URBAN DENSIFICATION THROUGH THE PERMANENCE AND TEMPORALITY OF NON-RESIDENTIAL INFRASTRUCTURE

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Abstract

As the urban population within the Netherlands grows and diversifies, cities face increasing challenges in meeting their increasingly unpredictable needs. Along with the challenge of urban densification, where space has become limited, there is an increasing need for the prudent implementation of non-residential infrastructure that is able to maximise this limited space whilst meeting these changing demands effectively. This brings about the conundrum of what degree our infrastructure should be adaptable and how this element of temporality implicates our neighbourhoods. Thus, this paper explores how non-residential infrastructure can be effectively implemented and adapted within Dutch neighbourhoods to respond to these changes. Through the analysis of neighbourhoods in Amsterdam and Almere, this paper forms an outline of how these demographic needs can be expected to shift and how non-residential infrastructure can meet them, what current strategies are employed in introducing and prioritising different types of non-residential infrastructure and how non-residential infrastructure may adapt to these changing demands.

Keywords: neighbourhood, demographics, adaptive construction, non-residential, urban densification

1. Introduction

As the population in the Netherlands continues to increase, the demand for housing within its cities continues to rise, in particular the population of Amsterdam is expected to increase by 19% between 2021 and 2035. *(De Jong et al., 2022)* This translates into a target of 105,000 additional dwellings to be built, as proposed by the municipality. Non-residential infrastructure will also be needed to support these neighbourhoods and provide amenities and services for its residents. *(Dantzig, 2022)* Aside from the increase in population it is also important to consider how its demographics are expected to change and how the demands of the neighbourhood may change with these shifts. In Amsterdam's current climate there has been increased unpredictability in the shifts surrounding its population, where not only is it increasing exponentially but also the rate at which its main demographic is diversifying. *(Statista, 2024a)* This results in a range of needs to be met through public and non-residential infrastructure within these neighbourhoods. With the unpredictability of how its demographics will change in the near future, the prudent use of space is important in ensuring that these demands can be effectively met and that the limited space can be maximised. Therefore, it is necessary for non-residential infrastructure to be tailored to the changing demographical demands of each neighbourhood,

allowing for the neighbourhood to adapt to these changes. Thus, it is necessary to have an understanding of what each demographic needs and when they need it, lending itself into finding the balance of how permanent each iteration of non-residential infrastructure should be implemented in meeting these

changing needs. Therefore, this research studies the correlation between the evolving demands of Dutch neighbourhoods due to their changing demographics and how that translates into the need for different types of non-residential infrastructure and how new construction can effectively meet these changing demographic demands. This will be done through the following research question:

"How can non-residential infrastructure be effectively introduced into Dutch neighbourhoods in response to their evolving demographic needs through the use of timber construction?"

This will be undertaken through the following sub-questions:

1. "What is the expected demographic shift within Amsterdam?"
2. "What is the role of permanent infrastructure within our neighbourhoods?"
3. "How are standard public infrastructure and institutions implemented and how do they correlate to the development of neighbourhoods?"
4. "How can adaptive infrastructure be imposed onto neighbourhoods to promote the ease of adaptability of non-residential institutes?"

Through the research the following definitions were used:

Non-residential infrastructure | Building and spaces designed for public institutions and functions (schools, supermarkets, retail, general practitioner, restaurants, etc.) *(Al-Shargabi et al., 2022)*

Non-residential functions | Purpose of a building or infrastructure, it relates to the operations and processes within the building not designated for dwellings(Designing Buildings Ltd, 2021)

This idea of a neighbourhood that grows alongside its residents and adapts to their changing needs was embodied through Peter Cook's "Plug-in City". Which pursued the idea of a replaceable city system, where all elements from floors to public amenities were allocated a permanence rating, a projected lifespan before getting replaced. In this scheme, residential units were to be relocated every 15 years to be closer to non-residential infrastructure that best catered to their needs. *(Archigram, 1999)* Similar to Brand's shearing layers of change where to prolong the lifespan of a building each building layer is replaceable and made to be able to be replaced independently. In the context of a neighbourhood this would extend to an open city system, a framework that will allow for the freedom and flexibility of individual design and possibly the gradual addition or adaption of non-residential infrastructure. *(Manifesto — Open Building, n.d.)* By adopting a framework it also allows for the creation of curated space for temporary infrastructure which would create allowance for adapting or change. *(Oswalt et al., 2013)*

2. Methodology

This research aims to identify the relationship between expected demographic shifts and their resulting demand for respective non-residential infrastructures in Dutch neighbourhoods and consequently the strategies employed in meeting these demands. This was conducted mainly through site analyses of various neighbourhoods in Amsterdam and Almere, coupled with projections and historical documentation of the sites and how non-residential infrastructures have been introduced into these neighbourhoods. Through the site visits the following questions were investigated:

1. "What are the triggers for the introduction of the different types of non-residential infrastructure and if they are implicated by the demographical shifts within the neighbourhoods? "
2. "How are different types of non-residential infrastructure prioritised in residential neighbourhoods?"
3. "What are the available types of non-residential infrastructure and how much traffic do they garner?"

The site visits consisted of the documentation of existing non-residential infrastructure and surveyed their conditions, traffic and activities that surround these facilities. After which the data was compared in ascertaining what can be considered to be essential non-residential infrastructure and patterns. Taken against the demographical changes within each neighbourhood the triggers and strategies in which non-residential infrastructures are implemented were identified. And hence resulting in an overarching strategy for new neighbourhoods.

3.1 "What are the expected demographical shifts within Amsterdam?"
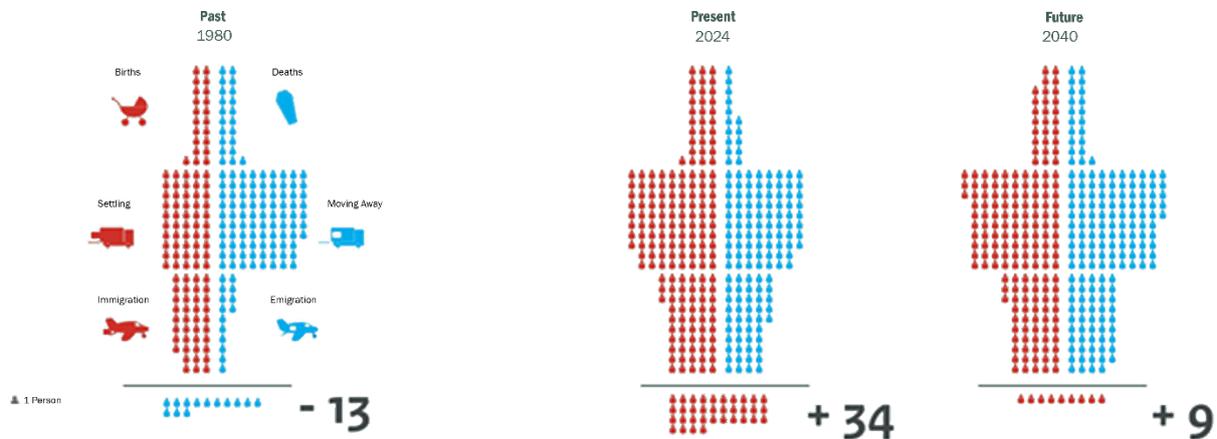

