Influences of the spatial neighborhood layout on shaping child-friendly places

A comparative study investigating the child-friendliness of a cauliflower and VINEX neighborhood in Deventer

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Influences of the spatial neighborhood layout on shaping child-friendly places

A comparative study investigating the child-friendliness of a cauliflower and VINEX neighborhood in Deventer

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Abstract

The physical activity levels of children are decreased compared to the past. Research has shown that children engage in less activities outdoors and that the spatial neighborhood environment is a major contributing factor; it is often seen that large spatial developments ignore the essence of creating diverse and rich play areas for children. Child-friendly environments which provide enough opportunities for children to fulfill their physical activity demands are necessary to maintain children's physical and mental well-being. This study aims to determine the child-friendliness of the spatial neighborhood layout, particularly present in a cauliflower and VINEX neighborhood. The question arises: How does the potential degree of independent mobility and affordances of children influence the child-friendliness of a cauliflower and VINEX neighborhood? In the context of this research, independent mobility describes the ability of children to travel alone and potential affordances indicates the properties of an object or place and the potential interactions with its users.

Based on a literature review on the influence of potential independent mobility and affordances on the child-friendliness of an environment, a mixed-method approach was employed. An observational study and a GIS network analysis were used to study the potential independent mobility of children and the available neighborhood affordances. Per neighborhood, the results have been assembled into the Bullerby model. The degree of potential affordances in both neighborhoods is equal, however VINEX neighborhoods tend to have clusters of child-friendly places that requires higher independent mobility, whereas the spatial structure of a cauliflower neighborhood does not enable children to travel further distances and only provides a limited availability of affordances near residences. Based on the conclusions, planners should consider adding playground equipment, water items and plants that enhance play opportunities for children. To enhance the independent mobility in the cauliflower neighborhoods, it is recommended to construct safe routes for children.

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1. Introduction

1.1. Background

Health and well-being are important aspects measuring the quality of life for both adults and children. The World Health Organization (WHO) has defined quality of life as '*an individual's perceptions of their position in life, in the context of the culture and value systems in which they live, and in relations to their goals, expectations, standards and concerns*,' (WHO, 1996, p. 153). Physical activity such as play, games, sports, physical education and recreation contributes to the health and fitness of children. However, there is a large increase in physical inactive lifestyles of children in the Netherlands: children are tempted to watch more TV, spend more time behind a computer and are often brought to school by car (De Vries et al., 2005; De Vries et al., 2010). Moreover, parents and researchers have the impression that children are less playing outside, which can be partly explained by the decline of outdoor play options. The realization of new housing districts and infrastructure developments usually have more priority than the construction of play areas for children (De Vries et al., 2005). The lack of proper playing areas does not only result in a decline of physical activity levels but can also result in bullying and fighting due to competition for playing equipment and spaces (Latfi & Karim, 2012). More child friendly environments that provide enough opportunities for children to fulfill their physical activity demands are thus necessary to maintain their physical and mental well-being. This child-friendliness of an environment is regarded by two criteria: the diversity of environmental resources and the access to play areas (Moore, 1986). To measure the environmental friendliness of the built environment, Kyttä (2003) has developed the Bullerby Model that combines the two aforementioned criteria; a hypothetical model that weighs the degree of independent mobility to the number of affordances for children, which indicates the properties of an object or place and the interactions with its users. This results in four types of children's environments.

The construction of child friendly environments has since long been an important aspect of planners in the Netherlands. The deterioration of the environment for children has already been observed during the 1970's and can be attributed to the increasing dominance of the car (Berm, 2018). The so-called cauliflower neighborhoods were created to provide safe areas for children to play and to diminish traffic flows with the use of 'woonerven:' traffic calmed areas without the dominance of cars (Meulendijks, 2010). Going forward to more recent spatial planning projects, it is observed that the VINEX neighborhoods nowadays are popular among families with young children (Kooiman & Latten, 2013) due to the diversity of facilities within those neighborhoods (Li, 2013).

Interestingly, both types of neighborhoods differ greatly from their spatial structure and will differ in accessibility and affordances for children, but they similarly have been found very popular and attractive for families to live in. However, knowledge on the child friendliness of these neighborhood environments is lacking. Therefore, this thesis will assess both types of neighborhoods on their child friendliness of the environment by investigating the potential independent mobility and the degree of potential affordances that are available for children, using Kyttä's Bullerby Model.

1.2. Research Problem

The decline of proper playing areas and the increasing dominance of the car proposes a threat to the living environment of children and limits the opportunity for children to participate fully and freely in outdoor activities (Malone, 2001). To limit further deterioration, knowledge on how the neighborhood design influences the children's environment is required. This research aims to discover the influence of the spatial layout of a cauliflower and VINEX neighborhood on the environmental quality for children. Thereupon, this research is a contribution to knowledge about the degree of independent mobility of children and provides insights in the availability of potential affordances and the play opportunities for children within those neighborhoods. The overarching goal of this bachelor project is to advice policy makers and planners on how to construct more child-friendly environments in the two proposed neighborhood types. Within this thesis, focus is placed on two neighborhoods in Deventer: Colmschate-Noord (Cauliflower) and De Vijfhoek (VINEX) (figure 1.1.).

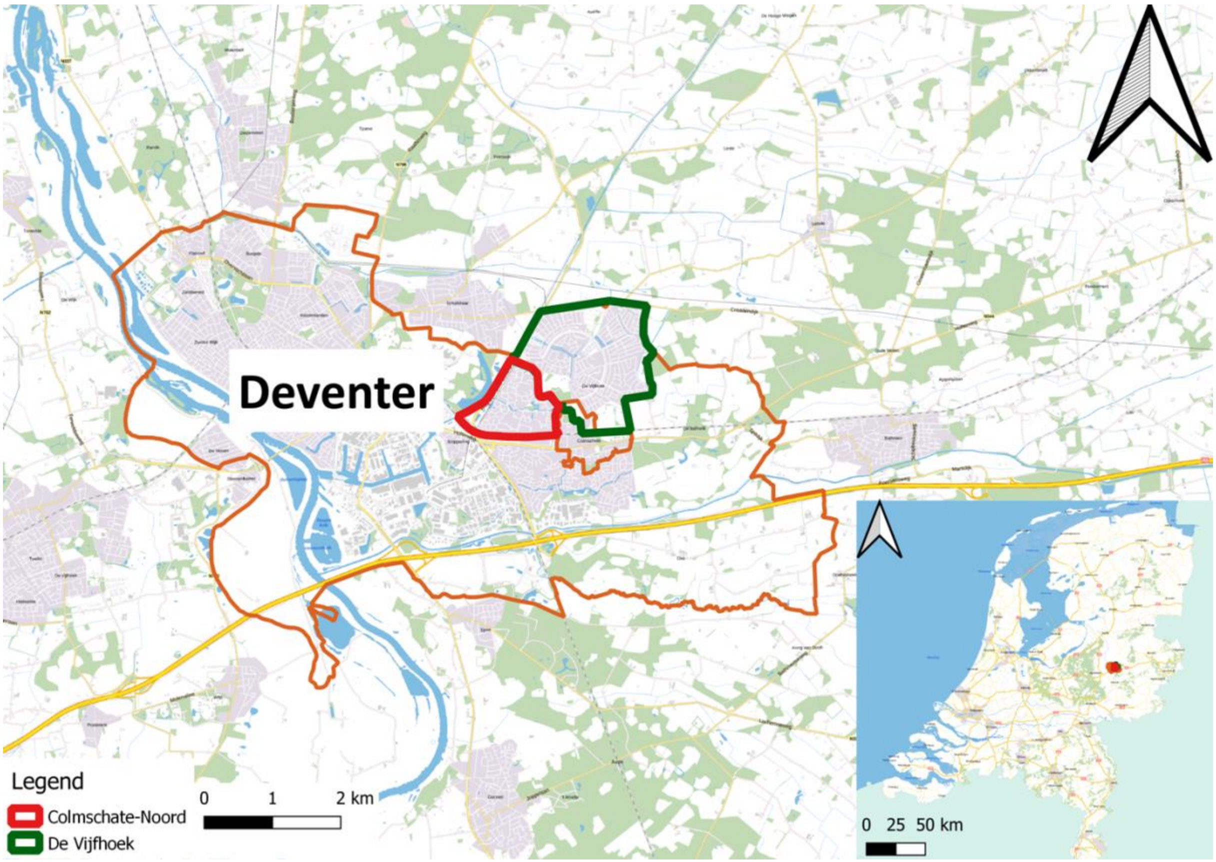


Figure 1.1. *Overview location neighborhoods Deventer (QGIS, 2020)*

The following main question is formulated:

How does the potential degree of independent mobility and affordances of children influence the child-friendliness of a cauliflower and VINEX neighborhood?

To answer the main research question, the following sub-questions are formulated:

1. To what extent do potential independent mobility and affordances influence the child-friendliness of a neighborhood?
2. What are similarities and differences on the accessibility to children's facilities in a cauliflower and a VINEX neighborhood in Deventer?
3. How do a cauliflower and VINEX neighborhood in Deventer compare regarding the degree of potential affordances for children?
4. What are spatial policies that can be implemented that increase the child-friendliness of the cauliflower and VINEX neighborhood?

1.3. Outline

The following chapter (chapter 2) structures the theoretical foundation that is underlying this thesis and includes the theoretical framework regarding the implications that the built environment has on child-friendly places. A conceptual framework is included to visually support the relationships between concepts and theories that have been revealed in this chapter. Chapter 3 introduces and describes how a literature review, observational study and network analysis have been employed within this thesis. The fourth chapter focusses on the results and explains and reflects on the general findings referring to the literature presented in the second chapter. An answer to the sub-questions will be formulated whereupon a conclusion is made in chapter 5, followed by recommendations aimed for planners and policy makers. Chapter 6 discusses the limitations of this research and proposes ideas for further research.

2. Theoretical Framework

In this chapter, the most relevant concepts and theories will be defined and discussed with the use of a literature review. In addition, the sub-question *'To what extent do potential independent mobility and affordances influence the child friendliness of a neighborhood?'* will be discussed and answered. Subsequently, a conceptual model will be presented to show the relationships of the relevant concepts within three general domains.

2.1. The Bullerby model

The Bullerby model was first mentioned in 2003 by Kyttä and is described as '*a hypothetical model in which the degree of independent mobility and the number of actualized affordances covary in four types of children's environments*' (Kyttä, 2006, p.1) and is designed as a tool to assess the 'child-friendliness' of the built environment (Kyttä, 2003). The four types of children's environments include *Wasteland*, *Glasshouse*, *Cell* and *Bullerby* (table 2.1.). These spatial environments are determined by the degree of independent mobility (see 2.1.2.) and by the degree of affordances that could be actualized (see 2.1.1.) (figure 2.1.). The optimal and most child-friendly type of a child's environment is described as Bullerby and concerns environments where the degree of independent mobility and affordances are high. According to Broberg et al. (2013), places that promote a meaningful exchange between place and child through affordance actualization, offer opportunities for environmental learning and develop environmental competence through direct experiences can be ascribed as child friendly environments. Thus, a child-friendly environment should contain sufficient possibilities for a child's independent mobility, which enables them to roam around and discover environmental affordances (Kyttä, 2003).
The Bullerby model is widely applicable in many settings (urban, suburban, rural) and for various ages (infants, children, teens) to assess the child-friendliness of the environment (Brewer et al., 2018). Planners and can use the model as guidance to transform a given non-optimal environment to the optimal Bullerby environment. However, to make assumptions about the environment, the concepts of affordances and independent mobility have to be treated beforehand.

Categories	**Description**
Cell	Children are limited on their travel abilities and have no opportunity to form a close relationship with the environment (Kyttä, 2003).
Wasteland	Children are able to freely roam around, however the dull environment provides no play opportunities for children (Broberg et al., 2013).
Glasshouse	The rich environment provides many attractive opportunities for children, however they cannot autonomously reach them (Kyttä, 2003).
Bullerby	Ideal circumstances where children can freely move around and are able to participate in a variety of outdoor activities. (Kyttä, 2006).

Table 2.1. *Description of Bullerby model categories*

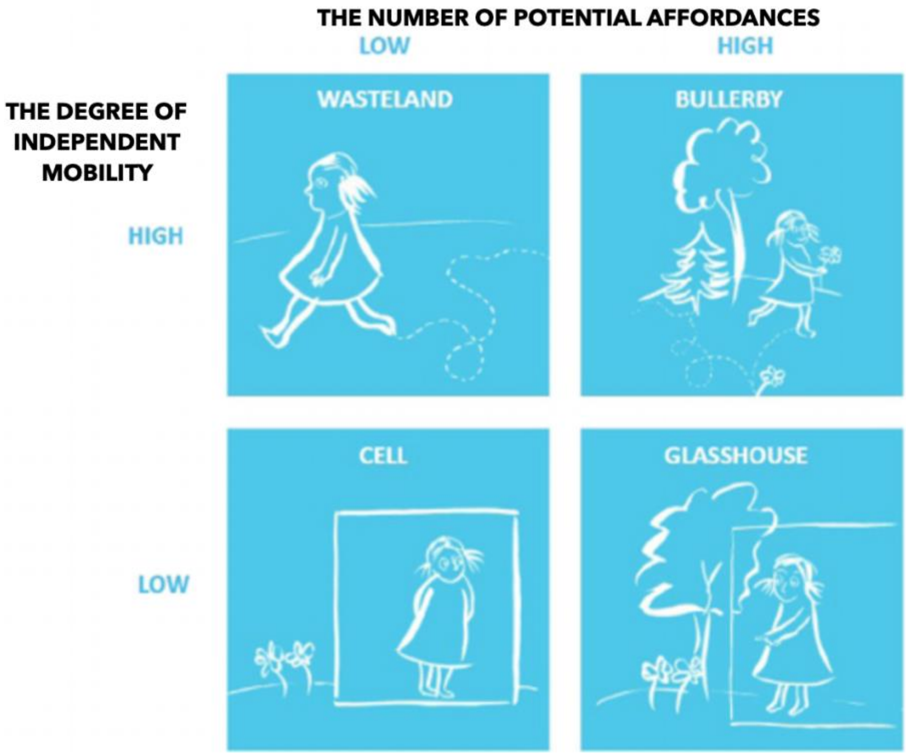


Figure 2.1. *The Bullerby model modified from original (Broberg et al., 2013)*

2.1.1. Affordances

The concept of affordances has long been used before Kyttä's research; in 1979 researcher J.J. Gibson has made up the word and described it as '*the functionally significant properties of the environment that are perceived through active detection of information,'* (Kyttä, 2002) and is defined in term of possibilities for action (Prieske et al., 2015), which often involves the physical opportunities and dangers which the organism perceives (Kyttä, 2004). The physical environment provides such affordances. There are four types of affordances: *potential*, *utilized, perceived* and *shaped*. The latter three types of affordances are actualized affordances, which have originally been used the model. However, within this research, the focus has solely been placed on potential affordances, due to the COVID-19 pandemic when writing this thesis (see 3.5.). The Bullerby model is therefore altered due to the circumstances: the degree of actualized affordances is replaced by the degree of potential affordances. A distinction needs to be made between potential and actualized affordances. Potential affordances can be seen as qualities of the environment, whereas actualized affordances are relationships between individuals and the environment. Kyttä (2003) gives an example: '*Affordances of a playground seem different for each individual, (…) their existence is potential, independent of users, and they are waiting to be actualized,'* (p.50). The list that is shown in figure 2.2. provides an overview of affordances which are adopted by Kyttä (2002), where she investigated the availability of affordances in different neighborhood settings.

