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Sight & Safety: a Case Study on the Effect of the Urban Environment on Fear of Crime, Visual Proximity and Walking Behaviour

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Sight & Safety: a Case Study on the Effect of the Urban Environment on Fear of Crime, Visual Proximity and Walking Behaviour

Bachelor Thesis Project

To fulfill the requirements for the degree of
Bachelor of Science in Spatial Planning & Design
at University of Groningen under the supervision of
Charlotte Miller, MSc and **Dr. Mohamed Saleh, MSc**

Lars C. Huizer (S3784789)

June 17, 2022

Colophon

Title	*Sight & Safety: a Case Study on the Effect of the Urban Environment on Fear of Crime, Visual Proximity and Walking Behaviour*
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Version	Final Version
Date	June 17, 2022

This document was typeset with LaTeXusing the Overleaf editor. The template for this document was adapted from Manvi Agarwal's template made available on the Overleaf website. The diagram for the conceptual model was created using the draw.io software. Editing of the various figures as well as the creation of the Prospect/Refuge model were performed using Adobe Photoshop. The maps were created using ArcGIS Pro. DepthMapX was used to create the Visual Proximity Model, which was further developed into the Prospect/Refuge model. Zotero was used to manage the bibliography, and the LaTeXpackage *apacite* was used for the styling of the in-text referencing and reference list.

Acknowledgments

First and foremost, I would like to express my deepest gratitude towards my supervisors Charlotte Miller, MSc and Dr. Mohamed Saleh, MSc for their guidance throughout the project. Their advice and extensive knowledge were invaluable in helping me write this thesis. I also wish to acknowledge the technical support provided by Dr. Gerd Weitkamp and the Geodienst regarding everything GIS. Furthermore, I also had great pleasure in working with my colleague Wiebren Veenstra, who provided me with useful feedback through his peer-review.

I would be remiss if I did not mention my friends and family. I would like to thank Florens for his motivational support to work hard through the deliberation of my work. Finally, I would like to express my appreciation for my parents and my brother, whose unwavering support and belief in my work have helped me all the way to the end.

Abstract

Natural surveillance is an important contributor towards creating safe and walkable places. The layout and the characteristics of the built environment are an important factor in facilitating natural surveillance. However, little research exists linking the perception of safety, walking behaviour and the built environment, let alone including natural surveillance as a variable. This thesis employed a survey within the neighborhoods of De Hunze / Van Starkenborgh and Beijum within the city of Groningen, and ran a regression analysis to find the impact of the built environment and perception of safety on walking behaviour. Additionally, a method for modelling natural surveillance using depthMapX was created and applied to the areas of study. It was found that the built environment has an effect on both walking behaviour and fear of crime, but no significant link exists between fear of crime and walking behaviour. The natural surveillance model created shows potential in predicting fear of crime, but requires further configuration to accurately represent real-life scenarios. Future research should apply the methods employed to different neighborhoods in order to gather verification data.

Keywords— Fear of crime, Built environment, Walking behaviour, Regression analysis, Natural surveillance, Visual proximity, DepthMapX

List of Abbreviations

In order of appearance:

NS	Natural Surveillance
CPTED	Crime Prevention Through Environmental Design
VGA	Visibility Graph Analysis
VP	Visual Proximity
FoC	Fear of Crime
PSS	Position in Social Space
DH/VS	De Hunze / Van Starkenborgh
PABS	Pedestrian and Bicycling Survey

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1 Introduction

The more an offender believes they are seen, the less likely they are to commit a crime. Through Natural Surveillance (NS), a form of oversight "provided by people going about their everyday business" (Clarke, 1997, p. 21), a community is able to prevent crime and to increase levels of perceived safety. To planners and geographers, NS would be more recognizable as Jacobs' (1961) 'eyes on the street'. The concept of NS is employed in the strategy of Crime Prevention Through Environmental Design (CPTED), a movement based on the work by Jeffery (1971) that suggested that through urban and architectural design, it is possible to prevent the behaviours that lead to criminality. Newman (1996) further expanded on Jeffery's work by creating defensible space theory, where it was argued that NS is an important factor in creating a defensible space in which inhabitants can feel safe.

In an article by Desyllas, Connoly, and Hebbert (2003), an attempt is made to model NS, generating maps by which the 'degrees' of natural surveillance in central London and a university campus are compared. This was done using the program Fathom, which employs a Visibility Graph Analysis (VGA). VGA involves "laying a grid over all public space and interrogating the visibility relations of every point in the grid to every other point." (Desyllas et al., 2003, p. 646). The analysis resulted in a map on which visual relationships can be identified (see Figure 1). Although the results of Desyllas et al's work is interesting, its application towards urban planning is limited since there is a lack of data that verifies whether or not the model is accurate. Furthermore, no existing work shows whether employment of the model has use as a predictor for safety from crime.

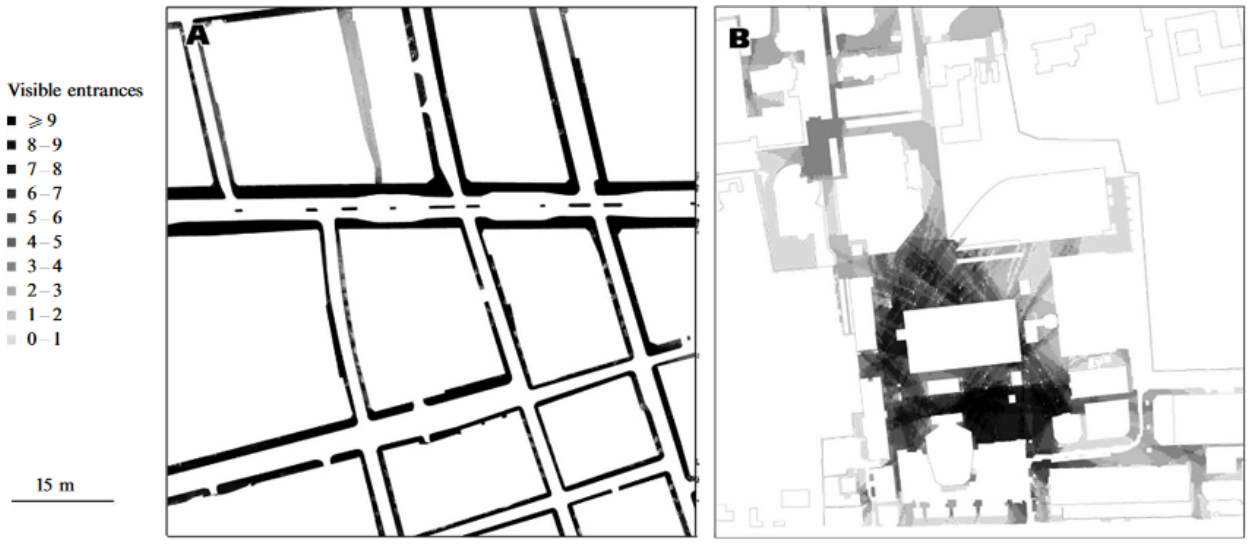

Figure 1: Desyllas et al. (2003)'s model of the degree of natural surveillance within central London and a local university campus.

1.1 Research Problem

There is a lack of papers that attempt to reconcile the built environment, walking behaviour and perception of safety. Although the link between perception of safety, walking behaviour and the perception of the built environment is researched in a paper by Hong and Chen (2014), they mention that research before them often only looks at the link between two of the three, meaning the relationship

between all three has not been properly recorded. However, there is no mention of NS by Hong and Chen. This is not necessarily surprising as NS is a concept used more often within the field of criminology, whereas the authors have a history in urban planning. In any case, this delineates a gap in research where the impact of NS on the perception of safety and walking behaviour is unexplored.

NS is an important aspect within the field of criminology, but its application to urban planning currently is limited. As Desyllas et al. (2003) put it, there has been a lack of clear empirical methods for evaluating the levels of NS. By optimizing the amount of NS in a given area during the design stage, one could ensure that the area would be and feel safer due to a higher level of social scrutiny. Desyllas et al. mention that their model could be used by applying it to different urban designs and testing for correlations between the degree of NS and different types of crime. As of yet though, there have been no articles that attempt to do so, meaning that the explanatory value and usefulness of the model is not confirmed. Affirmation of the model's practicality in real-life means that it could become a valuable tool in aiding urban design choices, with the purpose of encouraging NS and by extension safer and more walkable environments.

Statistics from the municipality of Groningen (2020) gathered from their yearly livability survey indicate that there seems to be a mismatch between the perception of safety and the actual amount of crime (Figure 5) within Beijum. Whereas the subjective safety from violence is considered 'unfavorable' compared to the rest of Groningen, the objective safety is considered 'neutral'. For the neighborhood of De Hunze / Van Starkenborgh (DH/VS) this situation is reversed, where the objective safety is rated lower than the subjective safety. The differences in the urban morphology between Beijum and DH/VS, where Beijum is a typical 'cauliflower' neighborhood and DH/VS is more linear in its road network, provide a compelling case by which the impact of the built environment on the perception of safety and walking behaviour can be analyzed. Subsequently, this research aims to create and employ a natural surveillance model within Beijum and De Hunze / Van Starkenborgh in the city of Groningen and comparing its results with gathered survey data to verify its usefulness.

1.2 Research Questions

To summarize, this paper will attempt to answer the following questions:

Q Main. To what extent does the perception of the built environment and fear of crime affect walking behaviour, and how effective is natural surveillance modelling as a crime predictor?

- Q1. To what extent does the perception of the built environment affect fear of crime?
- Q2. To what extent do fear of crime and the built environment affect walking behaviour?
- Q3. To what degree is there an overlap between the constructed natural surveillance model and the inhabitant's perception of safety within their neighborhood?

2 Theoretical Framework

To create a methodology through which to analyze the two neighborhoods of study, the theoretical framework will discuss various concepts such as the link between perceived crime safety, the built environment and walking (Hong & Chen, 2014), visual experience of urbanity and proximity (Gibson, 2015; Appleton, 1996; Gehl, 2011), and fear and fear of crime (Garofalo, 1981). Fear of crime, and fear in general, are relevant due to their importance for personal decision-making, especially in the context of walking, where one might avoid certain streets if it feels unsafe to walk there. Under this subsection of the theoretical framework, the model of how fear works will be discussed. Furthermore, the implications of trying to measure fear through surveys will be discussed, as these are important to methodology. Also relevant is the visual experience of the environment (which includes urbanity) due to its ability to modulate NS and by extension fear. This subsection of the framework will discuss how people visually interpret their environment, and what nuances come into play when experiencing one's surroundings considering that the act of "experiencing" yields different results from person to person. The last subsection of the theoretical framework will discuss the interlinkage of these different factors and will tie them together into a conceptual model.

