to define where cars and where cyclists can go. Examples of real barriers are fences or hedges. It is important that it is clear that people are taking responsibility for this place. If not, it loses its power and can even have a reverse effect. If people can violate this territoriality rules, it shows a disrespect of norms and can worsen the situation. This is in line with the goal framing theory, the broken window theory and the defensible space theory (Cozens et al., 2005; Keizer et al., 2008; Keizer et al., 2011; Steg et al., 2011; Wilson and Kelling, 1982; Luten, 2011; Newman, 1996).

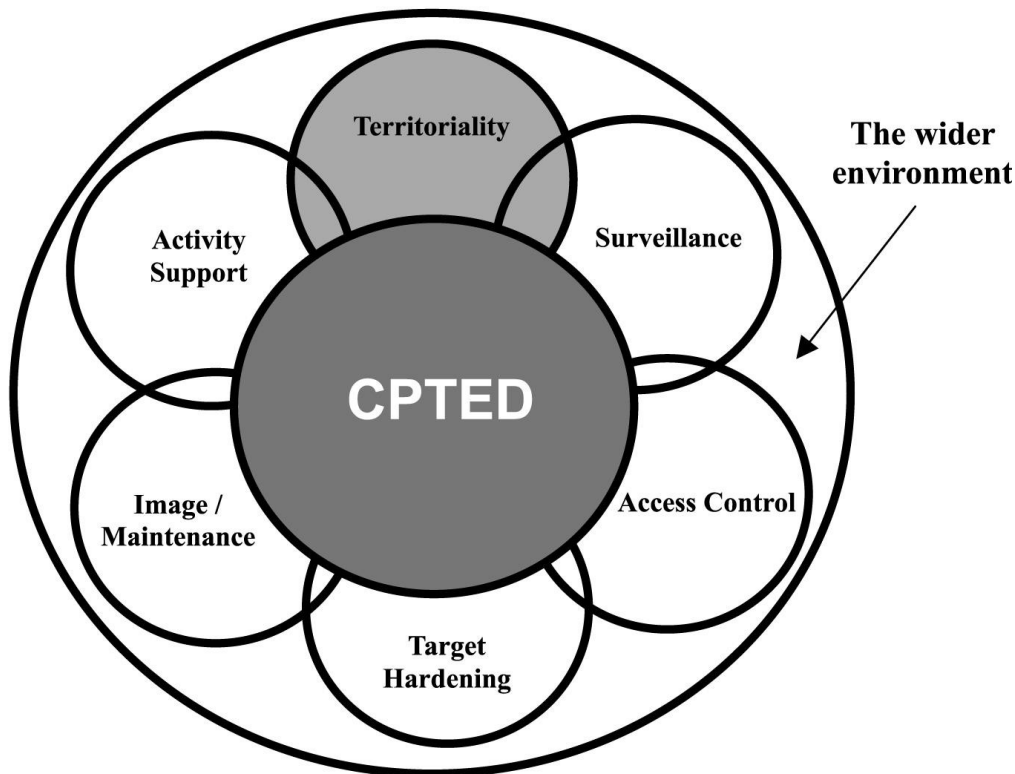


Figure 4: The six key concepts from first-generation CPTED (Cozens et al., 2005)

2.3.2 Surveillance

There are four types of surveillance that can be distinguished: informal or natural surveillance, formal or organised surveillance, mechanical surveillance using camera's, and mechanical surveillance using lighting. This is based on the thought that people, when being observed, behave more according the norm. This is in line with the goal framing theory and the 'eyes on the street' from Jane Jacobs (Cozens et al., 2005; Keizer et al., 2008; Jacobs, 1961).

For informal or natural surveillance the number of people is important. How many people are present, and how many windows of residential areas are facing towards the area? However, a crowded area is also not positive, for this can increase small crimes such as pickpocketing. Sightlines too are important. If sightlines are low due to buildings hedges or other obstacles, offenders have more concealment (Cozens et al., 2005; Appleton, 1975; Fisher & Nasar, 1992; Jorgensen et al., 2012)

Surveillance can also be formal and organized, such as police officers, security guards, railway guards or shop owners. Although most studies show impressive declines in crime rates and fear of crime when formal surveillance increased, studies concerning railway stations and the Underground in England showed diverse outcomes (Cozens et al., 2005; Webb and Laylock, 1992; Deschamps et al., 1992; Van Andel, 1986).

The influence of cameras is still vague. There are studies showing positive effects, but also studies showing no effects. It is hard to show a relation, because the introduction of cameras is mostly accompanied with other measurements. Cameras can also give an unsafe feeling, because people start to think why there are cameras; apparently the place is not safe. However, there are several studies showing the positive effects of cameras (Cozens et al., 2005).

Lighting is especially important at night. Studies show a positive effect of increased lighting on safety levels and the feeling of safety. The positive effect is not only due to the presence of lights,

but also due to the better formal and informal control that is made possible by these lights (Cozens et al., 2005).

2.3.4 Access control

To make sure people can go where they are allowed to go, and that people cannot go where they are not, access control is important. Offenders may not have the opportunity to offend because they cannot access, and intended victims must have the opportunity to escape. Access control too can be formal (e.g. security), informal (physical barriers) and mechanical (e.g. locks). This is in line with the prospect refuge (and escape) theory (Cozens et al., 2005; Appleton, 1975; Fisher & Nasar, 1992).

2.3.5 Target hardening

Target hardening means that it is made more difficult for offenders to get what they want. However, it has been discussed if this should be a part of CPTED because it can conflict with surveillance, territoriality and image. No fortress should be created, where people hide themselves behind solid, high walls. Target hardening can however be achieved in a more modest way, by inserting locks, physical barriers and surveillance. However, physical barriers should not result in a decrease in sightlines (Cozens et al., 2005).

2.3.6 Image/Maintenance

Good maintenance of the area has a positive effect on both crime rates and the fear of crime. This includes clean walls free from graffiti, clean streets and repairs of broken elements such as tiles, windows and lamps. This is in line with the goal framing theory, the broken windows theory and theories of landscape preferences (Cozens et al., 2005; Cozens et al., 2005; Herzog & Gale, 1996; Keizer et al., 2008; Nasar & Fisher, 1993; Steg et al., 2011; Wilson & Kelling, 1982).

2.3.7 Activity support

Activity support means, that unsafe activities are located in safe surroundings (e.g. money transactions), and that 'safe' activities will attract ordinary people who might discourage the presence of 'unsafe' people, for this will create more informal surveillance (Cozens et al., 2005).

2.4 CPTED in the Netherlands (VOB)

The Netherlands have their own institutions with concern to CPTED, the SVOB. In the Netherlands, CPTED is called VOB, what stands for 'Veilig Ontwerp en Beheer' which means 'Safe Design and Maintenance'. SVOB distinguishes however other categories in environmental design than CPTED, namely: visibility, accessibility, unambiguity and attractiveness (Luten, 2011). These four categories contain the same information as CPTED. Surveillance and activity support can be placed under 'visibility', access control and target hardening under 'accessibility', image/maintenance under 'attractiveness' and territoriality under 'unambiguity'. In their manual, SVOB gives their four guidelines the following explanation.

2.4.1 Visibility

Visibility is about seeing and being seen, a clear overview of the area, open sightlines, enough lighting, visibility, and the presence of other people (informal and formal surveillance). It is important not to create a situation of a false sense of security; so can lighting itself not provide security. On the other hand, the creation of an excessive situation with too much visibility is not desirable due to possible harm towards the safety (e.g. stairs made out of glass) and privacy of people (Luten, 2011).

2.4.2 Accessibility

Areas need to be accessible for wanted usage and inaccessible for unwanted use. Also, it must be understandable for people which areas they may and may not access. This can be done physically (e.g. placing fences) or organizationally (e.g. surveillance). Important is the ability to get away. This is in line with the expansion of the prospect refuge theory, namely the ability to escape (Fisher & Nasar, 1992). Thus, people will feel safer if they have the ability to leave if they want to, and if it is not possible for 'unwanted people' to get in.

2.4.3 Unambiguity

Consistency is about clarity of the function, ownership and meaning of a place. It is important to create an unambiguous area with a clear division of territory, so it is clear what is public and private space. It is important to avoid creating anonymous spaces. Nobody feels responsible for such spaces. If the function of a space is clear, it creates a feeling of safety and control. Anonymous spaces occur for example between public roads and residential areas, where it may not be obvious if it is part of a private garden or public space. People also need to be able to quickly understand a situation, knowing where they need to go and how to get away if necessary. People must be able to orientate and understand their surroundings. By being consistent in colours, signs and information, people will be more capable in doing so. If this is not done properly, people can feel insecure, which can lead to a feeling of unsafety (Luten, 2011).

2.4.4 Attractiveness

An attractive environment is important to create a feeling of security. Attractive environments contain universal aesthetic qualities (e.g. green spaces) and a proper maintenance of the area (Luten, 2011).

2.5 Environmental design and railway stations

In literature, there have been various definitions and aspects about what would be important in the environmental design of a place to make it more safe. There are studies that focus on small aspects of environmental design (e.g. the effect of lighting), and studies using several aspects. Studies examining the entire theory of CPTED or VOB are less present, for this seems very difficult. In Cozens words:

“Empirical research, which attempts to measure the component parts of the built and social environment, to make purposeful modifications to it and evaluate the effectiveness of such interventions, is fraught with difficulty.” (Cozens et al., 2005; p. 329)

This is also applicable to railway stations. There are some studies researching specific aspects in station areas and their influence on safety such as the influence of graffiti or surveillance (Webb & Laycock, 1992; Deschamps et al., 1992; Andel, 1996; Sloan-Howitt & Kelling, 1990), but comprehensive studies are barely available. One comprehensive study that has been conducted with regard to station areas, is a study of Cozens et al. (2003) about railway station in the UK. In this study they made use of virtual reality, making a film of six differing station areas during daytime. Participants were asked to watch the videos and tell if they feared for their personal safety or not, both during the day and after dark, in different areas of the railway station. Afterwards, they could rank different CPTED measures that they thought would be best to improve the situation (Cozens et al., 2003).

It is questionable in what amount the theory of environmental design is applicable for railway stations, as the theory is in basis focussed on residential areas. Railway stations are fundamentally different areas with a different function as are residential areas. Residential areas contain a lot of private space, where people live, know each other and feel responsible for their own house and possessions. Railway stations are (semi-) public spaces, needing to attract people to take the train and to make fast traffic movements possible. Here, people generally do not know each other.

2.6 Critics and environmental design

There are some limitations to environmental design strategies, such as CPTED and VOB. First, these measurements have no influence on irrational crimes such as drunk behaviour. Secondly, there are also demographic, social and psychological factors that have an influence on the perception of safety. So do statistics show that in the Netherlands non-western migrants feel more often unsafe than Dutch natives do (CBS, 2014c). In the second-generation of CPTED these factors are better included. Thirdly, there are critics that state that environmental design measures only displace the criminal activities. However, this should not be an argument to do nothing. Fourthly, when a neighbourhood or an area has reached a tipping point and gets stuck in a downward spiral, environmental design measures cannot improve the situation (Cozens et al., 2005). Most of this criticism and these limitations are regarding the influence of environmental design measures on the actual safety, although they indirectly also say something about the perception of safety. When at a certain place the actual safety is low, this will namely also have an impact on the perception of safety. This study was however too small to investigate the precise influence of socio-economic factors and the influence of actual crime rates on the perception of safety. Some small data has been collected, but this was not enough to research (Appendix D). The researcher also did not include theories on social involvement and participation (such as using block leaders, night watchers, etc) which has been included in some other studies concerning residential areas. This is less relevant for railway stations, as these are (semi-) public spaces (Perkins et al., 1990).

2.7 Conceptual model

The aim of this thesis is to examine how environmental design can improve the perception of safety on railway stations. The conceptual model in figure 5 visualises the structure of this research. The structure of the model is based on the adaptive capacity wheel from Gupta et al (2010). All railway

stations have aspects of environmental design. Twelve aspects can be distinguished, placed in the four main categories as proposed by SVOB, because this research is a Dutch case study. Every aspects can score 'low', 'moderate' or 'high' for the presence of these aspects, which in the end influences the scores for the four main categories and finally also the score of environmental design. A high score on environmental design means a high score on the perception of safety, and a low score on environmental design means a low score on the perception of safety. It is however not known if every aspect has the same value, or that one aspect is more/less important than others. This is why the perception of the travellers on the importance of the aspects is of relevance. Finally, also differences in time and the location of the different railway stations can be of relevance on the presence and the importance of the aspects

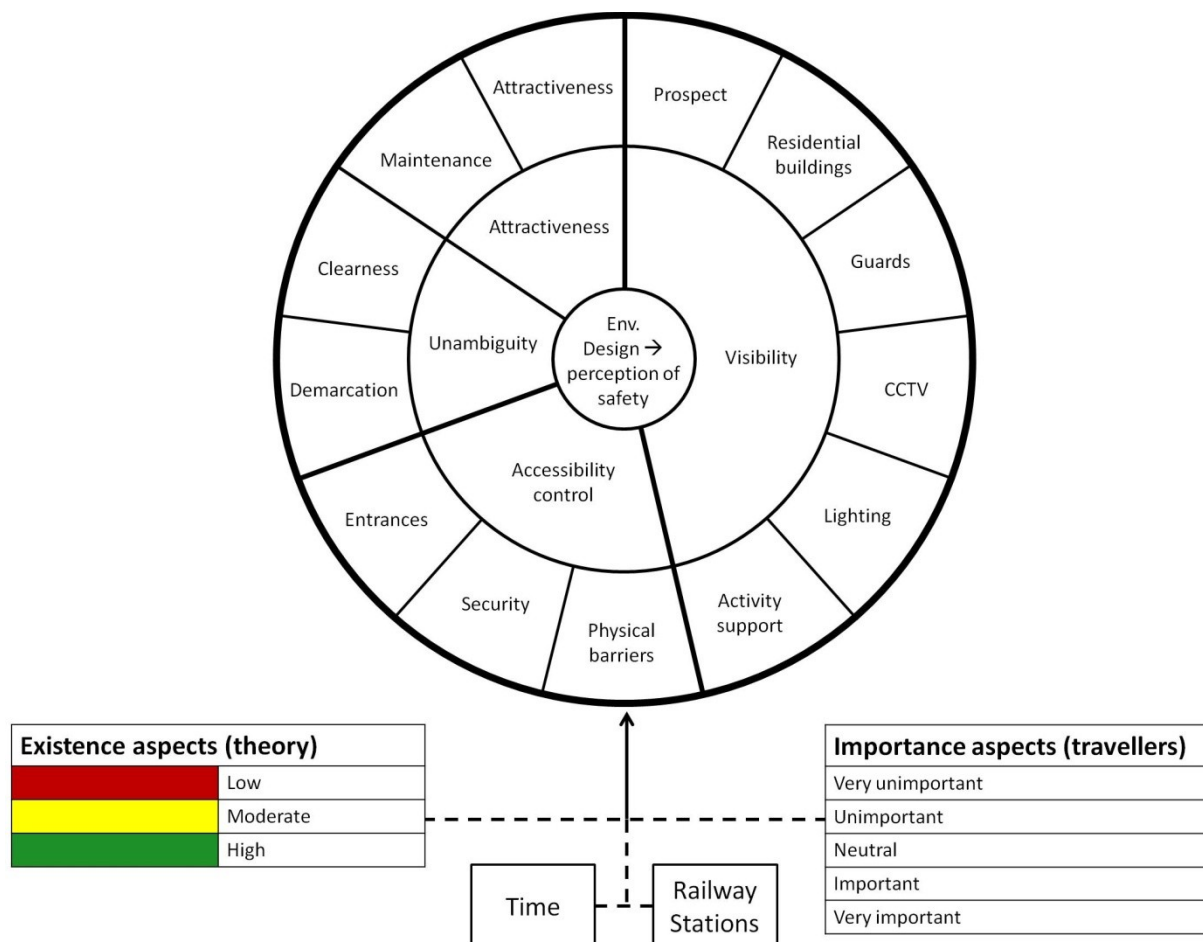


Figure 5: Conceptual model (based on the adaptation capacity wheel; Gupta et al., 2010)

2.8 Final remarks

The concept of environmental design with regard to the perception of safety was born in the United States. It's precise working, in which situation which aspects are most important, and how to evaluate environmental design is however not exactly known (Cozens et al., 2005). Despite this, the concept has been broadly accepted, also in the Netherlands. To analyse how environmental design can improve the perception of safety in the case of railway stations in a Dutch city, the above conceptual model is constructed based on the relevant theories.

Chapter 3 - Research design

This study is based on case studies, an interview, questionnaires and field observations. These are rather high on external validity, but relatively low on internal validity (Steg et al., 2012), which is in line with the aim of this research; the theory itself is namely not tested, but this research investigates how the theory can be applied on railway stations.

3.1 Case study areas

A case study gives the possibility to get a clear view of a situation so it will be possible to analyse how a system works (Rice, 2012). This corresponds to the objective of this research to determine to what extent the different aspects of environmental design are present in the case studies. For this research three case studies are conducted. As mentioned before, the case studies chosen are the three railway stations in the city of Groningen: Groningen Railway Station, Northern Railway Station, and Groningen Europapark Railway Station (see figure 6).



Figure 6: Location of the three railway stations in the city of Groningen

It is important for this analysis to indicate which areas are part of the railway stations. This will be based on the distinction that has been made by Spoorbouwmeester, NS and ProRail (2011). They state that a railway station has four different domains and a connecting zone between the domains (see figure 7). These domains are:

- Connecting domain: the area surrounding the railway station, that connects other travel modes such as biking with the railway station. This is often designed as a square in front of the station. It is important to make sure that the railway station is in harmony with the surrounding areas. Smaller railway stations do not always have (a clear) area domain.
- Reception domain: this is the area where the traveller can get travel information or information about the direct area around the railway station, other travelling modes (e.g. OV bicycle/bus station) or the city. This is also the place where passengers have the opportunity to buy tickets. A railway station can have several reception domains. Reception domains are often open for anyone, also non-passengers. It is also a meeting place, and there can be small catering and retail facilities.

- Travel domain: this area is more often enclosed, for example using entrance gates, sometimes only accessible with an OV chip card. This area consists of the platforms, the place where passengers can wait for the train and get on and off the train. This area also provides information about departure times and such.
- Recreational domain: this domain is often only present in larger railway stations. It provides the traveller (or non-traveller) with a comfortable way to pass time while waiting for the train. It contains facilities such as retail or catering. In some station areas, complete shopping malls are connected to the railway station. It is a place not only for travellers; it is a place to meet and recreate.
- Connecting zone: this is the walking zone that connects the different domains, from the connecting domain to the reception domain and finally the travel domain. If a recreational domain is present, this is situated outside the main walking route, not disturbing the passenger flows.

The study area contains the railway station within its own boundaries, and also the forecourt of the railway station, if this is present.

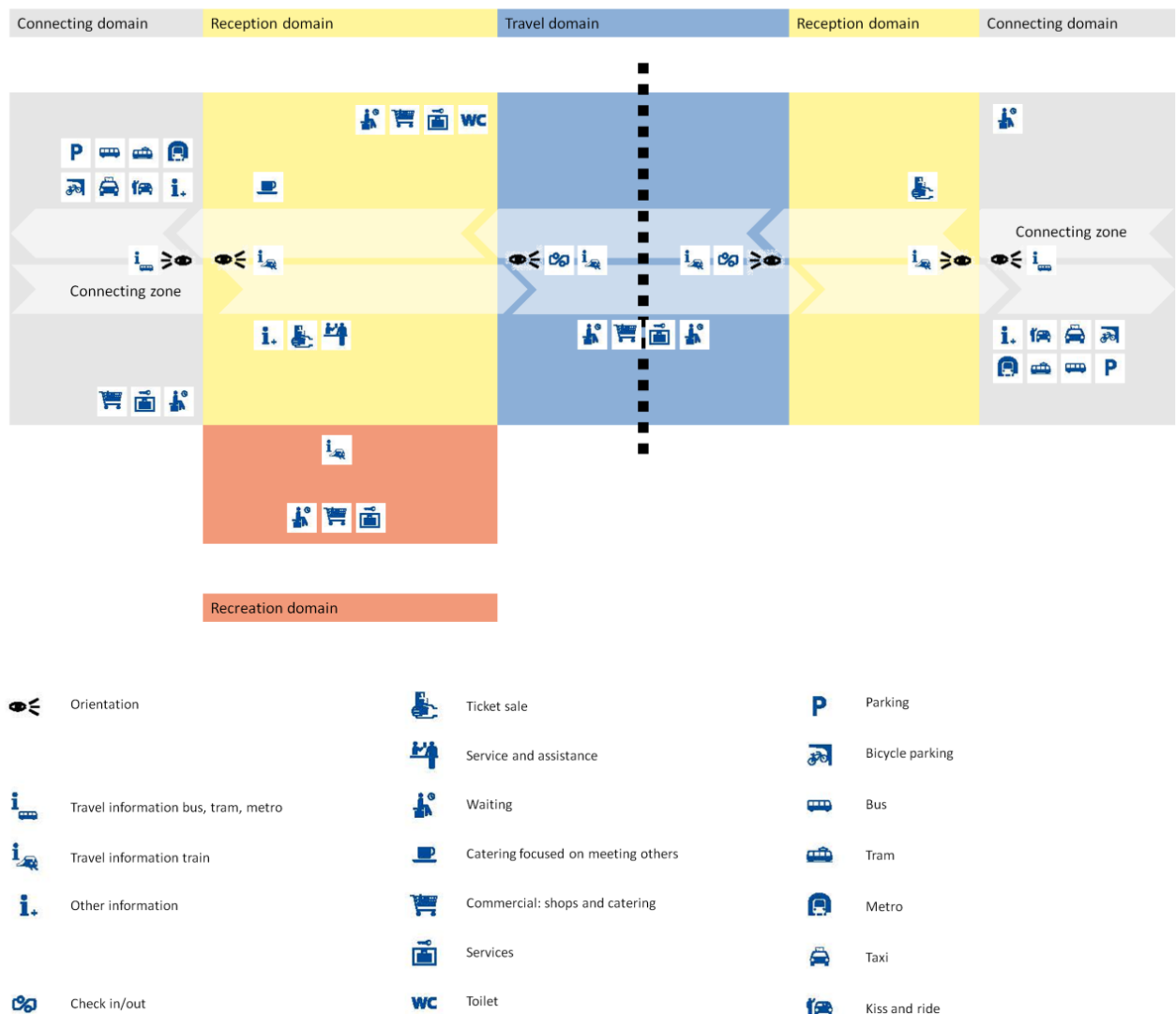


Figure 7: the different domains of a railway station and its functions (Source: Spoorbouwmeester, 2011)

3.1.1 Groningen Railway Station

The main railway station of Groningen is the oldest railway station in the city. A first, simple version was built in 1866, but the historical building as it is nowadays was built in 1895. In those days the railway station was located just outside the city; nowadays it has a more central position. The original building is a mixture of renaissance and gothic styles and was designed by I. Gosschalk. The station area has been changed in the 60s of the 20th century and is in the 90s restored in the original situation. Extra platforms were build and some stores were put on the middle of the station. The square in front of the railway station also changed. An underground bike park facility has been constructed, and the roof (the train station square, also called 'stadsbalkon') is partly lifted; it now shows an undulating square with a high level of visibility and sightlines into the parking facility, but it obstructs the view from one side of the railway station to the other and from the railway station to the city centre. The Groningen Railway Station is an official national monument since 1975 and is listed on the cultural heritage list (Groote, 2015; OCW, 2015; Zevenbergen, 2007).