Environmental qualities that support certain affordances	Affordances	Environmental opportunities for sociality	Affordances for sociality
Flat, relatively smooth surfaces	• affords cycling • affords running • affords skipping • affords skating • affords playing hopscotch • affords skiing • affords playing (football, ice-hockey, tennis or badminton)		• affords role playing • affords playing rule games • affords playing home • affords playing war • affords being noisy • affords following/ sharing adult's businesses
Relatively smooth slopes	• affords coasting down • affords skateboarding		
Graspable/ detached objects	• affords throwing • affords digging • affords building of structures • affords playing with animals • affords using plants in play		
Attached objects	• affords jumping-over • affords jumping-down-from		
Non-rigid, attached object	• affords swinging on • affords hanging		
Climbable feature	• affords climbing • affords looking out from		
Shelter	• affords hiding • affords being in peace and quiet		
Mouldable material (dirt, sand, snow)	• affords moulding something • affords building of snow		
Water	• affords swimming • affords fishing • affords playing with water		

Figure 2.2. *Affordances of a child's environment (Kyttä, 2002)*

The extent to which children can actualize their affordances is closely related to their degree of independent mobility. The more children can travel, the more affordances may be accessible to them and the higher the motivation to roam in the environment (Kyttä, 2003).

2.1.2. Independent mobility

Independent mobility is an important source for physical activity of children and additionally counts up some important health benefits (Schoeppe et al., 2014). The concept of independent mobility can be described as *'the ability and freedom of children to move around and play in public space without the need for adult supervision'* (Hillman et al., 1990; Schoeppe et al., 2014; Page et al., 2009). Independency enables children to develop cognitive, psychosocial and developmental benefits by means of social interaction with other children, thereby learning to solve problems on their own (Schoeppe et al, 2014). Recent studies have shown that the independent mobility of children has been diminished for the past fifteen years. Especially the decrease of independent mobility to a child's leisure activities is an undesired consequence of car usage (Fyhri et al., 2011). This trend can be attributed towards increased parental concerns about traffic risk perception, 'stranger danger,' longer distances to school and leisure activities which negatively affects children's 'mobility licenses': permits to perform activities independently (Schoeppe at al., 2014; Kyttä et al., 2015). Independent mobility can thus vary per child, as an individual's qualities determine the extent to which they want or are able to have the licenses to explore the world (Kyttä, 2003). As children get older, their degree of independent mobility increases due to an increase in licenses or abilities, generally meaning that older children travel larger distances than younger children (Fyhri & Hjorthol, 2009).

Previous research has shown that the parental restrictions for independent mobility of children to facilities depends on the travel distance to those facilities (Schoeppe et al., 2015). The majority of adults restrict their children to travel 500 meters independently from their home to certain facilities (62%), while only 20% would allow their children to travel more than 1000 meters from home.

Since children are mainly restricted to walking or cycling, independent mobility usually involves active transportation to leisure activities (Schoeppe et al., 2014). When children have a low independent mobility, their active transportation diminishes, which results in lower physical activity levels (Kyttä et al., 2015). Physical activity thus correlates with the levels of independent mobility (Broberg et al., 2013). The built environment has a significant role on travel mode choice and physical activity levels of children (Buck et al., 2011). One way to incorporate all variables of the physical environment and to measure its relationship with activity levels is with the use of the Neighborhood Accessibility index, which functions as a theoretical tool to calculate the potential degree of interdependent mobility.

2.2. Neighborhood Accessibility Index

The accessibility to facilities within a neighborhood is an important indicator for physical activity of both adults and children (Cerin et al., 2006). Various research has been done on analyzing the relationship of environmental variables and their effect on children's physical activity (Buck et al., 2011; Lin & Yu, 2011; Cerin et al., 2006). These environmental variables have been implemented into a Neighborhood Accessibility Index which enables assessment of the spatial neighborhood environment and the possibilities to walk or cycle within the urban area.

2.2.1. Accessibility indicators

Accessibility indicators are environmental factors which are closely related to having a positive effect on the physical activity and independent mobility levels on children. Understanding these accessibility indicators, that encourage the use of active transportation modes, is needed for planners to create built environments that allow physical activity for children (Broberg, 2015). Inspired by the research of Ackerson (2005), several indicators that are related to safe active transportation modes have been established. An overview of the accessibility indicators can be found in table 2.2. These indicators are categorized by 'spatiobehavioral', 'spatiophysical' and 'spatiopsychosocial' aspects by Lee & Moundon (2003). 'Spatiobehavioral' neighborhood characteristics entail aspects of the built environment that cause interaction between road users, resulting in a higher chance of collisions. As safety concerns of both parents and children will be influenced, independent mobility decreases (see 2.1.2.). 'Spatiophysical' characteristics give an indication on the ability of children to walk and cycle safely through a neighborhood, whereas the 'spatiopsychosocial' indicators involve aspects about the attractiveness of the neighborhoods and the location destinations for children (Lee & Moundon, 2003). Attractive environments are associated with higher levels of active transportation (Giles-Corti et al., 2005).

Accessibility Indicators	*Category*
Neighborhood feels safe for walking	'Spatiobehavioral'
Neighborhood feels safe for biking	'Spatiobehavioral'
Number of Driveways	'Spatiobehavioral'
Number of traffic calming	'Spatiophysical'
Bicycle lane	'Spatiophysical'
Path obstructions	'Spatiophysical'
Sidewalk completeness/continuity	'Spatiophysical'
Sidewalk condition/maintenance	'Spatiophysical'
Crossing aids	'Spatiophysical'
Lightning	'Spatiophysical'
Wayfinding aids	'Spatiophysical'
Is attractive for walking	'Spatiopsychosocial'
Is attractive for biking	'Spatiopsychosocial'

Table 2.2. *Neighborhood Accessibility Indicators inspired by Ackerson (2005).*

2.2.2. Children's facilities

Statistics from the province of Overijssel show that the population, including children from 6 years and older, use active transportation modes mainly for recreational purposes (CBS, 2018) (Appendix A). Leisure activity destinations are thus an important factor for the physical activity patterns of children (Potwarka et al., 2008). Higher accessibility of those leisure facilities increases the child's independent mobility (Buck et al., 2011). Furthermore, the article of Buck et al. (2011) demonstrates examples of children's leisure facilities such as public playgrounds, sports facilities and parks/green space. Despite that most trips are made towards leisure facilities, the article of Li (2013) emphasizes the importance of non-leisure facilities such as schools and day-cares as they play a major role in the daily travel pattern of children.

Since children will likely visit these facilities often, focusing on the accessibility of these location types would be a suitable option to measure the potential degree of independent mobility within these neighborhoods.

2.3. The cauliflower neighborhood

As a reaction to Dutch modernist planning principles until the 1960s and their corresponding social problems, a new planning policy, Derde Nota Ruimtelijke Ordening, was established (Rijksdienst voor het Cultureel Erfgoed, n.d.) with the aim to restore 'human beings as the measure of all things,' (Wekker, 2016). After the second world war, many cities were subjected to a rapid increase of car traffic, population growth and prosperity. The pressing housing shortages required the construction of many (prefabricated) houses within a short timeframe, in accordance with the modernistic ideals of the CIAM (Rijksdienst voor het Cultureel Erfgoed, n.d.). The aforementioned policy acknowledged the problems of the modernist urban planning and therefore focused on restoring social cohesion and collectivity among neighborhood residents (Berm, 2018). The cauliflower neighborhoods that came to rise in the 1970s, were designed for spontaneous encounters between neighbors and to enhance personal identification with the neighborhood environment

(Wekker, 2016). Characterizing these neighborhoods is the low-density housing blocks formed with several nuclei that resembles a cauliflower structure (figure 2.3.). These neighborhoods often contain dead-end streets, also called 'woonerven'. 'Woonerven' were considered as the core principle of the neighborhood and were expected to influence the driver behavior, road safety, quality of life and pattern of activities in public space (Kraay, 1987). They functioned as undesignated play areas and were widely appreciated due to their accessibility for all children (Krishnamurthy, 2019). Cars were not banned but integrated in the neighborhood environment so that they still could be used, despite their loss of overall predominance (Schreuder, 1978). The neighborhoods spatial layout that offers traffic calmed streets, playgrounds and an overall safe physical environment for children made them especially popular under families (De Vletter, 2004).

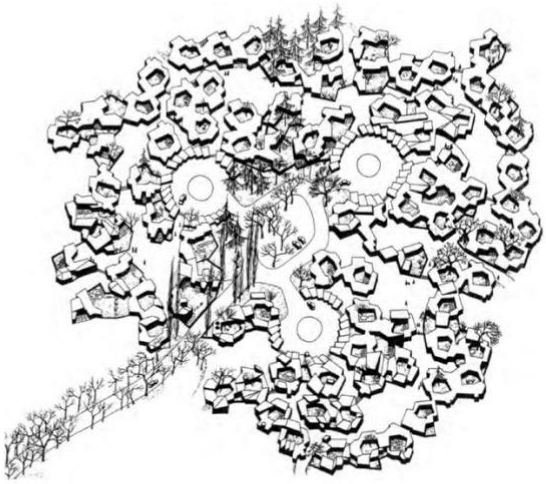


Figure 2.3. *Concept art showing the cauliflower structure of the neighborhood (Ubink et al., 2011).*

Although the urban vision of the cauliflower neighborhood seemed promising, the spatial layout has received criticism by New Urbanists (Wekker, 2016): the inward focused layout of the neighborhood reflected the 'wijkgedachte' well, however it was also this layout that functioned as a physical barrier that separates the neighborhood from the outer world (Wassenberg & Ruijsbroek, 2006). Thereupon, the lack of proper public transportation and an interconnected pedestrian and cycling network caused a heavy dependency on the car, thereby conflicting with its traffic calmed neighborhood vision.

2.4. The VINEX neighborhood

Over the past decades, it has been increasingly less attractive to live in dense urban regions: many households migrated from the inner city towards so called *growth centers (groeikernen)* in the outer city regions (Heins, 2004) but continued to work in the cities (Li, 2013). Commuting from and to the city resulted in an increase in car mobility and caused pressure on the environment (Snellen et al., 2005). The national government intended the realization of bundled urbanization (*gebundelde verstedelijking*) with the aim to '*support urban growth; limit growth on car mobility; and to place residential areas, employment and facilities at such distance from each other that the accessibility by bicycle and public transport is optimal,'* (Li, 2013, p.7.). These principles were adopted in the VINEX policy document. VINEX is an abbreviation for Vierde Nota Ruimtelijke Ordening Extra, which originated from 1990's (Snellen et al., 2005). In accordance with the national objectives, the VINEX neighborhoods were designed to reduce car usage by connecting everyday facilities and activities with public transport, walking and cycling, with the idea to create the so-called 'compact city' (Snellen et al., 2005; Lörzing et al., 2006; Baas, 2018). Residences, workspaces and other facilities would be situated in such way that accessibility is optimal by bicycle and public transport (Li, 2013) thereby encouraging active transportation (Baas, 2018). Characterizing the VINEX neighborhoods are the high densities, mixing of functions, availability of a public transport network, a poly-centric urban morphology and an extensive pedestrian and cycling network (Hilbers et al., 1999). The variety and availability of facilities make the VINEX neighborhood attractive for households with children. In contrast to the cauliflower neighborhood, play activities do no longer take place on the street, but in designated play areas (Krishnamurthy, 2019). A case study of the Nesselande VINEX neighborhood illustrates this development. Two 'child clusters' are located at the heart of the neighborhood and mainly contains functions for children (Li, 2013). However, it has been observed that the appreciation of these designated play areas diminishes when they are difficult to reach or further away (Krishnamurthy, 2019).

2.5. Conceptual model

Based on the earlier mentioned concepts, a conceptual model has been created (figure 2.4.). This conceptual model illustrates in a generalized way the relationships between the discussed concepts and theories. Three main domains are established in this model: the governmental domain, the environmental domain and the social domain focused on the child-friendliness of neighborhoods.

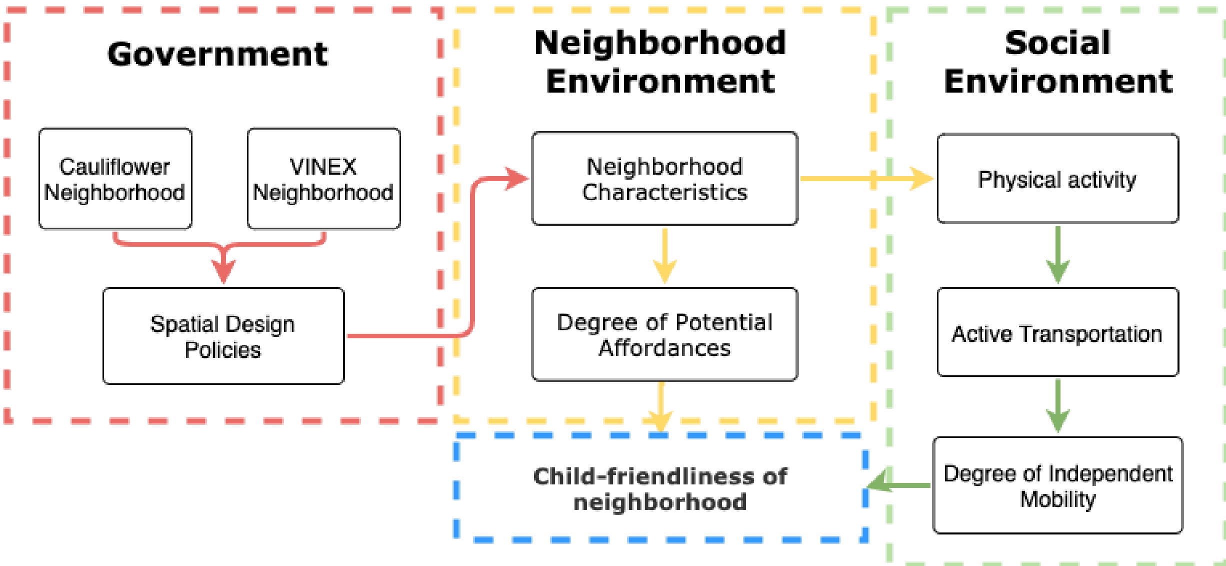


Figure 2.4. *Conceptual model*

2.6. Hypotheses

Regarding the main question of this research '*How does the potential degree of independent mobility and affordances of children influence the child-friendliness of a cauliflower and VINEX neighborhood?*' a hypothesis is created. This hypothesis includes the expectations on the corresponding sub-questions. To answer, '*What are similarities and differences on the accessibility to children's facilities in a cauliflower and a VINEX neighborhood in Deventer?*' it is expected that the VINEX neighborhood will have the highest scores regarding the potential degree of independent mobility, due to the extensive focus on mobility management and infrastructure planning in the Vierde Nota Ruimtelijke Ordening Extra policy document. Expectations on the question '*How do a cauliflower and VINEX neighborhood in Deventer compare regarding the degree of potential affordances for children?*' include that the outcome will result in a tie between the two neighborhoods. While the VINEX neighborhood has a spatially open morphology, which allows play activities for children near the residential area, the more confined cauliflower neighborhood contains ‘woonerven,’ which provides opportunities for playing on the street. Both neighborhood types have their own spatial qualities, but taking into account the previously stated hypotheses, expectations are that children living in the VINEX neighborhood will benefit most from the spatial environment in this area. Whether these hypotheses can be kept of refuted will be investigated in the following chapters of this research.