2.1 Experience of Environment and Human Senses

In order to later on discuss the concept of fear, it is important to consider how one perceives the environment around them. In his book "The Ecological Approach to Visual Perception", Gibson (2015) states that the physical aspect of our surroundings is not necessarily meaningful, but the meaning what one gives to it is. He defines the term 'environment' through this distinction; the environment does not equal the physical world, but rather is a perception of it. In the same book, Gibson coined the term 'affordances', which he defines as such:

> The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill. [...] I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment (p. 119).

Within a spatial context, affordances can be considered as the subjective qualities the physical environment has, differing per onlooker. For instance, whereas someone able-bodied might view stairs as a way to go from one place to another, someone who is mobility-impaired would consider it an obstacle. These affordances can be linked to the prospect-refuge theory of Appleton (1996). Explicitly put, examples of prospect include areas with high levels of visual acuity. refuge on the other hand entails for example being out of sight, or having your back against the wall.

Appleton (1996) describes through the lens of habitat theory that the human perception of landscapes is either positive or negative depending on the perceiver. As an example to how one might experience fear, he uses a predator-prey dynamic, indicating that both may find different affordances within the same environment; a prey would like to be in an environment in which he has proper visual acuity over his surroundings (high prospect), but is able to hide himself (high refuge). Conversely, a predator could use the same environment to ambush prey. It follows from this line of thought that the approach from an area with high prospect to one without would elicit a negative response, much like one might consider it to be scary to have to enter a dark place coming from a well-lit area. Appleton uses this theory primarily in the context of landscape design from an aesthetic perspective, but it is also relevant to this paper; Prospect-Refuge theory showcases that one's perception of the environment

can be different depending on their demographic and psychological characteristics since one would find different affordances according to one's differing attributes. It follows from this line of thought that one's experience of visual acuity and by extent their fear of crime is of a subjective nature as well.

Viewsheds can be defined as the view that can be seen from a specific perspective. As an example, the viewshed of a person standing on the street will be much less than that of someone who is standing at a vantage point. However, viewsheds are not necessarily limited only by obstructions, but also by distance. Gehl (2011) defines the interaction of vision and social interaction as such; from around ½ to 1 kilometer, one can identify people at a distance depending on various factors such as lighting and movement. Visuals within 100 meters are referred to as the 'social field of vision', meaning that it is possible to identify a person's characteristics and the activity they are doing. For this paper, Visual Proximity (VP) will be defined the same as in the paper by Stojanovski (2020); it will refer to the area within the viewshed that falls within the social field of vision and can be properly perceived by an individual as per the condition of Gehl (2011).

The degree of VP is directly related to the levels of Prospect/Refuge. In areas where the observer has a high level of visual acuity over his surroundings and thus high VP, the level of prospect will be higher. The inverse of this relationship is true for refuge, where areas with a high level of VP provide lesser feelings of shelter than when out of sight. This interplay between prospect and refuge poses a scale where they are placed at opposite ends; areas that feature high prospect have low refuge, and vice versa. Following the theory of Appleton (1996), it can be said that individuals will feel more at ease if they find themselves in an area that has a balance of Prospect/Refuge. This is further corroborated by Herzog and Kutzli (2002). The concept of natural surveillance is closely related to prospect, as increased levels of NS are the result of people using public space and experiencing high levels of VP over their surroundings thus providing oversight. Furthermore, higher levels of prospect are conducive to enhancing feelings of perceived security (Schroeder & Anderson, 1984) in the same way as NS. Inversely, refuge can be linked to lower levels of NS. For the purposes of this study, VP will serve as a stand-in for NS due to their similarities.

2.2 Fear of Crime and Perception of Safety

Much like how the same physical environment can induce different feelings in different onlookers, fear follows the same pattern. Fear is defined by Garofalo (1981) as 'an emotional reaction characterized by a sense of danger and anxiety' (p. 840). Furthermore, Garofalo distinguishes Fear of Crime (FoC) into the two categories of property theft and physical crime. Although the two can be linked (e.g., burglary, where violent theft of a valuable can lead to physical danger), the fear of property theft can be thought of as more considerate whereas fear of physical danger is an autonomic response to a cue in the environment. For the purposes of this paper, FoC will be restricted to only the fear of physical harm, as this type of fear is more relevant to walking behaviour.

Garofalo (1981) furthermore differentiates between actual and anticipated fear. Actual fear of crime is triggered by an occurrence in one's environment (or "to be set off" by something). Anticipated fear is different in that it refers to the expectation of being fearful in an environment. As an example, Garofalo states:

> "[...] it is obvious that the person walking alone in a high crime area at night is experiencing something quite different than the suburbanite who is telling an interviewer that he or she would be fearful in such an area at night" (1981, p. 841).

It is important to note that these two types of fears, while different, are still interrelated; if a person has experienced FoC in the past, they will likely anticipate that they will experience FoC in the future, which in turn will cause the person to be more likely to experience FoC in analogous circumstances. This is further corroborated by Mesch (2000) indicating that those with prior crime experiences become more sensitive to experiencing crime-related fear.

Relevant to one's FoC is also their Position in Social Space (PSS) (Garofalo, 1981). A person's PSS dictates in what way they operate within a certain socioeconomic structure. One part of PSS is lifestyle; daily routines, vocational activities, and the like. But PSS also has a temporal aspect, including a person's past experiences and future prospects. It would make sense to say that demographics play a large part in PSS, as many of the factors within demographics such as income, employment, marriage etc. are both results of, and influences in, PSS. The model for FoC as made by Garofalo (Figure 2) shows PSS as a starting point, mentioning that it is a major influence in how FoC eventuates due to its effects cascading down the model. For the purposes of this paper, the concept of PSS will be simplified where only the demographic aspect will be taken into account, since the full scope of PSS would be difficult to describe and analyse with the given time and resources.

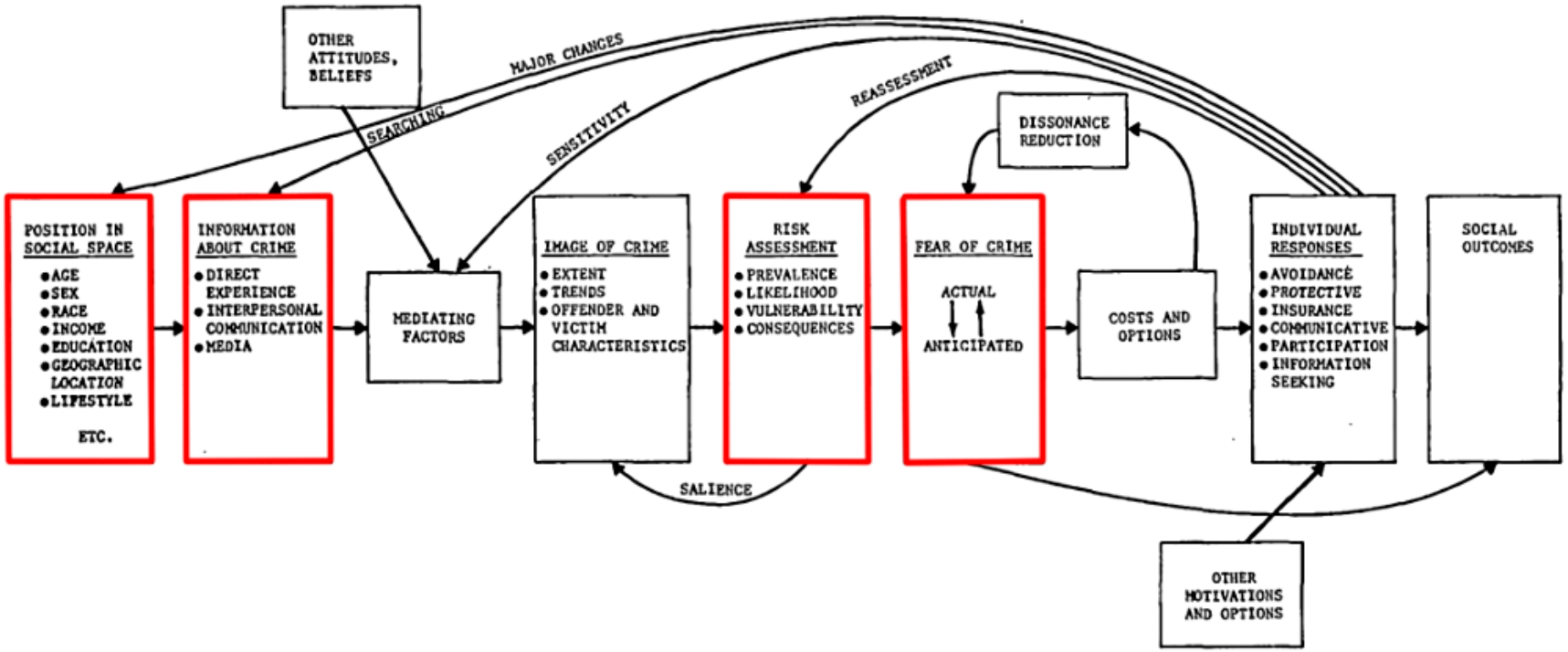

Figure 2: Garofalo's model for Fear of Crime (1981) (emphasis added by the author). The boxes marked in red indicate the aspects of Garofalo's model that were implemented into this thesis. Information About Crime suggests that past personal experiences with crime, or communicated experiences have an effect in future perceptions of crime. Risk Assessment is where the spatial quality relevant to this thesis comes into play; depending on the affordances experienced within an area, it might be conducive or unfavourable to the level of FoC experienced.

2.3 Fear of Crime, the Built Environment and Walking Behaviour

To research the effect of the perception of the built environment on FoC, it is important to take into account the various variables that may affect FoC. Important factors include demographics, street lighting, amount of traffic an area gets, etc. However, this might prove to be a difficult task, as multiple literary reviews (Nair, Ditton, & Phillips, 1993; Welsh & Farrington, 2008; Farrington & Welsh, 2002) have indicated that there have been difficulties in establishing the effect of e.g., improved street lighting on reducing crime. Nair et al. (1993) tell that although it would make sense that improvements in street lighting would cause a reduction in crime, their effects cannot be guaranteed. Moreover, Nair et al. explain that taking measures to decrease the risk of crime (or 'target hardening') might have the adverse effect contributing to the FoC. This underlines the difficulty to study and the subjectivity of FoC, where taken measures do not always lead to the expected results.