Groningen Railway Station is with an average of 19.915 passengers a day, a railway station of medium size. Based on large questionnaires, executed four times a year, passengers scored this railway station in general with a grade of 7,5. This makes this railway station one of the best in The Netherlands, with a relative score of 98 in the first quarter of 2015. For this relative score, the best scoring railway station is given 100 points, and the worst is given only 1 point. There are 328 railway stations in the Netherlands, so a score of 98 is very good. People were also very positive about their safety perception, scoring the railway station with a 7,4 (ProRail, 2015a).

Figure 8 shows a map of Groningen Railway Station. The main entrance is on the north side, where the historical building is located. Entering the railway station at this location leads to the station hall, which is shown in the upper left picture. There are three platforms, which all have railway tracks on both sides, creating six platforms. The lower left picture shows platforms 3 and 4 from the eastern side. The lower right picture shows the southern entrance of the railway station, which is a traverse. In total, there are eight entrances on this railway station, on the map visible by the red dotted lines.

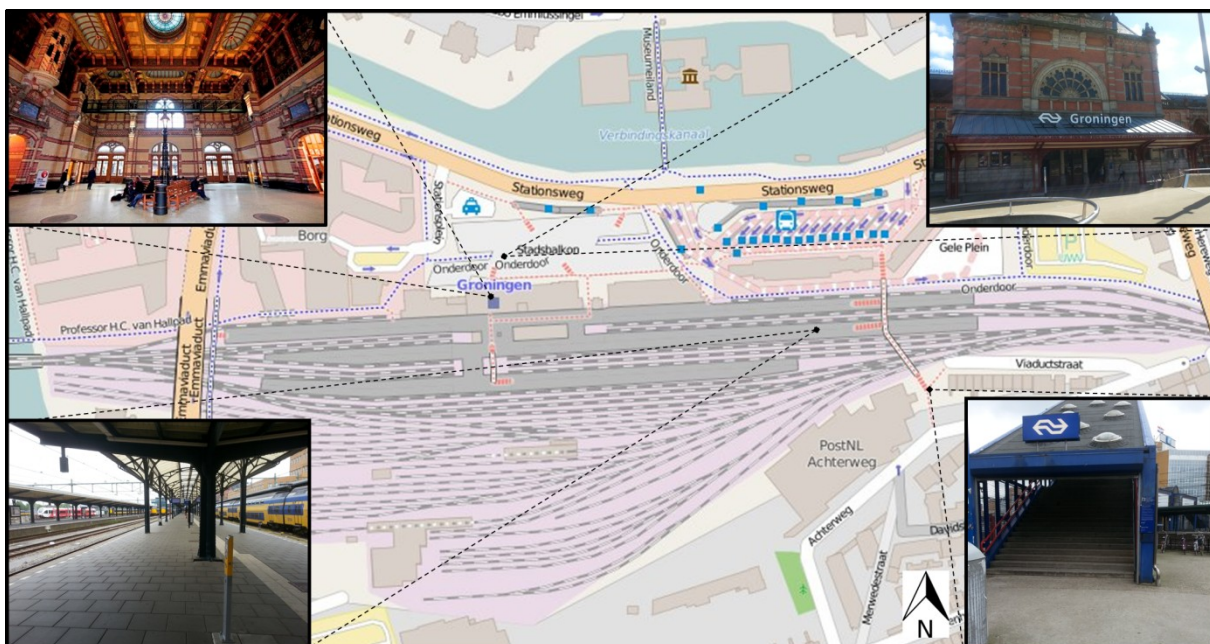


Figure 8: Map Groningen Railway Station (Sources: own pictures; OpenStreetMap-authors, 2015; NS, 2015b)

3.1.2 Northern Railway Station Groningen

The Northern Railway Station exists since 1884, only a couple of decades later than Groningen Railway Station. The building was closed in 1973 and was replaced in 1974 by a new viaduct railway station. The railway station was renovated in 2006, because the area was known for its negative atmosphere. This was also due to a murder in 1997 in the direct vicinity of the railway station. To improve the environmental quality and to increase the liveability and public safety the whole area was renewed. On the railway station, they closed the old stairwells and replaced them with open stairs. The old stairwells are nowadays home to small art galleries (Bramer, 2013; Puts, 2015). Aside from the two new stairs to reach the two platforms, there are also two ramps which allow cyclists and others to reach the platforms. Under the platforms a café is situated, 'café het noorderstation'. Arriva is the only passenger railway operator connecting this railway station. Other facilities on this railway station are bicycle stands, bicycle locks and free car parking right in front of the railway station.

Groningen Northern Railway Station is with an average of 1.888 passengers a day a small railway station. Passengers scored this railway station in general with a grade of 6,4 which makes it a relatively low scoring railway station. People were also not really positive about their safety perception, giving it an average score of 6,2. A point that scored really bad was the charm and attractiveness of the railway station, with an average score of 4,2 out of 10 (ProRail, 2015b).

Figure 9 shows a map of the railway station. The upper left picture shows the view when standing on one of the platforms. The lower right picture shows the view when standing on ground level, showing both the road going under the platforms as the stairs towards the eastern platforms. On the map, the stairs are shown with two red dotted lines. There are two other ways to enter the platforms, mainly by two ascending pathways. These are also shown as two red dotted lines, going all the way up to the north and then bending towards the platforms. The upper right picture shows the view when standing on the northern end of one of these paths, looking towards the south, where the upgoing path on the right side leads towards the platform, and the lowering path on the left to the ground level.



Figure 9: Map Northern Railway Station (Source: own pictures; OpenStreetMap-authors, 2015)

3.1.3 Railway Station Groningen Europapark

Groningen Europapark Railway Station is a new railway station located in the southern part of the city of Groningen. A temporary station was built in 2007 and in December 2012 the official railway station opened. It is located between a business park and a residential area. It has three platforms and two passenger railway operators, NS and Arriva. Underneath the platforms is a tunnel with a bicycle path and a sidewalk, that connects the business park with the residential area. Two of the platforms (platform 2 and 3) can only be reached via this tunnel by stairs or elevator. The first platform can be entered from two levels: from the tunnel level and from ground level. There are three squares: two small deepened squares on the two ends of the tunnel, and a larger square that is connected to the first platform. Underneath this large square is a bicycle parking. The railway station was during Architecture elections in 2013 chosen as the most beautiful new building in 2013 in the City of Groningen (Sporbouwmeester, 2013).

Railway Station Groningen Europapark is with an average of 1.950 passengers a day a small railway station. Passengers scored this railway station in general with a grade of 7,2 which makes it a relatively good scoring railway station. People graded their safety perception also with a 7,2 (ProRail, 2015c).

Figure 10 shows a map of the railway station. The first platform has one railway track, and the second platform has one railway track on each side. The lower left picture shows the view on the railway station from the southern side, looking to the north, showing in front the railway station and the tunnel, and the white building of the municipality of Groningen on the background. The upper right picture shows the view when standing on the first platform and looking towards the east, showing a small part of the platform, the elevator and stairs leading towards the platforms, and the entrance of the bicycle parking.



Figure 10: Map Groningen Europapark Railway Station (Source: OpenStreetMap-authors, 2015; Spoorjan, 2013; DeOpenbareRuimte.nu, 2013)

3.2 Data collection

Principally primary data have been used, collected by the use of field observations, questionnaires and an interview. The secondary data that have been used are GIS data (BAG, Top 10NL) and data provided by ProRail (results survey and maps). The data collection has been conducted in the following steps:

1. Field observation
2. Interview
3. Survey

The field observation, together with the interview, answers the following sub questions:

“In what amount are the elements of environmental design present at the railway stations in Groningen?”

“What are the characteristics of environmental design of the places that are regarded to being most unsafe?”

“What are the differences between environmental design between daytime and dark”

The survey answers the following sub-questions:

“Which aspects of environmental design are most important for the perception of safety from users of the railway stations?”

“What are the differences of the perception of safety between daytime and after dark?”

3.2.1 Field observation

In previous studies concerning environmental design, researchers often made use of questionnaires to measure the environment based on how people perceived it. In this way, researchers did not analyse the environment themselves; they let people indicate how they perceived the different aspects (territoriality, accessibility, attractiveness and visibility). This approach was used 20 years ago, and is still an often used method today (Perkins et al., 1990; Pitner et al., 2012). Because the results are based on self-reports and interpretations, there is a risk of a response bias. An environmental inventory is more reliable in such situations (Perkins et al., 1990; Pitner et al., 2012). It is plausible that, especially for the relatively large Groningen Railway Station, a fair amount of the railway travellers has never been in certain parts of the railway station and thus cannot reflect on these places. This is why a location analysis will be conducted to analyse the case studies as objectively as possible. A field observation is a good way to get an impression of the (complex) environment of the railway stations, for this can be hardly captured using secondary data. Being at the place itself gives a better understanding of the dynamics of a certain place (Turkington, 2010). During this research, for some aspects GIS will be used to help analyse and show some environmental cues for the different railway stations.

The field analysis contains three steps: measuring, interpreting and valuing. For an analysis as described, this is not as straightforward as it sounds. A lot of the aspects are hard to measure. You can for example rather easily measure how well an area is lighted, by measuring the Lux with an app. Aspects such as prospect and attractiveness are hard to measure and cannot be captured in numbers. They are based on the (subjective) interpretation of the researcher. Secondly, the measurements must be interpreted. This can also cause problems. Which level of illuminance is sufficient? And which level is not? Different organisations and different countries use different minimum levels. Thereby, also ProRail uses different levels. The Dutch SVOB however states that a

minimum of 100 Lux should be required on platforms (SVOB, 2015c). Public lighting needs to be at least 3 lux, and for tunnels this is 15 lux according to the PKVW (ccv, 2011). According to ProRail, tunnels at railway stations should at least be 50 lux, and traverses 40 (ProRail, 2009). At last, it can be said that one aspect would be more important than the other. For example, security may be more important than an attractive environment. In theory it is not known which aspects are being prioritized; therefore an investigation has been done in the form of a questionnaire to construct an image of the importance of the different aspects (see section 3.2.3).

Because some aspects of environmental design, such as (camera) security and surveillance, are relatively hard to analyse in a field observation, an interview has been conducted (see section 3.2.2). This interview enlightened some aspects that had been noted in the field observation.

Based on the field observation, the different aspects of environmental design have been 'graded', based on the amount in which these aspects are present. They will be put in one out of three possible categories: 'low', 'moderate', 'high' (see conceptual model, figure 5). These scores will be based on standards as they are visible in table 2.

There are some guidelines given in literature and also SVOB with regard to environmental design in station areas (APTA, 2010; Cozens et al., 2003; SVOB, 2015b; SVOB, 2015c). Based on the four points distinguished by SVOB, these are:

- **Visibility:** windows in doors and shelters can increase visibility, along with a smart arrangement of the area, a mixture of functions (including shops and such), security patrols, camera's and proper lighting, on the station as well as the routes towards the station area. When including stairs, people need to have a clear overview of the area before leaving the stairs. When there are tunnels in the area, they must be straight, well lightened and there should be no indented walls. Lighting must be in harmony with the environment, not creating an area where one place is lighted very well and the other not at all.
- **Accessibility:** there should be enough entrances present on the station area for safety reasons. However, too many entrances gives complications with controlling them. The entrances can be watched using surveillance, but also barriers as fences and entrance gates can control the people entering the station area. If necessary, during 'quite' hours parts of the station area can be closed.
- **Unambiguity:** it must be clear for the users of the railway stations where to go. This can be done using signs, colours or symbols. Vegetation and fences can be used to show people where they can and cannot go. It must be clear where the station area begins and ends.
- **Attractiveness:** the area must be properly maintained, having no graffiti, litter, signs of vandalism or broken things such as lights. The placement of garbage bins gives people the opportunity to easily throw their garbage away. Also, if there is vegetation, this should be well maintained and cut, not reducing line of sights. Station areas can be made more attractive by including benches, art or even a piano.

Based on these considerations and the general literature of environmental design, the following standards are developed for all aspects (table 2), resulting in a 'high' 'moderate' or 'low' score for that specific aspect on environmental design. For example, if there is CCTV on the entire railway station, the score for CCTV will be 'high'. Because such an analysis cannot be completely objective and depends on the insights of the researcher, every choice made in the field observation will have a broad explanation, summing up all the observing and considerations being made. This ensures

transparency and makes sure nothing is left to the imagination and interpretation of the reader (Gupta et al., 2010). The different measurements per aspect are visible in the table below.

Category	Aspect	Description	Measurement (low, moderate, high)
Visibility	Prospect	The overview of the area, influenced by the number of objects. Objects made out of glass are positive	<ul style="list-style-type: none"> ○ Low ○ Moderate ○ High
	Residential buildings	Presence of residential buildings with windows facing towards the station within 150 meters	<ul style="list-style-type: none"> ○ Few (low) ○ Some (moderate) ○ Many (high)
	Guards	Presence security (formal and informal)	<ul style="list-style-type: none"> ○ None (low) ○ Some (moderate) ○ Many (high)
	CCTV	Presence of camera's	<ul style="list-style-type: none"> ○ None (low) ○ Some (moderate) ○ Many (high)
	Lighting	Proper lighting, being above minimum and having no big changes in lighting	<ul style="list-style-type: none"> ○ Low ○ Moderate ○ High
	Activity support	How well are functions mixed and are sensitive activities within sight	<ul style="list-style-type: none"> ○ Low ○ Moderate ○ High
Access control	Physical	Physical barriers, to prevent unwanted people from entering the railway station	<ul style="list-style-type: none"> ○ Few (low) ○ Some (moderate) ○ Many (high)
	Security	Presence of security at the entrances, preventing unwanted people entering	<ul style="list-style-type: none"> ○ None (low) ○ Some (moderate) ○ Many (high)
	Number of entrances	Is there a good balance in the number of entrances	<ul style="list-style-type: none"> ○ Low ○ Moderate ○ High
Unambiguity	Demarcation	Is it clear where different areas begin/start using physical barriers or symbols	<ul style="list-style-type: none"> ○ Low ○ Moderate ○ High
	Clearness	Clearness of information, how understandable is the situation	<ul style="list-style-type: none"> ○ Low ○ Moderate ○ High
Attractiveness	Maintenance	How well maintained is the area (litter, graffiti, vandalism, need for reparations)	<ul style="list-style-type: none"> ○ Low ○ Moderate ○ High
	Attractiveness	Is the environment attractive (greenery, buildings, music, art)	<ul style="list-style-type: none"> ○ Low ○ Moderate ○ High

Table 2: measurements for grading the different aspects of environmental design for a railway station

3.2.2 Interview

To be able to obtain data that are hard to acquire using only field observations (such as CCTV, which is not always clear if this is present in an area), an interview has been held with Gertrud Kuis, the location manager from NS for all railway stations in northern part of the Netherlands. This interview has been conducted as a semi-structured interview. Semi-structured interviews are useful, for they make sure certain key questions are answered, but also give the ability to go further into detail if necessary, providing information that may not have been foreseen by the researcher (Longhurst, 2010). This interview has been conducted in Dutch. The interview questions can be found in the appendices in English, but the transcript is in Dutch. The transcript of this interview can be requested for those authorized.

3.2.3 Survey

The questionnaire has been held on location to indicate the perception of safety from users of the railway station. For this reason the questionnaire is kept short. A survey is useful, for it is a good method to reveal people's opinions about social and environmental issues, such as risk perceptions (Mc Lafferty , 2010). For a reliable result, at least 30 participants were needed per location, so at least 90 in total. 100 persons filled in an usable questionnaire. The survey has been conducted on location, because it contains questions about people's feelings and experiences, which people can qualify better if they are in that particular area.

The survey contained three main questions: (1) general socio-economic questions, (2) perceptions on which aspects of environmental design are most important for their perception of safety, and (3) on which specific location they felt most unsafe. All questions were asked for a situation both during the day and after dark. The questionnaire is visible in Appendix A. The questionnaire was the same for all railway stations, with exception of the map which differs per railway station. Appendix C shows the descriptive statistics of this survey.

The questionnaires for every location were held both on a weekly day (both during the day as during rush hour) and also on a weekend day, to obtain a broad response group, including students, commuters and people travelling by train for a field trip or holiday.

While conducting this research there was an ethical issue that had to be taken into account. Namely, if there were participants who have been victim of for instance (sexual) assault, the questions could be confronting and difficult to answer. It is possible that these people do not want to cooperate with a questionnaire containing such questions. However, by assuring the participants that the questionnaire was completely anonymous, by asking general questions without going into detail, and by making open question ("why do you (not) feel safe") not compulsory, this has been soothed.

3.3 Data analysis

The researcher has analysed to what extend the railway stations currently perform with regard to environmental design characteristics, based on the field observations, showing which aspects need more attention on the different railway station. Every aspects has been graded 'low' 'moderate' or 'high' and have been put in the diagram visible in the conceptual model, figure 5. Also the most unsafe places on the three railway stations have been analyzed, showing their scores on environmental design, and the reasons given by the travellers why these places were perceived as

being most unsafe. These results show which aspects of environmental design (that score low) are being mentioned as important reasons for unsafe feelings, and which aspects are not.

Hereafter, the results from the questionnaire were included, to see if people using the railway stations thought some aspects might be more or less important than others (One-Way repeated measures ANOVA), if there were differences in perceptions during day and after dark (paired-samples t-test), and if there were differences between the three railway stations (One-Way between subjects ANOVA). Also, statistical analyses were conducted with regard to socio-economic and demographic factors influence. The data collected was however not comprehensive enough to include this in the analysis. The results from these tests are however visible in Appendix D.

Based on all the data, recommendations were given about adjusting the model with regard to railway stations, showing which aspects are perceived as being least or most important. Based on this adjusted model, recommendations have been done on how to improve the perception of safety on the railway stations, especially for those places pointed out as being 'most unsafe'.

Chapter 4 – Results

This chapter will show the results of this research. First, the results of the field observations, added with information from the interview, will be shown. Thereafter, the specific places that have been pointed out as being ‘most unsafe’ by the participants will be mentioned and analysed. Thirdly, the results from the questionnaire will be analysed. Finally, all results together will be investigated.

4.1 Observation results

First, the observation results of Groningen Railway Station will be illustrated. Secondly, Northern Railway Station will follow, and last is Railway Station Groningen Europapark. At each section, first the results of the analyses will be shown in a figure, both for daytime and after dark. Afterwards, a thorough explanation of these results will be given, describing the situation on the railway station, and visualizing it with maps and pictures of the area.

4.1.1 Groningen Railway Station

The figures below show how well the main railway station scores on environmental design, for both during the day and after dark. There is almost no difference between the two figures, with expectance of the aspect ‘maintenance’. In the following sections the scores given to the different aspects will be explained. For several aspects (e.g. CCTV), this is the same during the day and after dark. When aspects differ after dark, this will be explained. After this section, there is a page with photo’s to visualize the aspects of the railway station. Also figure 8 in section 3.1.1 can be used to gain an image of the railway station.

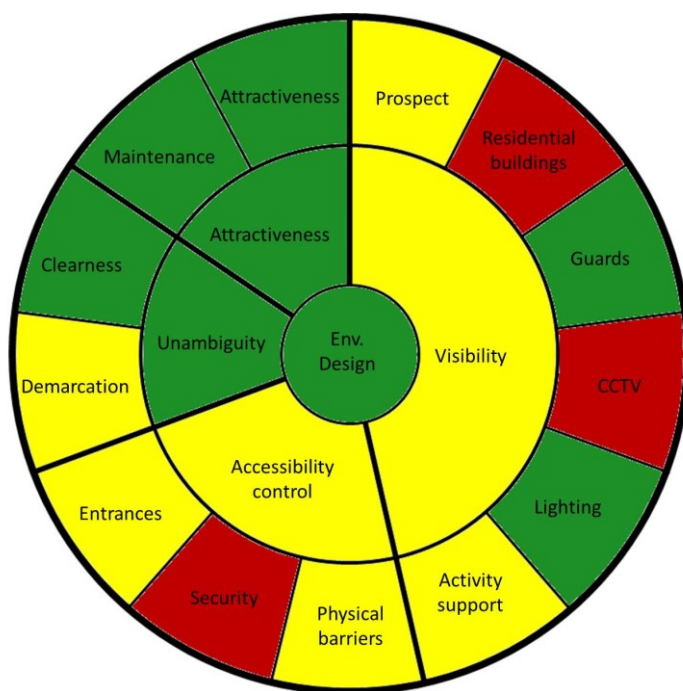


Figure 11: scores Groningen Railway Station during the day

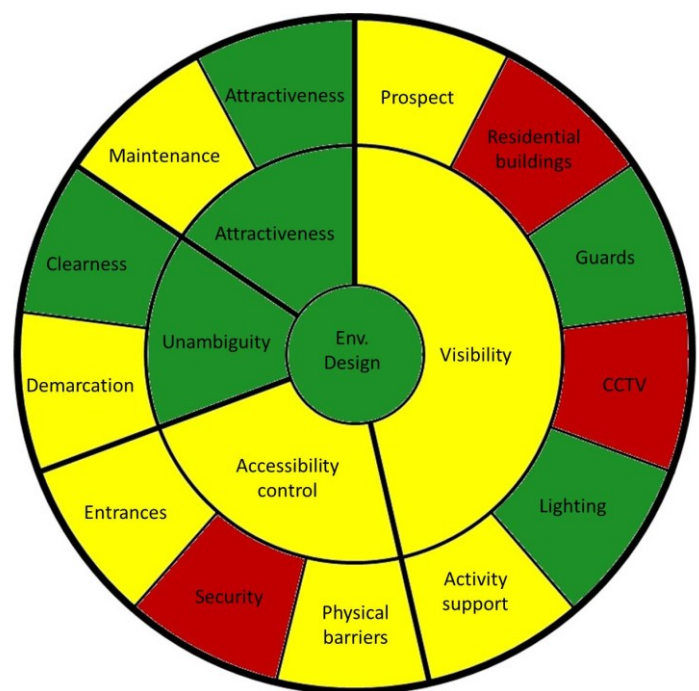


Figure 12: scores Groningen Railway Station after dark

4.1.1.1 Visibility

The 'prospect' of the area is moderate. There is some overview of the area when waiting on the platforms, and on the south side of the railway station is a storage area for trains. This gives a broader view to the southern side of the railway station. In the middle of the railway station are some shops located, and also a traverse with a signal box, where the last two are no longer in use. These buildings block the view from one side of the station to the other, as well from north to south (from the station building to the platforms) as from east to west (one side of the platform to the other) for the two middle platforms. The traverse and signal box are however a municipal monument and thus cannot be removed (Monumentera, 2015). The only enclosed area in the railway station is the station hall. However, when entering the station hall, the 'prospect' is really good, there are just some benches in the middle of the hall, and a lot of windows in the doors and the walls which give you a good view of the area behind it. However, with the construction of the square in front of the railway station, the 'stadsbalkon', the view got blocked from the station hall to the city. The 'stadsbalkon' also blocks the view from the eastern to the western side of the station. On the other hand, it also gives some good impulses to 'prospect'; when standing on one of the higher points of the square, you have a good view of both the station area and the city of Groningen. The rising ends of the square also give better 'prospect' for the bike parking facility, giving a good overview of the parking area when outside, and vice versa. The traverse at the eastern side of the station bends in the middle. This lowers the 'prospect' when walking through the traverse. However, the traverse does contain some mirrors that increases the overview, as do the walls. However, when coming down the stairs, information boards sometimes block the view. This lowers the overview when coming down the stairs and entering the platform. The overview from the other side of the station, the stairs coming down from the Emmaviaduct, is better. The stair is open and does not have walls or a roof. In general it can be said that the 'prospect' on the railway station is only moderate. There are some aspects that increase the 'prospect', such as mirrors and glass doors, but there are also buildings that obstruct the overview, such as the traverse, the shops and the 'stadsbalkon'.