3. Methodology

Within this chapter, the methodological methods and choices will be discussed. To answer the research questions, a mixed method approach including an observational study and a network analysis will be adopted. The research questions and their corresponding methodological approaches can be read in table 3.1 and a schematic overview on how the data will be analyzed can be found in figure 3.1.

Main question	**Type of data**	**Methods**
How does the potential degree of independent mobility and affordances of children influence the child-friendliness of a cauliflower and VINEX neighborhood?	Quantitative /qualitative	Outcome of the sub-questions
Sub-questions		
1. *To what extent do potential independent mobility and affordances influence the child-friendliness of a neighborhood?*	Qualitative	Academic literature review.
2. *What are similarities and differences on the accessibility to children's facilities in a cauliflower and a VINEX neighborhood in Deventer?*	Quantitative /qualitative	Observational study: Neighborhood Accessibility Index GIS: Network analysis
3. *How do a cauliflower and VINEX neighborhood in Deventer compare regarding the degree of potential affordances for children?*	Qualitative	Observational study
4. *What are policies that can be implemented that increase the well-being of children in a cauliflower and VINEX neighborhood?*	Quantitative /qualitative	Bullerby neighborhood scores on child-friendliness

Table 3.1. *Overview of the methodological approach*

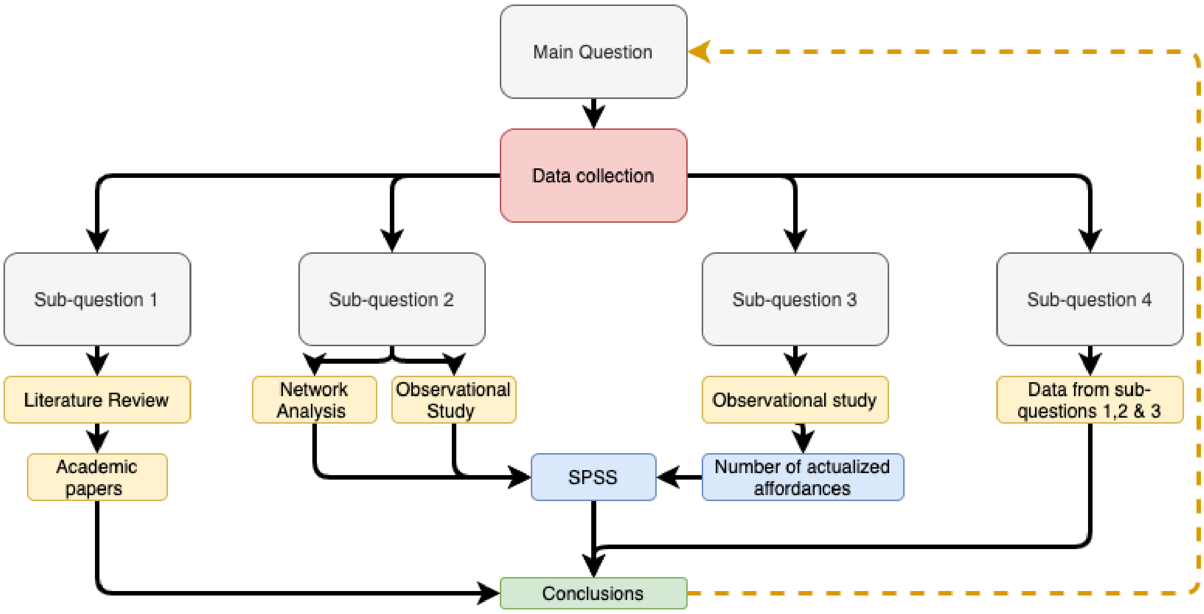


Figure 3.1. *Overview data analysis*

3.1. Literature review

The first sub-question is answered using a literature review (see 2.1.). For this literature review, academic literature sources have been used, making use of Google Scholar and SmartCat. To find suitable academic literature, several key search terms have been used, including *independent mobility, children, affordances, Kyttä Bullerby model, child-friendliness, child friendly cities, child inclusive urban design*. The literature review has been considered suitable since an inventory of important variables regarding independent mobility and affordances could be made. These variables have been implemented in the methods for data collection.

3.2. Research area

This research makes use of a case-study. A case study is a qualitative research method that enables analysis of a phenomenon as a single, but integrated phenomenon (Gagnon, 2010). A case study provides an in-depth understanding of phenomena and the involved actors. Therefore, this method is appropriate for describing, explaining and prediction processes at the individual or group level (Woodside & Wilson, 2003) and is considered suitable for this research. The city of Deventer has been chosen for analysis because of the presence of a cauliflower and VINEX neighborhood within the same district. These two neighborhoods concern: Colmschate-Noord (cauliflower) (figure 3.2.) and De Vijfhoek (VINEX) (figure 3.3.). The location of these two neighborhoods within the same city district makes it convenient for analysis due to their close proximity, yet there are many demographic differences of interest (*Appendix B)* (CBS, 2020). As many families live within these neighborhoods, this area fits well within this study. An in-depth characterization of the research area can be found in *Appendix C & D*.

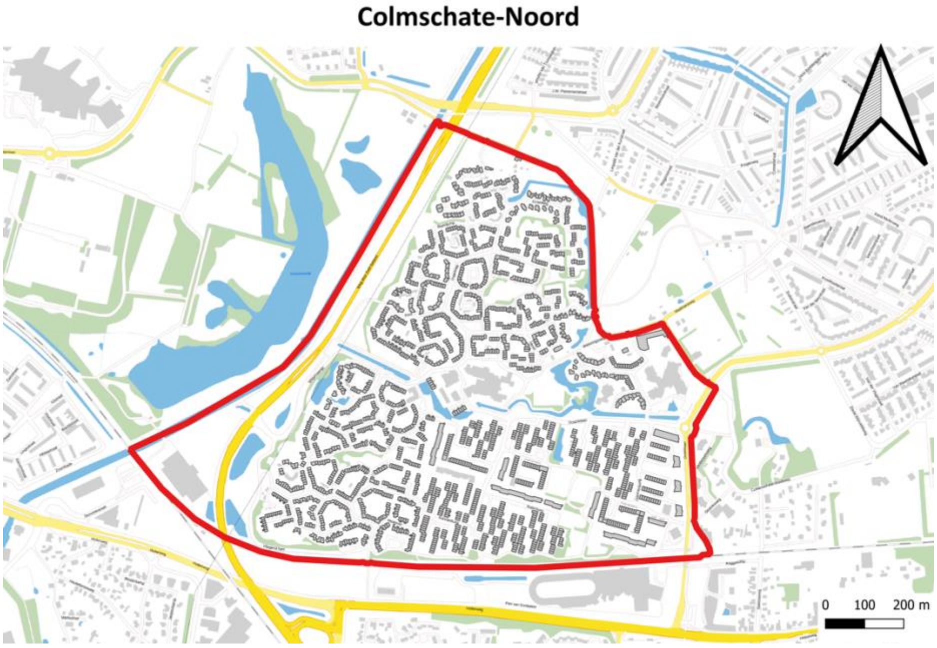


Figure 3.2. *Colmschate-Noord neighborhood (QGIS, 2020)*

Figure 3.3. *De Vijfhoek neighborhood (QGIS, 2020)*

3.3. Observational study

To answer the second and third sub-questions, an observational study will be conducted. Both sub-questions will have their own criteria and checklists. For the observational study, facilities that are related to children are visited in both neighborhoods. The facility types have been chosen on the basis of the literature (see 2.2.2.). In *Appendix E*, the observation locations can be seen. These locations are based on the children's facilities that are present in both neighborhoods which has been investigated in *Appendix C & D*. Eight children's facilities in the cauliflower neighborhood will be visited, whereas the VINEX neighborhood contains ten facilities.

3.3.1. Accessibility to children's facilities

In order to look for similarities and differences between the neighborhoods, an observational analysis will be held at children's facilities (*Appendix E)* with the help of the Neighborhood Accessibility Index. Since actual mobility cannot be measured due to the COVID-19 pandemic, this tool is chosen instead to make theoretical assumptions about mobility. In order to assess the accessibility of the neighborhood and the degree to which children are potentially able to travel independently, scores will be attributed to the accessibility indicators using a score sheet (table 3.2) (*Appendix F*). The neighborhood accessibility scores can be found in *Appendix G*. A two-samples t-test is used to discover similarities and differences between the two neighborhoods.

Indicators	Potential rating (low to high)	Example response	Score
Neighborhood feels safe for walking	0-3	Degree of agreement	
Neighborhood feels safe for biking	0-3	Degree of agreement	
Driveways	0-1	No/yes	
Presence of traffic calming	0-3	Degree of agreement	
Bicycle lane	0-1	No/yes	
Path obstructions	0-1	No/yes	
Sidewalk continuity	0-2	Low/moderate/high	
Sidewalk condition/maintenance	0-2	Low/moderate/high	
Crossing aids	0-1	No/yes	
Lightning	0-3	N.a./Low/moderate/high	
Wayfinding aids	0-1	No/yes	
Is attractive for walking	0-3	Degree of agreement	
Is attractive for biking	0-3	Degree of agreement	
Total score	Maximum score: 27		……

Table 3.2. *Accessibility indicators and scores*

In addition to the Neighborhood Accessibility Index, a network analysis will be conducted to determine the accessibility to a facility. More about the network analysis can be read in section *3.4*.

3.3.2. Potential affordances

Another part of the observational study is to investigate the potential affordances that both neighborhoods offer for children. A checklist has been created, which can be found in *Appendix H & I*. This checklist has been used by Kyttä (2002) to investigate the availability of the affordances in a neighborhood. This same strategy will be adopted. Subsequently, the number of available affordances was divided by the total amount of affordances (32), resulting in a scale factor ranging from 0 to 1 (low-high). Finally, a Mann-Whitney test will be used to discover similarities and differences between the two neighborhoods.

3.4. Network Analysis

When measuring the accessibility to a children's facility, it is important to not only look at spatial characteristics that enable independent mobility, but also at the performance of the infrastructure network, which includes footpaths, cycle paths and main roads within the neighborhoods (see *Appendix C & D)*. The performance of the infrastructure network will be measured by calculating the service area of the facilities that have also been used in the observational studies (*Appendix E*). Facility types that are included are: playgrounds, schools, daycare, supermarkets and sports facilities. This service area will be used to express how accessible a location is to dwellings, thus indicating how well children are able to visit the facilities.

Distances to calculate the service area have been set to 100 meters, 300 meters, 500 meters and 1000 meters, based on the travel distances of children (see *2.2.2.*). When calculating a service area, an isochrone is created that makes use of the aforementioned infrastructure network. Subsequently, the number of dwellings that are within a certain distance will be calculated using 'Basis statestieken voor velden' from the Analysis toolbox. A detailed description on how this network analysis has been performed is included in *Appendix J*. The outcome of the network analysis includes the relative percentages of dwellings that fall within a certain distance. This thus indicates the percentage of houses that are covered by the service area out of the total number of houses within the neighborhood.

The outcome of the network analysis is used to make statements about the centrality of the locations within the neighborhood and will be compared and analyzed together with the degree of potential independent mobility that a neighborhood facilitates (see *3.3.1.)*. A two-samples t-test will be used to discover similarities and differences between the neighborhoods. Subsequently, assumptions can be made on the accessibility to children's facilities from the performance of the infrastructure network, as well as from the neighborhood environment. Together with the data of the observational study, a more comprehensive picture on the accessibility to those facilities is drawn.

3.5. Ethical considerations

Due to very problematic ethical considerations on reaching out to children and the current coronavirus, this research has adopted a methodological approach with the least possible ethical issues and high feasibility. The outbreak of the COVID-19 in Wuhan (China) has led to a pandemic. To prevent the spread of the virus, a social lock-down was announced in March 2020 and as a result, schools and universities had to close.

The pandemic made getting in touch with the research population difficult. Especially since children cannot be approached directly without permission of parents: interviewing or surveying children has not been feasible. Consequently, an observational study and GIS analysis have been the main approach.

Whereas GIS data is straightforward and can be objectively interpreted, the observational study may cause some ethical difficulties. The data depends on the interpretations of the researcher alone. Subjectivity (conscious or unconscious) cannot be ignored when making observations as values differ per individual. To overcome the subjectivity of the results, this research does not solely depend on observations but also includes a network analysis.

4. Results

Within this section, the results of the performed observational studies and the network analysis will be discussed. The results are divided into two categories. Each category treats a sub-question and discusses the results for both neighborhoods. Subsequently, the results of both the accessibility to children's facilities as well as the degree of independent mobility will be combined and visualized into the Bullerby model.

4.1. Accessibility to children's facilities

In this section, the results of the following research question will be shown: '*What are similarities and differences on the accessibility to children's facilities in a cauliflower and a VINEX neighborhood in Deventer?*' The raw data of the potential degree of independent mobility can be found in *Appendix K* and raw data on the network analysis in *Appendix L*. First the cauliflower neighborhood will be discussed followed by the VINEX neighborhood. Subsequently, a reflection will be made.

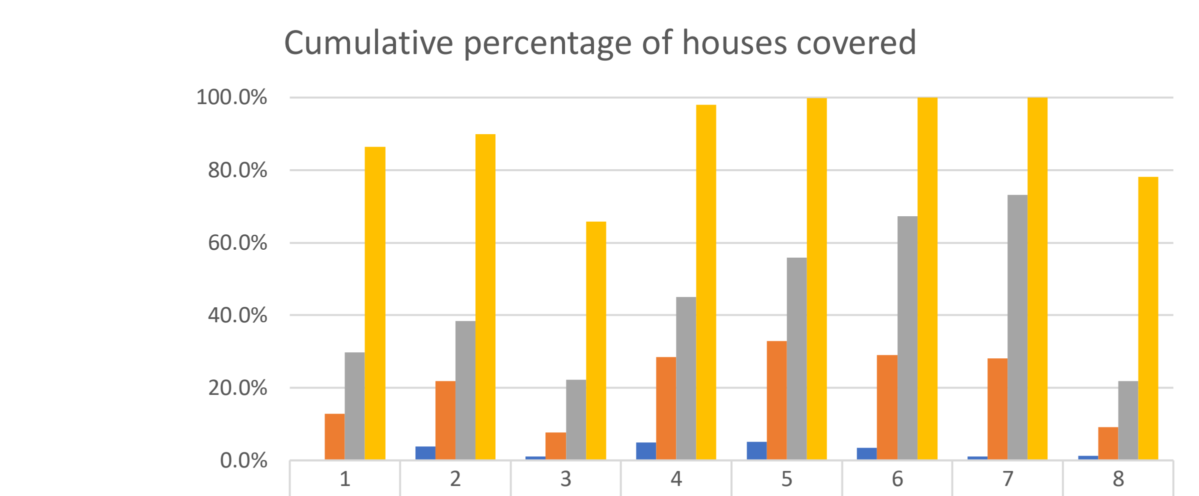
4.1.1. Cauliflower neighborhood

Table 4.1. shows the scores per facility and their degree of potential independent mobility. What can be seen is that most locations have been categorized with a low score for potential independent mobility. This indicates that the neighborhood does not allow independent mobility. Subsequently, figure 4.1. shows the results of the network analysis. The bars in this figure illustrate the distribution of houses per distance as they show the relative cumulative coverage of houses within the neighborhood. Therefore, a short yellow bar means a low coverage of houses.