The link between FoC and walking behaviour has been discussed in various papers (Mason, Kearns, & Livingston, 2013; Loukaitou-Sideiris, 2006). Mason et al. found that antisocial behaviors such as burglary and feeling of safety were associated with less and more frequent walking respectively. Loukaitou-Sideris furthermore concluded that the link between perceived safety and physical activity can at times either be strong or ambiguous. She attributes this to methodological inconsistencies between studies (e.g., different variables; crime statistics instead of the perception of safety), and the differing demographic characteristics of those studied. Loukaitou-Sideris notes though, that "regardless if perceptions are accurate, they have the power to affect individual actions and motivations [...] (2006, p. 220)", meaning that an 'incorrect' FoC will still affect walking decisions.

2.4 Conceptual Model

The conceptual model (Figure 3) will serve as a basis through which to understand the variables involved within FoC and per extent the walking behaviour. The characteristics of the built environment and more specifically their VP's will serve as the independent variable for the study. The other explaining variables that are accounted for are summarized under PSS.

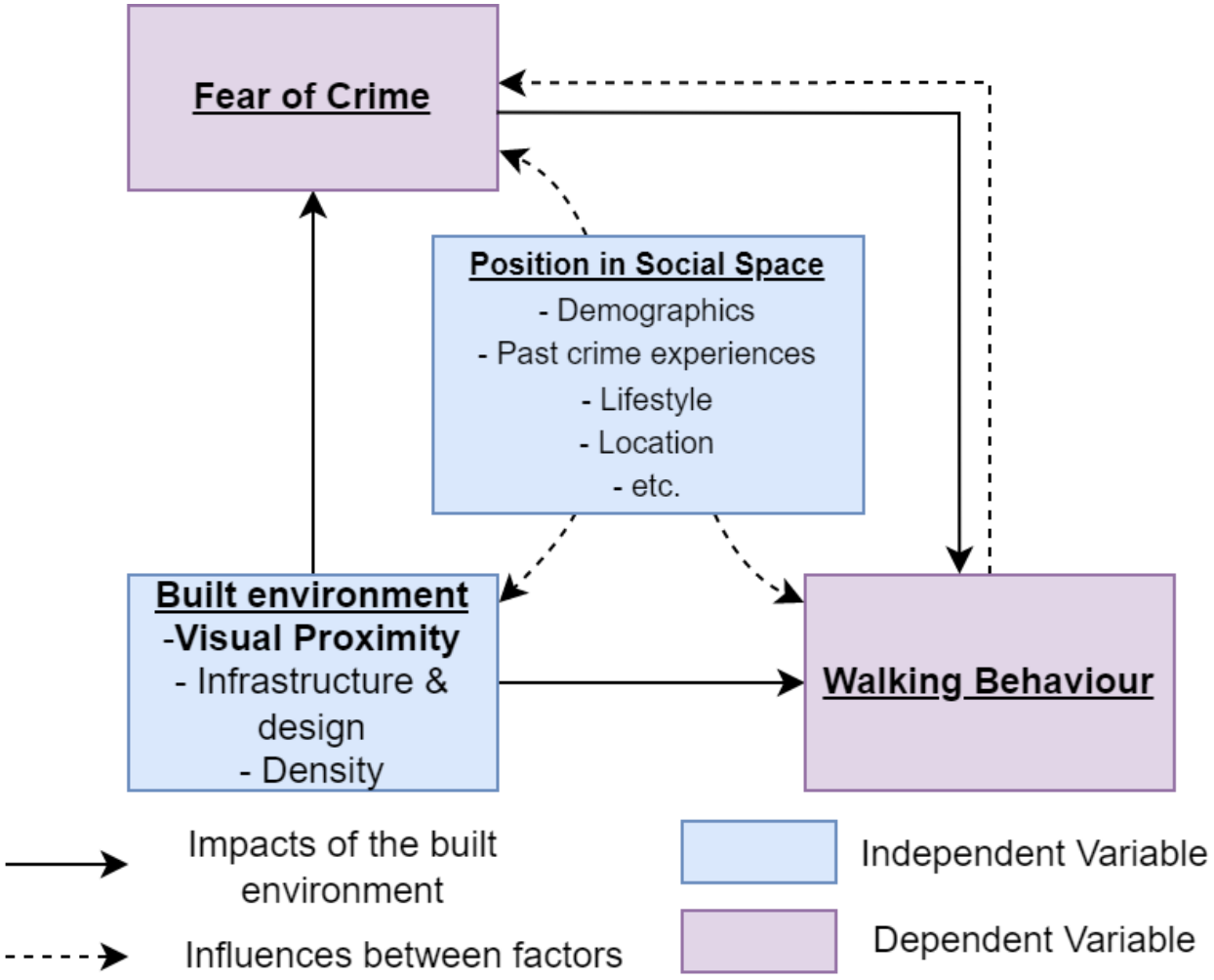

Figure 3: Conceptual model showcasing the relations between the built environment, walking behaviour and the fear of crime. Note how the built environment has two ways of impact on walking behaviour; one directly, and one by having an influence on fear of crime.

2.5 Hypothesis

Within this research, it is hypothesized that areas that are balanced in the level of Prospect/Refuge are conducive in decreasing the levels of FoC. Furthermore, it is expected that transitioning from an area where Prospect/Refuge is balanced to one where it is skewed towards refuge may cause FoC. As such, areas in which viewsheds are broken up due to e.g. street typology are hypothesized to lead to FoC. Since FoC has the ability to negatively influence walking behaviour, it is expected that areas causing FoC as per the above mentioned processes facilitate walking to a lower degree.

3 Research Methodology

The purpose of this research is twofold:

- To analyze the extent of the effect the perception of the built environment on the perception of safety from crime and its effect on walking behaviour
- To verify whether or not the created VP models have value in predicting FoC.

The research takes a mixed-method approach: firstly, a map modeling VP has been created of the two chosen areas of study. Secondly, through the survey program Qualtrics, data was collected regarding a variety of variables. These variables include questions revolving around the respondent's PSS and their perception of the environment, as well as their walking behaviour in their neighborhood. Finally, the survey contained a question where respondents are asked to indicate on the map where in their neighborhood they have felt unsafe. The results from this question were then used to compare with the constructed VP model.

3.1 Case Selection

For this research project, the decision was made to choose two areas local to the author in the city of Groningen, namely the neighborhood of DH/VS, and the neighborhood of Beijum. These areas were chosen due to their differing urban morphologies (Figure 4). DH/VS is characterized by its very linear road network, whereas Beijum is a typical 'cauliflower' neighborhood; the streets generally only have one access road and the many bends and turns facilitate lower traffic speeds, making it more attractive for pedestrians. However, these bends and turns lead to decreases in VP and therefore will affect the extent of NS. Additionally, compared to DH/VS, Beijum has more greenery that may obstruct vision, leading to the same result.

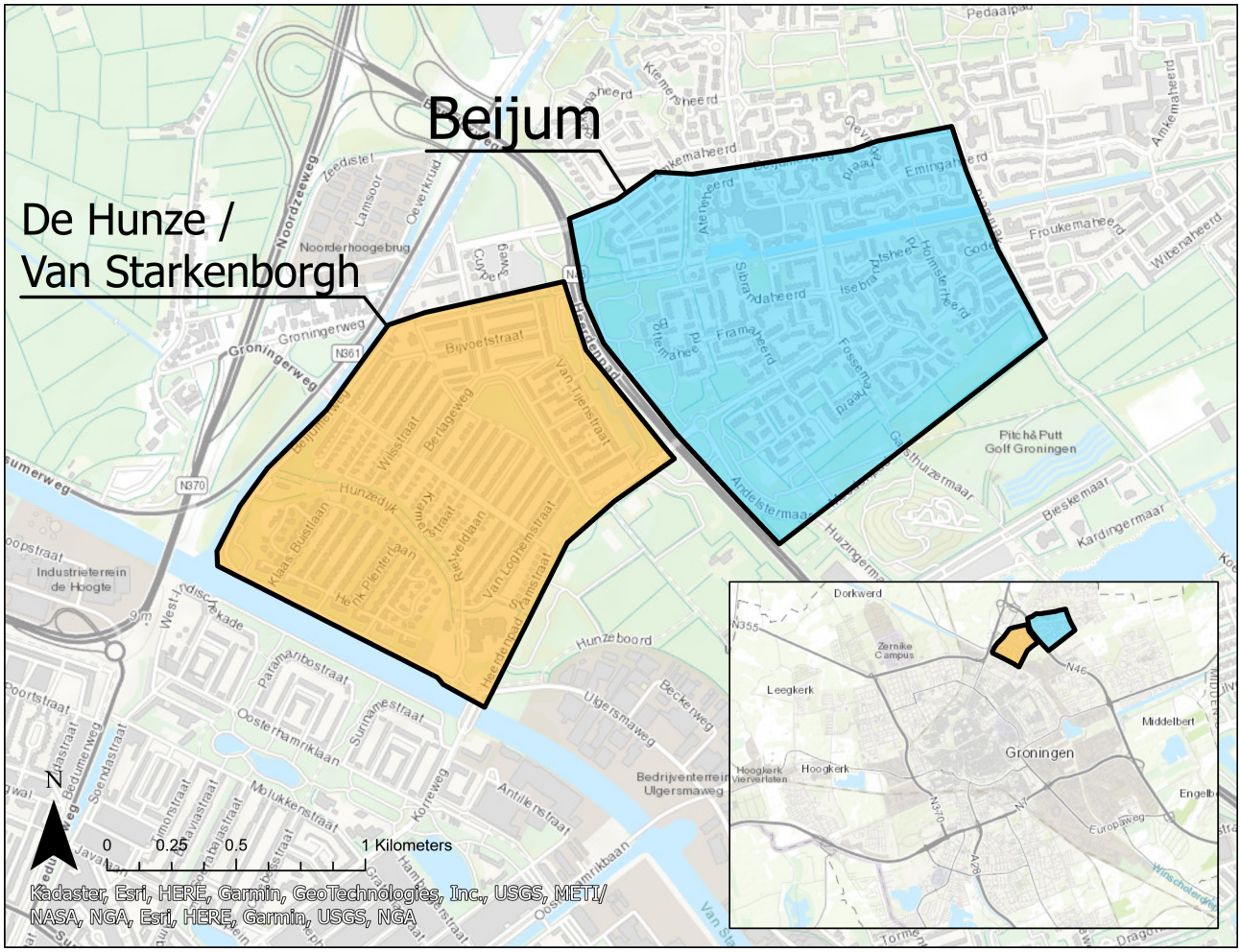

Figure 4: Map indicating the neighborhoods of Beijum and De Hunze / Van Starkenborgh relative to the city of Groningen.