There are only a few residential buildings with sight on the station area (figure 13). On the northern, eastern and western side are no residential buildings; only office buildings and shops. On the southern side, there is a row of industrial buildings such as a storage area for trains. Beneath these buildings are the first houses of a residential area located. This creates a large distance between the platforms and the residential buildings on the south side, over 300 meters. There can thus be concluded that there is no social control on the railway station by the presence of residential buildings.

There is no formal control during the day on the railway stations. The shops do provide security, as the shop owners function as guardians. Also the service point at the station forms a sort of formal security. These shops and the service point are open the entire day. Also the conductors and machinists function as guards, as they keep an eye on the platforms. During all nights there are guards, including a dog. These guards are present after the NS information desk closes at 23:00. Besides these formal guards with dog, some services are open till late in the evening, some even till the last train arrives (around 02:00). The Albert Heijn and the Burger King are open until 00:00 and the bicycle shop till 02:00. The guards at the bicycle parking are present during the entire night. After the last train arrives, the guards with dog leave. This is at the point that the traveller is not affected anymore, because there are no more trains departing or arriving. Still there is informal security around during the night, namely the people cleaning the trains. This is done after the last train

arrives until the morning. There is also a process manager for the platforms present the entire night. So after dark there is nonstop formal and informal security on the railway station (Interview Kuis).

Buildings surrounding Groningen Railway Station

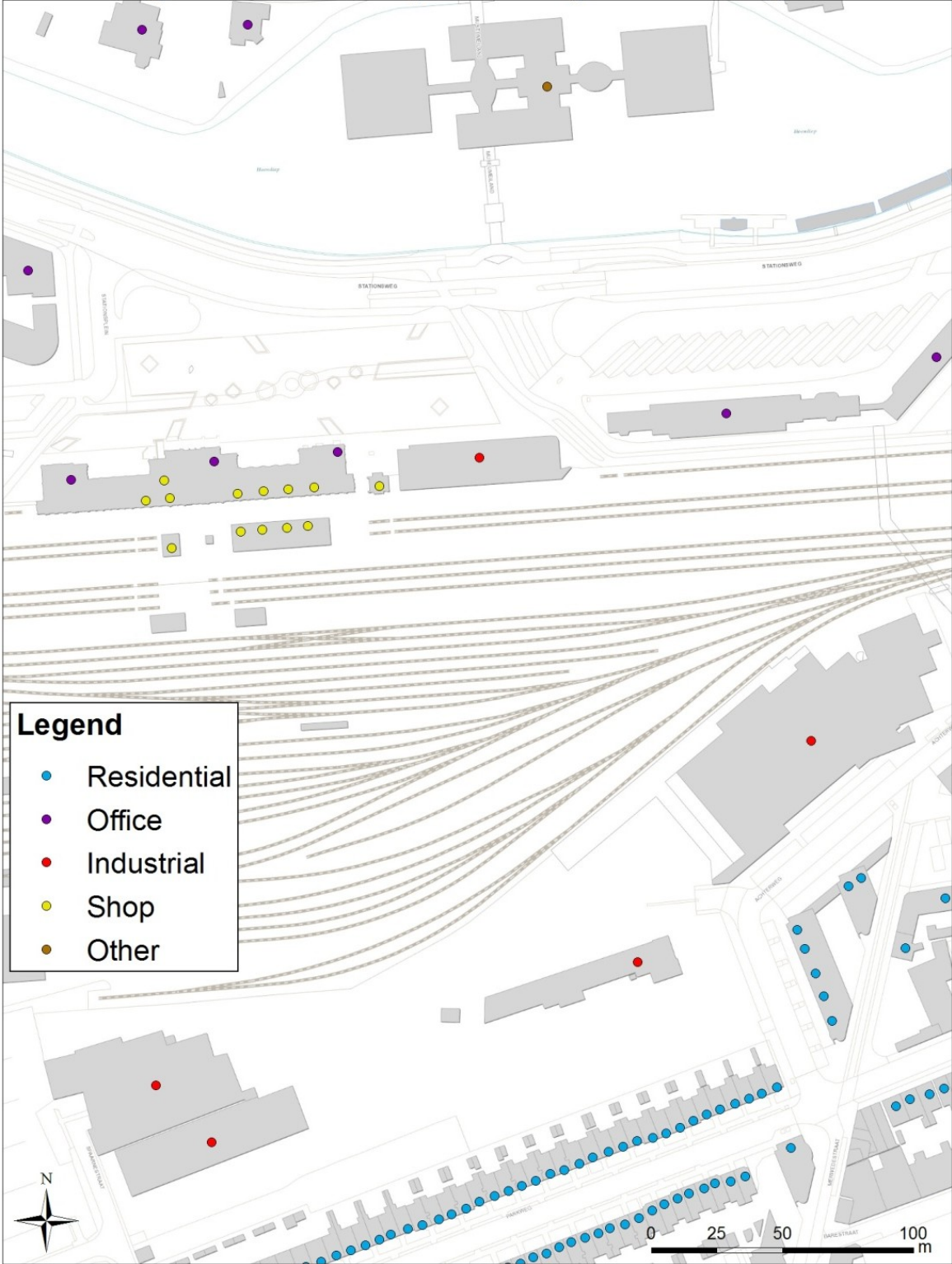


Figure 13: types of buildings surrounding Groningen Railway Stations

Some shops have camera security, but there is no CCTV on this railway station. There are in general no severe incidents on this railway station, where cameras are mostly placed after incidents. There is a plan for the 20 or 30 biggest railway stations to get CCTV, so it might be that Groningen Railway Station gets CCTV in the future (Interview Kuis).

The railway station is properly lightened. There are some areas that are open, which allows natural light to enter. At these places (stationsbalkon and the front of the railway station), the lighting is well above 100 lux. There are separate roofs above the platforms, protecting passengers from the weather. The old roof closest to the station building is made of wood in a bright colour. It does not allow the sunlight to go through. The second roof is made of corrugated sheets, which allows more sunlight to shine through, giving more natural sunlight. The last two most southern platforms have a more modern roof, lifted on the sides, so more light has the ability to enter. On all platforms the lighting is good, being around 150-200 lux or higher. The same can be said for the traverse on the eastern side of the railway station. At last, the station hall has poorer lighting. There are windows in the walls and doors which allows sunlight to enter, and inside there are lamps. The lighting is however just above 100 lux, which is close to the limit. The lighting at night is high, but at some places it is not proper enough. The lighting at the traverse and the station hall at the eastern side of the railway station during the night is around 150 lux. The platforms are all lighted till the very end. There were no broken lights, and the lighting at the platforms is around 100 lux. At the borders of the railway station, the lighting is below 100 lux, but these differences are not so big that you walk into a black wall. Across the stadbalkon a walking route is lighted, but the remaining parts of the square are dark. It can thus be said that the railway station is well lighted at night, and the transition to the area outside the railway station is done properly. The square does have dark places, but during the night it is not necessary to lighten the entire square.

This railway station is relatively large, and thus allows several facilities to be present. This causes a mixture of functions and thus more social control creating a safer environment for users of the railway station (figure 14). Sensitive activities are in this way also safer to perform, because there is more social control. This is visible by the placement of the ticket machines in the centre of the railway station, where it is visible for passengers, shop owners and people from the service desk of NS. There are also some vulnerable activities that have a less visible place, but are still in sight. So is another ticket machines placed between two buildings of the railway station, only controlled by people walking by and people that are on the square in front of the railway station. There are no shops around. Also, the ATM is placed in the corner of a building. This also is only visible for people passing by or people that are on the 'stadsbalkon'. This route is an often used route because it gives access to the bus station area as well as the bicycle parking. In the bicycle parking security is constantly present. The guards from the bicycle parking can partly see this area from their post. This thus increases the activity support. The ticket machine on the eastern side of the station is visible from people walking by, people cycling and the people from the bicycle shop which is open the entire day. There are thus several eyes on this place. However, the lockers in the railway station are placed on the back wall of the shops, in a place that is not visible from the shops or the service desk. It is also nearby the unused traverse and signal box, that blocks the views from other parts of the station. It can thus be said that the 'activity support' is only moderate for this railway station, having a lot of sensitive activities being well located, but placing the lockers in a place that is less visible for other people.

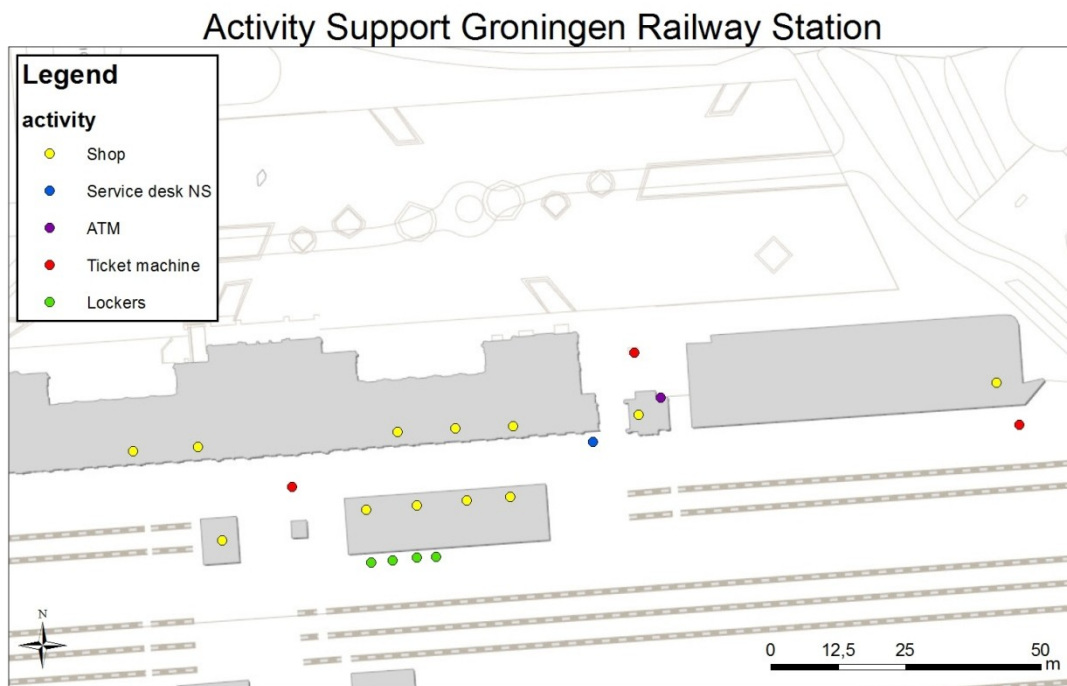


Figure 14: different (sensitive) activities and their position towards each other on Groningen Railway Station

4.1.1.2 Accessibility

The entire station area is enclosed by fences. The entrance of the station area at the southern end of the eastern traverse can also be closed, but this almost never happens. In the last five years, it has never been closed. There are no entrance gates that allow only people with an OV chip card to enter, because the station area is also a place to meet people, without having the intention to take the train. There are neither entrance gates on the railway station, nor towards the platforms. The plan is, after rebuilding the railway station, to place entrance gates before entering the platforms (Interview Kuis). During the night, there are no extra fences being placed or entrances closed. This makes the situation the same as during the day, although after dark less entrances would be necessary than during rush hour. The southern entrance of the passage could be closed, but this has never been done in the last five years. Only on rare cases the police asks if the entrance can be closed (interview Kuis).

There is no formal security by the entrances of the station. In the central part of the station there are the service desk and the shops that offer some security, but in principal the station area can be entered by anyone.

There are a lot of entrances to this station, eight in total. This can be practical; as a user of the facility you do not have to walk all the way around to the central entrance but can enter the station from several angles. Also the ability to escape when necessary is higher. On the other hand it is hard to control this amount of entrances, especially the ones furthest away from the central buildings. In these places there is less formal and social control, which is visible by the amount of vandalism. The traverse on the eastern side contains about three quarter of all the graffiti in the station area. Travellers also say that, standing at the end of a platform, they feel enclosed. The railway station thus has relatively much exits, but this can cause deserted areas and there are also still some places people feel they can be easily enclosed.

4.1.1.3 Unambiguity

Overall it is very clear that you are entering a station area. All the entrances provide information boards with house rules, NS logo's and boards containing information about travelling times. However, of some areas it is less clear if they are part of the station area or not. So are there ticket machines just outside the station, and of the 'stadsbalkon' it is also not clear if it belongs to the station or if it is public terrain. Platform 1 also functions as a road, where it is free for people to cycle. This is however also not clear, and not clearly embarked, which may cause accidents with travellers that are not suspecting cyclists. The old building of the railway station does however provide a clear image about what its function is, and where you are definitely entering the station area.

The provision of information is high. On every place where you can enter the station there are digital information panels about destination, departure times and the transport operator for that particular track. There are also still the old yellow information boards. The ordering of the platforms is logical, and different types of information boards lead you in the right direction; within the railway station and also towards other facilities right outside the station area such as the bus station and the bicycle parking. There are also some aspects that lower the 'clearness' of the situation. There are still some old stamping machines that do not look very attractive and are also often out of service. This can confuse people if they should use them or not. However, an information desk is present for passenger that need help. Another aspect that can confuse passengers is the presence of two transport organisations on one railway station, Arriva and NS. Both have their own information desk, of which NS is the only one directly visible. Which lowers the confusion, is that both transporters have their own platforms. The railway station does not have different colours of tiles to show where the station area begins or ends, or to show the main walking route, but there are guiding strips for blind people.

4.1.1.4 Attractiveness

The maintenance of the area is pretty good. The station area is, although it is relatively big, kept clean. There are some cigarette butts and chewing gum on the ground, and there is some graffiti. But most of this graffiti is very small and mostly located in one specific area of the train station (eastern traverse). There are some old stamping machines that downgrade the image, but in general the place is kept clean. To make the place more comfortable and prevent litter there are bins and smoking areas. NS uses a cleaning programme to keep the railway station clean. On Groningen Railway Station seven days a week a cleaning team cleans the railway station between 5 and 7 in the morning, and continues to clean it till half past 6 in the evening (Interview Kuis). There is a bit more litter when it is getting dark. There are also more people urinating, because the toilet closes at 22:00. This is conform to the cleaning schedules on this railway station, which is cleaned during the day but not in the evening. This makes the railway stations in the evening less clean.

The historical building of the railway station forms a beautiful element of the station. So do several (informal) ratings show that the railway station is often in the top five of the most beautiful railway stations in the Netherlands (Rookhuizen, 2014; NS, 2014; Filedier, 2015). After the building had been redesigned in the 60s, they brought it back to its original state in the 90s. Inside, the station building is richly decorated, making it a pleasant place to stay, but there are only three benches in the station hall, giving room for only 20 people. The roof above the first platform is still the original one, including the old pillars. The other, corrugated roof looks less attractive. The railway station does not have greenery, except some trees on the 'stadsbalkon'. It is difficult to include greenery on platforms, because the transfer capacity must be kept high. Because the 'stadsbalkon' is property of

the municipality, the station cannot change anything here (Interview, Kuis). On the 'stad balkon' you have a good view of the station building and standing on the ends you also can see the historical city centre of Groningen. On the 'stad balkon' is a statue ('de peerd of ome loeks' / the horse of uncle Lucas) and the square is rising towards the ends which prevents the square from being monotonous. Just behind the historic building a public piano is placed on a location with great acoustics. The railway station does have a lot of beautiful features, but they are mostly located near the centre of the station. Further away from the historical building, the atmosphere is less. This counts for the platforms furthest away, and also for the traverse on the eastern side. They did improved the place by creating a corner with glass pictures of the railway station in the traverse.



Photo's of the railway station in a glass wall on the traverse on the eastern side of the railway station



A piano on the railway station

The 'stadsbalkon' after dark. Not the entire square is lighted, only the main walking paths. Bright lights are shining through the entrance of the bicycle parking below



4.1.2 Northern Railway Station

The figures below show how well the northern railway station scores on environmental design, for both during the day and after dark. In the following sections the scores given to the different aspects will be explained. At the end of this section is a page with pictures to show some of the aspects and situations that will be explained. Also figure 9 in section 3.1.2 can be used to obtain an image of the appearance of Northern Railway Station.

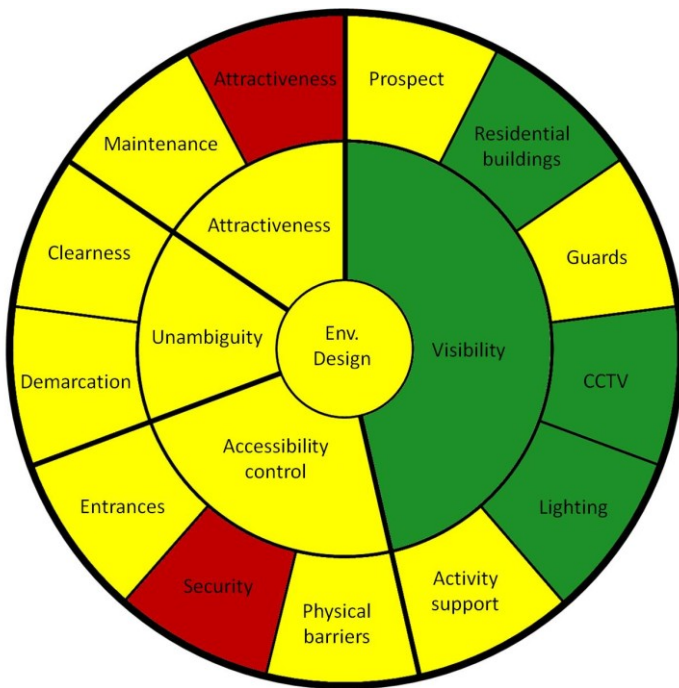


Figure 15: scores Northern Railway Station during the day

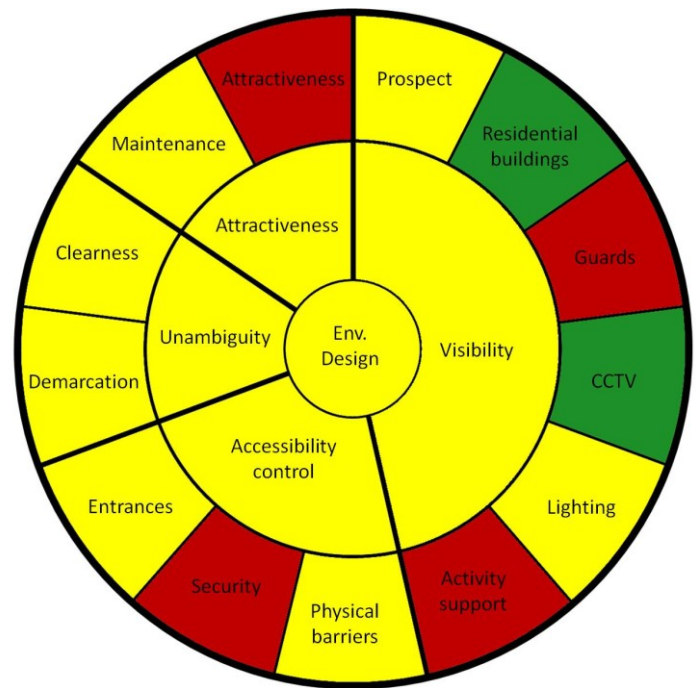


Figure 16: scores Northern Railway Station after dark

4.1.2.1 Visibility

The railway station being heightened gives directly a disadvantage on ‘prospect’. It is more difficult for people on the street to see what is happening on the platforms a few meters above them. The prospect is increased by putting glass windows on the platforms. The walls along the entire platforms are made of glass. This gives people the ability to see the street and the surrounding area. With the two platforms in front of each other, makes it possible for people standing on one platform to look over to the other side, so they can keep an eye on the people waiting on the other platform. The stairs towards the platforms are open and have no walls or ceilings. This increases the overview tremendously. It is however not possible to look from one side of the station to the other when standing downstairs. Between the stairs leading to the platforms is a lunch café. Next to it is an art gallery. This being in the middle does lower the ‘prospect’. Another aspect that decreases the ‘prospect’ is the amount of greenery. Around the railway station there are some trees planted, also in front of the platforms. This blocks the view from the platforms –through the glass walls- towards the residential buildings in the summer. The bicycle paths towards the platforms have a line of greenery next to it, blocking the view from the surrounding area on these paths in the summer

The railway station being in the middle of a residential area, there are a lot of residential houses facing the railway station (figure 17). On the northern side a school is located, and a small area around the station is intended for parking.