Figure 1:Ingoing and Outgoing within Amsterdam, (pbl.nl, 2016)

In the last several decades demographical shifts in Amsterdam have not only increased in magnitude but has also been part of an overall growth in its population. Figure 1 examines the overall population changes within Amsterdam and the manner in which the population changes. Generally, the population is expected to increase though at a slowing rate. In 1980, the initial degrowth of its population was due to the introduction of satellite cities like *Almere* which prompted people to move out of the centre of Amsterdam for cheaper yet accessible housing. Though this increase is expected to slow in the future what remains is a large demographical change which naturally translates into Amsterdam's architecture having to adapt to these changing needs. *(pbl.nl, 2016)* With a large proportion of this change being a result of immigration and emigration, Amsterdam has and will receive a huge change in its cultural demographic, which in itself poses demands on the type of housing available and how its neighbourhoods are structured in meeting these new demands. The increase in change in its cultural demographic also correlates to other factors like income level hence placing new demands onto the structure of its neighbourhoods and non-residential infrastructure. *(Trifonova, 2023)*Within the Netherlands, its population is also ageing, the average age has increased by 8.8 years between 1975 and today. (Statline, 2025) This would indicate that there is a need for increased non-residential infrastructure and facilities to accommodate for the elderly, resulting in the increase of specialised medical and care facilities(physiotherapists, heart specialists, elderly care centres).
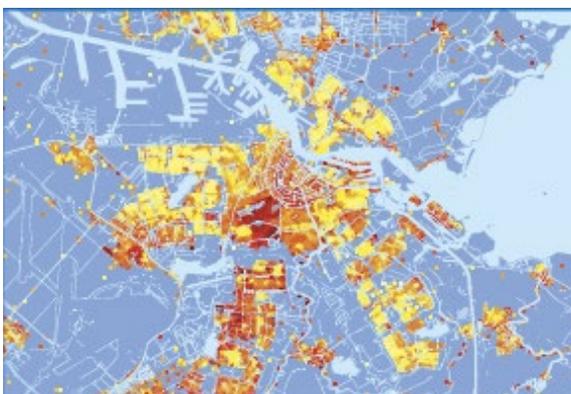

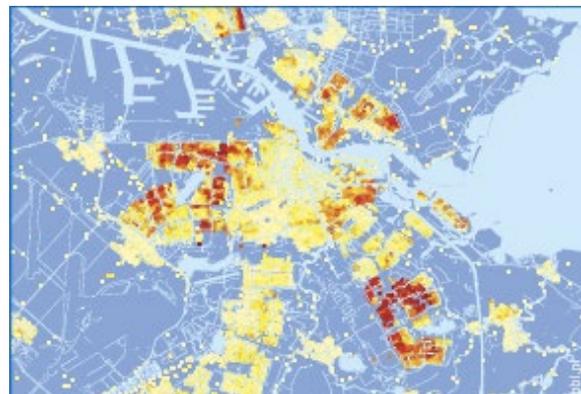*Figure 2: Income level per person (2008),* (pbl.nl, 2016)

Figure 3: Proportion of population of Non-Western Background (2010), (pbl.nl, 2016)

3.2. "What is the role of permanent infrastructure within our neighbourhoods?"

As these demands associated with the changing demographic arises, there is a need for our cities to adapt to meet these needs. And often this leads to infrastructural changes, however as these demographics continue to evolve and these needs grow how much should be adapted and what is the merit to permanent infrastructure within our neighbourhoods? In the Everyday Urbanism, Margret Crawford refers to "everyday public space" as the connective tissue that holds daily life together through lived experiences. When this everyday space becomes more permanent, more lives are held together by these spaces and eventually a community is fostered around these spaces.(Chase et al., 2008)

Permanent infrastructure also plays a role in the creation of a sense of place, through establishing recognisable permanent elements. And as a neighbourhood grows alongside these permanent elements, emotive bonds, attachments and experiences are tied to these infrastructures and spaces. (Foote & Azaryahu, 2009) When people have a shared sense of space it helps to also foster communities and retain its population. This will help to minimise how and the rate in which its main demographic may shift, reducing the need for new infrastructure. Therefore permanent infrastructure help foster communities and reduce the rate in which its demographics change.

4. Case Studies

4.1   Background

In understanding how neighbourhoods in Amsterdam and their demands change over time, 7 neighbourhoods constructed in different periods were analysed. The neighbourhoods selected were all developed as new neighbourhoods as opposed to neighbourhoods that were developed onto existing infrastructures to increase the uniformity between these neighbourhoods and draw a more accurate comparison. The two areas selected were *Almere* and *Ijburg*, both new residential areas with close proximity to the centre of Amsterdam. The neighbourhoods were selected based on their period of development. Prior to the site visits, the number of and types of public infrastructure and amenities of each area were documented as well as their current demographics.

In visiting these areas the primary goal was to gain insight on how non-residential infrastructures have been implemented in these neighbourhoods and what the strategies undertaken in the implementation of these infrastructures are. Through these site visits their non-residential infrastructures were accounted for and analysed, the condition and traffic surrounding these non-residential infrastructures were used as indicators of their necessity. And through this an approximation was drawn on when each type of
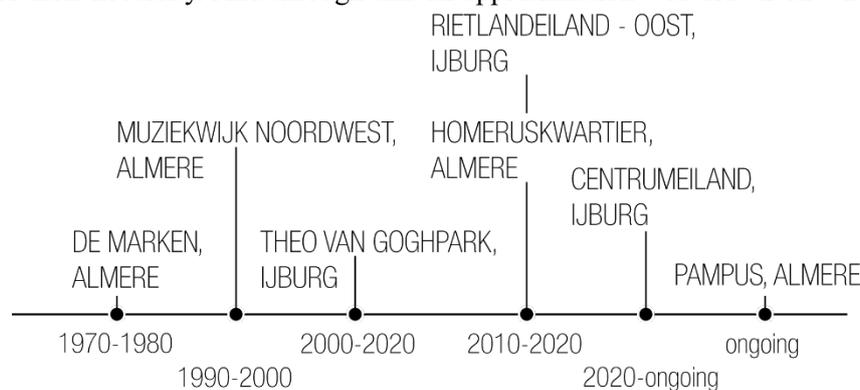