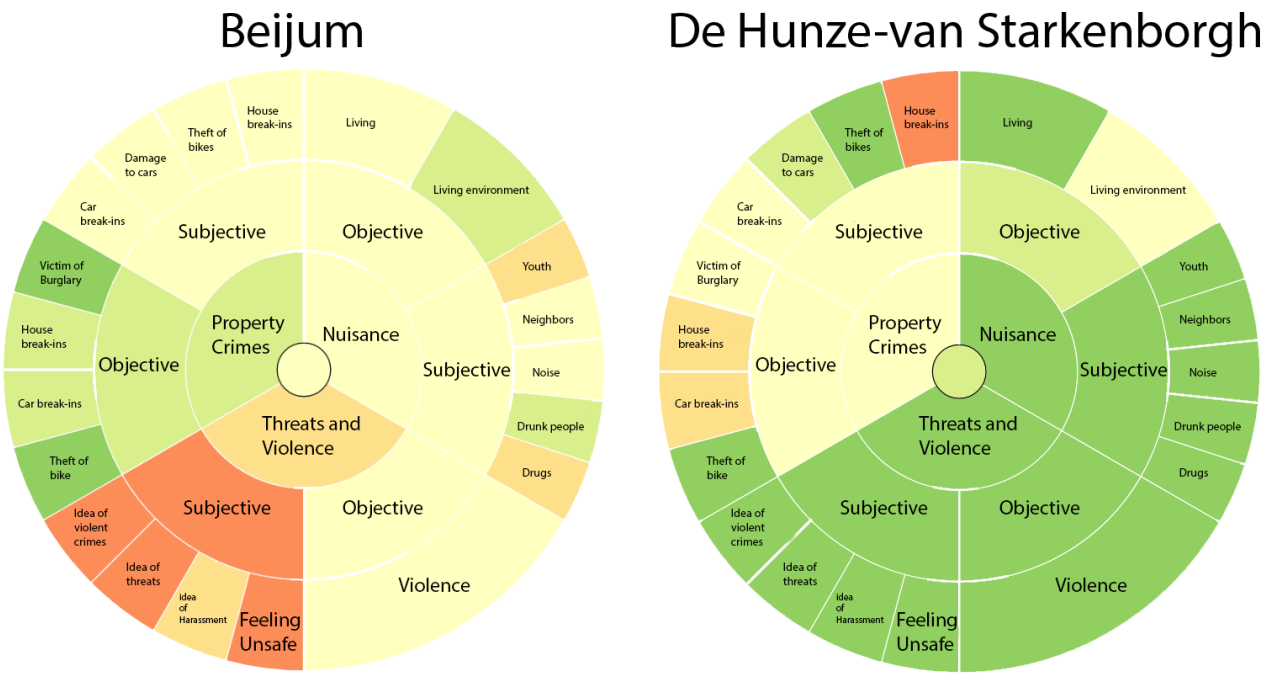

Figure 5: Diagram indicating the results from the yearly livability survey performed by the municipality of Groningen (2020). (Translated to English by the author)

3.2 Survey Strategy

In order to ensure that a proper level of respondents could be achieved, the following strategies were utilized:

- Flyers with a link to the survey environment were distributed through mail-slots within the areas of study.
- Two posts were made on the respective area's neighborhood Facebook page advertising the need for respondents.
- Respondents who completed the survey were offered the opportunity to participate in a raffle where they would have the chance to win one of three €25 gift cards.

3.3 Research Ethics

Within this research project, various ethical considerations have been made due to the nature of the data gathered, and the possible ramifications of the conclusions. Firstly, since the two case study areas are quite small, the ensurance of confidentiality is important. The questionnaire was set up in a way that left no personally identifiable information within the results to ensure that the research will not have negative social implications. Secondly, there is a potential for conclusions drawn about the neighborhoods and their demographics to be potentially hurtful. This requires special attention to ensure that spatial and social justice can be attained. There is no requirement for the surveys to not be non-transparent, since the author considers the risk of priming on the quality of the data to be minimal. Respondents were made aware that they are always welcome to withdraw their consent from participating within the project and are allowed to ask questions about the research and its purposes at any time. The respondents were furthermore informed that the gathered data would be deleted at the end of the project (July 8th).

The author, although living in close proximity to the two areas of study, has no personal connection to either of them. The author is aware of the prejudice that Beijum is considered to be more 'criminal' compared to the rest of Groningen. As such, the objectivity of the author can be put into question. To ensure that the study remains objective, the author has attempted to maintain neutrality by making sure that the method of surveying and GIS analysis remains consistent between the two areas of study, as well as by maintaining an outsider's perspective.

3.4 Survey Instrument

The survey (Figure A.1) has been constructed to gather data within four categories similar to the paper by Hong and Chen (2014). These categories include *Demographics* (or PSS), *Built Environment*, *Perception of Crime* and *Walking Behaviour*. In order to ensure that the respondents live within either of the two areas of study, they are provided with the image of a map. Respondents are then asked to indicate whether or not they live within the boundaries as indicated. This will ensure that the data collected is relevant to the study.

The questions collecting data regarding PSS have been constructed through a combination of basic demographic questions such as age, gender, income etc., as well as through adaptation/translation of the Pedestrian and Bicycling Survey (PABS) (2010). The purpose of the questions from PABS within this research is to see to what extent individuals already have the disposition to walk. Firstly, PABS was chosen due to its use within the paper by Hong and Chen (2014) which will allow for a comparison of results between papers. Secondly, the questions within the PABS have been validated by the test-retest method, scoring highly on reliability (Forsyth et al, 2012). Respondents were asked how many times in the past 7 days they walked for four different purposes. In order to operationalize walking behaviour for statistical analysis, the answers to these four questions were summed into the variable *Walking days*.

Furthermore, two questions (*Self-Selection* category in A.1) were asked explicitly to measure the attitude towards walking and its importance towards the respondent. One indicates whether the respondent prefers to walk instead of drive, and the other shows whether or not local walkability is considered important for deciding where the respondent lives. These questions aim to control for the effect of residential self-selection. In order to gain insight into respondent's perceptions of the built environment and their attitudes towards it, several questions are used from Hong and Chen (2014) who have adapted them from the Neighborhood Environment Walkability Scale (*Built Environment* category in A.1). These questions were selected if the test-retest method employed on them returned an intra-class coefficient higher than 0.59 (which is the degree to which one respondent answers the same when asked at different points in time) in the paper by Brownson et al. (2004). The questions are measured on a 5-point Likert scale ranging from 'Strongly Disagree' to 'Strongly agree'.

Finally, respondents were asked questions relating to the perception of safety while walking (*Crime Safety* and *Past Victimization* categories in A.1). Questions included are whether or not the respondent has ever felt unsafe whilst walking in their neighborhood, whether they in the past have been victim of crime, whether they know someone who has been a victim of crime within their neighborhood and whether the respondent feels that either question relating to criminality has an effect on their current feeling of safety. They were also asked how often they feel unsafe. These questions relate to the variable of PSS and seek to explain whether or not any past experiences of crime cause any difference to one's perception of safety. The question of whether or not the respondent has decided not to walk out of fear of crime was also asked. Respondents were also asked to indicate where on the map in their neighborhood they have felt unsafe.

3.5 Regression Model Setup

For the analysis on the relationship between walking behaviour, perception of crime and the built environment, a two-stage linear regression was performed through SPSS. Prior to running the analysis, the questions and statements used in the survey were grouped in categories (refer to Table A.1 for an overview). For the variable of *Built Environment*, the means were calculated for each appropriate category. For the variable of *Fear of Crime*, the same was done with the category *Crime Safety*.

For the first stage, the category *Crime Safety* was entered as a dependent variable, with the demographic, self-selection, built environment and past-victimization variables entered as independent variables. For later use in the second stage as an independent variable, the standardized expected value of *Crime Safety* was saved. Since the *Built Environment* variable is calculated into the expected value of *Crime Safety*, the indirect influence of *Built Environment* on *Walking Behaviour* through *Fear*

of Crime will be taken into account by the model (as indicated in Figure 3). For the second stage, the square root of the total *Walking Days* was entered as the dependent variable, with the categories of *Crime Safety*, *Self-Selection*, *Built Environment* and *Past-Victimization* entered as independent variables. The square root transformation of *Walking Days* was performed in order to ensure that the variable would not violate the assumption of normality for linear regression.

3.6 GIS Instrument

In order to generate a model that yield a map indicating VP, the decision was made to use a program named depthMapX, created by Alasdair Turner and further developed by Tasos Varoudis. (UCL Space Syntax, 2022). This was done since the original program used by Desyllas et al. (2003) is not available as of writing.

It should be noted that the depthMapX software has some limitations. Firstly, it is impossible within the map to mark certain features as inaccessible, but visually permeable such as bodies of water. Furthermore, this limitation denies the opportunity to only analyze VP from a pedestrian point of view on the sidewalk, instead having to include the middle of the street as well. This would result in a model that is not entirely accurate to a real-life scenario. Secondly, another limitation is that whilst the software Desyllas et al. (2003) used was also able to take into account the NS provided by windows from nearby buildings, such a method is unavailable for DepthMapX.

The Dutch government through PDOK makes various GIS datasets available for use. Among these is the Large-scale Topography Register (BGT) (2022), a dataset that contains the locations of all physical objects such as roads, sidewalks etc. By utilizing the BGT dataset, an AutoCAD file was created that indicates the publicly walkable space. An overview of the steps taken to create this export is available in Figure B.1 in the appendix.

The resulting map generated by depthMapX is then compared with the data gathered by the survey, to see whether or not there is an overlap between where people feel unsafe and where there is lesser degrees of visual proximity. Within depthMapX, two specific types of visibility graph analyses are relevant to the study, namely the methods of ”Calculate isovist properties” and ”connectivity”. These methods are directly linked to the prospect-refuge theory of Appleton, where ”isovist properties” indicate the degree of prospect and ”connectivity” the degree of refuge (Koutsolampros, Sailer, Varoudis, & Haslem, 2019). Processing the generated model in Photoshop by overlaying the maps and averaging the colors results in a map by which the balances and transitions of Prospect/Refuge can be identified.

4 Results of Survey & Regression Model

4.1 Respondent Descriptives

Table A.2 shows a summary of the responses gathered by the survey. After filtering out responses from those under the age of 18, those outside of the study area and the uncompleted surveys, the total respondence is 237, of which 146 come from the neighborhood of DH/VS and 91 from the neighborhood of Beijum. The sample includes a higher percentage of women rather than men, and consists predominantly of those without a migratory background. The household size on average is 2.70 and seems to be relatively the same over both areas of study. The average income is higher in DH/VS than in Beijum, and the same can be said to a lesser extent for the level of education and the length respondents have lived within their neighborhood.