Buildings surrounding Northern Railway Station

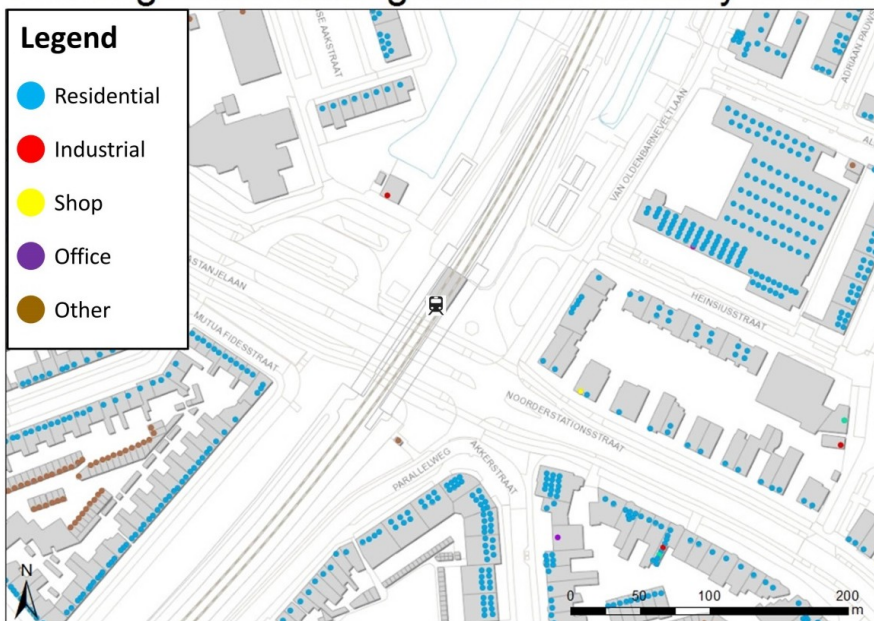


Figure 17: presence of residential houses around Northern Railway Station

There are no guards on this railway station. The only security is the owner of the lunch café below the platforms who keeps an eye on what is going on, and who also has a bouncer. He closes however at 18:00 and cannot see what is going on on the platforms above him (Interview Kuis). In the evening the lunch café is closed, which makes that also the informal security is not around anymore.

Since the murder in 1997 the railway station has got camera security. However, the images from the security camera's have been requested but three times since they have been placed (Interview Kuis).

The railway station is very open, so there is a lot of natural light. On every place of the station area the lighting is above 10.000 lux. The place that is least lightened is the road underneath the railway station, where you can walk from one side of the railway station to the other. Here the lighting is 200-300 lux. This is still well above the limit. After dark, the lighting in the area is moderate. There has been put attention into creating a good lightened area. A lot of lights have sensors, increasing the light intensity when there is movement. The platforms have proper lighting above 100 lux and the stairs leading to the platforms even between 200 and 400 lux. There are however some broken lamps and sensors on the platforms, which makes that the end of the southern platforms only has a light intensity of 50 lux, which is too low. The ascending pathways towards the platforms have sensors too, dimming when nobody is around. However, the ascending path on the western side is not at all places well lighted. When directly under the lights, there is a light intensity around 100 lux. But between the lights there are some really dark places. Also the placement of the lanterns start too late, and there is no 'background' light from residential buildings and street lanterns, which is the case for the ascending path at the eastern side. Besides, the stairs being well lighted (between 200 and 400 lux), the difference in lighting between the stairs and the area on ground level (not above 15 lux) is big, which makes it difficult to scan the direct environment when walking down the stairs. The bicycle parking is well lighted (around 150 lux), but the area around it is also poorly lighted (just above 0 lux), creating a difference in light intensity.

Sensitive activities are not always placed at a very tactical location (figure 18). The ticket machines are located at the bottom of the stairs, but they are both placed towards or completely against the buildings forming the fundament of the railway station. This makes the location somewhat darker and it is just outside the walking routes. It is however located closer to the lunch café, which increases the 'activity support'. At the western side, there is also the bus station, where sometimes busses stand waiting and thus also form a sort of security. The railway station gives the possibility to put your bicycle in a locker, but these lockers are placed at the very back of the bicycle parking, close to a green strip. There are no other functions than parking in this area. This makes the 'activity support' moderate in this area. After dark, the lunch café is closed (after 18:00). This has a negative effect on the 'activity support', which is in these hours low. There is no other function in the area than travelling by train, and sensitive activities are not placed at the safest locations.

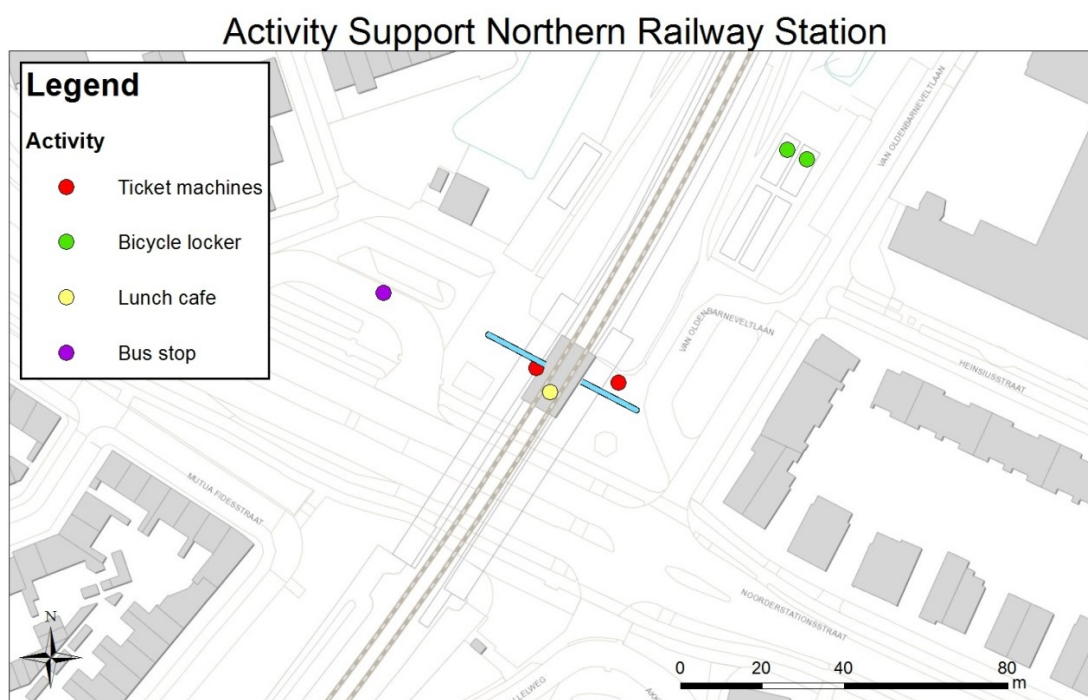


Figure 18: different (sensitive) activities and their position towards each other on Northern Railway Station

4.1.2.2 Accessibility

The railway tracks and platforms are enclosed by fences, and only accessible by four entrances. The other domains on the railway station are not enclosed. These entrances do not have access gates, and there is no intention to place these gates in the future. The area is thus easy to reach for unwanted people. This is an aspect participants of the questionnaire pointed out. There are often annoying loitering youth and drug users that create an unsafe feeling.

There is no security at the entrances, controlling who enters the station.

There are four entrances to the railway station. Two stairs, one for each platform, and two ascending paths that enable people to reach the platforms with their bike, wheelchair, etc. This ascending entrance is positive for the accessibility, for it gives for example cyclists an easier way to enter the railway station. The entrances for the stairs and the ascending path are relatively close, so the entrances can be easily secured and watched when necessary. When waiting on the southern sides of the platforms there is however just one way out, the stairs, which gives people the feeling to get easily enclosed.

4.1.2.3 Unambiguity

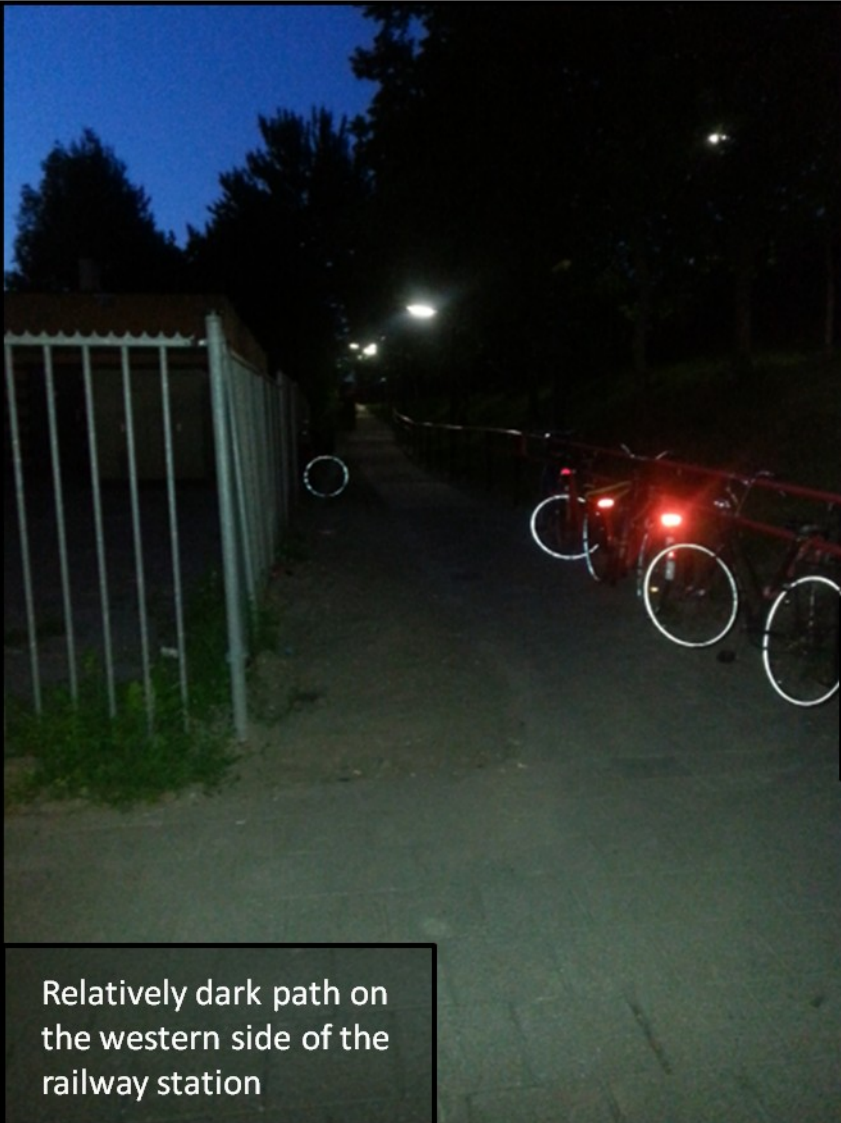
It is clear where the main entrances to the railway station are located. By creating a gateway structure and including logo's, house rules and information by the entrances, it is clear which area you enter. The two other entrances (ascending paths) provide less information. There is no information to where the paths lead, or if they are someone's property. The area on the ground surrounding the railway station is neither clearly the property of someone. Although there are bicycle locks from NS available, it is not clear that the bicycle parking is part of the railway station. However, the area being surrounded by public roads does give some clearness. At last, the name of the railway station is not easy to read or to notice. It is situated beneath the platform, above the road. It is in the shadow of the platform, so it does not stand out.

The information given is relatively good. Although the name of the railway station can be hardly seen and there is no information where the ascending paths can be used for and will lead to, the information about departure times and the platforms is very clear. However, there is one more element that can cause confusion. Besides the name of the railway station on the viaduct, there is an NS logo. This is the same for the bicycle locks. However, the only passenger railway operator on this railway station is Arriva and not NS. This may cause confusion, although it is a small detail. Finally, the guiding strip for blind people does not lead to the main stairs, but abruptly stops a couple of meters next to the stairs.

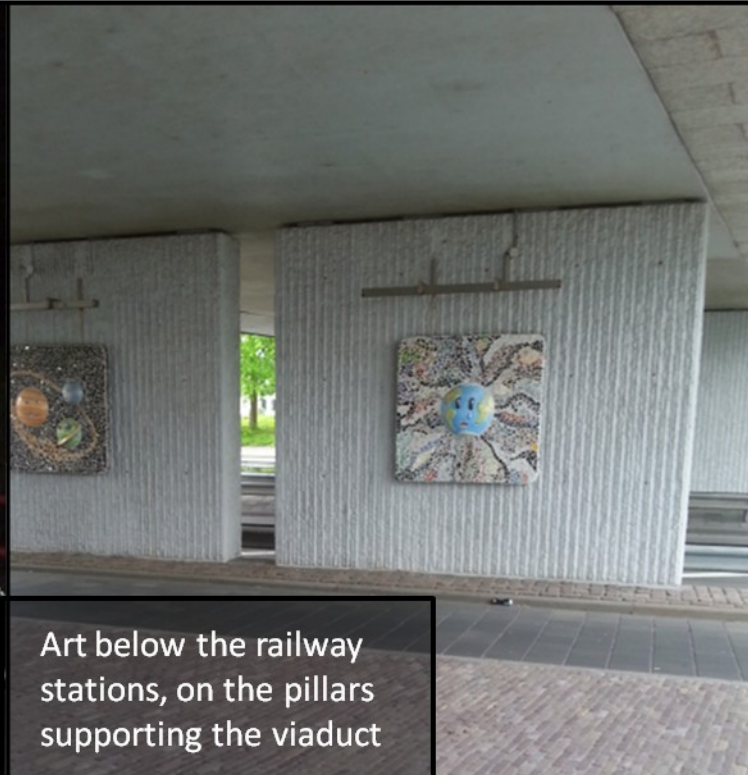
4.1.2.4 Attractiveness

The maintenance of the railway station is not very good. Even though it is relatively free of litter, there is not much graffiti and a cleaning team comes five days a week. In general, the railway station looks old and not well taken care of. The materials are old, there is flaking paint, some tiles are not laying straight and there was a broken vending machine that was falling apart. This was however fixed later on. Also, there is not enough space in the bicycle parking, so people park their bicycles outside the bicycle stands. This creates a messy appearance. This railway station has both positive and negative sides when it comes to maintenance. After dark the railway station is a bit messier. This is logical, for the railway station is only cleaned during the day. However, there are less wrong parked bicycles which gives the area a neater appearance.

There have been some measures to make this railway station more attractive. Under the viaduct some paintings are placed and a lot of greenery has been added in the area. Along the railway tracks as well as around the railway station there are trees and bushes. This makes the place look more friendly. The trees however have only a positive influence in the summer. The construction of the station itself is not attractive at all, being made out of concrete it looks gloomy. The platforms are relatively clean and the new materials make it look better, but beside that, nothing else have been done to make the area more attractive, only having functional items. It can be said that the complexity of this building is low, which makes it less attractive (Joye, 2007; Imamoglu, 2000; Herzog & Gale, 1996). The old stairwells of the railway station are nowadays being used as art galleries. On the stairwells art can be placed, visible from ground level and from glass windows on the platform. The tops of the old stairs are closed, but they left a strip open and put glass in it. All sorts of art can be placed, also TV's. However, travellers said they were sometimes more scared by them, then that they improved the attractiveness of the railway station or their perception of safety. Video's shown on those TV's are sometimes weird and gross, showing people walking down the stairs or people flossing their teeth. Accompanied by sounds, the negative effect increases. Not all sorts of art contributes to a better appearance of the station area.



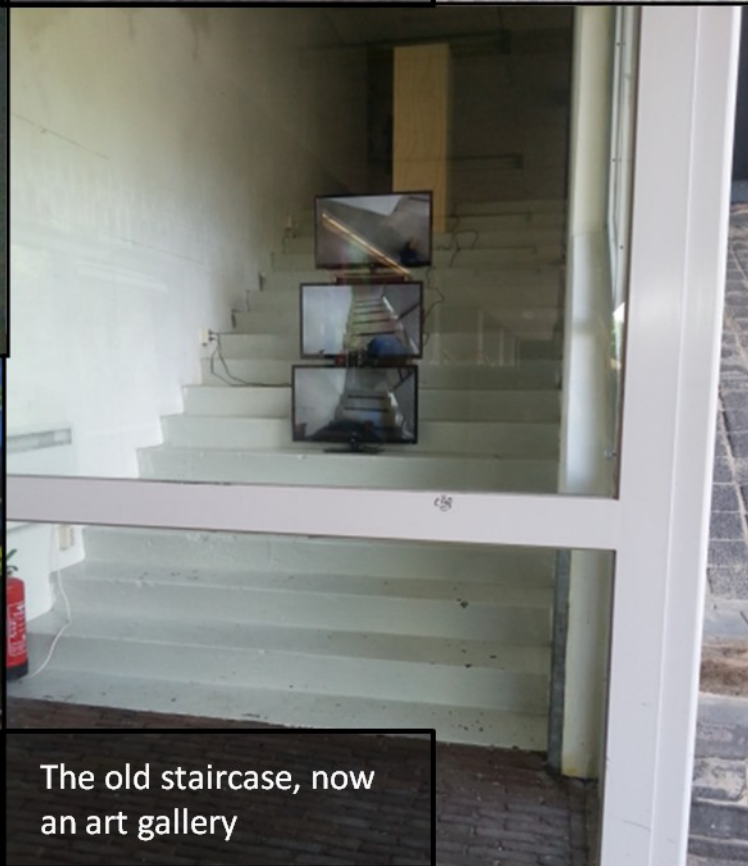
Relatively dark path on the western side of the railway station



Art below the railway stations, on the pillars supporting the viaduct



Great difference in lighting between stairs (200-400 lux) and the surrounding environment (<15 lux)



The old staircase, now an art gallery



Bicycle locks at the end of the bicycle sheds

4.1.3 Groningen Europapark Railway Station

The figures below show how well Groningen Europapark Railway Station scores on environmental design, both during the day and after dark. In the following sections the scores given to the different aspects will be explained. At the end, pictures are shown to visualize some aspects and places being explained, and also figure 10 in section 3.1.3 can be viewed to obtain an image of this railway station.

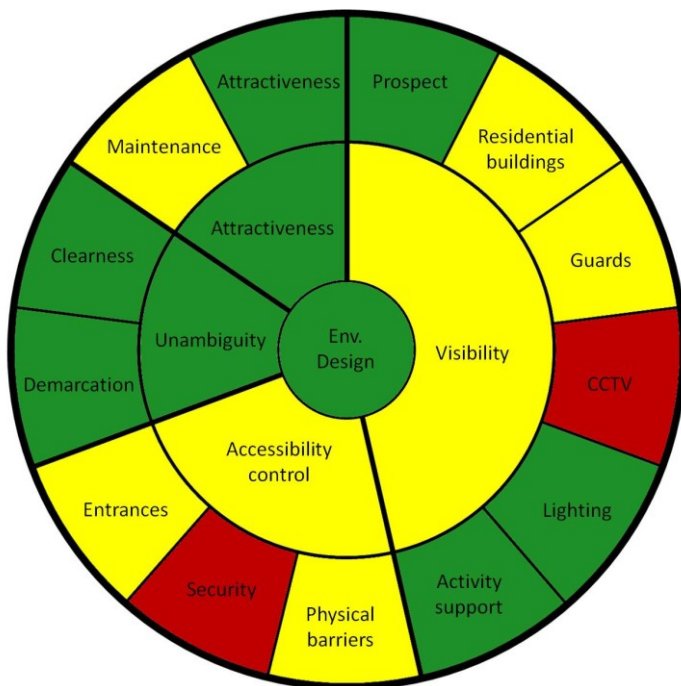


Figure 19: scores Groningen Europapark during the day

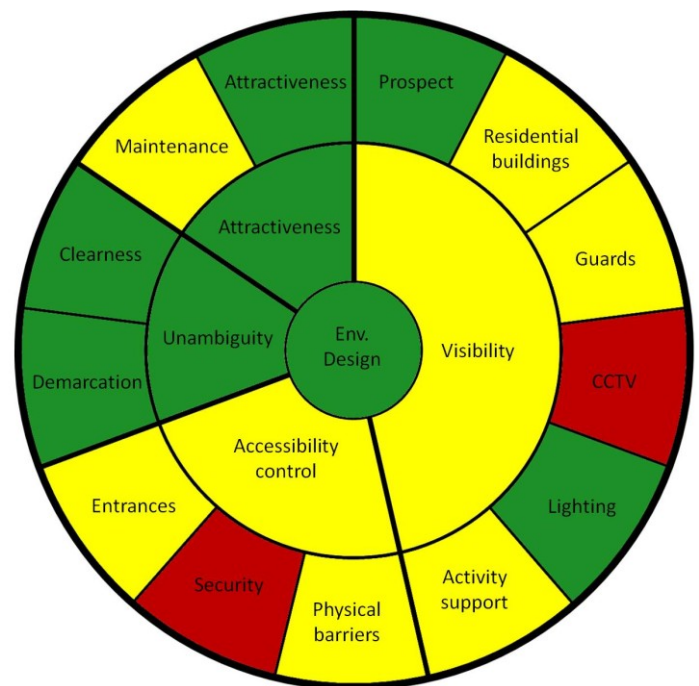


Figure 20: scores Groningen Europapark after dark

4.1.3.1 Visibility

The 'prospect' on this railway station is good. The platforms are open and also the area around the railway station is open, which gives good sightlines. On the platforms all 'obstacles' that could block sightlines such as the elevator, are made of glass. Also the walls that protect the people against the wind are made of glass. Fences that embark the area are low. The use of fences also gives the ability to have a better view from the platform to the area around and the small squares below. On the eastern side of the railway tracks, a wall shields the railway tracks from the area around. Standing on the higher platforms it is however easy to look over this wall. The visibility in the tunnel and the stairs leading to the middle platforms is also good. The tunnel is relatively big and has wide entrances and exits as it is connected to two small squares. Thereby the tunnel is straight, which is also good for the 'prospect'. However, the tunnel does have a small indented wall where it leads to the elevator. When using the stairs that leading to platforms 2 and 3, the prospect is also good. The entire space above the stairs is open, which gives people the ability to see what or who is on the stairs when standing on the platform and vice versa. Finally, the surrounding area has also good visibility of the tunnel (and platforms) because this deepened squares go in an ascending way up again, not creating straight walls but ascending grass fields and 'levelled' walls with a lot of greenery.

The railway station has on one side a business park and on the other a residential area (figure 21). The deepened squares do however use a large surface area, for they go up in an ascending way. This creates a distance of around 150 meters between the railway station and the residential houses.

This is so far, that it almost takes all the good out of the presence of these houses. However, the sidelines are created in such a way, that the houses do have a good prospect of as well the platforms as the tunnel. There are thus good sightlines, but only view houses at a relatively large distance.