Figure 2: Timeline of Studied Neighbourhoods

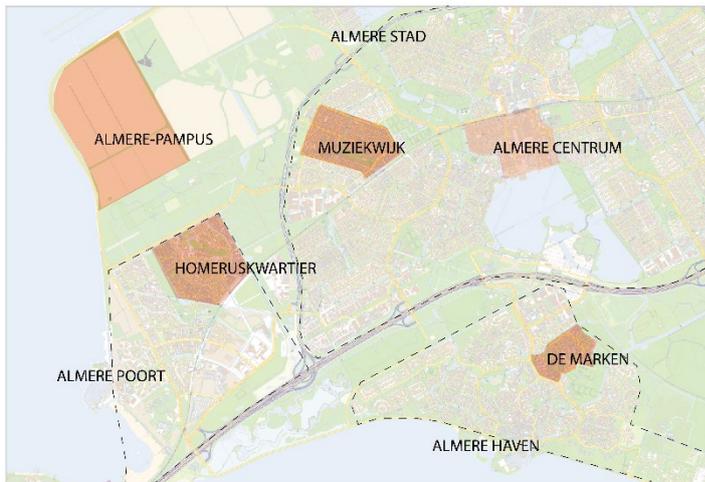infrastructure is most pertinent in each period and a potential period on when each function is most necessary.

Figure 4: Overview of Case Studies in Almere

Almere

Almere is a satellite city located at the periphery of Amsterdam, in Flevoland. As a new city, its neighbourhoods were developed completely from scratch with the first of its districts, *Almerehaven* being developed in the 1980s. As a city undergoing continuous expansion, its neighbourhoods vary in age and some of which like *Almere-Pampus* are still in the plans for development. Hence, whilst still maintaining a strong relationship to the city of Amsterdam, Almere still functions largely as a separate entity. Without existing infrastructures, the organisation of neighbourhoods within Almere is distinctly different in how non-residential infrastructures are implemented and used.

Figure 5: Overview if Case Studies Ijburg

Ijburg

Ijburg is located within the east of Amsterdam, currently built atop entirely new artificial islands, it currently houses numerous residential neighbourhoods. The main demographic within Ijburg is young families, which is reflected by the strong emphasis on child-oriented non-residential infrastructure. The structure of the distribution of non-residential infrastructure within Ijburg operates through a hierarchical structure where there is a high concentration of non-residential infrastructure contained within a primary neighbourhood with the peripheral neighbourhoods sharing these amenities whilst having a limited amount themselves. (as shown in Figure 5)

Within both areas, 7 neighbourhoods were visited; De Marken, Muziekwijk, Homeruskwartier, Almere-Pampus, Theo van Goghparkbuurt, Rietleiland Oost and Centrumeiland. These neighbourhoods contain varying demographics and this is reflected in the types of non-residential infrastructure located in each neighbourhood.
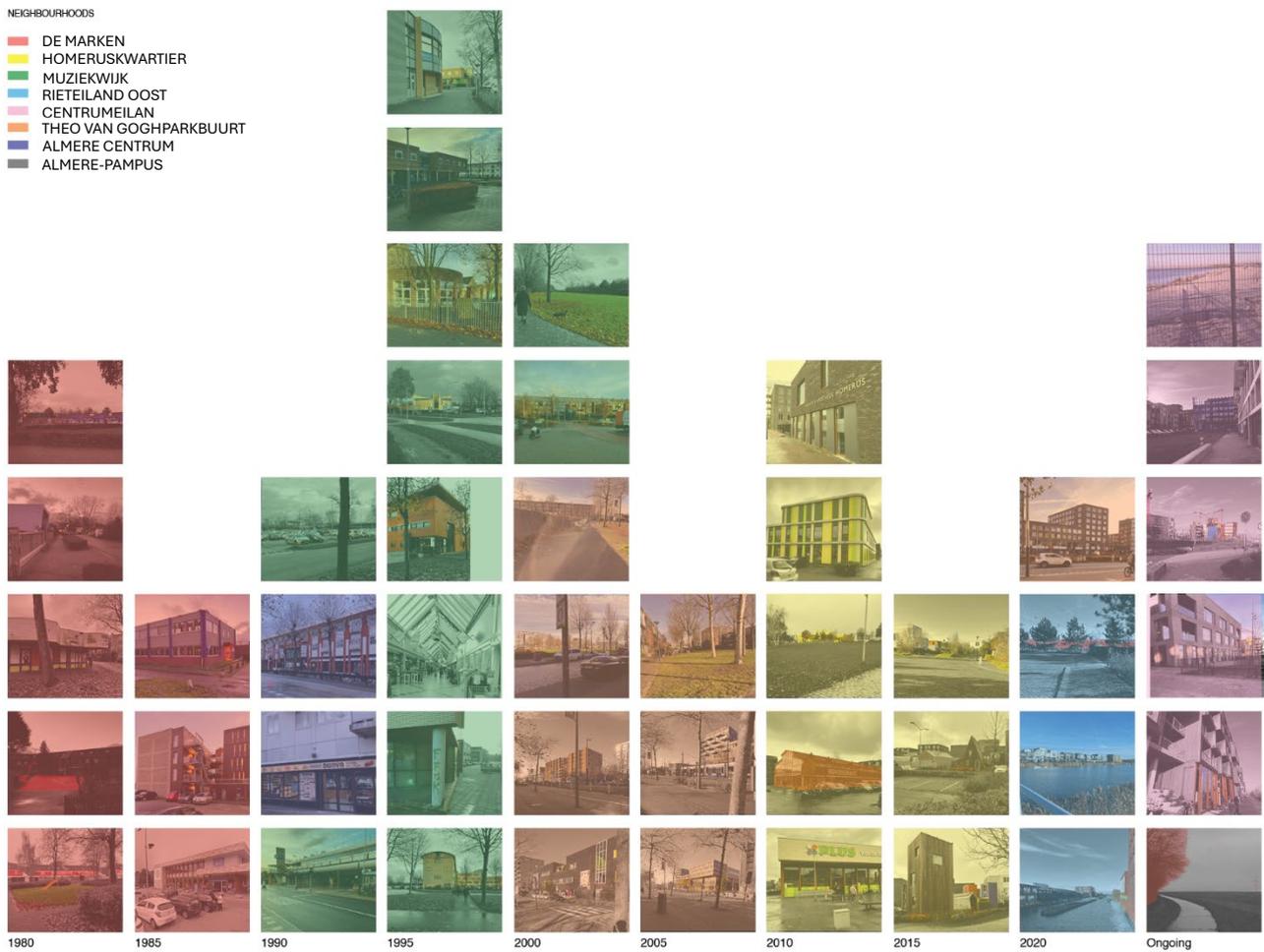
Figure 6: Overview of Non-residential Infrastructure and when they were Introduced