Table A.2 also indicates the responses relating to the variables of the study. On average, the total number of walking days over both areas equals around 6.25, where people from Beijum tend to walk 1.59 more days than those from DH/VS. This could be related to the fact that respondents from DH/VS indicated that there are relatively less shops in walking distance than in Beijum. The self-selection variables are around similar between both areas. Where both areas differ though, is the perception of crime; on the statements "There is a high crime rate in my neighborhood" and "Crime in my neighbourhood makes it unsafe to walk in the evening/at night", Beijum agrees more than DH/VS. Conversely, DH/VS has a higher past-victimization rate as well as knowing of victims. This contradiction is in line with the municipality's liveability survey (2020) as shown in Figure 5 , which indicates that the subjective safety of Beijum is low but the actual safety is relatively higher, with the opposite ringing true for DH/VS.

4.2 Regression Model Results

The results of the two-stage linear regression can be found in Table A.3. For stage 1, the table indicates whether it can be confirmed and to what extent the *Demographics*, the *Built Environment*, *Past Victimization* and *Self-Selection* variables have an effect on *Crime Safety*. The value for R^2 is equal to .398, meaning that the independent variables in the model are able to explain around 40% of the variance found within *Crime Safety*. For stage 2 on *Walking Days*, the value for R^2 equals .218, meaning that the independent variables in the model for *Walking Days* have less explanatory value for the variance in the dependent variable than in the model for *Crime Safety*.

4.2.1 To what Extent does the Perception of the Built Environment affect Fear of Crime?

For the variable of *Crime Safety*, a total of six categories were found to be significant by the regression model (Table 1). Three categories within the variable *Built Environment* have an effect on the perception of crime. Respondents who perceive the *Street Infrastructure* in their neighborhood to be well maintained, generally feel safer than those who do not. The *Built Environment* category with the highest negative relation to FoC is *Street Design*. This means that in the areas of study where the respondents find that there is enough light supply and enough alternative routes to the same destination, the amount of FoC is decreased. It follows from the fact that well-lit environments generally increase the amount prospect over an area, meaning that people will feel safer. Likewise, having alternative routes available gives people the option to avoid areas they deem to be unsafe. Finally, there is a positive association with FoC in the areas of study where it is found unpleasant to walk due to high amounts of traffic.

Stage 1: Crime Safety	Belongs to Variable	Beta	Result
Walkable Living Choice	Self-Selection	.206	Increase of FoC
Traffic	Built Environment	.186	Increase of FoC
Past Victimization	Crime Safety	.157	Increase of FoC
Street Infrastructure	Built Environment	-.182	Decrease of FoC
Age	Demographics	-.187	Decrease of FoC
Street Design	Built Environment	-.235	Decrease of FoC

Table 1: Overview of significant categories for Stage 1: *Crime Safety*, ranked by the relative strength of their effect.

4.2.2 To What Extent do the Fear of Crime and the Built Environment affect Walking Behaviour?

For *Walking Behaviour*, a total of three categories were found to be significant (Table 2). Within the variable of *Built Environment*, only *Accessibility* was found to be significant. Respondents who found that shops and other places are within walking distance from their homes, and that it is easy to walk from home to public transit, find an increase in the amount of walking days. However, the associated category *Accessibility* was found to have the weakest influence of the three categories that tested significant. The category with the highest influence on the amount of days walked is the self-selection variable of *Prefer Walking*, meaning that personal preference towards walking is relatively a stronger influence than *Accessibility*.

The variable of *Crime Safety* was not found to be significant for *Walking Days*, meaning that the model cannot confirm the notion that FoC has an impact, whether that be positive or negative, on the amount of days people walk. The only overlapping significant variable found between stages 1 and 2 is that of *Past Victimization*, of which the Beta coefficients are roughly similar. This could indicate that people who walk more have a higher victimization rate. This makes sense, considering that those who walk more frequently have a higher chance of personal interaction than those who do not, increasing the risk of a negative interaction.

Stage 2: Walking Days	Belongs To Variable	Beta	Result
Prefer Walking	Self-Selection	.285	Increase in Walking Days
Past Victimization	Crime Safety	.164	Increase in Walking Days
Accessibility	Built Environment	.145	Increase in Walking Days

Table 2: Overview of significant categories for Stage 2: *Walking Days*, ranked by the relative strength of their effect.

4.3 Visual Proximity Model Results

The generated models for the proximity model are available in figure 6 and figure 7. In figure 6, it can be seen that the network typology of DH/VS generally results in higher levels of Prospect/Refuge than in Beijum in figure 7. This can be related to the fact that DH/VS generally has longer sightlines, therefore resulting in a higher level of prospect especially when compared to Beijum, whose bending streets as typical for a ”Cauliflower neighborhood” lead to generally lower levels of prospect. These low levels of prospect tend to only be within the residential parts of Beijum among access roads; the distributor road that divides Beijum seems to get a good average of Prospect/Refuge.

4.3.1 To what degree is there an overlap between the constructed Visual Proximity Model and the inhabitant's perception of safety within their neighborhood?

Figure 8 and 9 combine the proximity model together with the survey results on where people have indicated they have felt unsafe in the past. As can be seen in Figure 8 for DH/VS, the amount of locations where people have felt unsafe seems to be more skewed towards locations where there is an imbalance of Prospect/Refuge. For Beijum in Figure 9, this trend is more clear to see, with the vast majority of unsafely indicated locations occurring in locations with a poor balance of Prospect/Refuge.

For DH/VS, the majority of locations where respondents have indicated they have felt unsafe can be found in the south western part of the neighborhood, and among the bike path connecting the rest of the city to the neighborhood of Beijum. For the most part, respondent-indicated-unsafe locations tend to be mostly found in areas with a biased balance of Prospect/Refuge. For Beijum, it can be immediately noticed that a vast majority of the respondent-indicated-unsafe locations are found towards the top of the map. In general though, the same can be said here that the vast majority of unsafely indicated locations tend to be in places where the level of Prospect/Refuge is unbalanced. An overview of a few locations of interest, combined with images, descriptions and takeaways, can be found in Appendix A.4 and A.5 for DH/VS and Beijum respectively.

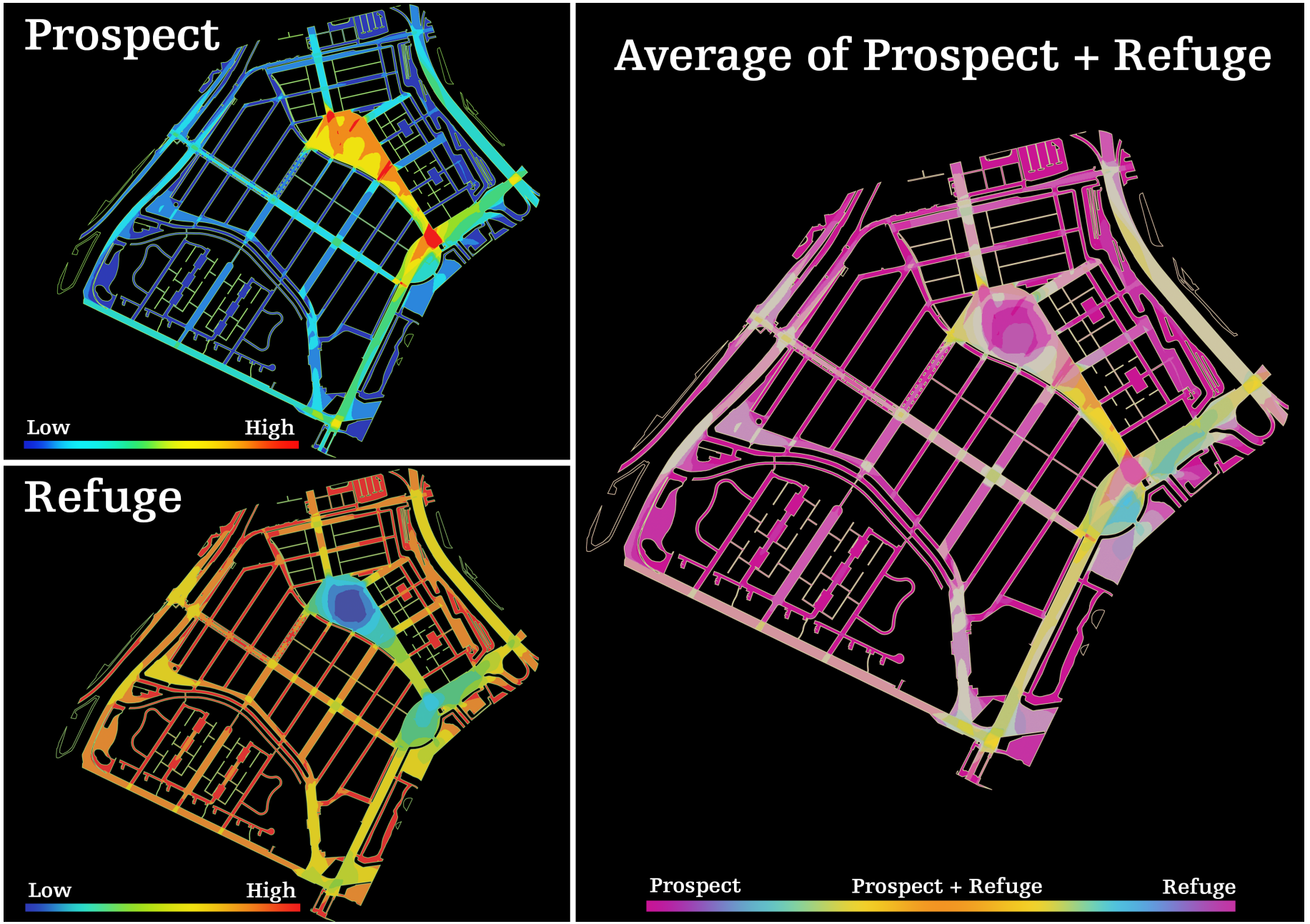

Figure 6: Prospect/Refuge model for the neighborhood of De Hunze / Van Starkenborgh