Groningen Europapark Railway Station - Residential Houses

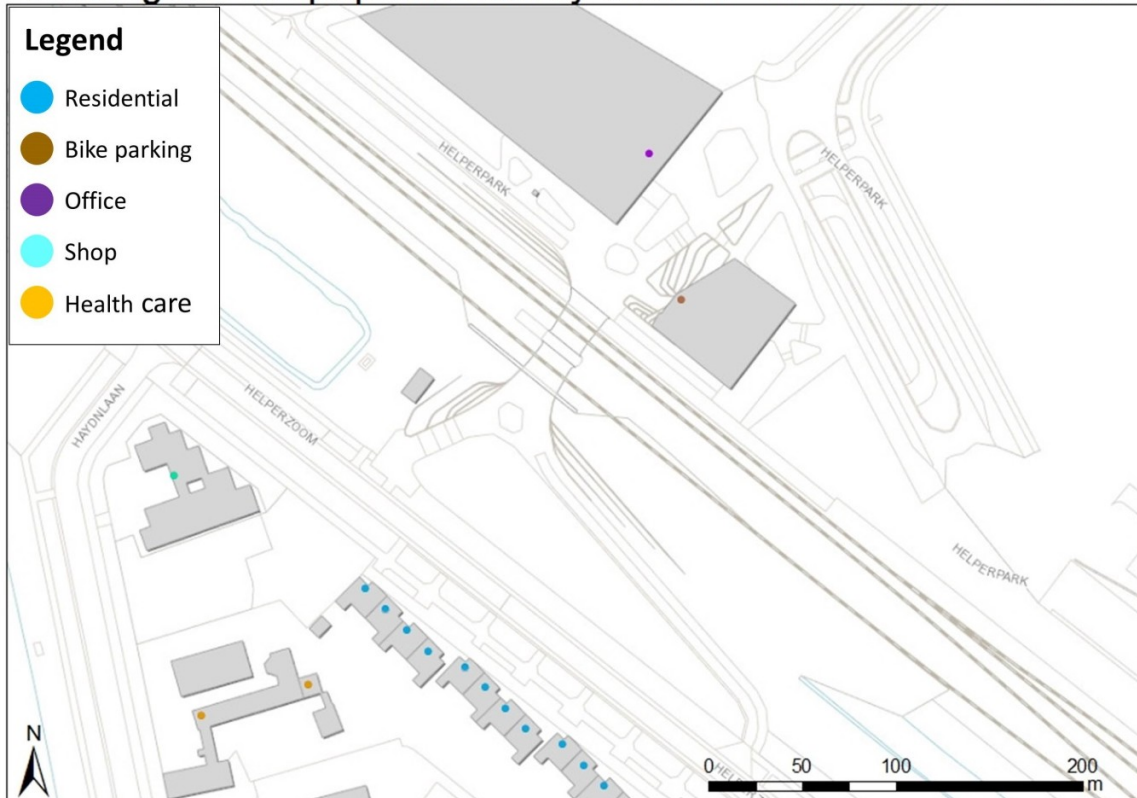


Figure 21: presence of residential houses around Groningen Europapark Railway Station

There is not much formal security on this railway station. The only formal security is the guard of the bicycle parking, but from his desk it is not possible to oversee a large part of the platforms. (Interview Kuis). There is also not much informal security, except the busses waiting at the busstop next to the railway station that have a view over the area, and the office buildings standing directly next to the railway station. It can thus be said that, all together, this is moderate. During the night the office buildings are closed, which lowers the level of informal security. However, the guard of the bicycle parking is present the entire night, and at the times there are still trains arriving and departing from the railway station, there are also busses driving from and towards the railway station. This means that after dark, there are still busses waiting at the busstop, standing there for several minutes. All this together still gives a moderate score.

There are no security camera's on the railway station (Interview Kuis).

The lighting on this railway station is good. Because the railway station is completely open, during the day there is a lot of sunlight. And the roofing's on the platforms are partly open, allowing sunlight to enter. This makes that almost everywhere on this railway station the luminance is above 1.000 lux. In the tunnel underneath the platforms this is around 300 lux, so still above 50 lux. By leaving a part of the roofing of the tunnel open (between platform two and three, where the stair is located), it is possible for sunlight to enter. After dark, the lighting in the is good. The platforms themselves are between 100 and 150 lux underneath the roofing. At places without roofing, at the end of the platforms, the lighting is less, around 50 lux. This creates a more natural lowering of

lighting, not having the entire platform lightened really well, and have none where the platform stops. In the tunnel, the lighting is around 50 lux. The squares are less lightened, below the 50 lux, but also here the lighting is natural.

The 'activity support' on this railway station is high. The ticket machines are located on the platforms, in sight of the waiting areas on the platforms, which increases the 'activity support' (figure 22). Below the railway station is a bicycle route, which increases the visibility on the area, as well as the office building of the Municipality of Groningen that is directly located in front of the station. Also, the guard of the bicycle parking can keep an eye on the ground activities. The 'activity support' is lower during the night, because the area is not very busy. Also the nearby building of the municipality is closed after dark.

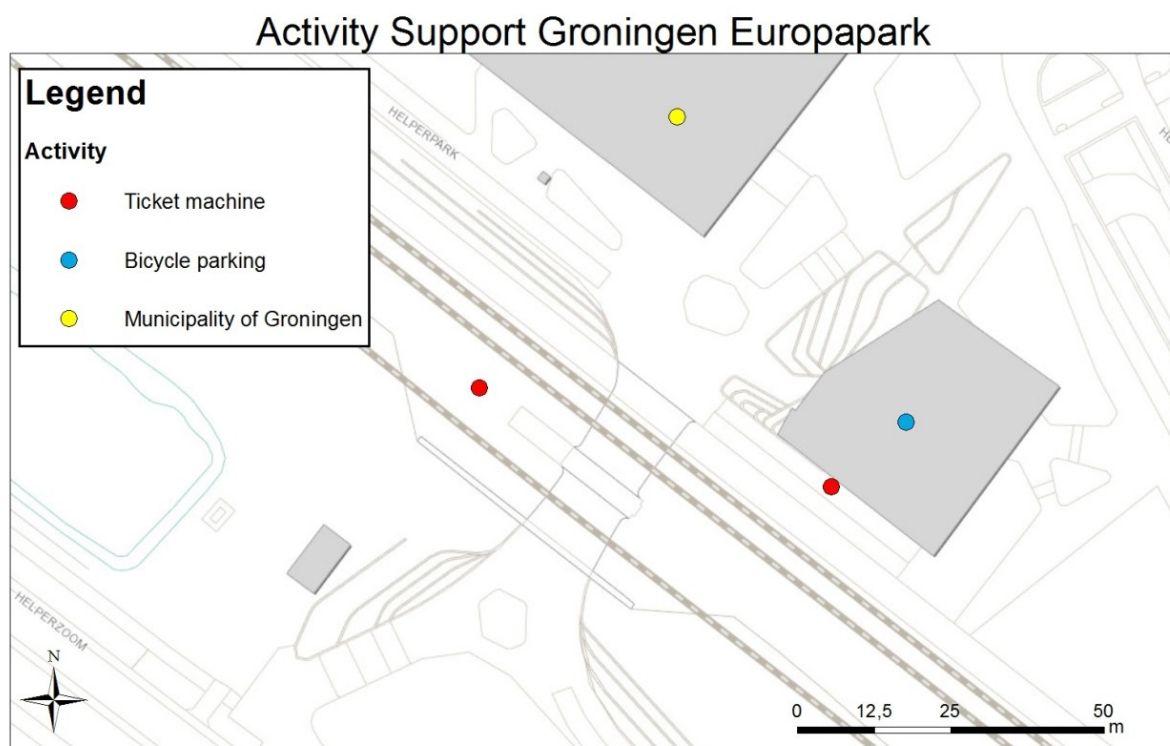


Figure 22: different (sensitive) activities and their position towards each other on Groningen Europapark

4.1.3.2 Accessibility

All around the railway tracks are fences. The railway station can only be entered using the entrances, although next to the entrance to platform 1 from the square, there are rather low fences so people could climb over. There are also no entrance gates at this railway station.

As said before there is no security on this railway station, neither with regard to accessibility control.

There are three ways to enter platform one: the stairs, the square and the elevator. Besides, there is also the possibility to climb over the fences. All these entrances are however directly next to each other, so if necessary they can be controlled and watched easily. Platform two and three can only be entered using the stairs or the elevator. These platforms are rather long because the intercity trains from NS must be able to stop here. This can cause passengers to have to take a long walk to reach these exits. It can thus be said concluded that platforms 2 and 3 have a poorer amount of entrances and exits than platform 1.

4.1.3.3 Unambiguity

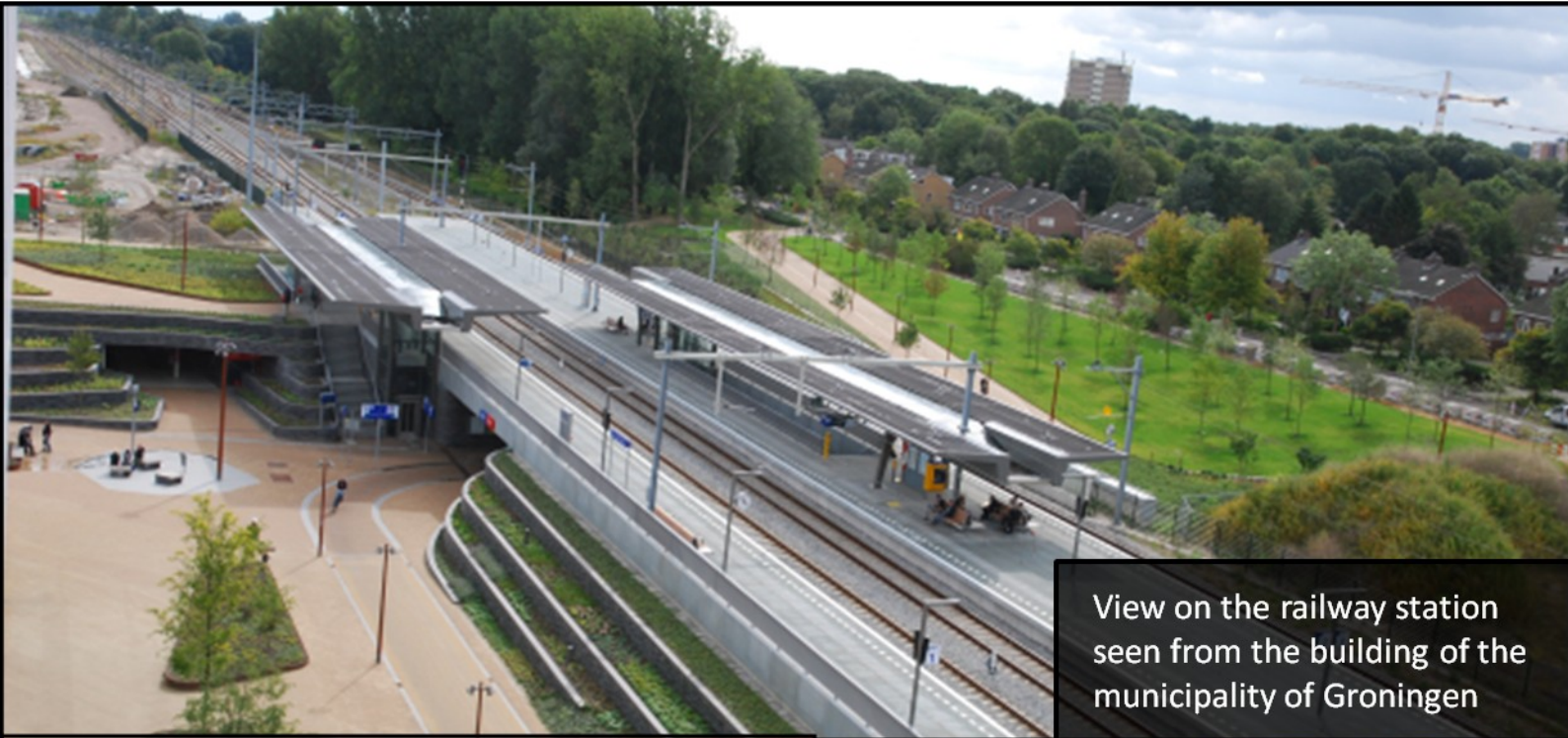
There is a clear demarcation on this railway station. Using different types of tiles, the part where you enter the platform and where the square thus end is made clear. The logo's and information too make clear where the railway area starts. The squares are not demarcated, but are in line with the image of the surrounding area of the railway station.

The clearness of information and easiness to understand the area is really good. On every entrance there is information about departure times and platform numbers. Different types and colours of tiles are used, showing the paths to the elevators and stairs. The only downsides in the clearness is the presence of two passenger railway operators, NS and Arriva. This unclearness is however solved by given each organization its own platforms. Arriva stops at platforms 1, NS at platforms 2 and 3. Besides, also here are old stamping machines present which are not being used anymore.

4.1.3.4 Attractiveness

The area is moderately maintained, having in the area almost no litter, but a lot of graffiti. Almost the entire wall at the western side is covered with graffiti. When it comes to litter, the area itself is relatively clean, except some cigarette butts on the ground. This can be the result of the absence of a smoking area with a special bin to dump your cigarettes. There is however relatively much litter on the other side of the fence on platform 1, in the bushes. It seems as if people easily throw their garbage over the fence instead of throwing it in the garbage bins that are relatively close. The railway station is very new and does not have any broken lights, windows or missing or broken tiles. Nowadays the railway station is being cleaned two times a week, for the railway station would be clean enough to not raise this frequency (Interview Kuis). The railway station is also clean after dark, with the acceptance of the graffiti.

The railway station is new, so there are no historical buildings. However, it looks attractive due to the input of a lot of greenery and the smart use of colours. So does the bicycle parking have green lights. For this railway station a new concept is used that is planned to be implemented on all railway stations in the Netherlands, making them more beautiful and comfortable.



View on the railway station seen from the building of the municipality of Groningen



Tunnel under the platforms after dark. Blue lights show the route from the stairs to the elevator. There is graffiti on the pillars



View to the south when standing on platform 2 and 3



View on the railway station after dark, when standing on platform 1



A stamping machine out of service. Are the stickers vandalism or a positive influence on the attractiveness?

4.2 Most unsafe places

This section will describe the places that were pointed out by travellers as most unsafe places on the railway stations. This does not have to mean that they felt unsafe at that specific place, for some people still found the most unsafe place at the railway station a safe place. The participants were asked to point out the place they felt most unsafe, both during the day as after dark, and score this/these places on a scale of 1 to 10, where 10 means that they feel totally safe. Finally, they also gave an explanation why they felt most unsafe at this specific place. Of all railway stations a map is provided, showing the places travellers pointed out as being most unsafe. In this map, it is also shown which grade was given (both during the day as after dark), and how many participants named this place. This amount of people is both visible by the size of the points on the map, as by the number between the parenthesis behind the grades.

4.2.1 Groningen Railway Station

Most Unsafe Places Groningen Railway Station

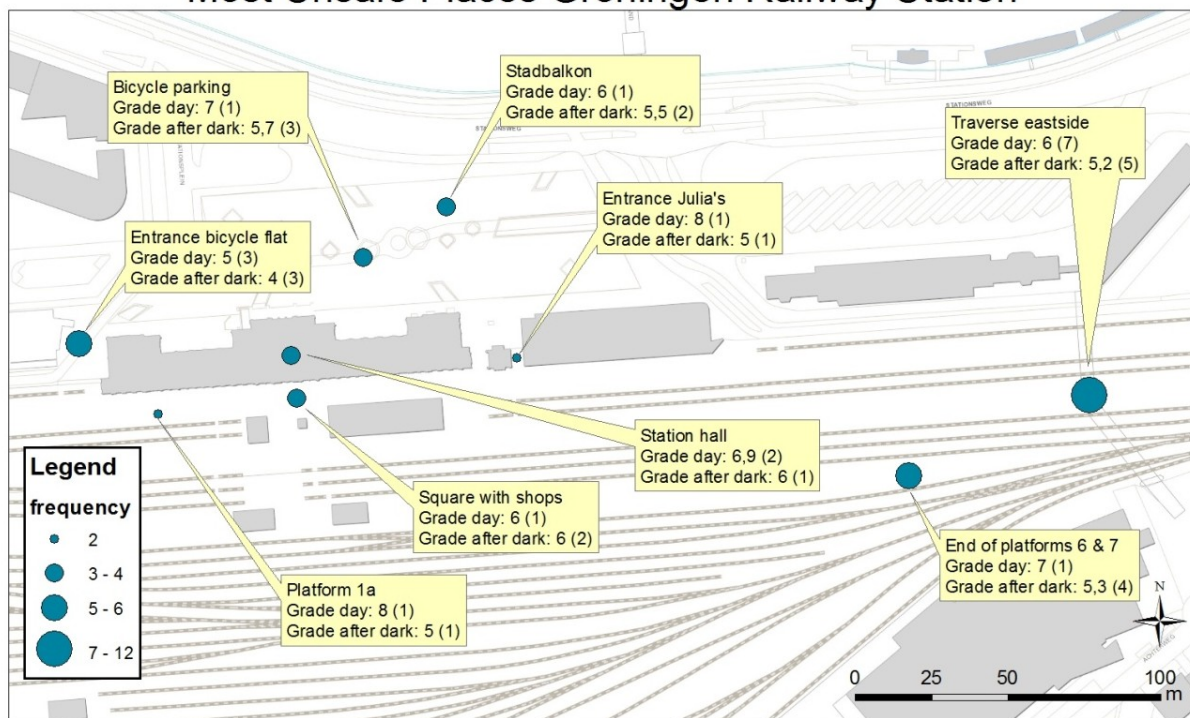


Figure 23: most unsafe places Groningen Railway Station. The size of the points indicate how many people in total named this place. For every place, the average grade is shown for both during the day and after dark. Behind these grades (between the parenthesis) is shown how many people named this place and thus graded it.

Figure 23 shows the places travellers pointed out as being most unsafe places on Groningen Railway Station. Around 48% of the participants named a place where they felt most unsafe during the day of after dark. The other 52% could not name a place or did not have the time to give an answer to this question. The grades during the day are almost all still a 6 or higher, which is positive. However, the grades drop after dark. The figure shows that people mostly named three places where they felt least safe: the entrance at the bicycle flat, the traverse at the eastside, and at the ends of platforms 6 and 7. These three places will shortly be illustrated.

The entrance at the bicycle flat is a quieter area of the railway station. The visibility in this area is relatively low, because there are no residential houses around, there are several objects

standing there such as a bicycle parking with two levels (the bicycle flat) and garbage containers which lowers the prospect; there are no sightlines from the shops and there is no CCTV. There is also no accessibility control, and the place is a bit more messy than other places, for there are no garbage bins. The reason given by participants for the unsafe feeling is mostly the presence of 'strange' people, people using drugs and homeless people, and low visibility. The problem with homeless people is also being confirmed by the location manager of NS. To solve this problem, a man with a dog is walking in the area every evening. Based on the theory it can be argued that mostly the visibility must be improved in this area, for example by increasing the activity support by creating a mixture of functions so the social control increases. This can be in the form of a kiosk at this part of the station.

Especially for the situation after dark the platforms 6 and 7 were pointed out by participants as being the most unsafe place on this railway station. There were two reasons given: (1) this places are furthest away from the main building and thus from other people, they are deserted, and (2) there is only one way out. When waiting on the platform, one could thus be easily trapped. Looking at the theory these are also the aspects this place scores badly: the absence of residential houses, guards, activity support and entrances/exits. These aspects are not easy to change, for residential houses cannot be placed closer and the old traverse standing between the main building and the platforms is a monument and cannot be removed. However, measures that could be taken are placing a kiosk to increase visibility, and connecting platforms 6b and 7b to the traverse on the eastern side to increase the ability to escape.

The traverse on the eastern side was mentioned most often as most unsafe place, both during the day as during the night. In the overall analysis this part of the railway station is already several times named for its relatively bad attractiveness and visibility. Reasons mainly given by the travellers were: (1) there are few people, (2) the prospect is bad because it has a corner, and (3) it is dirty. It is relatively easy to make the place cleaner, but it is hard to increase the number of people using this traverse or to remove the corner. Although mirrors have been placed, people still feel they have a bad prospect and visibility. However, maybe the traverse will be removed by the rebuilding of the railway station, in which way the most unsafe place of the railway station will be removed.

4.2.2 Northern Railway Station

Figure 24 shows the places travellers pointed out as being most unsafe for the Northern Railway Station. Compared to the other railway stations there were a lot more participants that could point out a place where they felt least safe, around 50% could name a place during the day, and around 80% after dark. The grades given after dark are clearly lower than during the day.

What is striking, is that almost all explanations for an unsafe feeling underneath the stairs and under the platform, are related to complaints about loitering youth, 'foreign people' and people using drugs (13 out of 18). Comments made were for example: "*There are strange people that give you the chills*", or "*Loitering youth with loud music, smoking weed, shouting at women*". All the other reasons were with regard to bad visibility due to lighting or low prospect (under the platforms). The last part is in relation to what was found during the location analysis, where after dark the lighting when coming from the stairs is suddenly much worse, and where the lunch cafe under the platforms lowers the prospect. With regard to the prospect not much can be changed, as the lunch cafe is a part of the foundation for the platforms. The transition from the more lighted platforms and stairs to the surrounding area must however be better adjusted. With regard to complaints about the people hanging around the railway station, maybe also here a guard with dog could be placed, or other

forms of security could be added. The only (informal) guard being the owner of the lunch cafe seems not enough to give people a safe feeling. Another measure that could be taken is playing classical music at the railway station. This has worked on other railway stations to drive loitering youth away and lower vandalism. It did however not always have a positive results, as wires were being cut in Kortrijk (Adriaen, 2012; Jackson, 2005).

Most unsafe places Groningen Northern Railway Station

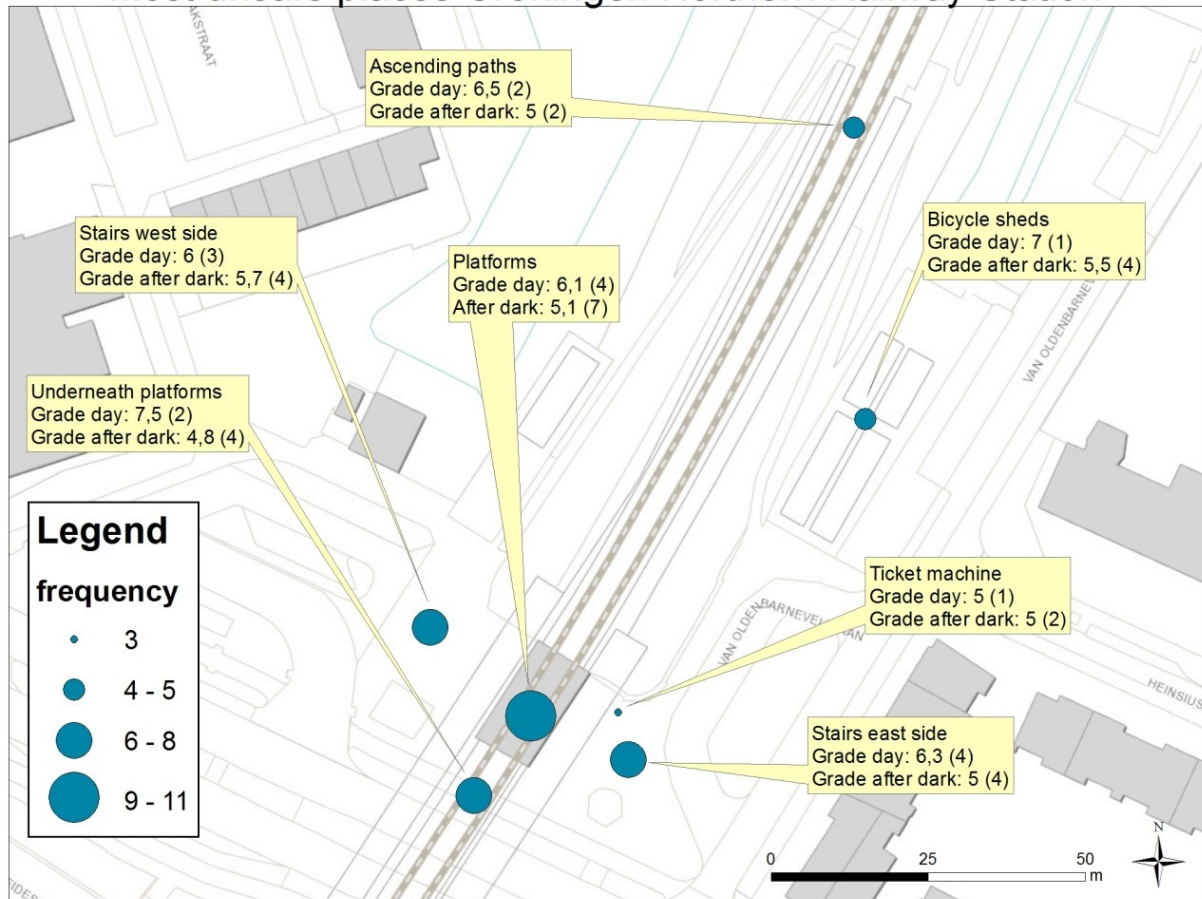


Figure 24: most unsafe places Northern Railway Station. The size of the points indicate how many people in total named this place. For every place, the average grade is shown for both during the day and after dark. Behind these grades (between the parenthesis) is shown how many people named this place and thus graded it.