DE MARKEN	MUZIEKWIJK	HOMERUSKWARTIER	CENTRUMEILAND	THEO VAN GOGH PARKBUURT	RIETLAND-OOST
• Kindergarten	• Kindergarten	• Kindergarten	• Daycare	• Kindergarten	• Sport Facilities
• Daycare	• Daycare	• Daycare	• Basisschool	• Daycare	
• Basisschool	• Basisschool	• Basisschool	• Specialised Medical Centre	• Basisschool	
• Art Club	• General Practitioner	• General Practitioner	• Gym	• General Practitioner	
• Disability Support	• Dentist	• Dentist		• Dentist	
• Supermarket	• Physiotherapist	• Physiotherapist		• Physiotherapist	
• Hardware Store	• Pharmacy	• Pharmacy		• Pharmacy	
• Garage	• Elderly care	• Elderly care		• Elderly care	
	• Specialised Medical Centre	• Specialised Medical Centre		• Specialised Medical Centre	
	• Disability Support	• Disability Support		• Supermarket	
	• Supermarket	• Supermarket		• Sport Facilities	
	• Garage	• Garage		• Restaurant	
	• Sport Facilities	• Sport Facilities		• Retail	
	• Restaurant	• Restaurant		• Beauty centres	
	• Religious Institutes	• Religious Institutes		• Cafe	
	• Retail	• Retail		• Specialised supermarket	
	• Beauty centres	• Beauty centres			
	• Cafe	• Cafe			
	• Hardware Stores	• Hardware Stores			

Figure 7: Overview of Non-residential Infrastructure in all studied Case Studies

4.2.1. Almere, De Marken

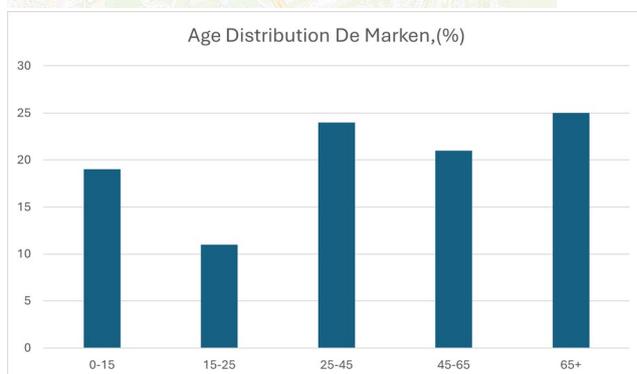Constructed: 1970 - 1980, *(AlleCijfers, 2025i)*

Total Population: 2995

Figure 8: Map of De Marken and Age Distribution, (AlleCijfers, 2025j)

De Marken is located within Almerehaven and was built in the 1980s, the neighbourhood exhibits a "cauliflower plan", and was built as one of the first neighbourhoods of Almere. As a "cauliflower neighbourhood", the neighbourhood was designed with the goal of the creation of intimacy and community, through the implementation of shared neighbourhood space to increase interaction between neighbours. (*Kappert,'* n.d.)

Built in conjunction with surrounding neighbourhoods (De Steiger, De Gouwen, De Hoven, De Werven), it is part of a Co-dependent Neighbourhood*(refer to Figure 18)* developing an interdependency on its surrounding neighbourhoods. The age distribution of the neighbourhood is generally balanced whilst exhibiting a slight skew towards an ageing neighbourhood. As a result, these are reflected through its non-residential infrastructure. De Marken contains several elderly homecare facilities and child-oriented facilities aside from which it is largely lacking in most other infrastructure such as pharmacies and general practitioners. Conversely, the neighbourhood does contain specialised disability care facilities. This is largely due to the availability of the absent infrastructure within the adjacent neighbourhoods and the sharing of these facilities that allow for a collective diverse range of infrastructure.

Additionally, with De Marken being constructed in 1970, its age is reflected through the condition of its infrastructure. The facades and public infrastructure appear to be poorly maintained. The lack of investment into the upkeep of the neighbourhood could be indicative of the low price in housing in De Marken(refer to Appendix C) and the general neighbourhood trajectory. Though not all buildings within De Marken were poorly maintained as several non-residential buildings were added to the neighbourhood over time, the disability care centre was built in approximately 1993 and further redeveloped in 2015 and 2018. This could be indicative of the increased need for care centres for the disabled. Additionally, the new larger supermarket was built in 2014, which corresponds to the increasing population in Almere. Hence, there is some correlation between the condition and types of non-residential infrastructure and the changing demographics of the neighbourhood.

4.2.2. Almere, Homeruskwartier

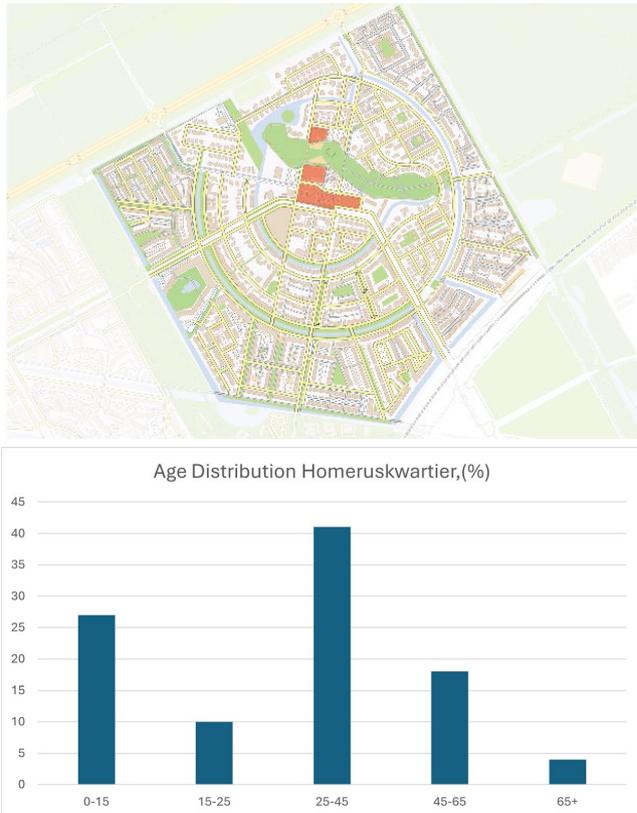Constructed: 2010 - ongoing (*AlleCijfers*, 2025k)

Total population: 8020

Figure 9: Map of Homeruskwartier and Age Distribution, (AlleCijfers, 2025l)

Located within Almere poort, Homeruskwartier is one of the new neighbourhoods that have been developed in Almere. New child-centred infrastructures have been introduced targeting newcomers into the housing market, which consists mainly of young families. Therefore, this is reflected in its demographics and hence its non-residential infrastructure, where there is a large concentration of child-oriented infrastructure. As a new neighbourhood, it has undertaken numerous new strategies in its development. The new non-residential construction consists of a combination of infrastructure that have minimised their construction time and construction that have been built with the option for future development. Including the use of demountable and prefabricated construction. (refer to Appendix E-1, E-2) The neighbourhood also consists of a strong green public centre, where most of its non-residential functions are located. This generates increased traffic within its centre and vibrancy. The neighbourhood also includes diverse housing types as well as experimental housing, this reduces the rigidity of the neighbourhood and creates a more hospitable environment.(refer to Appendix E-3) The neighbourhood is highly car-oriented with high traffic flowing through the neighbourhood as opposed to other modes of transport. Within the new neighbourhood, it is clear that its current main demographic was clearly targeted as the high concentration of child-centred infrastructure was pre-emptively introduced.