LOCATION ID	FACILITY	SCORE	DEGREE OF POTENTIAL INDEPENDENT MOBILITY
1	Playground	11	Low
2	Playground	12	Low
3	Skatepark	3	Low
4	Playground	9	Low
5	Football field	10	Low
6	Primary schools	17	High
7	Supermarket	6	Low
8	Daycare	12	Low
AVERAGE		10	Low

Table 4.1. *Results observational analysis Colmschate-Noord*

As can be seen from the figure, most locations have a relatively high coverage within the neighborhood of which two locations have full coverage (location 6 & 7). Despite these centrally located facilities, they generally score low on the degree of potential independent mobility. This thus indicates that this neighborhood does not allow travelling large distances, but this is compensated by the fact that the children's facilities are located close to residences. Children within this neighborhood are thus confined to their close living environments.



	1	2	3	4	5	6	7	8
Houses within 100m	0.1%	3.8%	1.0%	5.0%	5.2%	3.5%	1.1%	1.3%
Houses within 300m	12.9%	21.9%	7.7%	28.4%	33.0%	29.0%	28.1%	9.2%
Houses within 500m	29.7%	38.5%	22.3%	45.1%	55.8%	67.2%	73.1%	21.9%
Houses within 1000m	86.4%	89.9%	65.8%	97.9%	99.9%	100.0%	100.0%	78.1%

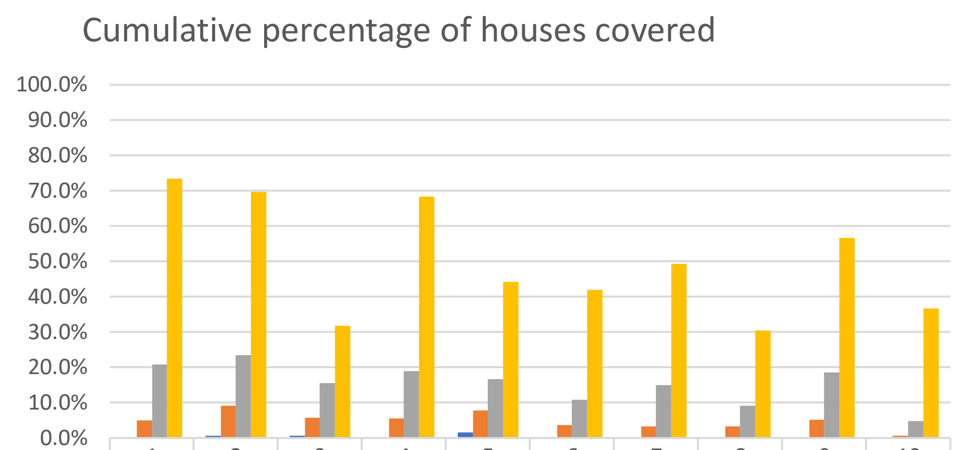
Figure 4.1. *Visualization of the cumulative coverage of houses within a certain distance around the facility in Colmschate-Noord*

4.1.2. VINEX neighborhood

Table 4.2. shows the results of the observational study and figure 4.2. presents the outcomes of the network analysis for the 10 locations that have been visited. It can be seen that the average score for degree of potential independent mobility is categorized as high; the spatial layout of this neighborhood facilitates children's independent travelling.
The network analysis indicates that none of the children's facilities are covered by the whole neighborhood. However, in relation to the potential independent mobility scores, these facilities overall sustain independent travelling well, despite their relatively remote location.

LOCATION ID	FACILITY	SCORE	DEGREE OF POTENTIAL INDEPENDENT MOBILITY
1	Shopping	8	Low
2	Primary schools	20	High
3	Daycare	14	High
4	Primary school	17	High
5	Daycare	13	Low
6	Daycare	13	Low
7	Play area	14	High
8	Sports field	11	Low
9	Petting zoo	16	High
10	Tennis fields	14	High
AVERAGE		14	High

Table 4.2. *Results observational study De Vijfhoek*



	1	2	3	4	5	6	7	8	9	10
Houses within 100m	0.1%	0.6%	0.6%	0.3%	1.5%	0.3%	0.1%	0.0%	0.2%	0.0%
Houses within 300m	4.9%	9.1%	5.8%	5.5%	7.8%	3.7%	3.3%	3.3%	5.2%	0.7%
Houses within 500m	20.9%	23.5%	15.6%	18.9%	16.6%	10.8%	14.9%	9.1%	18.5%	4.9%
Houses within 1000m	73.5%	69.7%	31.7%	68.4%	44.2%	42.0%	49.2%	30.5%	56.7%	36.7%

Figure 4.2. *Visualization of the cumulative coverage of houses within a certain distance around the facility in De Vijfhoek*

4.1.3. Reflection

To answer the sub-question *'What are similarities and differences on the accessibility to children's facilities in a cauliflower and a VINEX neighborhood in Deventer?'* the results of both neighborhoods have been compared and tested for significance. Analysis of the data has shown that performing a two-samples t-test is allowed on both the independent mobility scores (*Appendix M*) as well as on the network analysis data (*Appendix N*). The results of the significance tests are shown in table 4.3. and indicate a significant difference for both variables.

Two-samples t-test	**Degree of freedom**	**Significance (2-tailed)**	**Mean difference**
Degree of potential Independent mobility	16	0.037	-4.00
Network Analysis	16	<0.000	39.49

Table 4.3. *Results t-samples t-test*

The results reveal that there is a difference between the cauliflower and VINEX neighborhood regarding their accessibility to children's facilities. The VINEX neighborhood scores significantly better on the potential independent mobility. What stands out is that the locations in the cauliflower neighborhood seem to be more centrally located; indicating, in accordance with the theory presented (see 2.1.2.), that children are more likely to visit these facilities depending on their age, abilities and mobility licenses. In contrast, facilities in the VINEX neighborhood require longer travel distances. Nevertheless, in line with the hypothesis, the results suggest that the VINEX neighborhood facilitates a significantly better spatial layout and thus enables independent mobility more than the cauliflower neighborhood. The data conforms to the initial notion of the VINEX neighborhood; the explicit focus on mobility management and the focus on encouraging active transportation

modes in the VINEX policy document have resulted in the creation of a comprehensive infrastructure network throughout the neighborhood (see 2.4.).
The significant contrast in the data can well be translated to the context of the neighborhoods. The need for *bundled urbanization* and compact cities in the early VINEX era has resulted in the provision of many facilities, mixture of functions and infrastructure networks within this neighborhood. Hence, there was opportunity for wider dispersal of those facilities due to the supporting infrastructure layout. On the other hand, the confined character of the cauliflower neighborhood is a contributing factor that imposes major barriers on the mobility patterns of children (see 2.3.). The dense and closed urban morphology and, thereby, the lack of an integrated pedestrian and cycling infrastructure network and public transportation, only allows for short travel distances for both children and adults. Therefore, car dependency occurs: the dominance of the car is visible in the neighborhood picture and presents a threat in the traffic calmed '*realm of the child,*' conflicting with the initial expectations of Schreuder (1978).

4.2. Degree of potential affordances

This section will discuss and reflect the results for *'How do a cauliflower and VINEX neighborhood in Deventer compare regarding the degree of potential affordances for children?'* The raw data can be found in *Appendix O*. The cauliflower neighborhood will be treated firstly, followed by the VINEX neighborhood.

4.2.1. Cauliflower neighborhood

The results regarding the number of potential affordances for this neighborhood can be seen in table 4.4. Again, eight locations have been visited. The highest affordances index includes 0.59, which is present twice at the facilities.

LOCATION	FACILITY	AFFORDANCES INDEX
1	Playground	0,44
2	Playground	0,59
3	Skatepark	0,44
4	Playground	0,59
5	Football field	0,25
6	Primary schools	0,09
7	Supermarket	0,09
8	Daycare	0,25
AVERAGE		0,34

Table 4.4. *Affordances index per location in Colmschate-Noord*

4.2.2. VINEX neighborhood

For the ten locations in the VINEX neighborhood, the scores can be found in table 4.5. As indicated in the table, some facilities contain many potential affordances (primary school), whereas there are also some locations with extremely low affordances (tennis fields), which thus does not provide many play opportunities for children.

LOCATION	FACILITY	AFFORDANCES INDEX
1	Shopping	0,19
2	Primary schools	0,69
3	Daycare	0,16
4	Primary school	0,78
5	Daycare	0,09
6	Daycare	0,19
7	Play area	0,56
8	Sports field	0,13
9	Petting zoo	0,69
10	Tennis fields	0,03
AVERAGE		0,35

Table 4.5. *Affordances index per location in de Vijfhoek*

4.2.3. Reflection

To form an answer to the sub-question *'How do a cauliflower and VINEX neighborhood in Deventer compare regarding the degree of potential affordances for children?'* a Mann-Whitney test has been performed (table 4.6.) due to limited evidence of normally distributed data (*Appendix P*).

Mann-Whitney	**Z**	**Significance (2-tailed)**
Degree of potential affordances	-0.089	0.929

Table 4.6. *Results Mann-Whitney test*

The test outcome suggests that there is not enough evidence to assume differences on the degree of potential affordances between the two neighborhoods. Based on the popularity of the neighborhoods types under families, it was expected that both have their own spatial qualities that contribute to the child-friendly urban character. As the cauliflower neighborhood contains many playgrounds and traffic calmed 'woonerven,' (De Vletter, 2004), it provides a variety of opportunities for children to play almost anywhere in the neighborhood. The data gathered in this research supports these assumptions in the literature. Despite the lack of a significant difference on the degree of affordances, a comparative visualization of the data reveals a distinction in the distribution that is visible to the eye (figure 4.3.).

The relevancy of this figure is to indicate how affordances are shared by all facilities throughout the neighborhood. The previously stated assumption about the overall play opportunities in the cauliflower neighborhood is validated, as the figure implies a smaller distribution, meaning that a share of potential affordances is available for all facilities in the neighborhood. Contrasting, the affordances in the VINEX neighborhood show to have a higher dispersion, thereby indicating that some facilities contain an abundance of potential affordances, whereas other locations are empty. This data is in accordance with literature of Krishnamurthy (2019) and the findings of Li (2013) on the case study in the VINEX neighborhood Nesselande, where is talked about the emergence of so-called *'child*

clusters:' places that are particularly focused on children. This data is thus suggesting the existence of the *child clusters* within this VINEX neighborhood.
How the degree of potential independent mobility and affordances cohere and its potential implications on the child-friendliness of both neighborhoods, will be discussed in the following section.

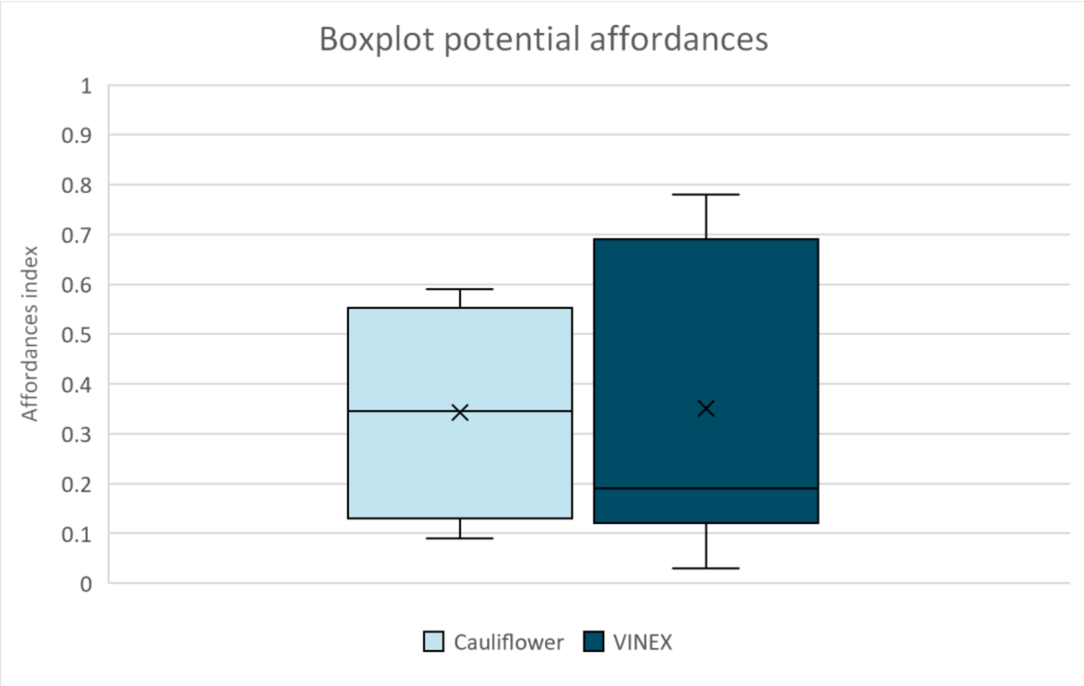


Figure 4.3. *Comparative boxplots affordances*

4.3. The Bullerby scores

This section illustrates the covarying degree of potential independent mobility and the potential affordances of both neighborhoods in the Bullerby model. This visualization shows the corresponding children's environments for each location and can be used to imply assumptions about the child-friendliness of the neighborhoods (figure 4.4.). Subsequently, limitations about the data will be acknowledged.
The visualization has been made by quantifying Kyttä's Bullerby model: values have been added on the x- and y-axis. This results in an index scale ranging from 0 to 1 on the x-axis and a scale from 0 to 27 on the y-axis.
Figure 4.4. suggests that the majority of the locations in the cauliflower and VINEX neighborhood can be categorized as sub-optimal: the most predominantly occurring category is *Cell*, thereby indicating the lack of affordances, as well as potential independent mobility.