The reason given for an unsafe feeling at the ticket machine was that people were withdrawing money. This is indirectly in line with what was found in the location analysis, as this 'sensitive activity' is not placed at the best location. It would thus be better to relocate this ticket machine to a place where it is better in sight.

The most given reason for an unsafe feeling at the bicycle sheds was the bad lighting (after dark). This is in line with what was found in the location analysis, where the differences in lighting at the bicycle shed itself and its direct surroundings is also bad. This transition in lighting should thus be improved.

The reason given for an unsafe feeling at the ascending pathways is a bad visibility, as the trees are blocking the view from the surroundings. This is in line with what has been found in the location analysis, although people said nothing about the lights and sensors that do not work properly in this area. An advice for this area is thus, that at least the greenery should be cut back.

Another option, is to place an elevator, maybe in the old stairways, so people do not have to take a long ascending path that takes them further and further out of sight.

The place where people feel most unsafe, and also the place that was most often mentioned, are the platforms. Almost unanimous people said that they felt unsafe at this place, because it can be deserted so that you are waiting on your own at the platform, or with only few other people around. Sometimes it was also said that you could easily be enclosed at the end of the platforms. This is in line with what was found during the location analysis, where there is low activity support and thus low mixture of functions, especially during the night. It is however very hard to mixture function at a viaduct railway station, because it is on a different level. This could be partly done by opening more functions underneath the platforms (also during the night), although they cannot see what is going on on the platforms. Another function can however not be that easily placed, as it is a matter of supply and demand.

4.2.3 Groningen Europapark Railway Station

Participants gave the best grades to this railway station, also when it came to the most unsafe places. Even for a situation after dark, 41 percent of the people (16 people) could not name a specific place. During the day, this was 64 percent (25 people). Besides, all places pointed out were graded relatively high, having no average grade below 5,5.

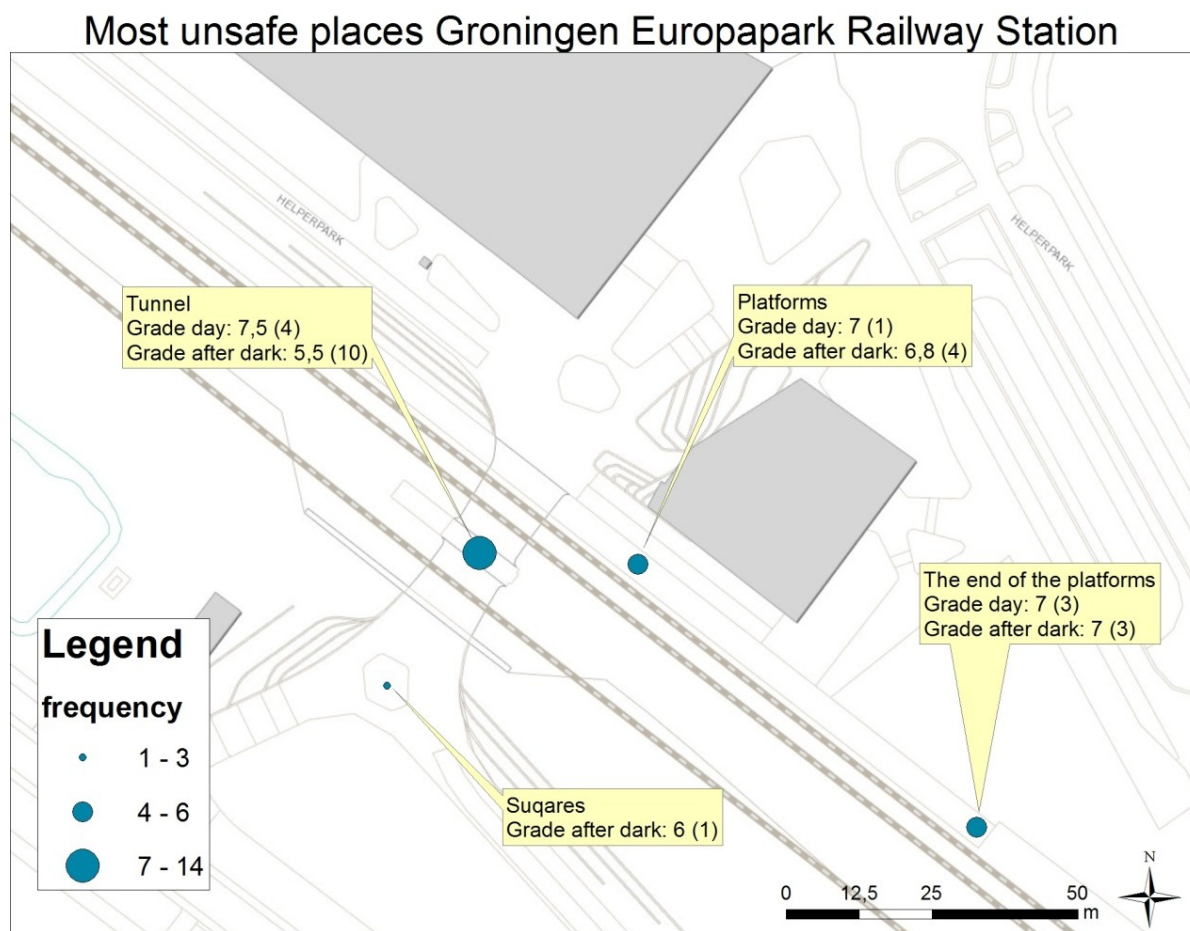


Figure 25: most unsafe places Groningen Europapark. The size of the points indicate how many people in total named this place. For every place, the average grade is shown for both during the day and after dark. Behind these grades (between the parenthesis) is shown how many people named this place and thus graded it.

Figure 25 shows that there are only four places pointed out by the participants of the questionnaire. A first place pointed out was the platforms themselves. The grades given are still good (7 during the day and 6,8 after dark), but people explained that there are after dark only few people here, which can give them an unsafe feeling. What is interesting is that only women pointed out this place.

A more specific place pointed out was at the end of the platforms. Also here, the grades are still high (a 7 for both day and night), but it was said that the visibility is lower, there being fewer people and because these places are relatively far away from the exits. This is in line with the location analysis, which showed that the escape route from the ends of the platforms is relatively bad, the exits being far away.

Only one participant pointed out the squares as most unsafe places, grading it (after dark) with a six. She said this was due to bad lighting. This is in line with the location analysis, this place being less lighted than other places on the railway station, under 50 lux.

The final place pointed out was most referred to by the travellers, namely the tunnel under the platforms. The grades given are still positive, a 7,5 during the day and a 5,5 after dark. People explained that this tunnel is the least visible place of the railway station, with the lowest prospect. It was also said that, because it is a tunnel, it thus gives you a more enclosed feeling. This is partly in line with the location analysis. It is logical that a tunnel is less visible, but this tunnel is designed really well, given this tunnel still a lot of prospect and visibility, although it is a tunnel. If you compare this tunnel for example with the tunnel of the Northern Railway Station and the traverse of Groningen Railway Station, the grades for the first are a 7,5 (day) and a 4,8 (after dark), and for the traverse these are a 6 (day) and a 5,2 (after dark).

Based on the comments given by the travellers, all reasons had to do with the visibility (few people, low visibility, low prospect). This can be improved by letting the guard from the bicycle shed also take a walk around the platforms. However, people pointed out that they feel safe on this railway station, also during the night on the most unsafe places they could imagine.

4.2.4 Final remarks

Groningen Railway Station scored good on several aspects of environmental design during the location analysis. The points that scored bad during this location analysis were also mentioned by the participants when pointing out the most unsafe places, this being the maintenance, prospect and visibility, although nothing was said about the access control which also scored bad on environmental design. Also, there was nothing said about the lockers, which from the field observation showed a bad score for activity support. A reason for this can be that the people asked never used these lockers. The scores for environmental design from the location analysis were mostly held down due to the traverse on the eastern side. This correlates with the perception of the passengers, as this place was most often referred to as most unsafe place. If the traverse would be removed or improved, scores could go up, and the railway station would get rid of a place that is being perceived as unsafe. It would be good to look how many people use this part of the railway station, and consider removing it. The reconstruction of the railway station can be a good opportunity to do something about this place. A new connection with this part of the city using a tunnel makes this traverse unnecessary.

Groningen Northern Railway Station scores much lower than the other railway stations on environmental design. Also the grades given by participants of the questionnaire of ProRail were much lower for this railway station. In general the location analysis is in line with what the

participants said, although the participants said nothing about the attractiveness or access control, which both scored low. Another remarkable difference of this railway station is, that a lot of the participants, both men and women, complained about loitering youth, 'foreign people' and drug users, who gave them an unsafe feeling. This seems a specific problem of this railway station, as are homeless people on Groningen Railway Station. It would thus be important to give this aspect special attention, by increasing (formal) security, or searching for other ways to solve this problem; an experiment with classical music could for example be an option. Finally, Northern Railway Station does have an Information & SOS pillar, which travellers can use when in danger or when they have a question. When in need, people can thus call for help (Interview Kuis). Such pillars are also present at Groningen Europapark. To what extent people think this Information & SOS pillar contributes to their perception of safety was not asked.

Groningen Europapark scored good on the questionnaire of ProRail, on the location analysis, and also on the analysis of most unsafe places, as most people explained they felt safe on the entire railway station. And the places they did point out as being most unsafe, they still graded with at least a 5,5. Besides, the results from this analysis and the location analysis showed similar results, although the participants said nothing about the access control, which scored bad. This was the same for all three railway stations. Besides, the travellers also said nothing about the maintenance of the area, which also scored moderate due to graffiti. As the participants did mention the maintenance problems for the other two railway stations, it can be discussed in which amount people bother by graffiti, this being almost the only problem at Groningen Europapark with concern to the maintenance.

4.3 Passengers perception

This chapter shows the results of the questionnaires. First, some general results will be shown with regard to the differences in the perception of safety between men and women and the between the railway stations. The second section shows the results with regard to opinions of the participants on the different aspects of environmental design, showing the differences between the railway stations, the differences between daytime and after dark and also showing the differences between the aspects of environmental design themselves. Appendix C shows the descriptive statistics.

4.3.1 Perception of safety

The average score the participants gave for their perception of safety during the day was an 8.4 (N=100) and after dark a 6.9 (N=97). An independent-samples t-test was conducted to compare the safety perception during the day for females and males. There was not a significant difference in the scores for males (M = 8.40; SD = 0.98) and females (M = 8.38; SD = 1.01); $t(98) = 0.08$, $p = 0.935$. The same test was conducted to compare the safety perception after dark for females and males. There was a significant difference in the scores for males (M = 7.44; SD = 1.16) and females (M = 6.57; SD = 1.12); $t(95) = 3.68$, $p = 0.00$. These results suggest that men feel more safe than women after dark, but that there is no difference between them during the day.

A one-way between subjects ANOVA was conducted to compare the effect of the differences of the railway stations on the perception of safety during the day based on the three categories 'Groningen Railway Station', 'Northern Railway Station' and 'Groningen Europapark'. There was not a

significant effect of the railway station on the perception of safety during the day in the three conditions [F (2, 97) = 0.82, p = 0.60]. The same test was conducted to compare the effect of the differences of the railway station on the perception of safety after dark based on the same three categories. Also here there was not a significant effect of the railway stations on the perception of safety after dark in the three condition [F (2, 94) = 1.74, p = 0.18]. These results suggest that there is no significant difference in the safety perception of passengers on the three different railway station in the city of Groningen for both daytime as after dark. A graph with the data is visible in figure 26. This figure also contains the data from ProRail, showing the general grades given for safety feeling on the railway stations. For Groningen Railway Station and Groningen Europapark these grades seem to be similar. The grades for Northern Railway Station were in the questionnaire of the researcher much higher than the grades from ProRail. Probably the reason it that the questionnaire of ProRail (N > 150) is much bigger than the one conducted for this research (N = 35) giving different results. Another reason can be that relatively more men participated in the survey on Northern Railway Station, than the two other railway stations (Appendix C); women feeling significantly less safe than men, may have given an distorted outcome. However, when conducting the same 'one-way between subject ANOVA' test using a split file, separating the data from men and women, also not a significant difference was found. There was no significant difference between the railway stations on the perception of safety after dark with regard to men [F (2,36) = 2,74, p = 0,80], and also not with regard to women [F (2,55) = 2,16, p = 0,125].

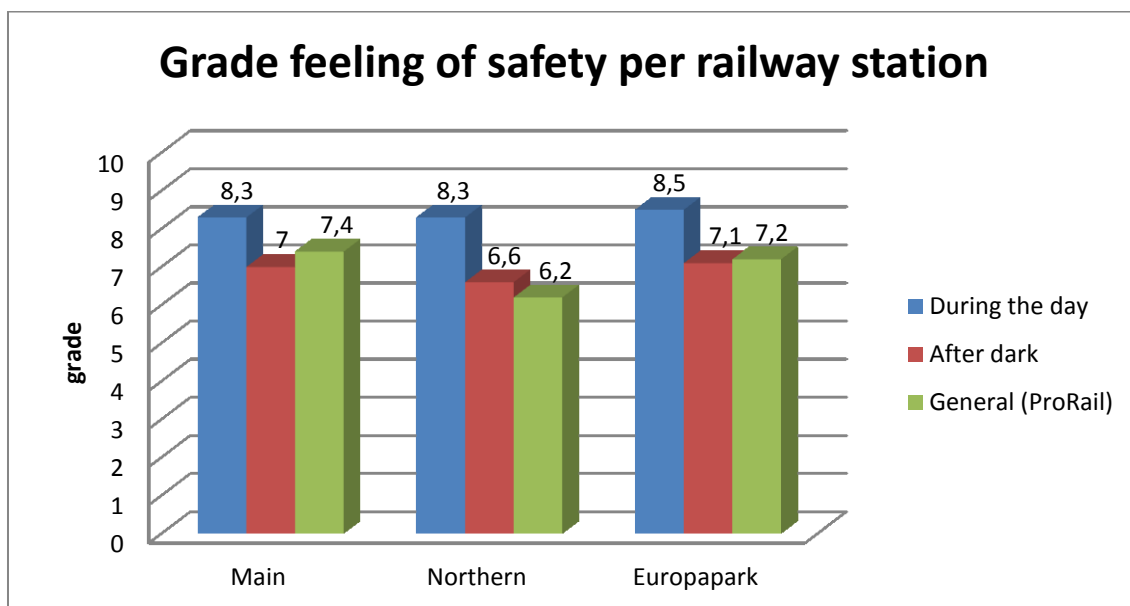


Figure 26: difference in the grades on the perception of safety between ProRail and researchers survey

Summarising, for the general aspects the following results have been found:

- Men feel more safe than women after dark, but there is no difference during the day
- There are no significant differences in scores on the perception of safety between the three railway station, both during the day and after dark (also not when looking at men and women separately), as they are being collected by the researcher. These differences are however visible in the data provided by ProRail.

4.3.2 Aspects of environmental design

The next sections show the results with regard to the answers on the survey with regard to the different aspects of environmental design. Participants were asked to indicate how important they thought the different aspects were for their perception of safety (not the existence of the aspects on the railway station), and to give them a 'grade' between 1 and 5, 1 meaning 'very unimportant' and 5 'very important', for both a situation during the day as after dark. First the effect of differences in time on the view of importance of the different aspects will be analyzed. Then, differences between the railway stations will be analyzed, to see if a general model can be created for environmental design for railway stations, or that there are other aspects that can influence the view on the importance of the different aspects. Finally, it will be analyzed how the aspects differ from each other and if in general some aspects seem more important than others.

4.3.2.1 Differences in time

To analyse an eventual difference in the importance of the different aspects of environmental design between daytime and after dark, a paired-samples t-test was conducted. For twelve of the thirteen aspects a significant difference was found (see table 3). Of these twelve aspects, 11 were found more important after dark than during the day. Only the attractiveness of the railway stations was found more important during the day than after dark. No significant difference has been found for the maintenance of the railway stations, which were said to be equally important during the day as after dark. These results are also visible in figure 27, which shows the different scores for all the aspects of environmental design, both during the day as after dark.

Aspect	Mean		Standard Deviation		t	Significance
	During day	After dark	During day	After dark		
Prospect	3.57	3.80	1.01	0.98	-2.34	0.021
Residential houses	3.05	3.38	1.05	1.04	-4.17	0.000
Guards	3.38	3.77	1.08	1.07	-4.94	0.000
CCTV	3.60	3.89	1.00	1.14	-4.23	0.000
Lighting	3.33	4.40	1.22	0.85	-7.84	0.000
Activity support	3.83	3.99	1.01	1.03	-2.03	0.045
Physical barriers	2.69	2.88	1.05	1.19	-2.81	0.006
Security	2.71	2.97	1.08	1.22	-3.55	0.001
Entrances	3.70	3.96	0.76	0.90	-3.55	0.001
Cleanness	3.77	3.87	0.98	0.95	-2.08	0.041
Demarcation	3.25	3.46	1.07	1.02	-3.55	0.001
Maintenance	3.86	3.84	0.94	0.92	0.41	0.685
Attractiveness	3.20	3.06	1.02	1.02	2.32	0.022

Table 3: The results of the paired samples t-test showing the differences in importance of the aspects during the day and after dark

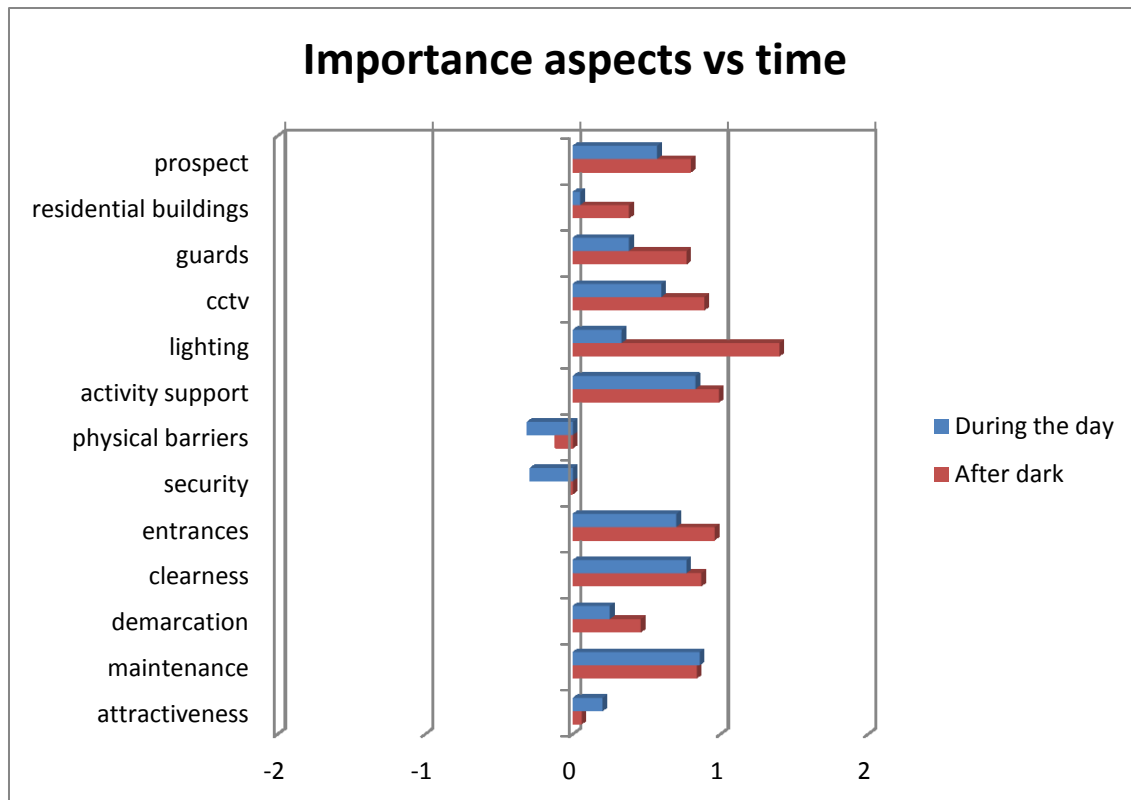


Figure 27: the difference in grades for the importance of the different aspects between daytime and after dark, with -2 being very unimportant and +2 being very important

4.3.2.2 Differences between railway stations

A one-way between subjects ANOVA was conducted to compare the effect of the different railway stations on the importance of the different aspects of environmental design during the day and after dark based on the categories Main, Northern and Europapark.

There was a significant effect of the difference of railway station on the rating of importance during the day at the $p < 0.5$ level for the three conditions for the following aspects: the prospect [$F(2, 97) = 5.60, p = 0.005$] and guards at the entrance [$F(2, 97) = 9.05, p = 0.000$]. With regard to the prospect during the day, a post hoc comparison using the Benferonni test indicated that the mean score for Railway Station North ($M = 3.1, SD = 1.22$) was significantly different from Groningen Railway Station ($M = 3.71, SD = 0.75$) and Railway Station Europapark ($M = 3.85, SD = 0.15$). With regard to the guards at the entrance, a post hoc comparison using the Benferonni test indicated that the mean score for Railway Station North ($M = 2.13, SD = 1.20$) was significantly different from Groningen Railway Station ($M = 3.17, SD = 0.86$) and Railway Station Europapark ($M = 2.76, SD = 0.92$).