4.2.3. Almere. Muziekwijk Noord-west

Constructed: 1990 - 2000 *(AlleCijfers, 2025c)*

Total population: 1675

Muziekwijk Noordwest is located in Almere stad, part of the expansion of Almere in 1990. Despite being constructed just over 30 years ago, its population has faced severe greying especially as the surrounding infrastructures have developed around this demographical shift.(refer to Figure 10) With the neighbourhood boasting a high concentration of care facilities as well as specialised medical centres. This may have also attracted new aged residents to the neighbourhood, bolstering the already grey population. The neighbourhood, consists of a strong core containing of basic non-residential functions and a large public park attracting high traffic.(refer to Appendix F) Despite its non-residential infrastructure being dated, high traffic was still observed.(appendix In general, the neighbourhood consisted largely of typical Dutch row housing indicating lower cost construction and housing types.

Figure 10: Map of Muziekwijk Noordwest and Age Distribution(AlleCijfers, 2025d)

Within the neighbourhood, it was clear that with its set of basic non-residential infrastructure, it allowed for the neighbourhood to function independently. And react to its changing demographics, with its greying population specialised medical centres such as physiotherapists and cardiology centres were introduced to meet its new demands. (refer to Appendix F-3, F-4) (*Topotijdreis: 200 Jaar Topografische Kaarten, n.d.*)

4.2.4. Ijburg, Theo van Goghparkbuurt

Constructed: 2000-2020*(AlleCijfers, 2025g)*
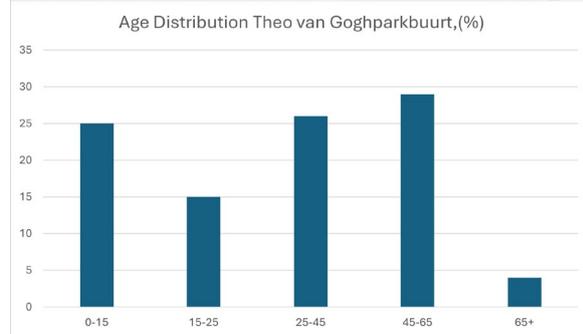
Total Population:13716

Figure 11: Age Distribution in Theo van Goghparkbuurt, (AlleCijfers, 2025h)

Constructed in the early 2000s, Theo van Goghparkbuurt is a large neighbourhood containing a large range of non-residential infrastructure and particularly a high concentration of retail functions. Though most of which was introduced during the initial construction of the neighbourhood, there were several new speciality supermarkets, specific to different minority groups. This corresponds to the increase in minorities within the neighbourhood and is likely a response to which. The non-residential infrastructure within the neighbourhood was diverse and extended beyond the basic, including large sport centres and high schools.(refer to Appendix I) This is likely due the neighbourhood being in combination with Rieteiland Oost and Centrumeiland a hierarchical neighbourhood structure. Where Theo van Goghparkbburt being the primary neighbourhood, containing a large range of non-residential infrastructure supporting the secondary neighbourhoods(Rieteiland Oost and Centrumeiland). This results in the secondary neighbourhoods consisting of primarily residential infrastructure with limited non-residential infrastructure. The 3 neighbourhoods are also well connected through roads and Centrumeiland is well connected through the tramline running through the neighbourhood reducing the commute time between the neighbourhoods.

4.2.5. Ijburg, Rieteiland Oost

Constructed: 2010-2020, *(AlleCijfers, 2025e)*

Total Population: 315

The dependency of Rieteiland Oost on Theo van Goghparkbuurt was apparent through the lack of non-residential infrastructure, which amounted to only a large set of tennis courts. Through the neighbourhood there was limited foot traffic observed and instead there was high vehicular traffic. The population of the neighbourhood was limited with relatively high income levels.(refer to Appendix C) This may have influenced the lack of presence of non-residential infrastructure.
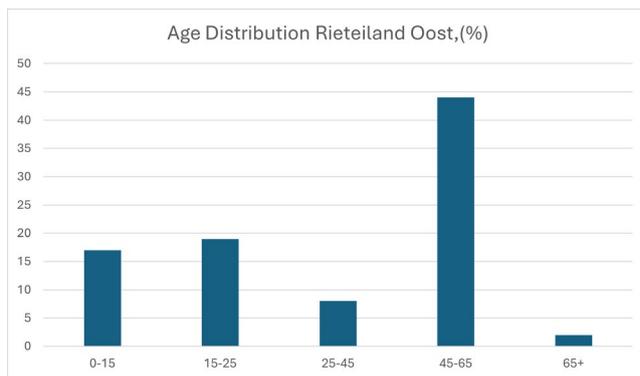

Figure 12: Tennis Courts (Above), Age Distribution Rieteiland Oost, (AlleCijfers, 2025f) (below)

4.2.6. Ijburg, Centrumeiland

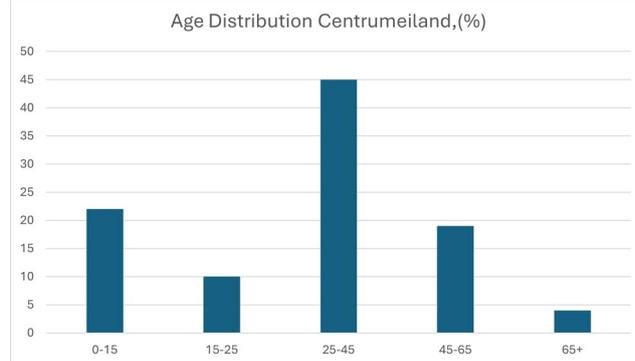Constructed: 2020-ongoing, *(AlleCijfers, 2025a)*

Total Population:1120

Age Distribution Centrumeiland,(%)

Figure 13: New modular apartments(above), Age Distribution Centrumeiland, (AlleCijfers, 2025b)

what may be deemed as basic human needs.