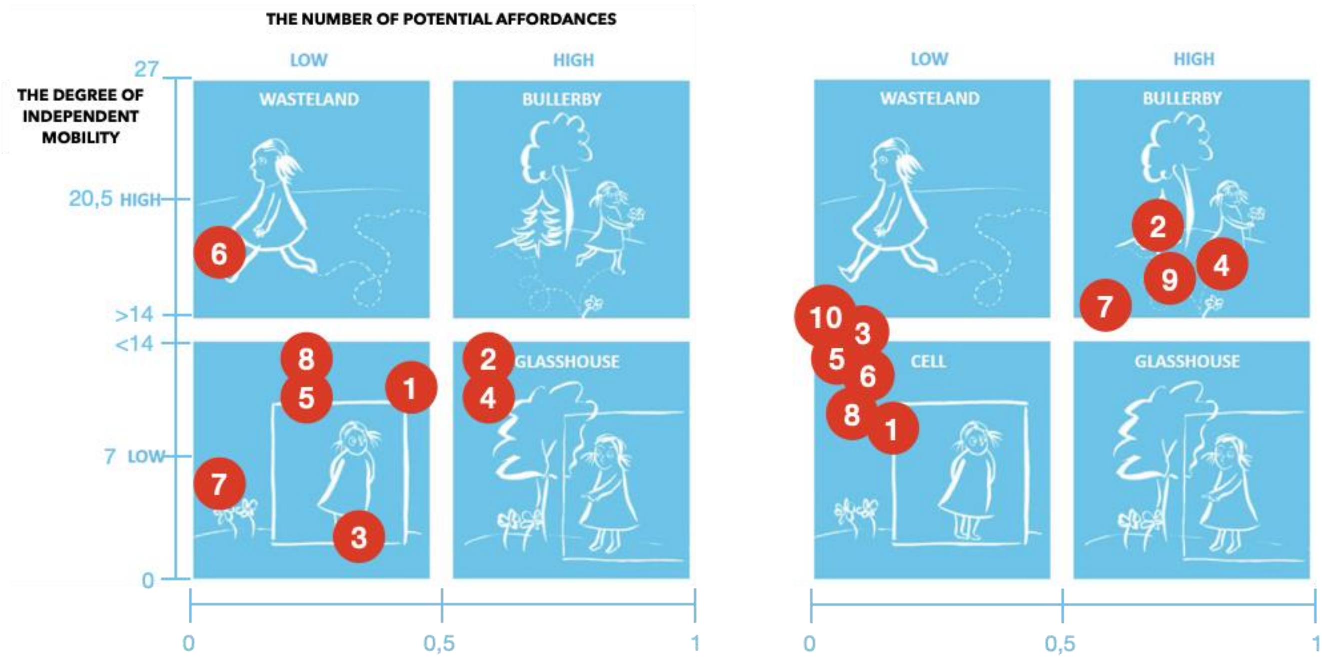


Figure 4.4. *Bullerby model scores of the cauliflower (left) and VINEX (right) neighborhood*

Remarkably, there is a gap between the Bullerby scores of the VINEX neighborhood (figure 4.4., right). Two groups of locations have been formed that can either be categorized as *Bullerby* or as *Cell*. When looking at the types of locations that have been categorized as *Bullerby*, data reveals that these locations are especially 'child-oriented' (schools, playgrounds, petting zoo). The other locations in this neighborhood that have a lower score on the Bullerby model, such as shopping, daycare and sports fields, do not only score lower on their affordances, but also on the potential degree of independent mobility.
The results indicate that the 'child-friendliness' of the VINEX neighborhood is more dispersed than in the cauliflower neighborhood: the VINEX neighborhood contains places that are specifically dedicated in creating the optimal children's environment, observed due to their high scores on both aspects. The distinct separation of the child and adult domain is present as this neighborhood contains *child clusters* that have been previously observed in other VINEX neighborhoods (see 2.4.).
As the data suggest that children in VINEX neighborhoods face more difficulty to reach those *child clusters* due to the distances to those locations, this neighborhood thus requires higher independent mobility licenses from parents and an increased ability of children to travel alone. Given this fact, the appreciation of the *child clusters* can diminish due to the large distances (Krishnamurthy, 2019). Nevertheless, the neighborhood facilitates a better infrastructure network for children (higher degree of potential independent mobility) in comparison to the cauliflower neighborhood. Children are theoretically well able to visit these *child clusters*.
On the other hand, the local orientation of the cauliflower neighborhood does not allow for travel outside the neighborhood, however, facilities that are present within the neighborhood are well covered according to the network analysis.
All in all, the data suggests that the child-friendliness of the VINEX neighborhood is more dispersed, whereas all locations in the cauliflower neighborhood are considered sub-optimal on child-friendliness, despite the more evenly dispersed potential affordances and the opportunities for children to play on the street.

5. Conclusion

This chapter will answer the following main research question: *'How does the potential degree of independent mobility and affordances of children influence the child-friendliness of a cauliflower and VINEX neighborhood?'* The research aimed to gain insights in the degree of independent mobility of children and in the availability of potential affordances and the play opportunities for children within a cauliflower and VINEX neighborhoods. The goal is to advice policy makers and planners on how to construct more child-friendly environments in the two proposed neighborhood types.
Based on a mixed-method approach on the degree of potential independent mobility and affordances and their implications on the child-friendliness of the neighborhoods, this thesis has shown how no neighborhood type can be considered as optimal child-friendly. However, both neighborhood types contain environmental qualities that, to some extent, contribute to the child friendly environments.
Contrasting the holistic and integrated vision of the VINEX neighborhoods, the more local orientation of the cauliflower neighborhoods seems to have been affecting the spatial quality of the children's environments negatively. The neighborhood design impedes a child to such extent that they cannot fulfil their affordances close to home, neither motivates the child to explore the potential affordances elsewhere. However, the central locations of children's facilities have been considered as an important quality of the neighborhood, especially the presence of the woonerven that function as local play areas.
The fact that the VINEX neighborhood contributes well to the independent mobility of children, justifies the argumentation that the mobility planning principles of the VINEX policy document have been well translated into practice. The *child clusters* in the neighborhoods do indicate the focus on shaping child-friendly locations, however, require longer travel distances, thus higher mobility capabilities of children. The high degree of potential independent mobility and the comprehensive infrastructure network can bridge the gap, but only do so for older children that possess the mobility capabilities.
This research has clearly illustrated that both neighborhoods require measures to increase the child-friendliness of facilities to reach the optimal *Bullerby* category.
A general improvement would be increasing the available affordances at children's facilities. Both neighborhood types already have certain affordances, but the optimal quality of the built environment is not yet reached. Facilities should be enriched with more playground equipment, water items and plants that enhance play opportunities for children. Attention should be paid to the wide diversion of child friendly environments in the VINEX neighborhood. To avoid the gap from widening, more affordances should be added to facilities other than *child clusters*. Focus has to be spread throughout the neighborhood, instead of on few locations.
Implications for a cauliflower neighborhood include the increase of the degree of potential independent mobility. Therefore, planners should consider the creation of safe routes that guide children through the neighborhoods to facilities. These routes should be clearly highlighted and supplemented with safe crossings, cycle paths and colorful markings to increase driver awareness, but also to attract and invite children to explore the neighborhood.

6. Reflection

Establishing generalized assumptions about the nature of all cauliflower and VINEX neighborhoods is limited by the methodological approach adopted in this research. Data about the potential independent mobility and affordances of children are obtained by observations of the researcher thereby inflicting research bias. Bias can be limited with the use of surveys or interviews, however this was not seen as a feasible research method due to the pandemic, but is recommended in case of repetition of this research.
As result, some adjustments to the data collection methods had to be made in order to perform observations. The original Bullerby model has been adjusted and is within this research focused on potentialities. Illustrating, actual independent mobility of children could not be measured due to the ecological fallacy of using indicators (Dubé & Brunelle, 2014). The aggregation of these indicators does not allow to determine how an individual reacts to their local environment. This is an important limitation and as consequence, this research refers to the potential independent mobility. Using surveys, interviews or GPS trackers would provide a useful insight in the actual mobility patterns of children.
Moreover, the indicators that were developed by Ackerson (2005) were mainly used in the United States and were developed for American cities. American indicators might not be suitable for judging the European cities and the results may therefore not be representative. This indicates the necessity for the development of European independent mobility indicators, where children's and parental perceptions on mobility to spatial neighborhood features should be taken into account.
It can however be questioned to what extent the Bullerby model can be used to make true assumptions about the child-friendliness of a neighborhood. Factors as exposure to environmental toxins and risks is considered part of the built environment that can have implications for young children (Moore, 2006), however are not incorporated. Further research is needed on how these environmental factors can be implemented into a more comprehensive model. The results of this research should thus be treated with some wariness given the used methodological approaches, nevertheless, can be considered as a hypothetical situation analysis on the child-friendliness of the two neighborhood types. Furthermore, this thesis serves as encouragement for further exploration of the topic in order to create more child-friendly environments in the future.

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8. Appendix

Appendix A CBS Trip Motives Overijssel

Populatie: Populatie: 6 jaar of ouder

Perioden: 2018

Regio's | Onderwerp

Vervoerwijzen | Reismotieven

		Overijssel (PV)		
		Gemiddeld per persoon per dag		
		Verplaatsingen	Afstand	Reisduur
		aantal	km	minuten
Fiets	Totaal	0,93	3,33	17,19
	Van en naar werk	0,16	0,65	2,71
	Winkelen, boodschappen doen	0,18	0,36	1,95
	Uitgaan, sport, hobby	0,18	0,62	3,28
	Toeren, wandelen	0,04	0,60	3,81
Lopen	Totaal	0,37	0,81	10,23
	Van en naar werk	.	.	.
	Winkelen, boodschappen doen	0,06	0,05	0,86
	Uitgaan, sport, hobby	0,07	0,19	2,46
	Toeren, wandelen	0,13	0,43	5,97

Figure 8.1. Trip motives population 6 years or older Overijssel

Appendix B CBS Neighborhood facts

This appendix shows the descriptive demographics of both neighborhoods.

Onderwerp							
				Wonen			
	Bevolking	Leeftijdsgroepen		Woningen naar type		Woningen naar bouwjaar	
Wijken en buurten	Aantal inwoners	0 tot 15 jaar	Bevolkingsdichtheid	Percentage eengezinswoning	Percentage meergezinswoning	Bouwjaar voor 2000	Bouwjaar vanaf 2000
	aantal		aantal inwoners per km²	%			
Wijk 8 Colmschate-Noord	6 065	1 050	6 193	84	16	94	6
Wijk 9 Colmschate-Vijfhoek	12 630	2 915	2 226	92	8	39	61

Bron: CBS

Figure 8.2. Demographics comparison neighborhoods

Appendix C Characterization research area: Cauliflower

Cauliflower neighborhood

Street characteristics

The Colmschate-Noord in Deventer is a typical cauliflower neighborhood; it is characterized by an entangled structure of bending roads and several 'woonerven', where there is some difficulty distinguishing the main arterial roads from the residential streets. Woonerven consist of a widening of the street and the integration of the footpaths in the road were several activities come together: cars and cyclists passing by, children playing on the street and access to the residences. The woonerven in Deventer are designed with small streets which only allow slow traffic, parking spaces, dead end streets and some green strips with bushes and trees (figure 8.3.). There almost no road markings within the residential areas other than some small traffic calming.

The dataset in QGIS does not provide detailed information and does not recognize the woonerven in this neighborhood. Instead, it classifies the roads as regular residential roads. In total, this neighborhood consists of 584 strips of road of which 27% are dedicated footpaths and 7% are cycle paths. The remaining 66% is classified as a regular residential road that facilitates motorized vehicles, cyclists and occasionally pedestrians (figure 8.4.).

Figure 8.3. Impression woonerf Colmschate-Noord

Colmschate Roads

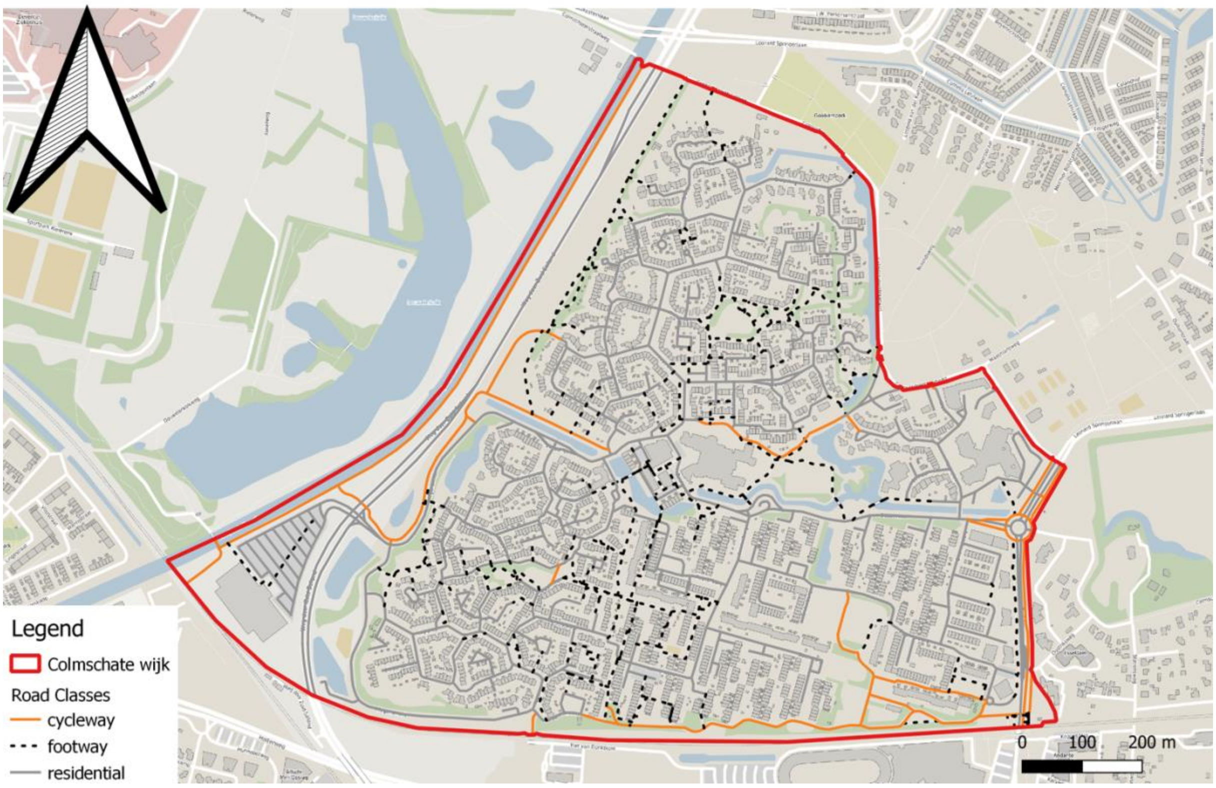


Figure 8.4. Road type overview Colmschate-Noord

Housing densities

It can be clearly seen that, on the architectural field, this neighborhood has been reduced to the 'human scale', due to the characteristics of the residences. All residences have a sloping roof and the housing topologies are ranging from one or two floor buildings and high-rise apartment buildings do not exist. The neighborhood consists of 3961 dwellings and has a total of 99 ha surface area. This results in a housing density of 40 dwellings per ha, which is on the higher average compared to the rest of the Netherlands. Nevertheless, these small streets and spaces in between the houses give the neighborhood a village-like ambiance.

Land-use characteristics

The cauliflower neighborhood has few facilities located in the area (figure 8.6.). There are schools and few shopping facilities. Moreover, there are a few 'official' playgrounds in the south of the neighborhood. These playgrounds contain equipment and are maintained by the municipality. Despite, children are not limited to these spaces alone, since there are many green areas within the residential areas where children can have their affordances. Mostly, the area consists of built residential space, but there is a fair amount of green space on the edges of the area (figure 8.5.). Despite, other than residential and green areas, this neighborhood does not provide many differentiated land uses.