There was a significant effect of the type of railway station on the rating of importance after dark for the following aspects: the prospect [$F(2,97) = 3.20, p = 0.45$], physical barriers [$F(2, 97) = 3.71, p = 0.028$] and guards at the entrance [$F(2, 97) = 5.15, p = 0.008$]. With regard to the prospect, a post hoc comparison using the Benferonni test indicated that the mean score for Railway Station North ($M = 3.45, SD = 1.06$) was significantly different from Groningen Railway Station ($M = 4.03, SD = 0.89$). However, Railway Station Europapark ($M = 3.88, SD = 0.91$) did not significantly differ from Groningen Railway Station and Railway Station North. With regard to physical barriers, a post hoc comparison using the Benferonni test indicated that the mean score for Railway Station North ($M = 2.45, SD = 1.39$) was significantly different from Groningen Railway Station ($M = 3.23, SD = 1.06$). Railway Station

Europapark ($M= 2.91$, $SD= 1.03$) did not significantly differ from Groningen Railway Station or Railway Station North. With regard to guards at the entrance, a post hoc comparison using the Benferonni test indicated that the mean score for Railway Station North ($M= 2.45$, $SD= 1.31$) was significantly different from Railway Station Groningen ($M= 3.37$, $SD= 1.11$). However, Railway Station Europapark ($M= 3.03$, $SD= 1.09$) did not significantly differ from Groningen Railway Station or Railway Station North.

These results show that 11 of the 13 aspects from environmental design are not rated significantly different during the day regarding the three railway station, with acceptance of the prospect and the guards at the entrance. Participants from Northern Railway Station rated these two aspects lower than participants from the other two railway stations. For the situation after dark, 10 out of the 13 aspects did not significantly differ from each other between the three railway station, with exception of the prospect, physical barriers and guards at the entrance. Participants rated these three aspects lower than people from the Groningen Railway Station. Participants from Railway Station Europapark rated these aspects in the middle of these two, and showed not a significant difference with the other two.

4.3.2.3 Differences between the aspects of environmental design during the day

The figure below (figure 28) shows that there are differences between the scores given for the different aspects of environmental design during the day. To analyse if these differences are significant, and if there are thus differences in the importance of the aspects of environmental design, a One-Way Repeated Measures ANOVA was conducted.

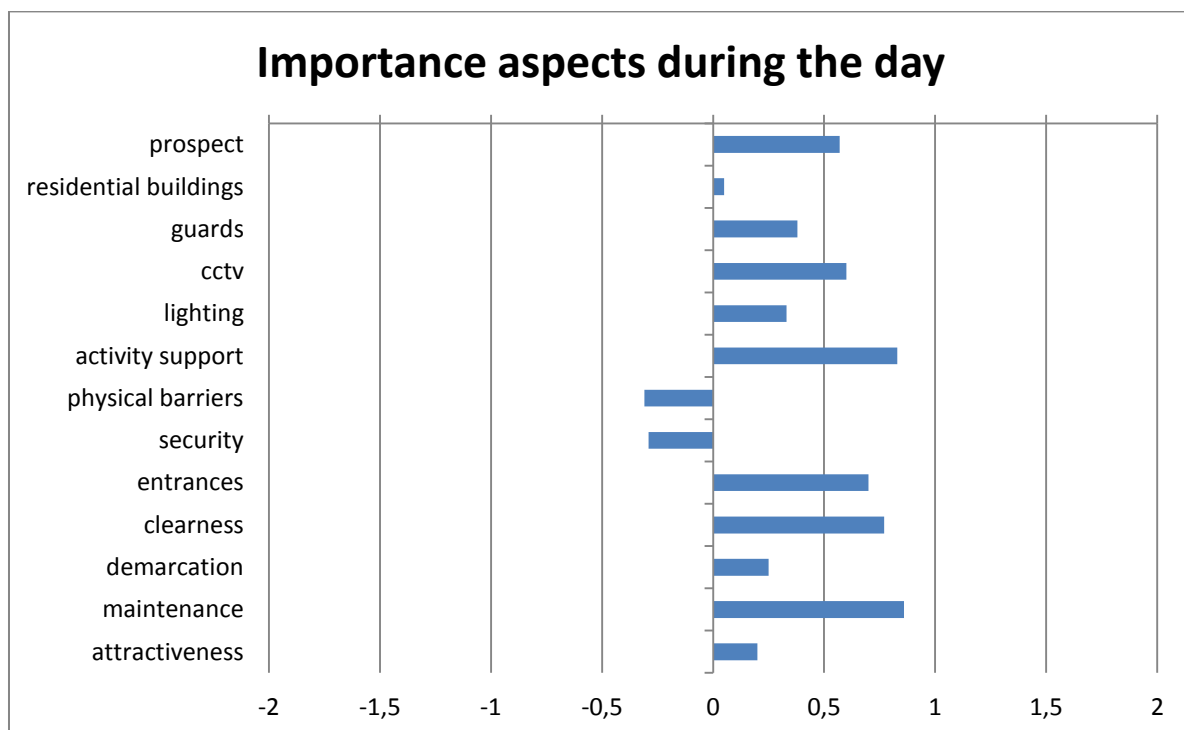


Figure 28: adjusted means showing the importance of the aspects (-2 totally unimportant; 2 very important)

There was a significant effect of the difference of the aspects on the rating of importance during the day at the $p < 0.5$ level, Wilks' Lambda = 0.336, $F(12, 88) = 14$, $p = 0.000$. With regard to the grading per aspect during the day, a post hoc comparison using the Benferonni test was conducted to indicate significant differences between the scores for the different aspects. The two tables below show the results of this test. Table 4 shows the mean scores and the standard deviations of all the aspects of environmental design, and table 5 shows which aspects have significant different results compared to each other. Every green box means that there is no significant difference. A red box means that there is a significant difference.

Aspect	Mean	Standard Deviation
Prospect	3.57	1.01
Residential Buildings	3.05	1.05
Guards	3.38	1.08
CCTV	3.60	1.00
Lighting	3.33	1.22
Activity Support	3.83	1.01
Physical Barriers	2.69	1.05
Security Entrances	2.71	1.08
Number of Entrances	3.70	0.76
Clearness	3.77	0.94
Demarcation	3.25	1.07
Maintenance	3.86	0.94
Attractiveness	3.20	1.02

Table 4: means and standard deviations from the grades (scale 1-5) of the different aspects during the day

	Prospect	Residential Buildings	Guards	CCTV	Lighting	Activity Support	Physical Barriers	Security	Entrances	Clearness	Demarcation	Maintenance	Attractiveness
Prospect	Green	Red	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green
Residential Buildings	Red	Green	Green	Red	Green	Red	Green	Green	Red	Red	Green	Red	Green
Guards	Green	Green	Green	Green	Green	Red	Red	Red	Green	Green	Green	Green	Green
CCTV	Green	Red	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green
Lighting	Green	Green	Green	Green	Green	Red	Red	Red	Green	Red	Green	Red	Green
Activity Support	Green	Red	Red	Green	Red	Green	Red	Red	Green	Green	Red	Green	Red
Physical Barriers	Red	Green	Green	Red	Green	Green	Green	Green	Red	Red	Red	Red	Red
Security	Red	Green	Red	Red	Red	Green	Green	Green	Red	Red	Red	Red	Red
Entrances	Green	Red	Green	Green	Green	Green	Red	Red	Green	Green	Red	Green	Red
Clearness	Green	Red	Green	Green	Red	Red	Red	Red	Green	Green	Green	Green	Red
Demarcation	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Green	Red	Green
Maintenance	Green	Red	Green	Green	Red	Green	Red	Red	Green	Green	Red	Green	Red
Attractiveness	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Green	Red	Green

Table 5: cross table showing significant differences between the grades for the aspects during the day

Looking at table 5, we can see that for example ‘physical barriers’ is significantly different from 10 other aspects, but it does not significantly differ from ‘residential buildings’ and ‘security’. On the other hand, ‘CCTV’ is only significantly different from three other aspects.

These results suggest that there are 8 aspects of environmental design that significantly differ from at least half of the other aspects (thus at least six): ‘residential buildings’, ‘activity support’, ‘physical barriers’, ‘security at the entrance’, ‘clearness’, ‘demarcation’, ‘maintenance’ and ‘attractiveness’ (table 5). ‘Maintenance’, ‘clearness’ and ‘activity support’ are found significantly more important than the other aspects during the day, which is also visible in figure 28. The presence of ‘residential buildings’, ‘physical barriers’, ‘security at the entrance’, ‘demarcation’ and ‘attractiveness’ are found significantly less important than the other aspects (figure 28).

4.3.2.4 Differences between the aspects of environmental design after dark

The same tests have been conducted to analyse the differences between the aspects of environmental design after dark. The figure below (figure 29) shows again the average grades that have been given by the participants to the different aspects.

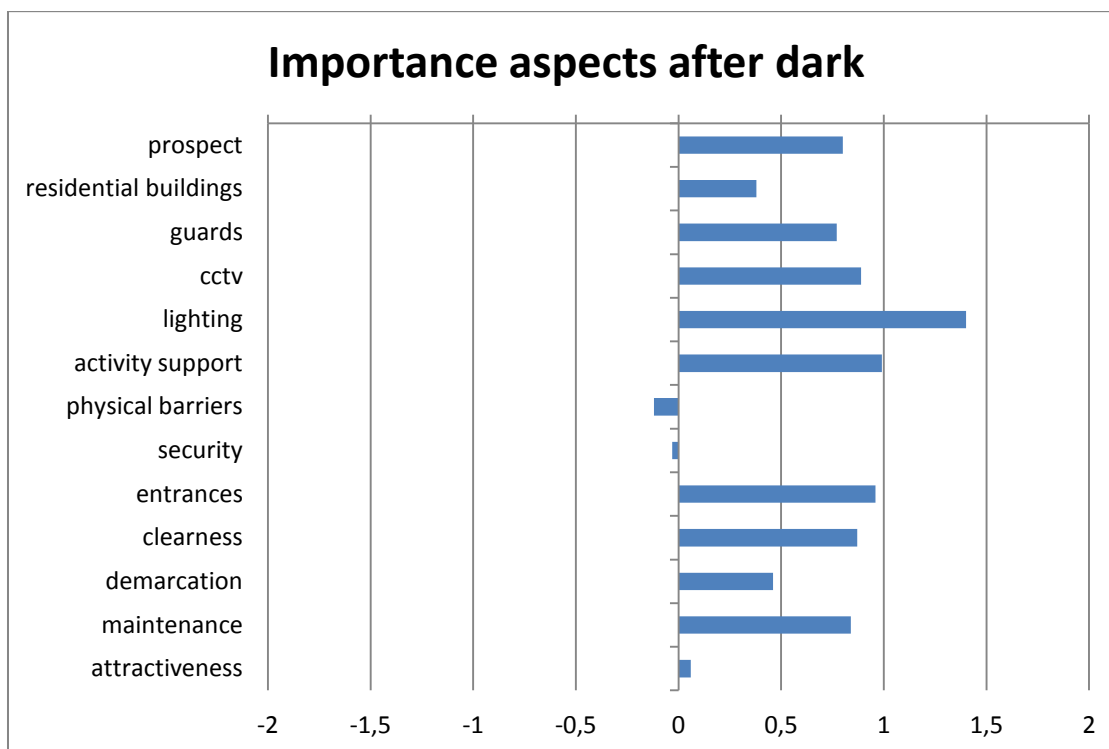


Figure 29: adjusted means showing the importance of the aspects (-2 totally unimportant; 2 very important)

A One-Way Repeated Measures ANOVA was conducted to compare the effect of the different aspects on the grades for importance given to them after dark based on the thirteen categories of environmental design. There was a significant effect of the difference of the aspects on the rating of importance after dark at the $p < 0.5$ level, Wilks' Lambda = 0.300, $F(12, 88) = 17$, $p = 0.000$. With regard to the grading per aspect after dark, a post hoc comparison using the Benferonni test was conducted to indicate significant differences between the scores for the different aspects. The two tables below show the results of these tests, table 6 showing the means and standard deviations, and table 7 showing which grades were significantly different from the others. In this table, the green boxes mean that there is no significantly difference, and for the red ones there is.

Aspect	Mean	Standard Deviation
Prospect	3.80	0.97
Residential Buildings	3.38	1.04
Guards	3.77	1.07
CCTV	3.89	1.14
Lighting	4.40	0.85
Activity Support	3.99	1.03
Physical Barriers	2.88	1.19
Security	2.97	1.22
Entrances	3.96	0.90
Cleanness	3.87	0.95
Demarcation	3.46	1.02
Maintenance	3.84	0.92
Attractiveness	3.06	1.02

Table 6: means and standard deviations from the grades (scale 1-5) of the different aspects after dark

	Prospect	Residential Buildings	Guards	CCTV	Lighting	Activity Support	Physical Barriers	Security	Entrances	Cleanness	Demarcation	Maintenance	Attractiveness
Prospect	Grey	Green	Green	Green	Red	Green	Red	Red	Green	Green	Green	Green	Red
Residential Buildings	Green	Grey	Green	Red	Red	Red	Green	Green	Red	Red	Green	Green	Green
Guards	Green	Green	Grey	Green	Red	Green	Red	Red	Green	Green	Green	Green	Red
CCTV	Green	Red	Green	Grey	Red	Green	Red	Red	Green	Green	Green	Green	Green
Lighting	Red	Red	Red	Red	Grey	Red	Red	Red	Red	Red	Red	Red	Red
Activity Support	Green	Red	Green	Green	Red	Grey	Red	Red	Green	Green	Red	Green	Red
Physical Barriers	Red	Green	Red	Red	Red	Red	Grey	Green	Red	Red	Red	Red	Green
Security	Red	Green	Red	Red	Red	Red	Red	Grey	Red	Red	Green	Red	Green
Entrances	Green	Red	Green	Red	Red	Green	Red	Red	Grey	Green	Red	Green	Red
Cleanness	Green	Red	Green	Red	Red	Green	Red	Red	Green	Grey	Green	Green	Red
Demarcation	Green	Red	Green	Red	Red	Red	Red	Red	Red	Green	Grey	Green	Green
Maintenance	Green	Red	Green	Red	Red	Green	Red	Red	Green	Green	Green	Grey	Red
Attractiveness	Red	Green	Red	Red	Red	Red	Green	Green	Red	Red	Green	Red	Grey

Table 7: cross table showing significant differences between the grades for the aspects after dark

Looking at table 7, we can see that for example ‘physical barriers’ is significantly different from 9 other aspects, it does only not significantly differ from ‘residential buildings’, ‘security’ and ‘attractiveness’. On the other hand, ‘prospect’ is only significantly different from four other aspects.

These results suggest that there are 6 aspects that significantly differ from half of the other aspects or more (thus at least six): lighting, activity support, physical barriers, security at the entrances, the number of entrances and attractiveness. Lighting, activity support and entrances are found significantly more important than the other aspects after dark, which is also visible in figure 29. Of these aspects, lighting is significantly different from all the other aspects. The presence of physical barriers, security and attractiveness are found significantly less important than the other aspects (figure 29).

4.3.3 Final remarks

The results of the last two analyzes are visible in table 8. This table shows which aspects were significantly more or less important than (at least 6 of) the other aspects. The aspects in red are both less important during the day and after dark, being ‘physical barriers’, ‘security’ and ‘attractiveness’. The aspect in green (activity support) was both during the day and after dark more important.

During the day		After dark	
Less important	More important	Less important	More important
Residential buildings	Activity support		Activity support
Physical barriers	Clearness	Physical barriers	
Security	Maintenance	Security	
Demarcation			Lighting
Attractiveness		Attractiveness	Entrances

Table 8: aspects found more and less important (than at least 6 other aspects) both during day and night

Below is a summary of all the statistical tests being performed and discussed in the previous section:

- Men feel more safe than women after dark, but there is no difference during the day
- There are no significant differences in scores on the perception of safety between the three railway station, both during the day and after dark (also not when looking at men and women separately), as they are being collected by the researcher. These differences are however visible in the data provided by ProRail.
- The different aspects of environmental design are thought to be more important after dark than during the day, with the exception of (1) attractiveness what was thought to be less important after dark than during the day, and (2) the maintenance, which showed no significant difference between daytime and after dark.
- During the day, 11 out of 13 aspects did not show differences between the railway stations, and after dark this were 10 out of 13. The differing aspects were prospect (only during the day), physical barriers and security at the entrance. This being just small differences, and two of the three aspects being seen as not important in the following results, makes believe that there is no difference between the railway stations and that a general model can be formed for environmental design with regard to railway stations.
- Physical barriers, security at the entrance and attractiveness are found significantly less important both during the day and after dark, where the first two aspects are also graded as being unimportant (a grade lower than 3 out of 5). During the day also residential buildings and demarcation were significantly less important, but they were still graded as important (graded above 3 out of 5).
- Activity support was both during the day and after dark significantly more important. During the day, also clearness and maintenance were significantly more important, and after dark lighting and the number of entrances. Lighting showed to be very important, being significantly different from all other aspects after dark, making it the most important aspect after dark, and also being the only aspect graded as ‘very important’ (graded above 4 out of 5).

4.4 Towards a new model

Taking all the results of the previous sections together, some observations can be made. First, there seems to be a similarity between the field observations and the results from the survey. The travellers indicated that they found some aspects more or less important than others. When looking at the most unsafe places, the explanations they gave for their unsafe feelings were similar to what they said to be important aspects of their safety perception. They often noted that they felt unsafe due to a lack of visibility, activity support, lighting, maintenance and the number of exits. In the questionnaire, these aspects were pointed out to be significantly more important than the others. However, environmental design aspects such as security at the entrances, physical barriers and the presence of residential buildings were never mentioned to be the cause of (un)safe feelings, even if these aspects scored low in that particular area. So, if the field analysis showed that there were aspects scoring low, these aspects were also pointed out by the travellers, but only those that were mentioned as being important (such as lighting after dark). Low scoring aspects that were pointed out as being less important (such as physical barriers), were never mentioned as a cause of their unsafe feelings.

Although the results of the researcher could not show a significant difference between the perception of safety between the three railway stations, the results from the questionnaire of ProRail does show a clear difference. Here, Northern Railway Station scores clearly worse than Groningen Railway Station and Groningen Europapark. Looking at the response of the participants of the questionnaire to the question on which particular places they felt most unsafe, much more people on Northern Railway Station could answer this question than on the other two railway stations, and the grades given were also lower, especially compared to Groningen Europapark, where there was no average score below 5,5. This can be explained by looking at the results from the field observations. These make clear, that Northern Railway Station scores high on several points, but that some of these points are being seen as not important, such as the presence of residential buildings. And the aspects that are pointed out to be important (activity support, etc), all scored moderate or even low for Northern Railway Station. On the other side, Groningen Railway Station and Groningen Europapark scored moderate or high for the aspects that were said to be important, and most of the aspects that got a low score were said to be not important. It thus seems that environmental design is a model that is applicable for railway stations, when the model is adjusted to the results of the survey.

It can thus be concluded that an adjusted model of environmental design can be made. Physical barriers and security at the entrance are said to be not important. This can be explained by the fact that a railway station is more or less a public space. It is meant to be open, and even has the function to meet people and (with regard to bigger railway stations) for people to go shopping in the recreational domain without coming there to travel. It is a place to travel and to meet people, so it must be easily accessible. If not, it loses its function. Still, there are entrance gates being placed at some railway stations, but as Gertrud Kuis explained, these are being placed with regard to fare dodging and not primarily to increase the (perception of) safety on a railway station (Interview Kuis). Looking at this from theory, 'target hardening' is not an aspect that seems to increase the perception of safety on railway stations. An aspect that is significantly less important is 'attractiveness'. Not only is 'attractiveness' the only aspect seen as being less important after dark than during the day, it is also seen as less important when compared to the other aspects. From theory, it is clear that attractiveness is only indirectly positive, for in theory it is said that an attractive environment can be positive for the perception of safety, but only if this place has been well cared for (Nasar & Fisher,

1993). It can thus be said that the maintenance is more important than the attractiveness, which is also visible from the results of the questionnaire, where the maintenance is significantly more important than the other aspects during the day. This is in line with the slogan of NS: “clean, whole and safe”, which means that the basics have to be okay, and if there is room and money for something extra, like for example a piano, this is optional (Interview Kuis). Attractiveness however is scored with an average score above 3 both during the day and after dark, which means that the people did find it at least in some extend important. This is not the case for security at the entrance and physical barriers; here the average score was below 3, meaning that people thought it unimportant. For this reason, physical barriers and security at the entrance can be said to be not important for the model, while attractiveness is the least important aspect from the remaining ones. Figure 30 shows an adjusted model of environmental design for railway stations. Security at the entrance and physical barriers are shown to be ‘not important’, both during the day and after dark. The only aspect in the category ‘accessibility control’ that is important, is the number of entrances. Here it seems, that the addition to Appleton’s prospect and refuge theory, which includes the aspect to escape (Fisher & Nasar, 1992), is indeed important for railway stations. Travellers even said that they found the possibility to escape more important than having a good prospect of the area.