Centrumeiland is a neighbourhood still undergoing development, despite which it is partially inhabited and has several non-residential infrastructure in place. The neighbourhood is expected to be completed in 2029, with 60-70% of its residences being self-built. And with there being an expected total of 1700 homes there is a high density of apartment buildings with currently just a single school and gym. *(Gemeente Amsterdam, n.d.)* Similar to Rieteiland Oost, Centrumeiland has a clear dependency on Theo van Goghparkbuurt, though this attributes to the limited non-residential infrastructure in the neighbourhood. The priority of functions like schools and gyms over more essential infrastructure like supermarkets can be likely attributed to the expected frequency of visits to these infrastructures in a week. Where the average Dutch resident visits the supermarket 2 to 4 times a week in contrast to schools which a family would use 5 days in a week. *(Food and Agriculture Organization of the United Nations & United Nations, 2006), (Statista, 2024b)* Especially in a neighbourhood targeted towards young families and equipped with a sufficient transport system, this priority could shift towards the frequency of use rather than

5. Results and Discussion

5.1. Overall Findings

Through the site visits in both Almere and Ijburg it was clear that the manner in which non-residential infrastructures is introduced and distributed within these neighbourhoods is closely connected to the demographics in each neighbourhood. Of which, these strategies have been observe to mainly target 2 scales, the urban and the building scale(refer to Appendix L). Through the urban scale, these strategies have adopted the "open city" concept, the creation of a framework for non-residential infrastructure to be inserted and given the allowance to adapt to future societal demands. Whereas, at the building scale the main consideration was how the building could be adapted to the user and this extended to not just non-residential infrastructure but also residential infrastructure. Additionally, these approaches were triggered by numerous catalysts which ranged from the changing demographics to its surrounding urban context changing. And lastly, these strategies employed were also contingent on numerous factors within the context of each neighbourhood and were adapted based on the applicability through these considerations.

5.2.1 Adaptive strategies surrounding non-residential infrastructure at the urban scale


Figure 14: Urban connectivity Strategies, Transport lines, Theo van Goghparkbuurt(Left), Central Green Network, Muziekwijk(Middle)

The strategies undertaken at the urban scale were aimed at future proofing the neighbourhoods through the focus on where and when non-residential infrastructure is introduced. This was closely linked in maximising activity surrounding these amenities thus leading to the exploration of the interconnectivity and traffic surrounding these areas.

Throughout the neighbourhoods in Almere, green corridors were heavily used in both between and within neighbourhoods. This strong presence of a green network, encourages traffic and vibrancy within and across these neighbourhoods. And often these green spaces led to neighbourhood centres with high concentrations of non-residential infrastructure. Not all neighbourhoods were observed to contain all basic non- residential infrastructure and often this was supplemented with strong connections to nearby neighbourhoods containing those infrastructures. In Ijburg, it was evident that this strategy was heavily undertaken through the use of an extensive tram network whilst centring the majority of its non-residential infrastructure within Theo van Goghparkbuurt, located within the centre of Ijburg. While

these strategies are may not directly implicate the adaptability of each building, they foster high traffic spaces that will be ideal spaces for non-residential infrastructures which will encourage the usage of them and preserve their centrality within the neighbourhoods.
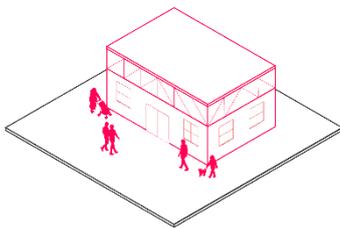
High traffic infrastructure
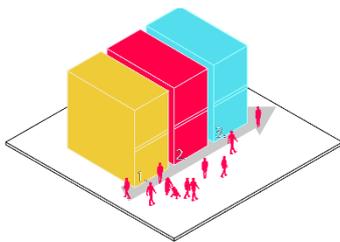
Introducing Infrastructure Based on Frequency of Use:

Strong Core Attractive Functions

Figure 15: Urban Strategies for Non-residential Infrastructure
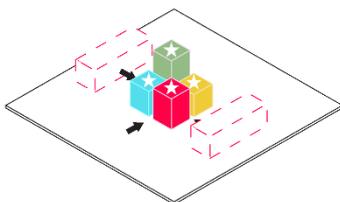
In addition to improving the accessibility through the neighbourhoods, it was also observed that various strategies regarding the selection of non-residential infrastructure and where they were to be located were undertaken. In most neighbourhoods, functions that would expect to attract higher traffic were located typically located in the centre of these neighbourhoods. These functions like schools, supermarkets and retail outlets were placed in close proximity to foster lively centres within these neighbourhoods. Additionally, attractive functions like sport complexes and higher level education were also located in some neighbourhood centres like in Theo van Goghparkbuurt, were observed to attract high levels of traffic. These strategies were undertaken in ensuring the longevity of these neighbourhood centres by encouraging increased human activity in these centres.

Through observing neighbourhoods of varying ages, it was apparent that there was a tendency for non-residential infrastructure that were expected to garner more daily traffic and use to be prioritised. Across almost all neighbourhoods, child-centred infrastructures were present, even in neighbourhoods with little to no other non-residential infrastructure. Conversely, supermarkets and general practitioners which may be deemed as essential functions were not always present in these neighbourhoods. And it seemed that there was a priority for the more frequently used child-centred infrastructure, this was also observed in Centrumeiland, Ijburg where functions like gyms and schools were introduced ahead of these essential functions. Thus leading to the hyptothesis that infrastructure was introduced based on the expected frequency of use by its users.

5.2.2. Adaptive strategies surrounding non-residential infrastructure at the building scale

This research was largely centred on the neighbourhood scale and how non-residential infrastructure have been implemented according to their changing demographics and respective needs. Through the site visits it was apparent that the strategies undertaken at the building level to preserve adaptability within building systems would allow for non-residential infrastructure to adapt from accommodating one function to another as building requirements differ from function to function. Various strategies were undertaken from how infrastructure is designed to be adaptable to how functions can be programmed into each building.

Figure 16: Demountable Construction in non-residential infrastructure

Permanent demountable infrastructure

Homeruskwartier being a relatively new neighbourhood has undertaken future proofing strategies within its centre to ensure that its non-residential infrastructure is able to adapt to possible future demographical changes. It was observed that numerous structures within the centre were largely demountable through the use of dry joints. This allows for the option for these structures to either be demounted or adapted whilst also providing the option for these infrastructure to be permanent.


Demountable Constructione
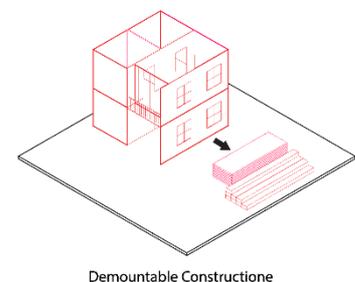
Open building concept

Across the various neighbourhoods non-residential infrastructure have adopted the open building strategy in different capacities. The open building strategy seeks to perpetuate the lifespan of buildings by at least 150 years by increasing their adaptability, through the separation of the building structure and its infill. (*Manifesto — Open Building*, n.d.) Through allowing the infill to change according to the demands of its users, the building shell can have several different lives as differing non-residential infrastructures. Within the studied neighbourhoods, non-residential infrastructure adopting the open building principles were common throughout but mainly found within the neighbourhoods built after 1990. Within Centrumeiland, the introduction of infrastructures consisting of large modules were observed. This along with the numerous self-residential units showed how infrastructure can still be given the potential to adapt in the future.