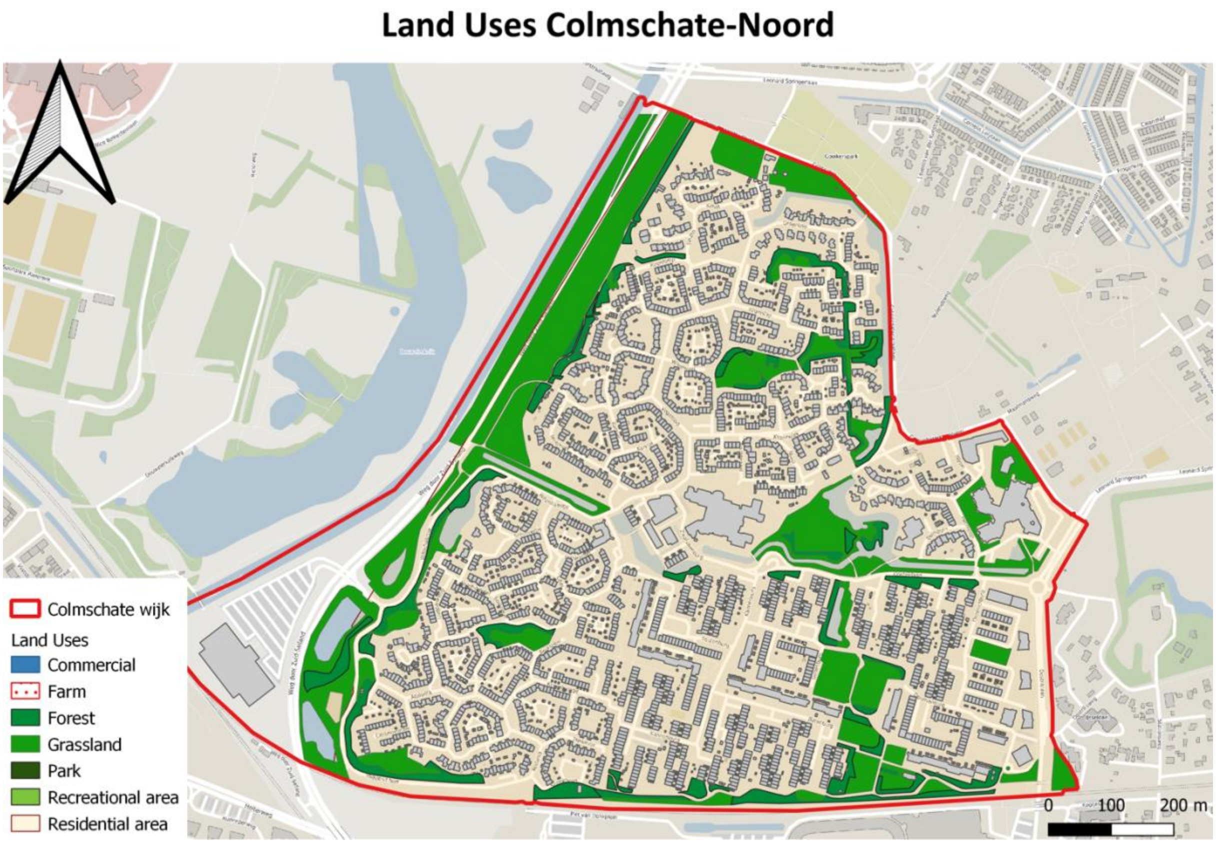


Figure 8.5. Overview land uses Colmschate-Noord

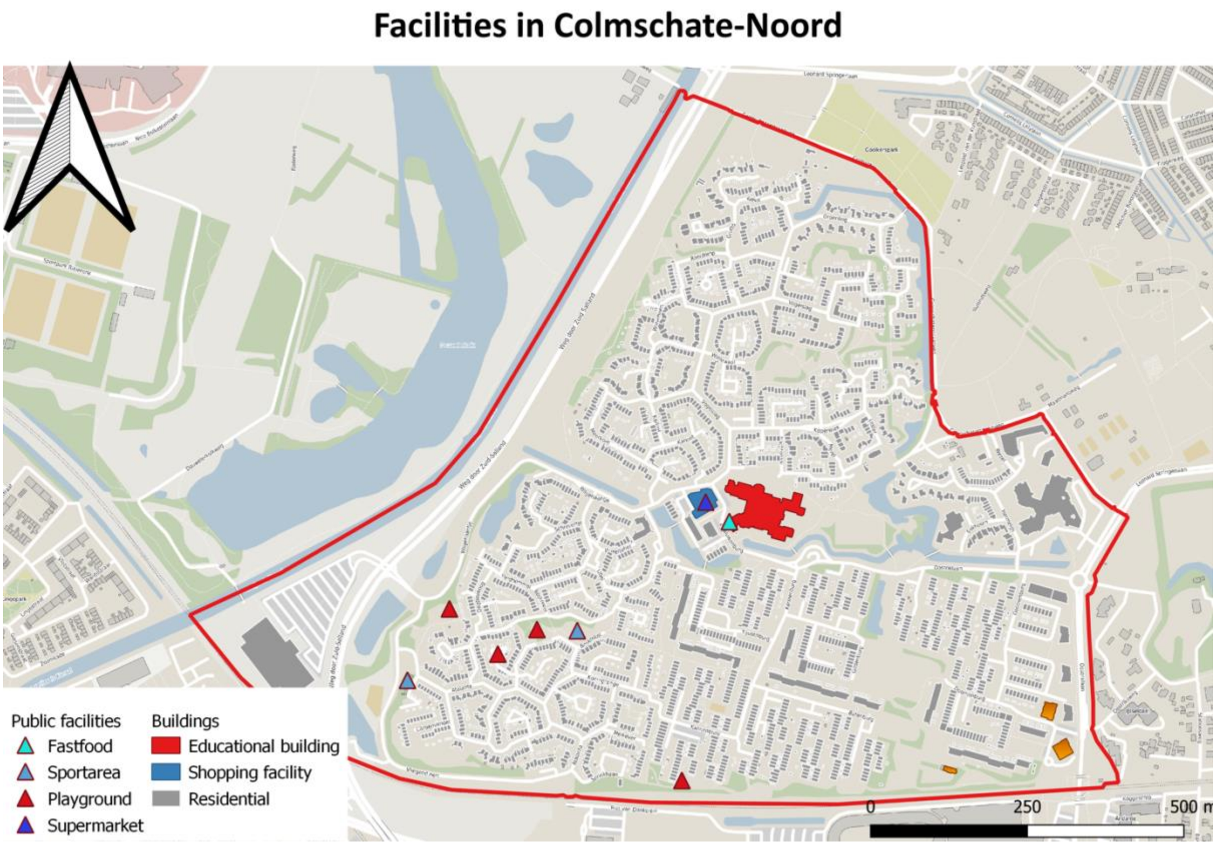


Figure 8.6. Overview facilities Colmschate-Noord

Appendix D Characterization research area: VINEX

Street characteristics

De Vijfhoek in Deventer is characterized by a clear hierarchical street network (figure 8.8.), with a large main arterial road (Leonard Springerlaan) that is connected to a large majority of the neighborhood. The Leonard Springerlaan functions as the access road were all traffic flows in and out of the district to all sub-neighborhoods. Connected to this arterial road are smaller, tiled streets that direct traffic to their destinations, still these roads are capable to process a certain amount of traffic, but some do contain traffic calming to limit the speed. One step further down in hierarchy are the residential streets (figure 8.7.). These streets are situated in dense residential areas where children often play outside and are characterized by cars that are parked along the street. Despite their location around residential areas, these streets are often continuous which results in a high amount of motorized traffic through the neighborhood, compared to the large number of dead-end streets in the cauliflower neighborhood.

Figure 8.7. Impression residential street De Vijfhoek

De Vijfhoek roads

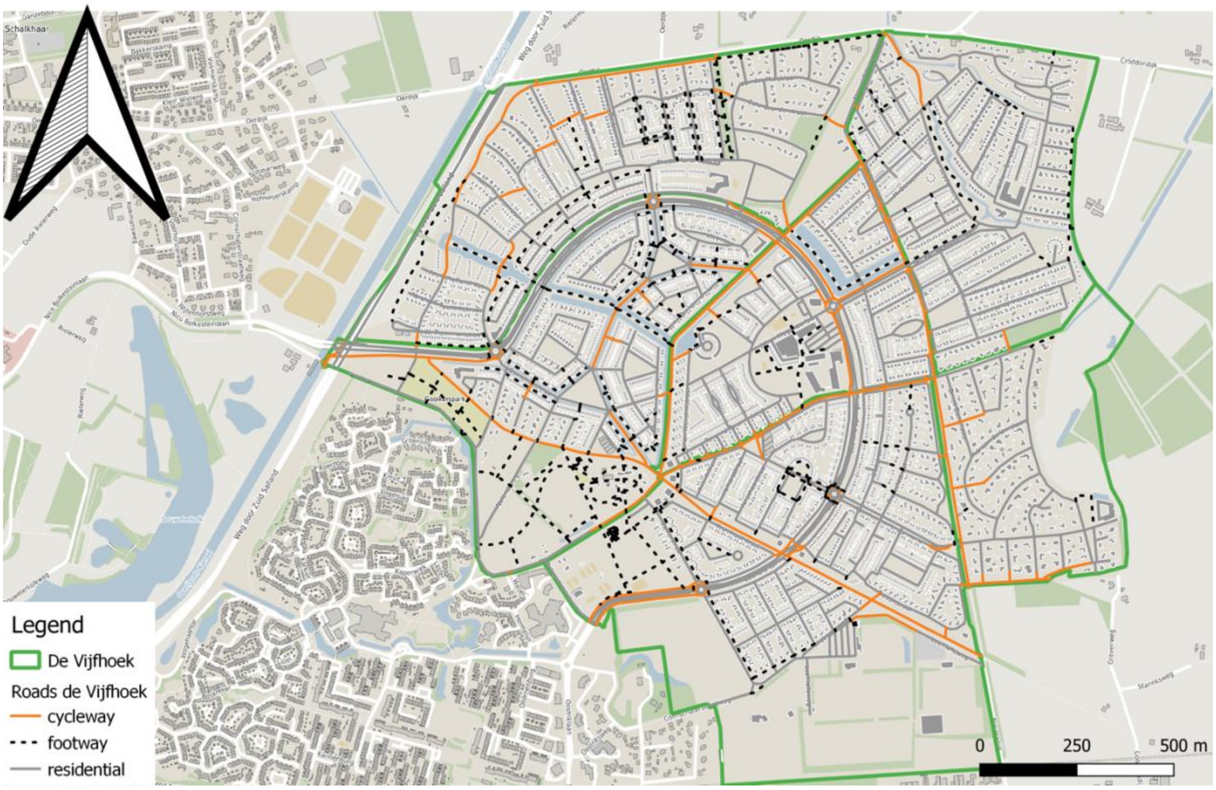


Figure 8.8. Road type overview De Vijfhoek

Housing densities

This neighborhood contains a wide variety of housing types that range from single floor elderly homes to high rise apartment buildings. The area is 275 ha and contains 7065 dwellings. This results in a housing density of approximate 26 dwellings per ha. In contrast to the cauliflower neighborhood, De Vijfhoek can be categorized as a lower average density neighborhood. This can be attributed to the large amount of clustered green spaces that are on the edges of the neighborhood. This calculation may there not be representative of the actual housing density of the neighborhood, since all dwellings are located together in a small area with multiple floors. A real comparison with the cauliflower neighborhood can therefore not be made. A Floor Area Ratio (FAR) would have been a better measure to calculate the densities of the neighborhood, though the current dataset did not contain reliable data on the number of floors and was therefore a limitation.

Land-use characteristics

De Vijfhoek has a variety of facilities to offer (figure 8.10). The area contains one shopping area, which is located in the middle were all shops are clustered. There are a number of schools distributed through the neighborhood and some daycares, which are described as other child facilities since they are not part of this analysis. On the south east of the neighborhood, there are large sport facilities where children can play sports.
Surprisingly, this neighborhood contains several small farms (figure 8.9.), of which one is located on the west side of the area. This is a local petting zoo where children can pet animals and play in the nature. Despite it was not very clear in the dataset, this area offers many facilities for children.

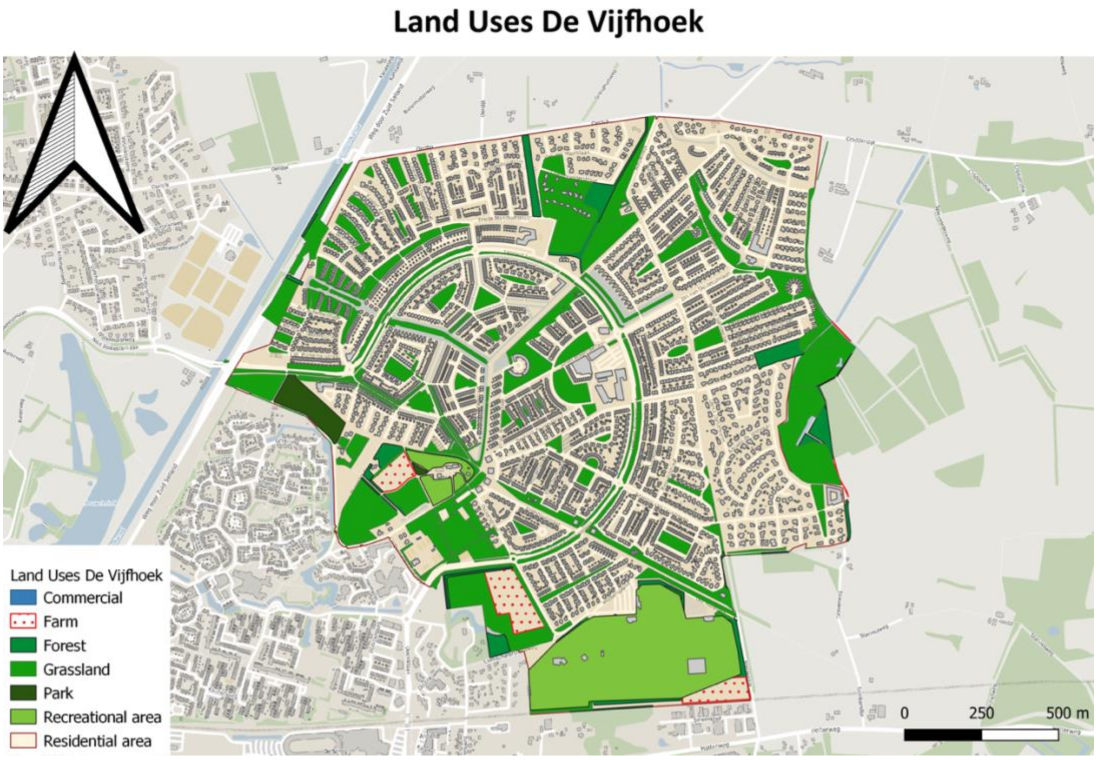


Figure 8.9. Overview land uses De Vijfhoek

Figure 8.10. Overview facilities De Vijfhoek

Appendix E Observation locations

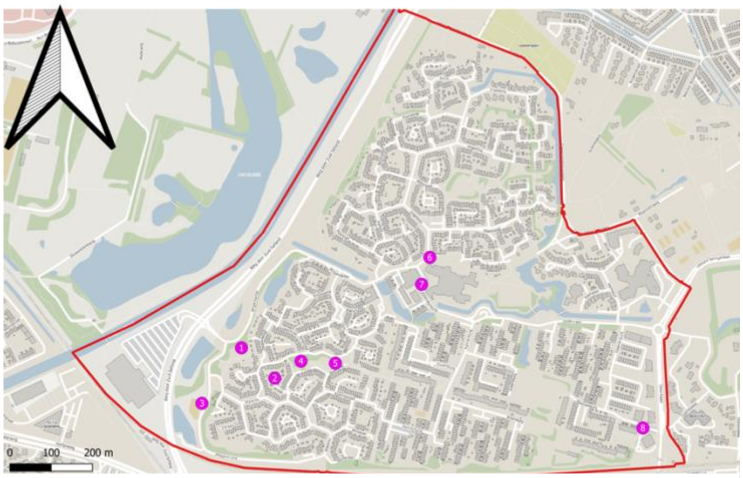
This appendix shows the locations that will be visited for the observational studies, which are based on the characterization of the research area (Appendix C & D).