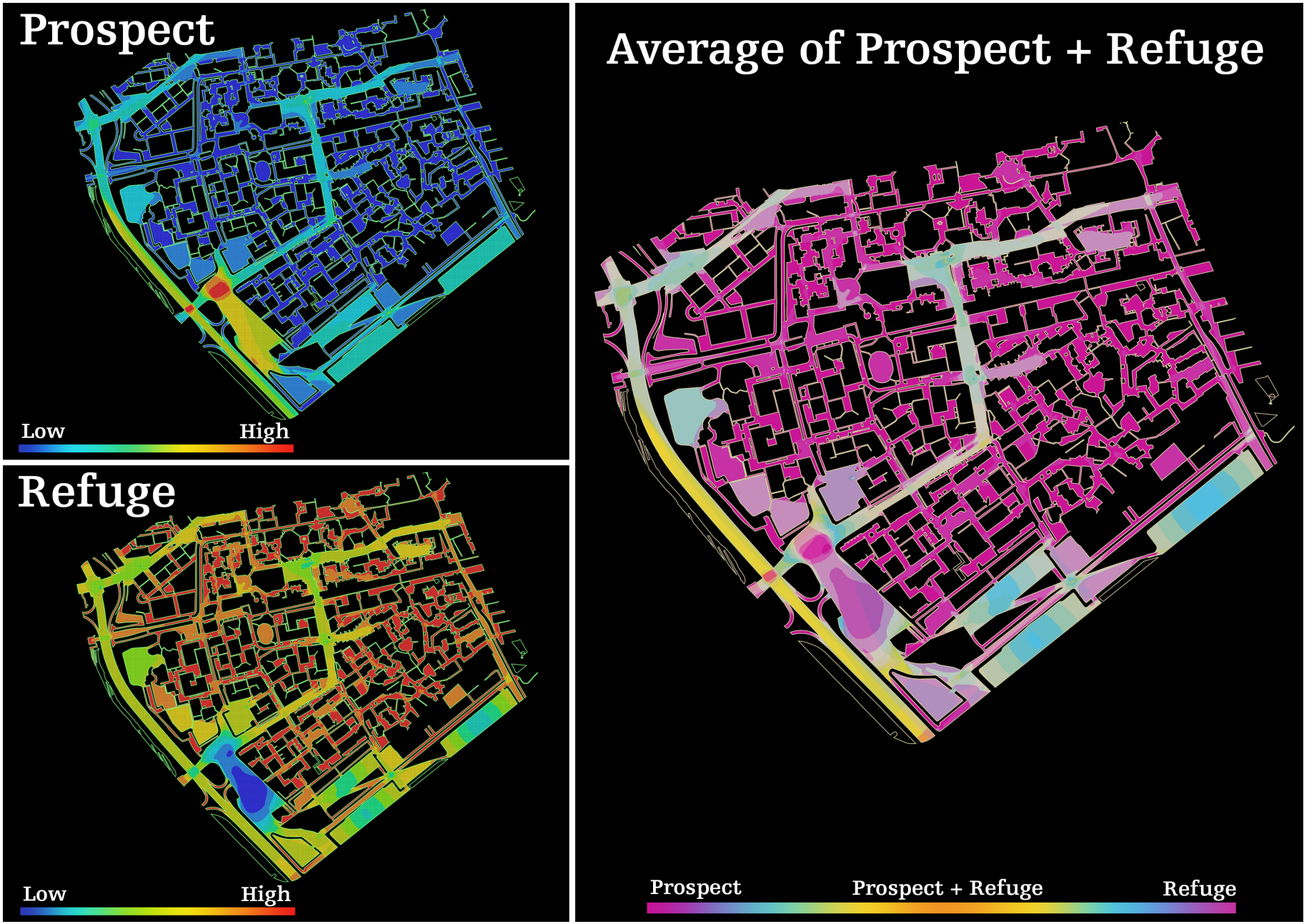

Figure 7: Prospect/Refuge model for the neighborhood of Beijum.

Figure 8: Prospect/Refuge map for De Hunze / Van Starkenborgh with added indications of where survey respondents have felt unsafe. See Table A.4 for an overview of pictures and descriptions of points of interest.

Figure 9: Prospect/Refuge map for Beijum with added indications of where survey respondents have felt unsafe. See Table A.5 for an overview of pictures and descriptions of points of interest.

5 Discussion & Conclusion

The results of the regression model suggest that there is a link between the perception of the built environment, fear of crime and walking behaviour, albeit not in the same ways as in the paper by Hong and Chen (2014). For the first stage of the regression model, FoC was found to have a negative relationship to the *Built Environment* categories of *Street Infrastructure* and *Street Design*, meaning that those who have positive perceptions towards the maintenance of street infrastructure such as sidewalks and towards the design of the street experience less FoC. This is further corroborated by Foster, Giles-Corti, and Knuiman (2010), who indicate that walkable neighborhoods have an effect in decreasing FoC. The positive relationship between FoC and *Traffic* indicates that those who perceive their amount of car traffic in their neighborhood negatively find an increase in FoC. A possible explanation for this could be that those who have a negative association with cars might be more neurotic in personality, which is associated with a negative affect (Costa & McCrae, 1980) and furthermore a higher level of FoC (Guedes, Domingos, & Cardoso, 2018). Age was found to be negatively associated with FoC; a possible reason for this could be that the decreased levels of activity which come with older age cause the perception of risk to drop (Tulloch, 2000). Finally, *Past Victimization* was found to increase FoC, which follows from the model for FoC posed by Garofalo (1981).

For stage two of the model where *Walking Behaviour* was analyzed, it was found that FoC does not have a significant effect on the amount of days walked among the respondents, contrary to Hong and Chen (2014). There could be multiple possible reasons for this. One, this study has not made use of *Density* as a variable relating to the built environment as opposed to Hong and Chen due to an oversight during the creation of the survey. Due to the way regression models work, the exclusion of *Density* may cause the model to over or underestimate the effects and significance of other variables. Considering that for Hong and Chen's paper *Density* was found to be significant in both cases, it is possible that the impact of not including this within the model has far-reaching effects. Two, it is likely that there are other confounding variables in play that were not used in the regression model, leading to lower levels of explained variance for both models. As Loukaitou-Sideiris (2006) pointed out, methodological inconsistencies between studies make it difficult to properly estimate the effect and extent of FoC. Due to the difficult nature of explaining and predicting behaviour, this is unfortunately difficult to avoid. Further inclusions of objective measures of the built environment (also beyond density) could give future research better methodological tools to address this issue properly.

First Stage (Fear of Crime)				Second Stage (Walking Behaviour)			
Hong Chen (2014)		This Thesis		Hong Chen (2014)		This Thesis	
Category	Belonging to	Category	Belonging to	Category	Belonging to	Category	Belonging to
Gender (Male)	Demographics	Age	Demographics	No. of Vehicles	Demographics	Accessibility	Built Environment
Accessibility	Built Environment	Street Infra	Built Environment	Density	Built Environment	Prefer Walking	Self-Selection
Street Design	Built Environment	Street Design	Built Environment	Prefer Walking	Self-Selection	Past Victimization	Crime
Sidewalks	Built Environment	Traffic	Built Environment	Walkable Living Choice	Self-Selection		
Density	Built Environment	Walkable Living Choice	Built Environment	FoC (Stage 1)	Crime		
		Past Victimization	Crime				

Table 3: Overview of the differences in significant categories between the paper by Hong & Chen (2014) and this thesis.

With this study employing correlational methods, it is important to note that the regression model merely indicates relationships between the dependent and independent variables and their strength. It is not able to indicate cause-and-effect, and the results of the model should rather point towards future in-depth study of the variables in play. Furthermore, a lack of significant correlation does not mean that there is no relationship, as the relationship can be non-linear.

This paper also explored the use of Visual Proximity modelling in predicting FoC. In general, it seems that most of the respondent-indicated-unsafe locations lie in areas where the balance of prospect and refuge is skewed. Furthermore, some indicated locations lie on the transition between balanced and unbalanced Prospect/Refuge, which as mentioned in the hypothesis was expected to cause FoC. The model has a few outliers that are located in areas with a balanced Prospect/Refuge; a possible explanation for these outliers is that due to the subjective nature of finding affordances, different people with a different position in social space will have their own experience of FoC. Another explanation for these outliers is that some respondents may have misunderstood the survey, due to the ambiguity of the question of ”where they have felt unsafe”. An example of this can be seen in the north-west cluster of unsafely indicated locations in Figure 9; considering that there are no sidewalks here, it is likely that respondents thought of traffic safety instead. This highlights one of the weaknesses of the study, where the phrasing of certain questions used in the survey can be interpreted differently than meant. It should also be mentioned that the use of VP as a stand-in for NS does not entirely capture one of the key properties of NS, where the amount of people using public space is important for the provision of surveillance. This is not necessarily an issue, so long as it is realised that the constructed model is purely indicative of the effects of the arrangement of the built environment. Another caveat of the created model, is that it is not always representative of actual walkable public space. Furthermore, depending on neighborhood morphology, the model will over or under represent levels of prospect or refuge in some areas. However, both of these issues should be remediable by using proper input geometry and careful configuration of depthMapX.

5.1 Conclusion

This paper has taken a look into the effect of the perception of the built environment and fear of crime on walking behaviour, and whether or not modelling VP can be effective as a predictor of fear of crime. By spreading a survey and employing a two-stage linear regression, it was found that the built environment has a effect on Fear of Crime through the categories of *Traffic*, *Street Infra*, and *Street Design*. These categories combined indicate that policies driven to improve pedestrian facilities can pedestrian facilities can have an effect in lowering FoC. *Walking Behaviour* was not found to be significantly linked with FoC, as opposed to prior studies, but the *Built Environment* category of *Accessibility* was, meaning that providing ease of pedestrian access towards various destinations such as shops can help facilitate walking. The differences in results between this study and the study the employed survey was based on, emphasize the implication that behaviour is difficult to predict, and gives rise to the need for a more standardized methodology by which to tackle the subjective nature of the studied topics.

The created Prospect/Refuge model shows some merit in its ability to predict FoC. However, its effectiveness should be put further to the test in different cases to verify its usefulness. Applying the Prospect/Refuge model together with survey results on unsafely indicated locations to different neighborhoods could help further development and understanding of the applicability of the model.