Sequential Introduction of Mixed Functions

Lastly, the sequential introduction of mixed functions were observed through the example of both Centrumeiland and Theo van Goghparkbuurt. Where the upper floors were first occupied by its residents and plinths left initially unoccupied and eventually functions are slowly introduced according to the potential demographics of its residents. This also provides the flexibility where these functions could easily change according to these demands hence allowing the neighbourhood to adjust to these changing needs.

Mixed Functions
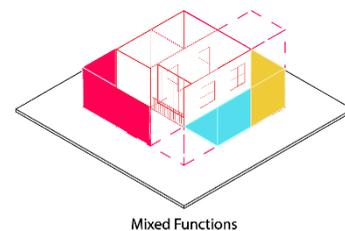
5.3. Other factors that influence how non-residential infrastructure is introduced

Aside from the above strategies, the manner in which non-residential infrastructure is introduced is also highly dependent on the context of each neighbourhood. Particularly, the neighbourhood structure as well as the population size within each neighbourhood. Through the site visits there were a several types of neighbourhood structures observed: Independent, co-dependent and hierarchical structures.
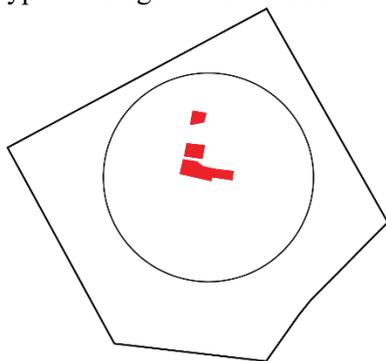
Figure 17: Independent Neighbourhood Structure

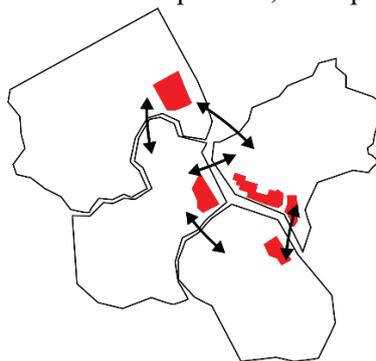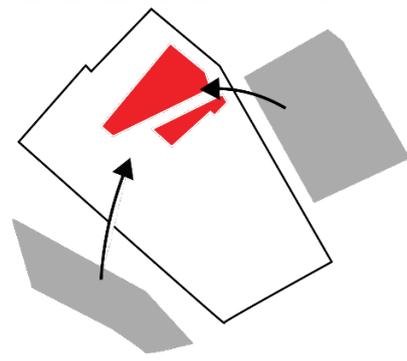*Figure 18: Co-dependent Neighbourhoods*

Figure 19: Hierarchical Neighbourhood Structure

Independent neighbourhoods as observed in Muziekwijk and Homeruskwartier function on their own, containing necessary basic amenities within themselves. These neighbourhoods tend to be located further from other neighbourhoods. And often their non-residential functions and infrastructure are located in the centre.

Co-dependent neighbourhoods as observed in De Marken, where the various neighbourhoods are located in close proximity and well connected. Allowing for amenities to be shared between the neighbourhoods and with each neighbourhood containing a different set of amenities. Which allows for a greater range of non-residential infrastructures within each co-dependent neighbourhood cluster.

Lastly, hierarchical neighbourhood systems consist of two separate neighbourhood structures: a core neighbourhood and secondary neighbourhoods.(denoted by grey in figure 19) This was observed in Ijburg, with Theo van Goghparkbuurt forming the core neighbourhood and Rieteiland Oost and Centrumeiland forming secondary neighbourhoods. All neighbourhoods are located in close proximity and are well connected, most non-residential functions are located in the core neighbourhood in the centre of the system. This allows secondary neighbourhoods to carry less non-residential infrastructure and maximise their space to contain residential infrastructure.

Additionally, the amount of non-residential infrastructure introduced was observed to correlate with the population size in each neighbourhood. Neighbourhoods like Muziekwijk, Theo van Goghparkbuurt and Homeruskwartier had higher total non-residential infrastructure per capita than neighbourhoods like Rieteiland Oost refer to Figure 20) This is generally directly related to the total population in each neighbourhood.

Lastly, these neighbourhoods also selected non-residential infrastructure based on the expected main demographic. In most of the newer neighbourhoods visited, there was a strong presence of child-centred infrastructure as the main demographic tended to consist of young families. Whereas in Rieteiland Oost which consists of high income matured families(Appendix D), little non-residential infrastructure aside from sports facilities were observed. With its high vehicular traffic, it notions towards the hypothesis that there is a reduced need for non-residential functions in close proximity. This heavy dependency on cars allows for its residents to conveniently access non-residential infrastructure within a broader radius.

Neighbourhood	Population	Child-centred Infrastructure		Medical & Care		Culture & recreation		Services		Total	Total per capita
		Total	Per capita	Total	Per capita	Total	Per capita	Total	Per capita		
Centrumeiland	1120	2	0.0018	1	0.0031	2	0.0017	0	0	5	0.0045
De Marken	2995	7	0.0023	7	0.0023	7	0.0023	4	0.0013	25	0.0083
Homeruskwartier	8020	12	0.0015	17	0.0021	33	0.0041	18	0.0022	80	0.010
Muziekwijk Noordwest	1675	6	0.0036	28	0.017	30	0.0022	19	0.011	83	0.038
Rieteiland Oost	315	0	0	0	0	2	0.0063	0	0	2	0.0063
Theo van Goghparkbuurt	1120	19	0.0014	13	0.00095	30	0.0022	14	0.001	66	0.059

Figure 20: Summary of the Data from the Site Visits, (refer to Appendix A & A-1)

5.4 Limitations

The main aim of this research was to develop an understanding of how non-residential infrastructure is implemented within neighbourhoods in relation to time, specifically how non-residential infrastructure is implemented in accordance to the changing demographics within a neighbourhood. And through the initial research there have been several limitations to how research has been conducted and its results. In maintaining a broader understanding, several neighbourhoods of varying ages were analysed however, this comes with several assumptions that all neighbourhoods react the same way towards their changing needs, that external factors like the available resources are the same and that these neighbourhoods were built with similar purposes and target groups.

Due to the limited time, the analysis was conducted on a small sample size resulting in results that may not be accurately representative of all the neighbourhoods within Amsterdam. In improving the validity of the results the survey could be repeated across other neighbourhoods of varying ages within Amsterdam. Additionally, another shortcoming was in ascertaining precisely when new infrastructures were introduced, thus in relation to the demographical changes it was not always clear whether they were added after these changes or pre-emptively.

Therefore, with the limited scope of data, conclusions made through this analysis would not be fully representative and instead the output of this research would consist of corroborated hypotheses rather than concrete conclusions. This provides an idea of how non-residential infrastructure can be implemented along with the expected changes in the demographics.