LOCATION CAULIFLOWER	FACILITY
1	Playground
2	Playground
3	Skatepark
4	Playground
5	Football field
6	Primary schools
7	Supermarket
8	Daycare

LOCATION VINEX	FACILITY
1	Shopping
2	Primary schools
3	Daycare
4	Primary school
5	Daycare
6	Daycare
7	Play area
8	Sports field
9	Petting zoo
10	Tennis fields

Table 8.1. Overview facilities cauliflower (left) and VINEX (right) neighborhood

Observation spots Colmschate-Noord



Observation spots De Vijfhoek

Figure 8.11. Overview observation locations cauliflower (above) and VINEX (below) neighborhood

Appendix F Degree of Potential independent mobility: score sheet

LOCATION (CAULIFLOWER)	FACILITY	DEGREE OF POTENTIAL INDEPENDENT MOBILITY (LOW/HIGH)
1		
2		
3		
4		
5		
6		
7		
8		
AVERAGE		

Table 8.2. Observation sheet used in cauliflower neighborhood

LOCATION (VINEX)	FACILITY	DEGREE OF POTENTIAL INDEPENDENT MOBILITY (LOW/HIGH)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
AVERAGE		

Table 8.3. Observation sheet used in VINEX neighborhood

Appendix G Network Accessibility scores

Based on the scores that are assigned to the accessibility indicators, a degree of potential independent mobility within the neighborhood can be established using this score table. Each observation spot will get an independent mobility score ranging from low to high.

Degree of potential independent mobility	*Score rating*
Low	<14
High	14 - 27

Table 8.6. Score table rating the degree of potential independent mobility of locations

Appendix H Potential degree of affordances: observation sheet

LOCATION	FACILITY	AFFORDANCES INDEX (CAULIFLOWER)
1		
2		
3		
4		
5		
6		
7		
8		
AVERAGE		

Table 8.4. Observation sheet used in cauliflower neighborhood

LOCATION	FACILITY	AFFORDANCES INDEX (VINEX)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
AVERAGE		

Table 8.5. Observation sheet used in VINEX neighborhood

Appendix I Affordances checklist

Environmental Qualities	**Affordances**	**Available?**
Flat, smooth surfaces	Affords cycling	
	Affords running	
	Affords skipping	
	Affords skating	
	Affords playing hopscotch	
	Affords playing (football, tennis, badminton)	
Relatively smooth slopes	Affords coasting down	
	Affords skateboarding	
Graspable/detached objects	Affords throwing	
	Affords digging	
	Affords building of structures	
	Affords playing with animals	
	Affords using plants in play	
Attached objects	Affords jumping over	
	Affords jumping-down-from	
Non-rigid, attached object	Affords swinging on	
	Affords hanging	
Climbable feature	Affords climbing	
	Affords looking out from	
Shelter	Affords hiding	
	Affords being in peace and quiet	
Moldable material (dirt, sand, snow)	Affords molding something	
	Affords building of snow	
Water	Affords swimming	
	Affords fishing	
	Affords playing with water	
Affordances for sociality	Affords role playing	
	Affords playing rule games	
	Affords playing home	
	Affords playing war	
	Affords being noisy	
	Affords following/sharing adults' businesses	
Total = 32 affordances	Result index = Number of affordances/32 ->	…

Table 8.7. Affordances observation checklist

Appendix J Description network analysis

A network analysis has been performed on each location that has been visited within the cauliflower and the VINEX neighborhood. The network analysis consists of the calculation of a service area in QGIS. This appendix will show in detail how the service areas have been established. QGIS has been preferred over ArcGIS Pro due to its user friendliness and wide availability of useful tools. The description of the network analysis will follow a chronological order.

Firstly, a base map with all the observation locations (Appendix E) has been used. The base map (OpenStreetMap) has been added using a WMS/WMTS layer for connection with the OSM server. Another layer with information about the buildings has to be added. Using WFS, connection to the PDOK geo-services can be made using the following URL: https://geodata.nationaalgeoregister.nl/bag/wfs/v1_1?request=getCapabilities&service=WFS. The layer 'pand' can now be added to QGIS. The 'pand' layer has to be clipped with the neighborhoods to limit the number of features in this layer. In the attribute table, the total number of residential buildings can be determined using a query. By including every building with '%woonfunctie%', the total number of selected buildings will result in 5114 number of residential buildings in the VINEX neighborhood.
Subsequently, to create the service area isochrones, the ORS Tools plugin has been downloaded from the QGIS Plugin Manager. This plugin can now be found in the Toolbox. To activate this plugin, an API (application programming interface) key has to be used for authentication. This can be easily done by creating an account on openrouteservice.org/dev/#/signup. Clicking on 'Isochrones From Point' will open a new window (figure 8.12.).

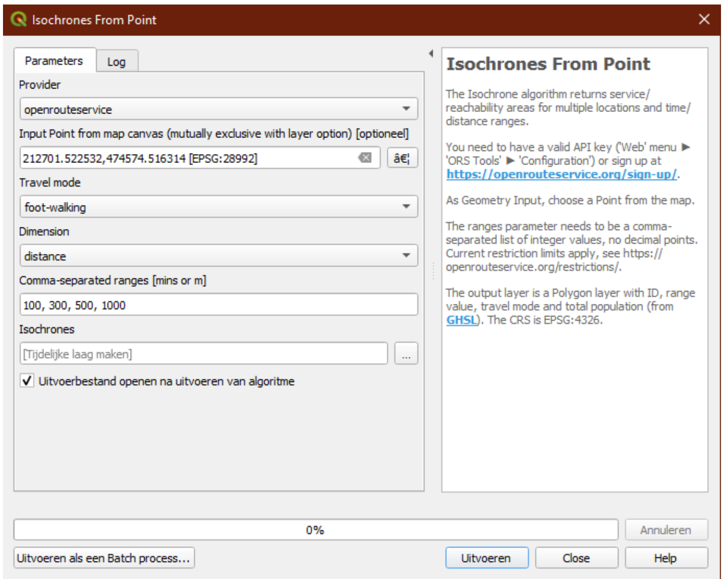


Figure 8.12. Isochrones from Point window

The location point has to be manually chosen and as an example, location 9 of the VINEX neighborhood has been chosen.
Travel mode has been put on 'foot-walking.' Cycling is another relevant travel mode within this research, however, since the isochrones did not differ, it was chosen to only use 'foot-walking' as travel mode in this network analysis. Dimension has been set to distance, which include 100 meters, 300 meters, 500 meters and 1000 meters (see 2.2.2). After executing this tool, a new polygon layer will appear. This polygon contains and isochrone with four 'rings' for each distance (AA_METERS: 100, 300, 500 or 1000). The isochrone can be better visualized setting the symbology at categorical, with a different color for each value of AA_METERS. At this moment, it is still unknown how many houses fall within the isochrone's 'rings.' Therefore, a vector overlay will be performed. The service area layer will be used as overlay on the dwellings-layer to compute the number of dwellings within a certain distance. The attribute table now contains both information about the building as well as the isochrone 'ring' in which it falls. Figure 8.13 illustrates the isochrone and the buildings that are within the isochrone for location 9 of the VINEX neighborhood.

Now the calculations have to be done. To calculate the cumulative coverage of houses that is within a certain distance from point 9, again a query is performed for each distance category. For example: the layer that resulted from vector overlay is used. The query has to be done four times for each distance. The first query: AA_METERS = 100. The 'Basis statestieken' tool from the Vector analyze toolbox in QGIS counts 8 buildings within 100 meters. Secondly, AA_METERS = 300. Now 267 buildings are within 300 meters. Note that this includes the 8 buildings that are within 100 meters. Thirdly, AA_METERS = 500 and lastly AA_METERS = 1000. The latter indicates the total number of houses that has been covered in this service area. For location 9, this includes 2898 buildings. Relatively, 57% of the residential buildings have been covered within this neighborhood. This query has to be performed for each location. Appendix L shows the excel file in which the data for each location is noted down.
All these steps, from calculating the isochrone till calculating the number of houses that are within a certain distance have to be repeated manually for 18 times (for each location).

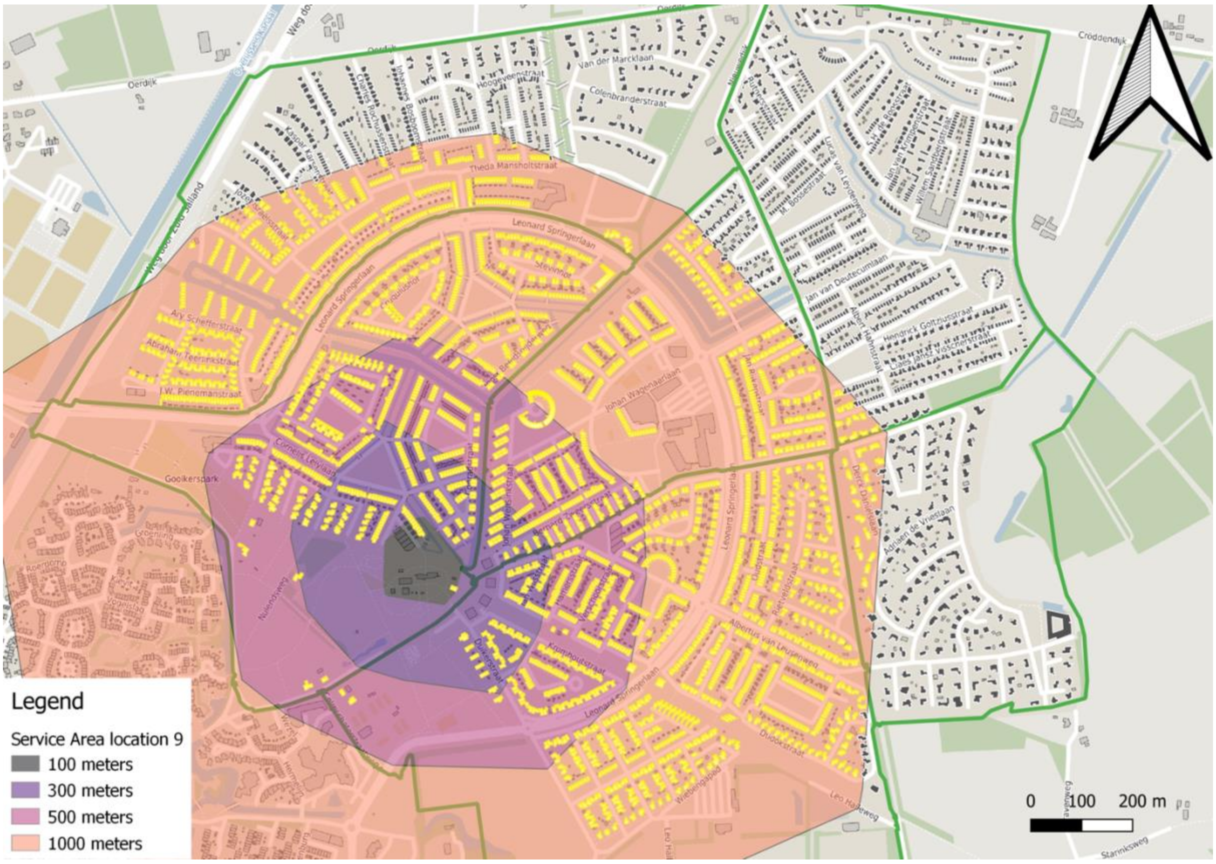


Figure 8.13. Location 9 service area isochrone

Appendix K Raw data independent mobility

Neighborhood	Walking_safety	Cycling_safety	Driveways	Traffic_calming	Bicycle_lanes	Path_obstructions	Sidewalk_continuity
Cauli 1	3	0	1	0	0	0	1
Cauli 2	3	3	1	0	0	0	0
Cauli 3	0	0	0	0	0	0	0
Cauli 4	3	0	0	0	0	1	0
Cauli 5	3	0	0	1	0	1	0
Cauli 6	1	2	1	2	0	0	2
Cauli 7	0	0	0	1	0	0	1
Cauli 8	1	2	1	0	0	0	1
VINEX 1	0	0	1	0	0	0	1
VINEX 2	3	3	0	2	1	0	0
VINEX 3	2	2	0	2	0	0	1
VINEX 4	3	3	1	1	1	0	2
VINEX 5	1	2	1	1	0	0	1
VINEX 6	2	2	0	0	1	0	1
VINEX 7	3	3	0	0	1	0	0
VINEX 8	1	1	1	1	1	1	1
VINEX 9	3	3	0	0	1	0	0
VINEX 10	2	2	0	0	1	0	0

Neighborhood	Sidewalk_condition	Crossing_aids	Lighting	Wayfinding_aids	Attractiveness_walking	Attractiveness_cycling	Mobility_score
Cauli 1	1	0	1	0	3	1	11
Cauli 2	1	0	3	0	1	0	12
Cauli 3	0	0	2	0	0	1	3
Cauli 4	1	0	0	0	3	1	9
Cauli 5	1	0	0	0	3	1	10
Cauli 6	2	0	3	0	2	2	17
Cauli 7	1	1	2	0	0	0	6
Cauli 8	1	0	3	0	1	2	12
VINEX 1	1	0	3	0	1	1	8
VINEX 2	1	1	3	0	3	3	20
VINEX 3	2	0	2	0	1	2	14
VINEX 4	2	0	0	0	2	2	17
VINEX 5	1	0	2	0	2	2	13
VINEX 6	1	0	1	1	1	3	13
VINEX 7	0	0	0	1	3	3	14
VINEX 8	1	0	1	0	1	1	11
VINEX 9	0	0	2	1	3	3	16
VINEX 10	0	0	3	1	2	3	14

Appendix L Raw data Network Analysis

Cauliflower neighborhood

#	Facilities	Number of dwellings reached														
		100m	%	300m	**300m comp**	%	500m	**500m comp**	%	1000m	**1000m comp**	%	Total	Relative num	Total numbe
1	Playground	3	**0,2%**	273	**270**	**14,8%**	628	**355**	**19,4%**	1827	**1199**	**65,6%**	1827	86%	2115
2	Playground	81	**4,3%**	463	**382**	**20,1%**	814	**351**	**18,5%**	1901	**1087**	**57,2%**	1901	90%	2115
3	Skatepark	22	**1,6%**	162	**140**	**10,1%**	471	**309**	**22,2%**	1392	**921**	**66,2%**	1392	66%	2115
4	Playground	105	**5,1%**	601	**496**	**23,9%**	953	**352**	**17,0%**	2071	**1118**	**54,0%**	2071	98%	2115
5	Footbal field	109	**5,2%**	697	**588**	**27,8%**	1181	**484**	**22,9%**	2113	**932**	**44,1%**	2113	100%	2115
6	Primary schools	75	**3,5%**	613	**538**	**25,4%**	1422	**809**	**38,3%**	2115	**693**	**32,8%**	2115	100%	2115
7	Supermarket	23	**1,1%**	594	**571**	**27,0%**	1547	**953**	**45,1%**	2115	**568**	**26,9%**	2115	100%	2115
8	Daycare	27	**1,6%**	195	**168**	**10,2%**	464	**269**	**16,3%**	1651	**1187**	**71,9%**	1651	78%	2115