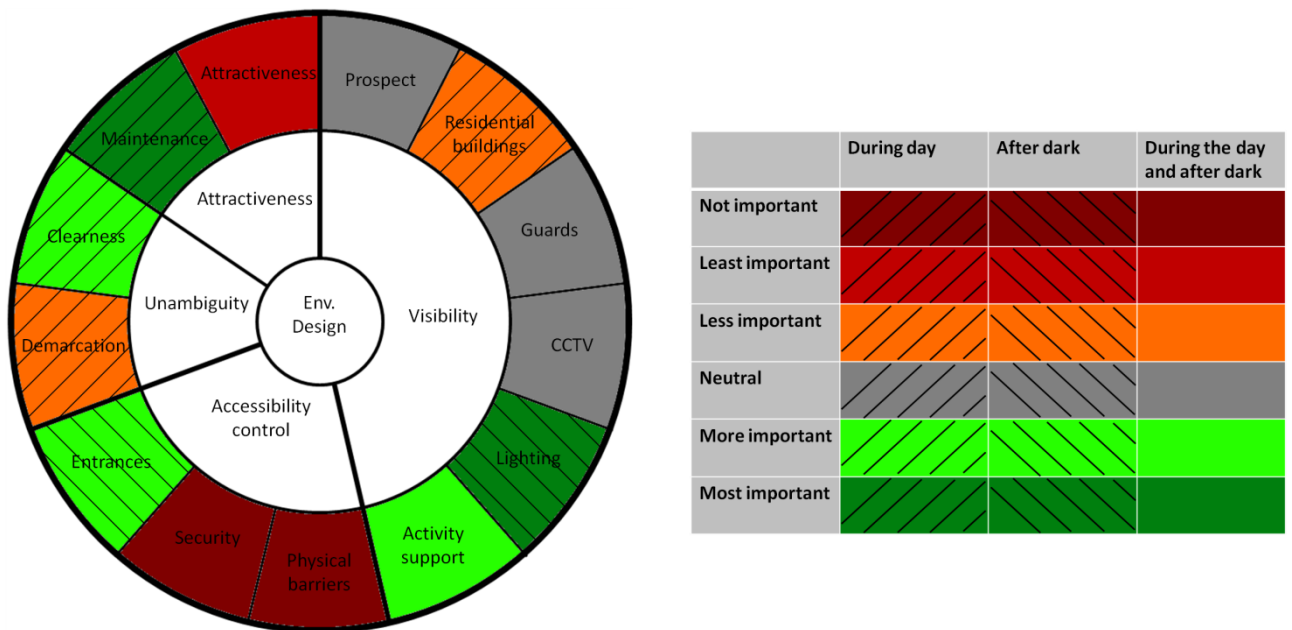


Figure 30: adjusted model of environmental design for railway stations

The figure shows that attractiveness is found less important than the other factors, both during the day and after dark, and is also the least important factor for the entire day. Attractiveness is thus something least important for environmental design, leading to something optional to create a pleasant environment. ‘Activity support’ is a factor that is more important than the others both during the day and after dark. It is however not seen as the most important factor, as maintenance is seen as the most important factor during the day, and lighting after dark. Besides those two, also clearness of the environment and having enough entrances are important factors. Two other less important during the day, are the presence of residential buildings and demarcation. This is also in line with what Getrud Kuis said; it is for a railway station not very important to have a clear borderline. It is important that travellers know where they are when entering the railway station, but

it is less important if they know if the front square of the railway station is property of NS, ProRail or the municipality of Groningen. It is more important that the railway station is in harmony with the surrounding environment (Interview Kuis). The prospect is also important, but not as much as some other aspects. It is important to create as much prospect and sightlines as possible, but you also have to work with what is already present. For example, the old traverse at Groningen Railway Station is an obstacle, which lowers the prospect. It is however a monumental building, so it cannot (easily) be removed. In such a situation, you should work with what is already present and create in those circumstances a best possible situation. Guards and CCTV are also said to be important, but not as much important as some other factors. In this case, it is best to see those two aspects as optional, as is also already done currently. CCTV and guards are present in situations where this is necessary because of incidents, such as a murder at Northern Railway Station and nuisance with homeless people at Groningen Railway Station (Interview Kuis).

Where lighting and maintenance are pointed out as the most important aspects, this is in general done well on the railway stations, with regard to the lighting and maintenance around Northern Railway Station (especially broken tiles etc), and the removal of graffiti in general. These two are relatively easy to be improved. Clearness is on all three station rather good, although Northern Railway Station could use some improvements. Two, more difficult, issues to improve are the number of entrances and activity support. Both aspects were mentioned as reasons why people felt unsafe at some places, being an absence of these factors in those areas. It is hard to ensure a good possibility to escape by providing enough exits along the railway tracks. Often there is only one entrance/exit, which gives people the fear of being enclosed and trapped. This could be solved by giving every platform an extra exit using a tunnel or a traverse, but this is expensive and may create abandoned traverses. The best option seems to create, if possible, several entrances for a platform, and, if this is not possible, to place this entrance in the middle of the platform. In this way, an exit is always nearby. Besides, the ends of platforms are in general barely used. So, when there is an entrance in the middle of the platform, travellers always have the option to wait for the train to arrive close to an entrance. With regard to Northern Railway Station, it can be argued that the ascending path should be replaced by elevators. These could be places in the old staircases. The other difficult aspect is 'activity support'. Especially at night, this is a difficult aspect, as the railway stations are at those time mostly deserted and facilities are closed. However, it cannot easily be said to 'place a kiosk', or to leave facilities open till the last train leaves or arrives, because this is depends on supply and demand.

Another important aspect, is the surrounding environment. A railway station can be designed as safe as possible, and still feel unsafe because it is located in a bad neighbourhood. This was especially visible at Northern Railway Station, where a lot of complaints were about the loitering youth and people using drugs. To solve such a problem, the focus should not just be on the railway station, but on the entire environment. This is also a problem NS or ProRail could not solve on their own, but where the interference of the municipality and police is needed to improve the entire neighbourhood. Besides, it is not only a 'bad neighbourhood' that can have a bad influence. As Gertrud Kuis explained, if the office building of the municipality of Groningen next to Groningen Europapark would be vacant, that would also have a negative influence on the railway station (Interview Kuis). This cannot be influenced by NS or ProRail, and needs the cooperation with other parties, such as the municipality.

Finally, it is important to notice that different aspects of environmental design can conflict with each other. For example, by placing trees at Northern Railway Station, the attractiveness gets

higher. However, the trees have been placed in such a way that in spring and summer they block the view from the platforms to the surrounding environment due to the leaves on the trees. When thinking about environmental design, it is thus important to see it as a whole and not as loose aspects.

Based on the adjusted model of environmental design, the following recommendations can be made for the different railway stations. First for Groningen Railway Station, the traverse on the eastern side should get some attention. It should be taken into consideration to remove the traverse when the railway station is being renewed, for this traverse is the biggest cause for unsafe feelings and a bad score on environmental design, mostly because the activity support and maintenance is low, and the corner in the traverse causes a bad prospect.

For Northern Railway Station, there are several aspects that can be improved. In general, attention should be given to a good lighting after dark, making sure the areas are well lightened and there are no significant differences in lighting. Also the maintenance of this area should be improved, by making sure tiles are present and lying straight, lights are working, the guiding strips for blind people lead to the entrances, and greenery is neatly cut away so sightlines stay intact. There should also be something done about the inconvenience caused by loitering youth and people using drugs, by trying to improve the entire neighbourhood, and if necessary make sure the area is watched by guards or the police, or experiment with solutions such as classical music. This should be done in cooperation with the municipality and the police. At last, the ascending paths should be replaced by an elevators which could be placed in the staircases that are now being used at art galleries. The ascending paths have a bad prospect, are deserted and require a lot of lighting. Replacing them with (glass) elevators may improve this situation.

There are no big changes needed for Groningen Europapark, as this railway station scores good on environmental design, which is also visible by the view of travellers on this railway station. They perceive it as really safe, and no average grades below 5,5 are given for 'unsafe' places. The only improvements that could be done here is the removal of graffiti. This railway station could be used as an example for other railway stations.

Chapter 5 –Conclusion and recommendations

This research has been conducted to investigate how environmental design can improve the perception of safety on railway stations. It has been found, that the theory of environmental design is indeed applicable for the improvement of the perception of safety on railway stations. The results from the field observation were in line with the perception of the travellers on unsafe places, and the reason why they felt unsafe at those places, with constantly the acceptance of three aspects that were never mentioned even though they scored badly, which was also visible in the scores given for the importance of the aspects, and which is why the theory does need some adjustments.

The two aspects ‘physical barriers’ and ‘security at the entrance’, both within the main category ‘access control’, are unimportant for the perception of safety. Travellers graded them as such, and these aspects were also found significantly less important than the other aspects. ‘Activity support’ was found significantly more important than other aspects both during the day and after dark; ‘maintenance’ and ‘clearness’ are also found more important during the day, of which ‘maintenance’ is the most important aspect. After dark, besides ‘activity support’ the aspects ‘lighting’ and ‘entrances’ were also found significantly more important, of which ‘lighting’ is the most important aspect. It can thus be said that the aspects ‘physical barriers’ and ‘security are unimportant for environmental design with regard to the perception of safety, where ‘activity support’, ‘lighting’ and ‘maintenance’ need extra attention as these were found most important. ‘Attractiveness’ was found less important, both during the day and after dark. However, it was still graded above average and thus in some amount perceived as important. It should be an aspect dealt with as an extra option, something to think of when the rest is okay.

Of all the aspects, three were graded different at the three railway stations. However, as two of those three (physical barriers and security) are unimportant for the model, only one aspect out of eleven (prospect) has been graded different for a situation during the day at Northern Railway Station compared with the two other railway stations. This only being a small amount, it can be concluded that there are no noteworthy differences between the perception of the travellers from the three railway stations concerning the importance of the different aspects of environmental design. This supports the conclusion that a general (adjusted) model for environmental design with regard to railway stations is indeed applicable.

With the exception of ‘maintenance’ and ‘attractiveness’, all other aspects of environmental design are found more important after dark, and people also feel less safe after dark. The factors found most important after dark (‘lighting’, ‘activity support’ and ‘entrances’) are all in line with the prospect, refuge and escape theory, which indicates unsafe feelings. This means that also after dark it is important for the perception of safety of users of the railway station to see and to be seen, to have informal and formal security. This can be difficult to execute; it is expensive to have guards at the railway stations, to have shops, and to keep these shops open after dark. For the shops, it must be profitable. Besides guards should only be used when there are incidents, or when they have occurred, for there is no money nor manpower to have them at all times at all railway stations. With regard to ‘entrances’, it is sometimes difficult to make more entrances for a platform. It could be solved by giving every platform an extra exit using a tunnel or a traverse, but this is expensive and may create abandoned traverses which will again cause trouble. The best option seems to create, if possible, several entrances for a platform, and if this is not possible, one entrance in the middle of the platform. This way, an exit is always nearby. Besides, the ends of platforms are in general barely used. So, when there is an entrance in the middle of the platform, travellers always have the option to wait for the train to arrive close to an entrance

ProRail and NS are doing a good job nowadays, although they could pay some more attention to maintenance (especially graffiti), entrances (if possible) and guards when incidents have occurred (loitering youth at northern railway station, although it can also be said this is a task of the police). Especially Northern Railway Station could use some redevelopment (together with a plan of action for the neighbourhood), such as fixing lights, creating proper changes in lighting, and replacing the ascending paths by elevators. Groningen Railway Station could consider to remove the traverse on the eastern side when redeveloping the Railway Station. Groningen Europapark could be used as an example for other Railway Stations. It is however important, when making plans with regard to environmental design, to keep in mind that the different aspects of environmental design can conflict with each other.

It should also be kept in mind that a Railway Station always stands in relation to its surrounding environment. This is what makes a railway station unique and influences the type of people using the railway station and what facilities can be present. Besides, the direct environment can have a negative or positive influence on the railway station, by being deserted, lively, very busy, or whatsoever. This makes that planning a railway station and finding solutions for problems does not have to stay within the boundaries of a railway station but can also be found outside these boundaries. For example, solving problems with loitering youth at Northern Railway Station is a task of the municipality, as this problem is not being caused by a 'bad' railway station, but by a 'bad' neighbourhood. A good cooperation between NS, ProRail, the police and the municipality is very important.

There are some critical points to this research. First, although this research has attempted to come up with general rules for railway stations, this research is restricted to the city of Groningen. It is important to remember that results may differ in other Dutch cities, and also in other areas with a different function (e.g. parks). These are differences that need to be investigated in further research.

Secondly, the surveys have been conducted during the day. Questions about the situations 'after dark' may thus have less reliable outcomes, for people can more accurately answer questions about their safety perception when it is dark, when it actually is dark. The researcher has however chosen to conduct the surveys during daylight, because at the time of this research (May and June) sunset is relatively late (after 21:30). After this time, especially on the Northern Railway Station and Groningen Europapark, there are less trains and less travellers, so it would be very hard to achieve a proper number of participants. Moreover, Northern Railway Station is not a comfortable place to conduct questionnaires at that time of day, because of the loitering youth and people using drugs.

Finally, although the field observation is as objective as possible, there are variables based on the insights and opinions of the researcher, such as the universal aesthetic qualities. Several aspects of the theory cannot be defined in numbers. It is impossible to be completely objective, so other researchers may have come to other conclusions.

A recommendation for further research is to investigate the use of environmental design on the perception of safety on other railway stations in the Netherlands, to look if a general model can be made. Also, it might be useful to conduct such a research during the winter, when people can be more easily asked for their perception of safety after dark when it actually is dark. Finally, this research had a focus on the opinion of the traveller on the importance of the different aspects of environmental design. Other researches could look for more objective results. It is however relatively hard to conduct such a research, for there must be found a way to block the influence of the

surrounding environment. A laboratory experiment could be an option, for example by using computer made scenes combined with virtual reality. In that way, it can be investigated how people feel in different environments where continually aspects of environmental design can be changed in every situation.

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Appendices

Appendix A: Interview Gertud Kuis – location manager NS

General

- What is the task of ProRail and NS to create safe railway stations?
- What is the function of the old stamping machines on the railway stations?

Groningen Railway Station

- How is the security regulated on the railway station, both day and night?
 - Which activities/tasks do they perform?
 - Is there CCTV on this railway station?
- Is there in some way control on who enters or leaves the railway station both day and night?
 - Using guards fences or entrance gates?
 - Are there areas or entrances that are closed at certain moments?
- How is the maintenance organised on this railway station?
- Are there measurements taken to make this railway station more beautiful and attractive?

Northern Railway Station

- How is the security regulated on the railway station, both day and night?
 - Which activities/tasks do they perform?
 - Is there CCTV on this railway station?
- Is there in some way control on who enters or leaves the railway station both day and night?
 - Using guards fences or entrance gates?
 - Are there areas or entrances that are closed at certain moments?
- How is the maintenance organised on this railway station?
- Are there measurements taken to make this railway station more beautiful and attractive?
 - Are the televisions and sounds in the old stairways of the railway station (which are now art galleries) part of a technique to scare loitering youth away?

Railway Station Groningen Europapark

- How is the security regulated on the railway station, both day and night?
 - Which activities/tasks do they perform?
 - Is there CCTV on this railway station?
- Is there in some way control on who enters or leaves the railway station both day and night?
 - Using guards fences or entrance gates?
 - Are there areas or entrances that are closed at certain moments?
- How is the maintenance organised on this railway station?
- Are there measurements taken to make this railway station more beautiful and attractive?

Guidelines

Are there in general guidelines provided on the railway stations for the following aspects (for example minimum lux) for both day and night? If yes, which?

- Amount of prospect of the environment
- Amount of guards present
- Presence of CCTV
- Amount of lighting
- Mixture of different functions
- Physical barriers to control the people entering the railway stations (e.g. fences or entrance gates)
- Guards at the entrance
- The amount of entrances and exits that a railway station should have
- Demarcation of the railway station and optionally different areas within the railway station the clarify who is the owner or responsible person of that particular place
- The level of information provision/ clearness where the traveller has to go
- Maintenance and cleaning of the railway stations
- Attractiveness

3. On which specific places on this railway station do you feel least safe, both during the day and after dark? This can be very specific places, such as 'the bench at the end of platform 2'. After that, give this specific place a grade between 1 and 10 for your safety feeling and explain why you feel unsafe at that specific place. Please also mark this specific place on the map below

Most unsafe place during the day:.....

Grade safety feeling of this specific place:.....

Reason for the unsafe feeling :.....

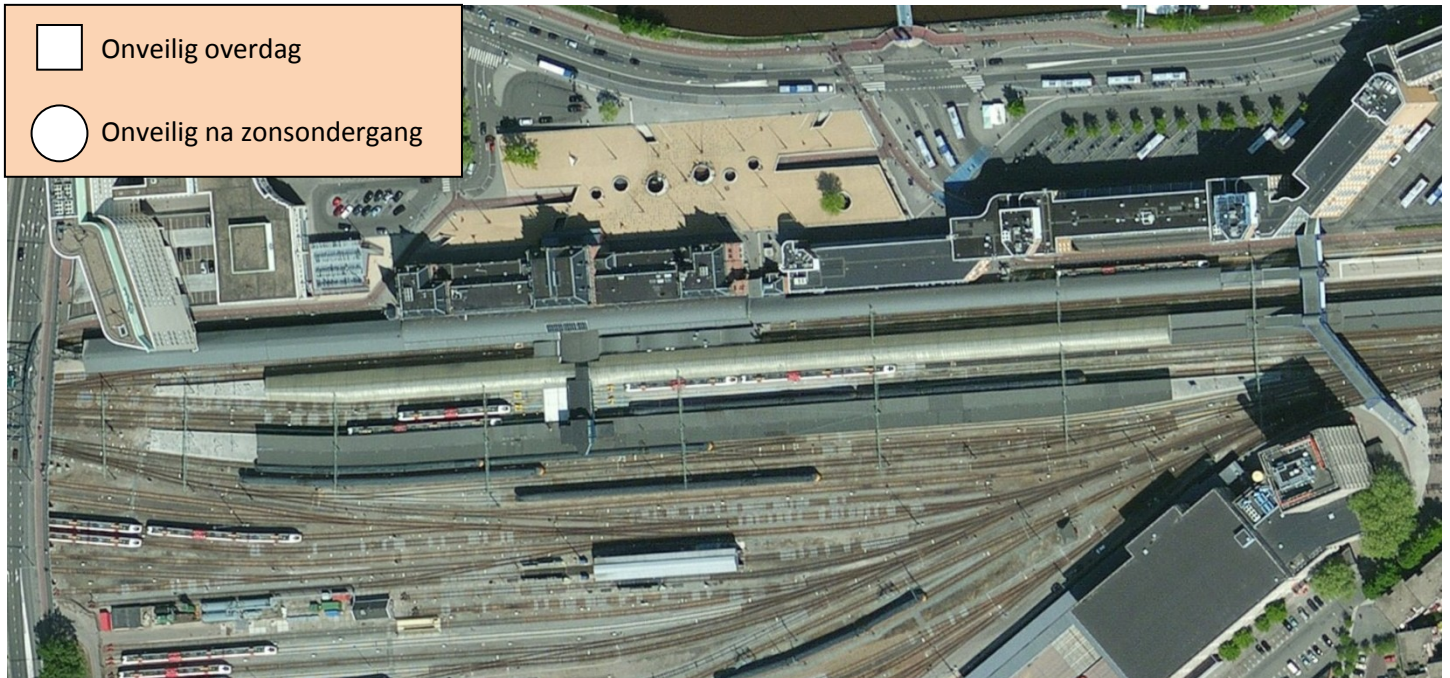
.....

Most unsafe place after dark:.....

Grade safety feeling of this specific place:.....

Reason for the unsafe feeling:.....

.....



Appendix C: Descriptive statistics

		Groningen Railway Station	Northern Railway Station	Groningen Europapark	Total	
N		35	31	34	100	
Gender	Male	13	16	11	40	
	Female	22	15	23	60	
Average grade	During the day	8,3	8,3	8,5	8,4	
	After dark	7	6,6	7,1	6,9	
Living in Groningen	Yes	16	6	8	30	
	No	18	24	23	65	
Finished education level	vmbo	2	4	5	11	
	Havo	4	8	2	14	
	Vwo	5	4	1	10	
	MBO	5	5	16	26	
	HBO	5	7	6	18	
	WO	13	3	4	20	
Average grade importance aspects	Prospect	Day	3,71	3,10	3,84	3,57
		Dark	4,03	3,45	3,84	3,80
	Residential houses	Day	2,89	3,10	3,16	3,05
		Dark	3,31	3,42	3,42	3,38
	Guards	Day	3,60	3,26	3,29	3,38
		Dark	4,03	3,55	3,68	3,77
	CCTV	Day	3,51	3,71	3,58	3,60
		Dark	3,94	3,97	3,71	3,89
	Lighting	Day	3,49	2,90	3,52	3,33
		Dark	4,51	4,39	4,29	4,40
	Activity support	Day	3,74	3,90	3,81	3,83
		Dark	3,97	4,13	3,87	3,99
	Physical barriers	Day	2,91	2,32	2,84	2,69
		Dark	3,23	2,45	2,97	2,88
	Security	Day	3,17	2,13	2,81	2,71
		Dark	3,37	2,45	3,06	2,97
	Entrances	Day	3,80	3,61	3,71	3,70
		Dark	4,17	3,94	3,77	3,96
	Demarcation	Day	3,00	3,42	3,35	3,25
		Dark	4,06	3,55	3,58	3,46
	Clearness	Day	3,91	3,77	3,62	3,77
		Dark	3,26	3,81	3,77	3,87
	Maintenance	Day	3,91	3,84	3,77	3,86
		Dark	3,89	3,84	3,81	3,84
Attractiveness	Day	3,43	3,00	3,13	3,20	
	Dark	3,17	2,97	3,00	3,06	

Appendix D: socio-economic factors

An independent-samples t-test was conducted to compare the safety perception during the day for participants living in the city of Groningen and participants who do not. There was not a significant difference in the scores for people from the city ($M = 8.53$; $SD = 0.86$) and people from other places ($M = 8.31$; $SD = 1.06$); $t(93) = -1.02$, $p = 0.309$. The same test was conducted to compare the safety perception after dark for people living in the city of Groningen and from outside. There was not a significant difference in the scores for people from the city ($M = 6.95$; $SD = 0.97$) and people from other places ($M = 6.94$; $SD = 1.06$); $t(90) = -0.02$, $p = 0.98$. These results suggest there is no difference in the safety perception between people living in the city of Groningen and people who live elsewhere, for both during the day as after dark.

A one-way between subjects ANOVA was conducted to compare the effect of education levels on the perception of safety during the day based for the educational levels vmbo; havo, vwo, MBO, HBO, and WO. There was not a significant effect of educational level on the safety perception during the day for the three condition [$F(5, 93) = 0.47$, $p = 0.801$]. The same test was conducted to compare the effect of educational levels on the perception of safety after dark. There was a significant effect of educational level on the safety perception after dark at the $p < .05$ level for the six conditions [$F(5, 90) = 2.73$, $p = 0.024$]. Post hoc comparisons using the Bonferroni test indicated that the mean score for vmbo ($M = 5.90$; $SD = 1.30$) was significantly different than MBO ($M = 7.38$; $SD = 1.05$). However, the other educational levels did not significantly differ from each other or from vmbo and MBO. These results suggest that there is a significant difference in the safety perception after dark between participants with a vmbo level and participants with a MBO level. However, this can also be the result of age differences. Participants with a finished education that is relatively low, are often younger than the other participants. This is also visible in the statistical test with regard to age.

A one-way between subjects ANOVA was conducted to compare the effect of age on the perception of safety during the day based on the age categories <20, 21-40, 41-60 and >61. There was a significant effect of the age categories on the perception of safety during the day at the $p < .05$ level for four conditions [$F(3, 96) = 3.10$, $p = 0.030$]. Post hoc comparisons using the Benferroni test indicated that the mean score for the age group <20 ($M = 8.19$; $SD = 0.15$) was significantly different than the age group 21-40 ($M = 8.77$; $SD = 0.90$). The other groups did not show any significant differences to each other. These results suggest that an increase in age results in a higher perception of safety during the day, but that this increase is mostly visible at a young age and not for higher age categories. The same test was conducted to compare the effect of age on the perception of safety after dark based on the same age categories. There was not a significant effect of the age category on the perception of safety after dark in the four condition [$F(3, 93) = 1.68$, $p = 0.177$]. These results suggest that, even though in the graph a difference is visible between the age categories and the safety perceptions after dark, this difference is not significant.