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Appendices

A Tables

Category	Question / Statement	Coded as	Possible Answers
	Walking Behaviour		
Walking Days	How many days a week do you walk to or from public transit? (e.g. bus stop or train station)	Q4.4	0-7 (Ratio)
	How many days a week do you walk to work or to school?	Q4.5	0-7 (Ratio)
	How many days a week do you walk to shop, visit someone, eat somewhere etc.?	Q4.6	0-7 (Ratio)
	How many days a week do you go for recreational or sporting walks (without a destination)?	Q4.7	0-7 (Ratio)
Self-Selection	I prefer to walk rather than drive whenever possible	Q4.9_1	Strongly Agree / Strongly Disagree (5-point Likert)
	The ease with which I can reach places on foot is important in my choice of where to live	Q4.9_2	
	Perception of Crime		
Crime Safety	There is a high crime rate in my neighborhood.	Q5.1_1	Strongly Agree / Strongly Disagree (5-point Likert)
	Crime in my neighbourhood makes it unsafe to walk in the evening/at night.	Q5.1_2	
Past Victimization	Have you been a victim of crime in the past?	Q6.6	Yes/No
	Do you know anyone who has been a victim of crime in the past?	Q6.11	(Categorical)
	Built Environment		
Accessibility	The shops are within walking distance from my house.	Q5.1_5	Strongly Agree / Strongly Disagree (5-point Likert)
	There are many places within walking distance from my house to go to.	Q5.1_6	
	It is easy to walk from my house to a stop (bus, train).	Q5.1_7	
Aesthetic	My neighbourhood is generally free of litter.	Q5.1_4	Strongly Agree / Strongly Disagree (5-point Likert)
	There are attractive buildings/houses in my neighbourhood.	Q5.1_8	
Street Infra	The pavements in my neighbourhood are well maintained (few cracks, even, paved).	Q5.1_9	Strongly Agree / Strongly Disagree (5-point Likert)
	There are pavements in most streets in my neighbourhood.	Q5.1_10	
	The crossings in my neighbourhood help pedestrians feel safe when crossing busy streets.	Q5.1_11	
Street Design	There is sufficient light supply (e.g. lampposts) in my neighbourhood.	Q5.1_3	Strongly Agree / Strongly Disagree (5-point Likert)
	There are many alternative walking routes to get somewhere in my neighbourhood (I don't have to take the same road every time).	Q5.1_12	
Sidewalks	There are pavements in most streets in my neighbourhood.	Q5.1_10	Strongly Agree / Strongly Disagree (5-point Likert)
	There is a grass strip separating the streets from the pavements in my neighbourhood.	Q5.1_13	
	There are trees along the streets in my neighbourhood.	Q5.1_14	
Traffic	There is so much traffic in my neighbourhood that it is unpleasant to walk there.	Q5.1_15	Strongly Agree / Strongly Disagree (5-point Likert)

Table A.1: Overview of the questions relating to Walking Behaviour, Perception of Crime and the Built Environment

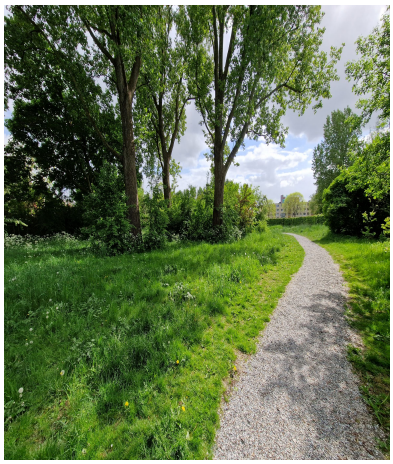
	Both areas (n = 237)				De Hunze / Van Starkenborgh (n = 146)				Beijum (n = 91)			
	Min	Max	Mean	Std. Dev	Min	Max	Mean	Std. Dev	Min	Max	Mean	Std. Dev
Socio-Demographics												
Age	2	7	4.91	1.434	2	7	5.34	1.343	2	7	4.22	1.306
Gender	1	2	1.70	.458	1	2	1.64	0.481	1	2	1.80	.401
Origins	1	5	1.06	.357	1	3	1.03	.202	1	5	1.12	.513
Household Size	1	5	2.70	1.274	1	5	2.59	1.183	1	5	2.86	1.395
Income	1	7	4.18	1.561	1	7	4.62	1.382	1	7	3.47	1.580
Highest completed education	2	6	4.86	.906	3	6	5.09	.828	2	6	4.47	.899
Length of stay at address	1	5	3.89	1.088	1	5	4.03	1.088	1	5	3.66	1.056
Walking Behaviour												
Total number of walking days	0	28	6.2489	4.316	0	28	5.6370	4.038	0	21	7.2308	4.583
Self-Selection												
Choose location with high walkability	1	5	3.09	1.075	1	5	2.94	1.002	1	5	3.33	1.146
Preference to walk	1	5	3.53	1.073	1	5	3.59	1.057	1	5	3.43	1.097
Perception of Crime												
5.1.1 High criminality	1	5	2.24	.932	1	4	1.92	.746	1	5	2.75	.973
5.1.2 Criminality in dark	1	5	2.21	1.016	1	4	1.87	.830	1	5	2.74	1.063
6.6 Past victim (dummy)	0	1	.444	.4834	0	1	.4965	.502	0	1	.363	.483
6.11 Know victim (dummy)	0	1	.654	.477	0	1	.671	.471	0	1	.626	.486
Built Environment												
5.1.3 Sufficient light supply	1	5	3.76	.880	1	5	3.94	.758	1	5	3.47	.981
5.1.4 Free from litter	1	5	3.11	1.124	1	5	3.47	1.026	1	5	2.54	1.036
5.1.5 Shops in walking distance	1	5	3.51	1.136	1	5	3.03	1.064	2	5	4.25	7.97
5.1.6 Places in walking distance	1	5	3.16	1.056	1	5	2.86	.997	1	5	3.64	.972
5.1.7 Easy walk to public transit	1	5	3.9	.985	1	5	3.74	.991	1	5	4.24	.899
5.1.8 Attractive houses	1	5	3.35	1.018	1	5	3.57	1.052	1	5	3.02	.869
5.1.9 Well-maintained sidewalk	1	5	3.22	1.040	1	5	3.38	1.013	1	5	2.6	1.032
5.1.10 Available sidewalks	1	5	3.94	.756	1	5	4.13	.608	1	5	3.64	.863
5.1.11 Safe road crossings	1	5	3.27	.941	1	5	3.27	.882	1	5	3.27	1.034
5.1.12 Alternative walking routes	1	5	3.67	.883	1	5	3.51	.911	1	5	3.92	.778
5.1.13 Separated roads with grass	1	5	2.73	1.112	1	5	2.36	1.032	1	5	3.31	.985
5.1.14 Trees next to road	1	5	3.76	.856	1	5	3.59	.913	1	5	4.02	.683
5.1.15 Unpleasant amount of traffic	1	5	2.03	.796	1	4	1.88	.697	1	5	2.27	.883

Table A.2: Descriptives of the respondents for the two areas of study. Note that most of these variables were collected on an ordinal or categorical basis, meaning that they are coded and not direct values. Please refer to Appendix A.1 for an overview of the questions and their associated codings

	Stage 1: Crime Safety (R^2 of .398)					Stage 2: Sqrt of Walking days (R^2 of .218)				
	Unstandardized Coeffs.					Unstandardized Coeffs.				
	B	Std. error	Beta	t	Sig.	B	Std. error	Beta	t	Sig.
Demographics										
Age	-.121	.041	-.187	-2.961	**.003**	-.076	.041	-.171	-1.873	.062
Gender (Male)	-.122	.108	-.062	-1.131	.259	-.173	.089	-.126	-1.949	.053
Income	-.060	.036	-.102	-1.657	.099	.000	.031	.001	.010	.992
Household Size	.003	.043	.004	.063	.949	.024	.034	.048	.695	.488
Built Environment										
Accessibility	.006	.066	.006	.095	.925	.108	.052	.145	2.094	**.037**
Aesthetics	-.101	.068	-.093	-1.478	.141	-.063	.059	-.084	-1.068	.287
Street Infrastructure	-.258	.097	-.182	-2.671	**.008**	-.166	.101	-.169	-1.638	.103
Street Design	-.335	.086	-.235	-3.891	**.001**	X	X	X	X	X
Sidewalks	.135	.099	.088	1.362	.175	.124	.081	.117	1.523	.129
Traffic	.212	.070	.186	3.012	**.003**	.049	.075	.061	.623	.531
Self-Selection										
Prefer Walking	-.090	.048	-.106	-1.847	.066	.167	.042	.285	3.969	**.001**
Walkable Living Choice	.174	.047	.206	3.664	**.001**	.055	.052	.094	1.064	.289
Crime										
Past Victimization	.286	.108	.157	2.644	**.009**	.207	.099	.164	2.099	**.037**
Knowing of Victim	-.001	.104	-.001	-.011	.991	.037	.083	.028	.448	.655
Crime Safety (Predicted)						-.145	.116	-.230	-1.245	.214

Table A.3: Two-stage regression model fitted for the Perception of Crime and for Walking Behaviour. The categories found to have tested significant are marked in bold for their respective stages. Note that the ”Street Design” category was not found to provide significant addition to R^2 by SPSS, and therefore was omitted.

Table A.4: An overview of various points of interest within De Hunze/Van Starkenborgh relating to the Visual Proximity model. For reference as to where these locations are situated, please cross-compare the numbering here to those in the map in Figure 8.

1. Near Klaas de Witpad	Description of Area	Takeaways
	This location is situated on the southwestern tip of DH/VS. It is a small park, with only a single road connecting access points on the west and south side. It is shielded from vision both due to the fact that not a lot of traffic comes by, and that a hedgerow obstructs vision from the street. There is no lighting infrastructure. As of writing, quite overgrown with greenery.	• Prospect/Refuge map seems accurate in that there is high refuge, but low prospect. • Prospect/Refuge map seems an oversimplification of real-world scenario, not capturing greenery properly.

2. Tonny van Leeuwenlaan	Description of Area	Takeaways
	This street is located within Van Starkenborgh in the south of DH/VS. Despite being marked as having a skewed balance of Prospect/Refuge, the street feels safe due to unobstructed vision, harbored by the high trees and wide street. Figure 6 indicates that the street is considered to have a low level of prospect, which does not match up with the experience of walking here. The nearby area indicated as unsafe is just out of vision, behind a couple of hedges whose morphology was apparently not captured in the BGT-dataset.	• Prospect/Refuge map might under-represent the amount of prospect in certain areas. • BGT-dataset does not seem to be entirely accurate, missing certain parts of the neighborhood leading to inaccurate representations of reality.

Table A.4: (cont.) An overview of various points of interest within De Hunze/Van Starkenborgh relating to the Visual Proximity model. For reference as to where these locations are situated, please cross-compare the numbering here to those in the map in Figure 8.