Table 8.8. Raw data network analysis cauliflower neighborhood

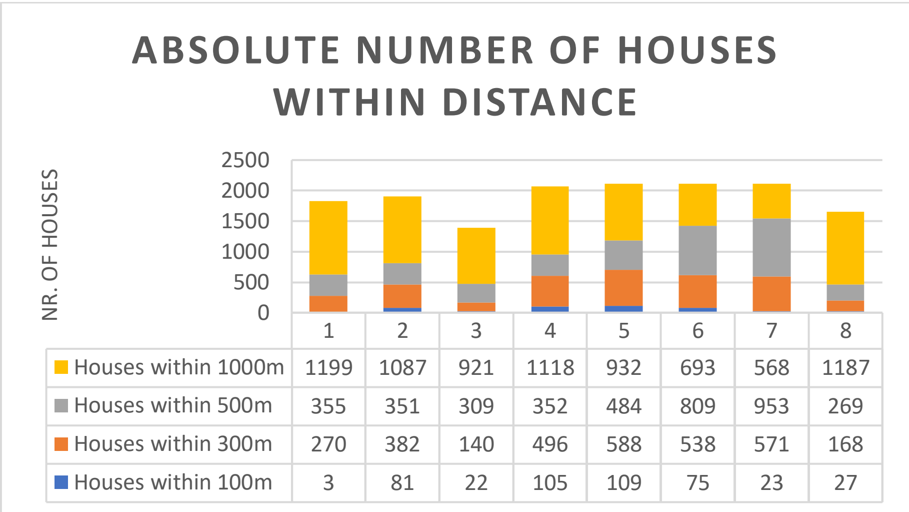


Figure 8.14. Absolute number of houses within distance cauliflower

VINEX neighborhood

#	Facilities	Number of dwellings reached														
		100m	**Coverage 100m**	300m	**300m comp**	**Coverage 30**	500m	**500m comp**	**Coverage 500m**	1000m	**1000m comp**	**Coverage 1000m**	Total	Relative num	Number of d
1	Shopping, Supermarket, Fast food	6	**0,2%**	252	**246**	**6,5%**	1069	**817**	**21,7%**	3757	**2688**	**71,5%**	3757	73%	5114
2	Schools	33	**0,9%**	463	**430**	**12,1%**	1201	**738**	**20,7%**	3567	**2366**	**66,3%**	3567	70%	5114
3	Daycare	32	**2,0%**	298	**266**	**16,4%**	799	**501**	**30,9%**	1621	**822**	**50,7%**	1621	32%	5114
4	Primary school	13	**0,4%**	282	**269**	**7,7%**	965	**683**	**19,5%**	3496	**2531**	**72,4%**	3496	68%	5114
5	Daycare	79	**3,5%**	400	**321**	**14,2%**	849	**449**	**19,9%**	2259	**1410**	**62,4%**	2259	44%	5114
6	Daycare	16	**0,7%**	191	**175**	**8,1%**	554	**363**	**16,9%**	2148	**1594**	**74,2%**	2148	42%	5114
7	Play area	5	**0,2%**	168	**163**	**6,5%**	762	**594**	**23,6%**	2518	**1756**	**69,7%**	2518	49%	5114
8	Sports field	2	**0,1%**	171	**169**	**10,8%**	465	**294**	**18,9%**	1559	**1094**	**70,2%**	1559	30%	5114
9	Petting zoo	8	**0,3%**	267	**259**	**8,9%**	946	**679**	**23,4%**	2898	**1952**	**67,4%**	2898	57%	5114
10	Tennis fields	0	**0,0%**	34	**34**	**1,8%**	250	**216**	**11,5%**	1875	**1625**	**86,7%**	1875	37%	5114

Table 8.9. Raw data network analysis VINEX neighborhood

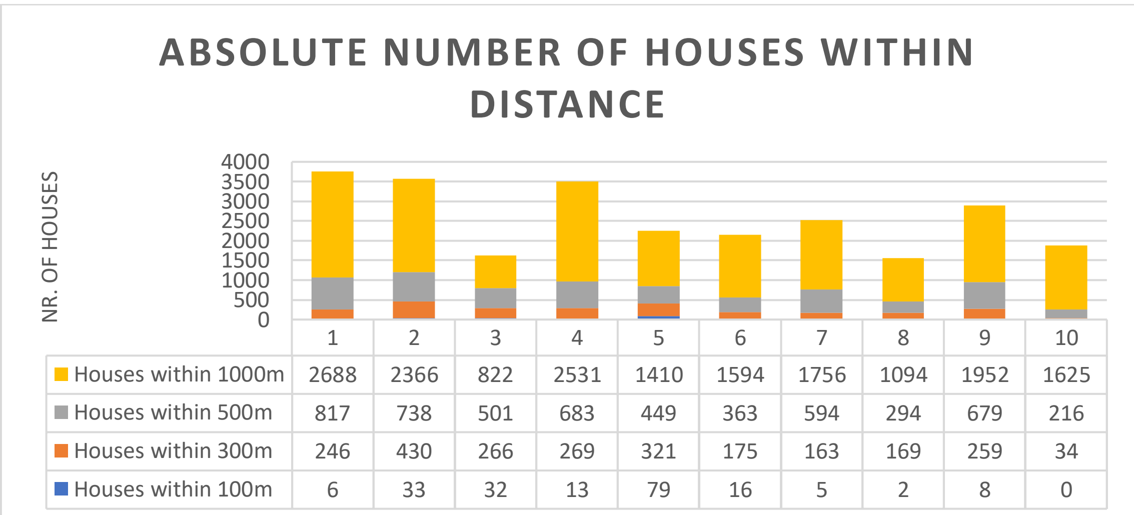


Figure 8.15. Absolute number of houses within distance cauliflower

Appendix M Independent mobility data: Normality & Levene's test

Figure 8.16. shows the Q-Q plot of the mobility scores for both neighborhoods. As can be seen, the data points are in line with the expected normalized results, indicating a normally distributed dataset. However, since Q-Q plots are not that straightforward in determining normality, a Shapiro-Wilk test has been performed. The results of this test can be seen in figure 8.17. As can be read from this figure, the Shapiro-Wilk test is very insignificant, this thus means that the dataset is normally distributed.

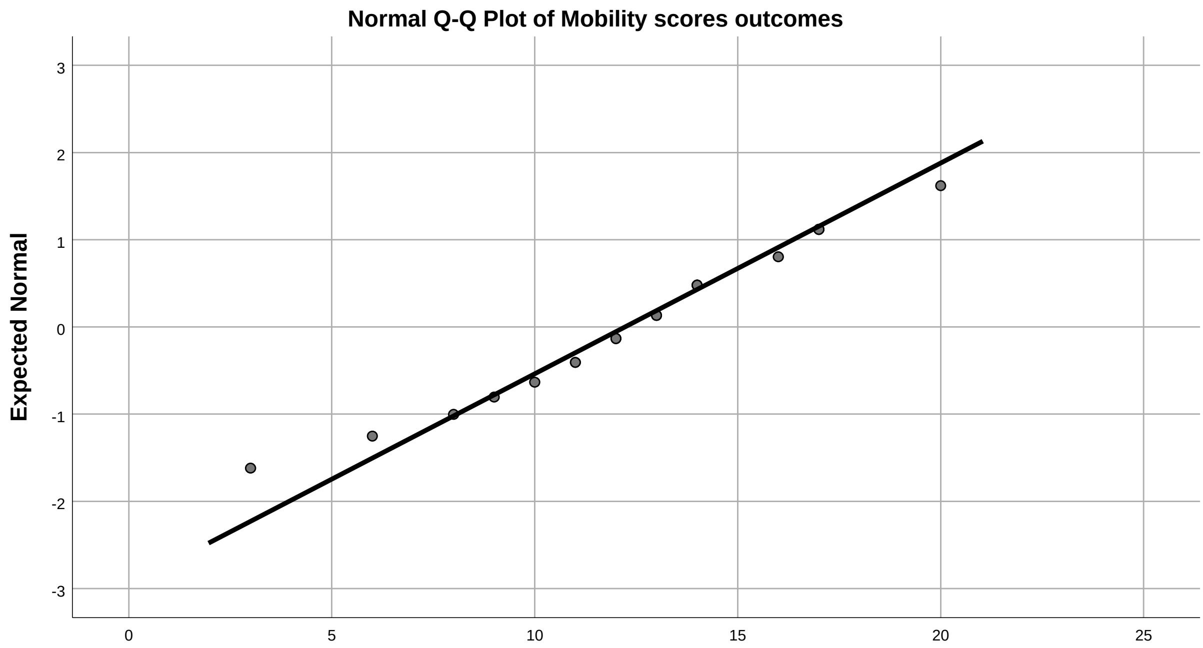


Figure 8.16. Q-Q plot of the mobility scores (whole dataset)

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Mobility scores outcomes	,112	18	,200*	,982	18	,971

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Figure 8.17. Shapiro-Wilk test of the mobility scores (whole dataset)

This appendix shows the results of the Levene's test that must be performed before executing the two-samples t-test. Using Levene's test will discover whether the two groups in the dataset (neighborhoods) have equal variances. Discovering whether the variances are equal is important for reading the significance of the two-samples t-test. The results of the Levene's test are shown in figure 8.18.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of .
		F	Sig.	t
Mobility scores outcomes	Equal variances assumed	,457	,509	-2,274
	Equal variances not assumed			-2,208

Figure 8.18. Two-samples t-test Levene's test for Equality of Variances

The significance of the Levene's test is 0,509. Having a confidence interval of 95%, the H0 can be accepted, thus assuming that there is not enough evidence for unequal variances.

Appendix N Network analysis: Normality & Levene's test

Tests of Normality

	Neighborhood type	Kolmogorov-Smirnov[a] Statistic	df	Sig.	Shapiro-... Statistic
Cumulative coverage of houses	Cauliflower	,242	8	,186	,842
	VINEX	,171	10	,200*	,914

Tests of Normality

	Neighborhood type	Shapiro-Wilk df	Sig.
Cumulative coverage of houses	Cauliflower	8	,079
	VINEX	10	,306

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Figure 8.19. Normality test network analysis

To indicate whether there is a significant difference in the network coverage to the facilities in both neighborhoods, a two-sample t-test has been performed due to the normality of the data (figure 8.19).

Levene's test has shown that equal variances can be assumed (figure 8.20).

Independent Samples Test

		Levene's Test for Equality of Variances F	Sig.	t-test for Equality of . t
Cumulative coverage of houses	Equal variances assumed	1,161	,297	5,700
	Equal variances not assumed			5,864

Figure 8.20. Levene's test network analysis

Appendix O Raw data affordances

Neighborhood	A_cycling	A_running	A_skipping	A_skating	A_hopscotch	A_playing_games	A_coastingdown	A_skateboarding	A_throwing	A_digging	A_building_structures	A_playingwith_animals	A_usingplants	A_jumpingover	A_jumpingdown	A_swinging
Cauli 1	No	Yes	Yes	No	No	Yes	No	No	Yes	No	No	No	No	No	Yes	Yes
Cauli 2	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	No	No	No	No	Yes	No
Cauli 3	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	No	No	No	No	Yes	Yes	No
Cauli 4	No	Yes	No	No	No	Yes	No	No	Yes	Yes	Yes	No	Yes	No	Yes	No
Cauli 5	No	Yes	No	No	No	Yes	No	No	Yes	No	No	No	Yes	No	No	No
Cauli 6	Yes	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No
Cauli 7	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No
Cauli 8	Yes	No	No	Yes	No	No	No	Yes	No	No	No	No	No	No	No	No
VINEX 1	Yes	No	Yes	Yes	Yes	No	No	Yes	No	No	No	No	No	No	No	No
VINEX 2	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No
VINEX 3	Yes	No	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No
VINEX 4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes
VINEX 5	No	No	No	No	Yes	No	No	Yes	No	No	No	No	No	No	No	No
VINEX 6	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	No	No	No	No	No	No	No
VINEX 7	No	Yes	Yes	No	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
VINEX 8	No	No	Yes	No	No	Yes	No	No	Yes	No	No	No	No	No	No	No
VINEX 9	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
VINEX 10	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No

Neighborhood	A_hanging	A_climbing	A_lookingout	A_hiding	A_peacequiet	A_molding	A_snow	A_swimming	A_fishing	A_water	A_role	A_rulegames	A_playhome	A_playwar	A_noisy	A_adultbuisin
Cauli 1	Yes	Yes	No	Yes	Yes	No	Yes	No	No	No	Yes	Yes	No	Yes	No	No
Cauli 2	Yes	Yes	Yes	No	Yes	No	Yes	No	No	No	Yes	Yes	Yes	Yes	No	No
Cauli 3	No	Yes	No	No	Yes	No	Yes	No	No	No	No	Yes	No	Yes	Yes	No
Cauli 4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	No
Cauli 5	No	No	No	No	Yes	No	No	No	No	No	No	Yes	No	Yes	Yes	No
Cauli 6	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No
Cauli 7	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No
Cauli 8	No	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	No
VINEX 1	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No
VINEX 2	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	No
VINEX 3	No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	Yes	No
VINEX 4	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	No
VINEX 5	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No
VINEX 6	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes
VINEX 7	No	Yes	No	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Yes	Yes	No
VINEX 8	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No
VINEX 9	No	Yes	No	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No
VINEX 10	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No

Appendix P Potential affordances: Normality test

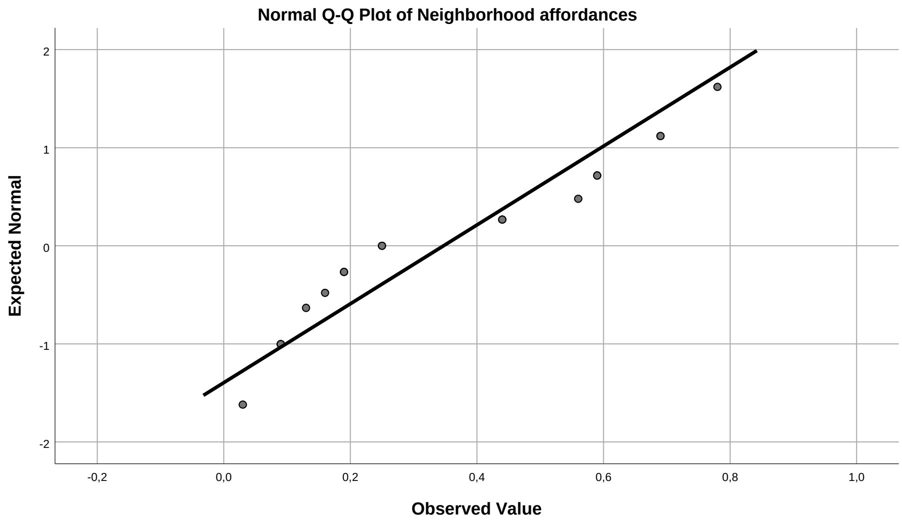


Figure 8.21. Q-Q plot affordances

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Neighborhood affordances	,208	18	,039	,895	18	,046

a. Lilliefors Significance Correction

Figure 8.22. Normality test affordances