3. Ulgersmaweg/Heerdenpad	Description of Area	Takeaways
	The Heerdenpad is an important cycling road between the inner city and the neighborhoods of DH/VS and Beijum. The area sees a lot of cycling traffic, meaning that the degree of NS should always be rather high. The supposed safety here is also reflected in the generally higher balance of Prospect/Refuge. Regardless, it is a location where people have indicated they have felt unsafe. Despite the high amount of traffic flowing through here, most of it is by car, which could mean that the natural surveillance provided by them does not contribute to a higher feeling of safety.	• Prospect/Refuge map seems is not always accurate in predicting lower FoC. • High traffic of an area does not guarantee that the location feels safer.
4. Van Ravensteynpad	**Description of Area**	**Takeaways**
	This street is located within De Hunze in the center of DH/VS. One respondent has indicated that they have felt unsafe near the corner of the street and the bike path. Visibility around the corner is poor due to visual obstruction of hedges, which might have contributed to the FoC. Occurs in a location with a transition from balanced to unbalanced Prospect/Refuge, which as mentioned in the Theoretical Framework could be experienced fearfully.	• Prospect/Refuge map might under-represent the amount of prospect in certain areas. • Transition between balances of Prospect/Refuge might be an indicator of FoC.

Table A.5: An overview of various points of interest within Beijum relating to the Visual Proximity model. For reference as to where these locations are situated, please cross-compare the numbering here to those in the map in Figure 9.

1. Corner of Stoepemaheerd	Description of Area	Takeaways
	This location is situated next to the mall of Beijum. It is characterized by an imbalance of Prospect/Refuge skewed towards Refuge. Poor visibility in combination with the fact that this area undergoes high traffic might contribute to the FoC.	• High traffic area in combination with poor prospect creates FoC.

2. Next to Channel	Description of Area	Takeaways
	This walkway is situated next to a canal, which is a popular spot to walk next to. However, levels of prospect where pedestrians are supposed to cross under the bridge are low, requiring two blind turns in order to see what is ahead. This, combined with the fact that it is poorly lit, make a reasonable explanation as to why two respondents have experienced FoC here. Another thing that stood out was the fact that the bridge curves upwards, which obstructs vision when walking over it. This is not reflected in the Prospect/Refuge model, which does not take heights into account.	• Prospect/Refuge map might under-represent the amount of prospect in certain areas. • Prospect/Refuge model does not take into account height differences, which leads to an improper representation of reality.

Table A.5: (cont.) An overview of various points of interest within Beijum relating to the Visual Proximity model. For reference as to where these locations are situated, please cross-compare the numbering here to those in the map in Figure 9.

3. Emingaheerd	Description of Area	Takeaways
	The Emingaheerd connects Beijum-south to the ring road of Groningen. It is also where the bike path connecting Beijum to the inner city and running past DH/VS is adjacent to. Relatively speaking, the Emingaheerd has one of the highest balances of Prospect/Refuge within the neighborhood. Still, as was the case in Table A.4.4, it seems that a transition from a location of good Prospect/Refuge balance to one with a skewed balance can be considered an indicator of FoC.	• Prospect/Refuge map seems is not always accurate in predicting lower FoC. • High traffic of an area does not guarantee that the location feels safer.

B Figures

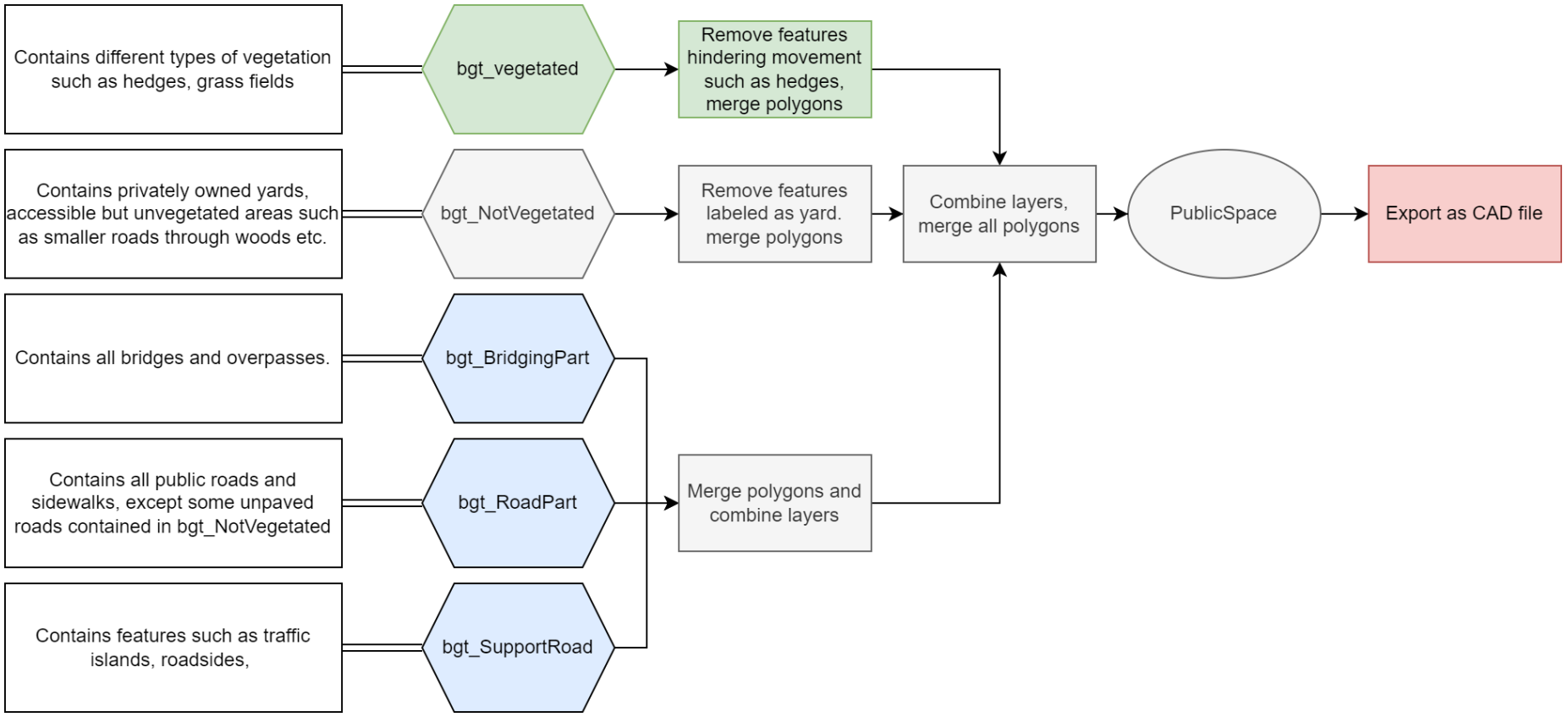


Figure B.1: Diagram indicating the descriptions and processing of the various GIS layers used for creating the input for DepthMapX

C Maps

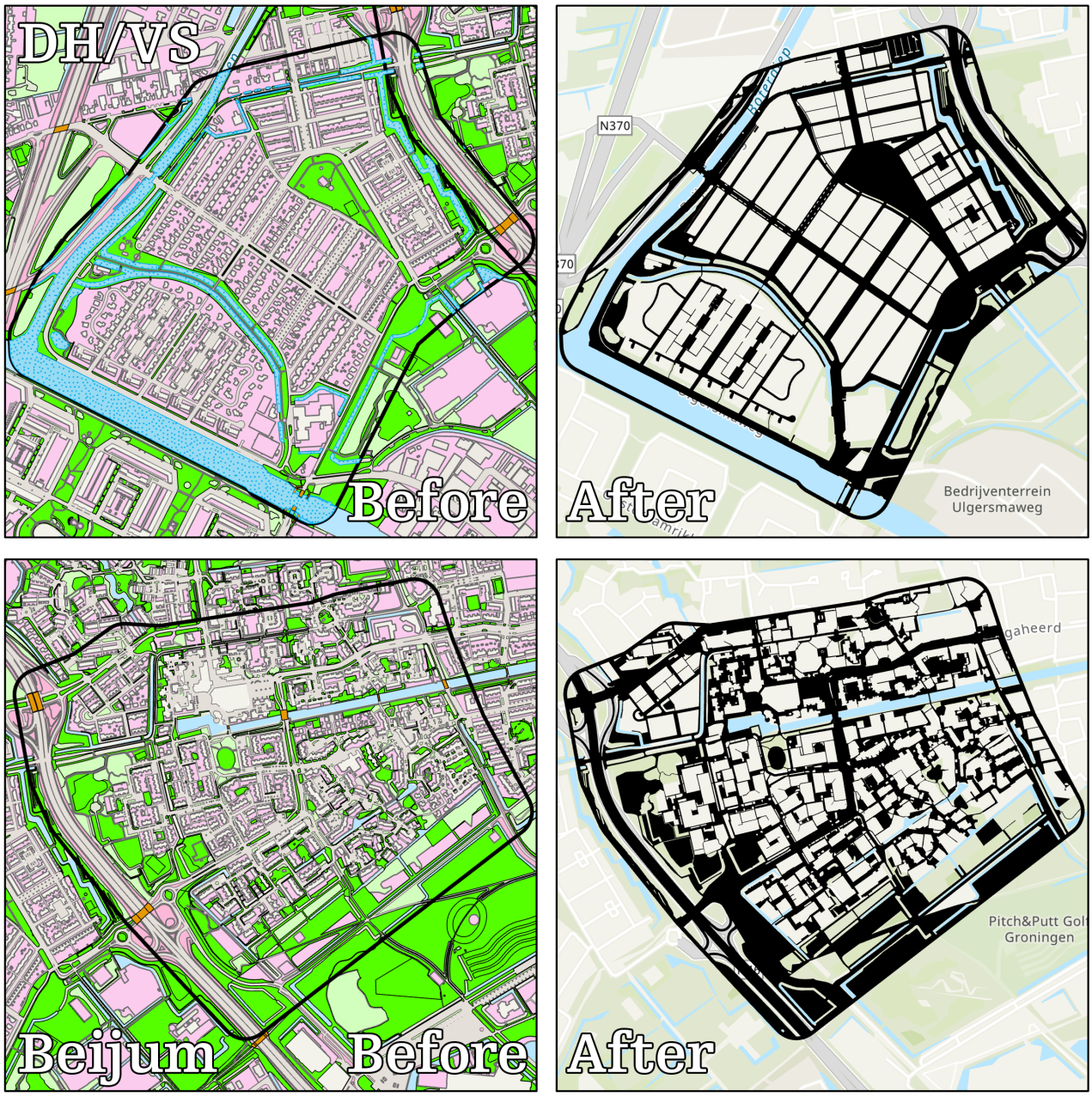


Figure C.1: Four maps indicating the BGT layers before processing for DepthMapX and after, by means of the instructions as indicated in Figure B.1.