TRIGGER/CATALYST

Ageing Demographic

Changing family composition

Changing Neighbourhood Population Size:
Growing/Shrinking

Change in Surrounding Neighbourhood
Development/Expansion/Change in Function

BUILDING SCALE
STRATEGIES

Adaptive Housing Types

Mixed Functions

Demountable Constructione

Low Cost Construction

URBAN SCALE
STRATEGIES

High traffic infrastructure

Green Corridor Network

Introducing Infrastructure Based on Frequency of
Use:

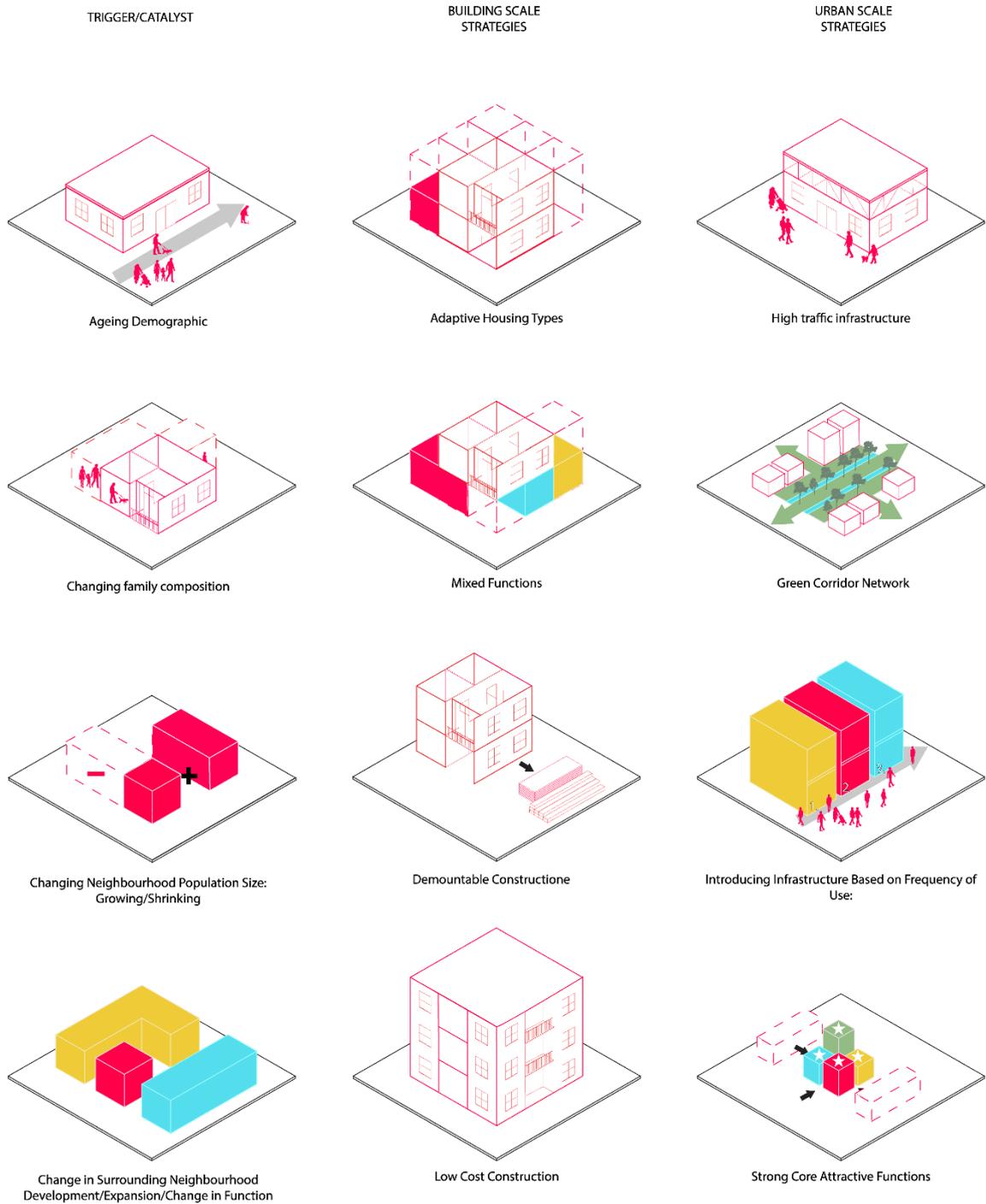Strong Core Attractive Functions

Figure 21: Summary of Overall Findings and Research, (Refer to Appendix L for descriptions)

6.   Conclusion

Through the research conducted it was clear that there were several patterns and strategies undertaken in the introduction of non-residential infrastructure in both new and existing neighbourhoods. These strategies provide an outline of how non-residential infrastructure can effectively be implemented in order to maximise their adaptiveness to the evolving demographic within Dutch neighbourhoods. Through the analysis of the neighbourhoods it is apparent that the strategies undertaken can be organised into urban scale and building scale strategies. The urban scale, focusing on the creation of spaces that can accommodate diverse types of non-residential infrastructure by encouraging the centrality of these areas within neighbourhoods to ensure that access and utility around these infrastructures are maximised. This is achieved through the improvement of transport lines and circulation routing, encouraging traffic and by grouping these functions together neighbourhood hubs are created. Additionally, the strategic selection of non-residential functions based on the expected frequency of use by its main demographic ensures that the main needs within neighbourhoods are met, therefore in a typical starter neighbourhood the progression can be as shown in figure 12. At the building scale, the focus is shifted towards the creation of adaptable construction and systems within the infrastructure that can accommodate for a diverse range of functions in allowing for non-residential infrastructure to adapt to its changing demographic needs.

Ultimately, this paper proposes a balanced approach of strategies from both scales to maximise the adaptiveness of the non-residential infrastructure in meeting the evolving demographic needs. This leads back to the original concept of permanence and temporality within these neighbourhoods, where ultimately everything is temporary which brings about the question of how temporary should our neighbourhoods be. And in the case of the studied case studies it was evident that in creating this permanence the urban scale needs to be targeted to create a platform that is resistant to change and can accommodate future more temporary functions in its space. This platform would allow for the creation of more permanent spaces that will help foster neighbourhoods through cultivating a sense of place whilst also allowing for these neighbourhoods to utilise the shell of adaptive infrastructure to house new functions that correspond to the evolving needs of the neighbourhoods.

Young Families

Ageing Neighbourhood

Child-centred
functions (Schools, childcare, etc.)

Core functions
(Supermarkets, GP, etc.)

Specialised
Medical & care facilities
(Elder Care, Physiotherapist, Disability support, etc.)

Established Neighbourhood

Secondary Functions
(Retail, restaurants, etc.)

Primary Neighbourhood

Common Established Functions
(Offices, Large Schools, etc.)

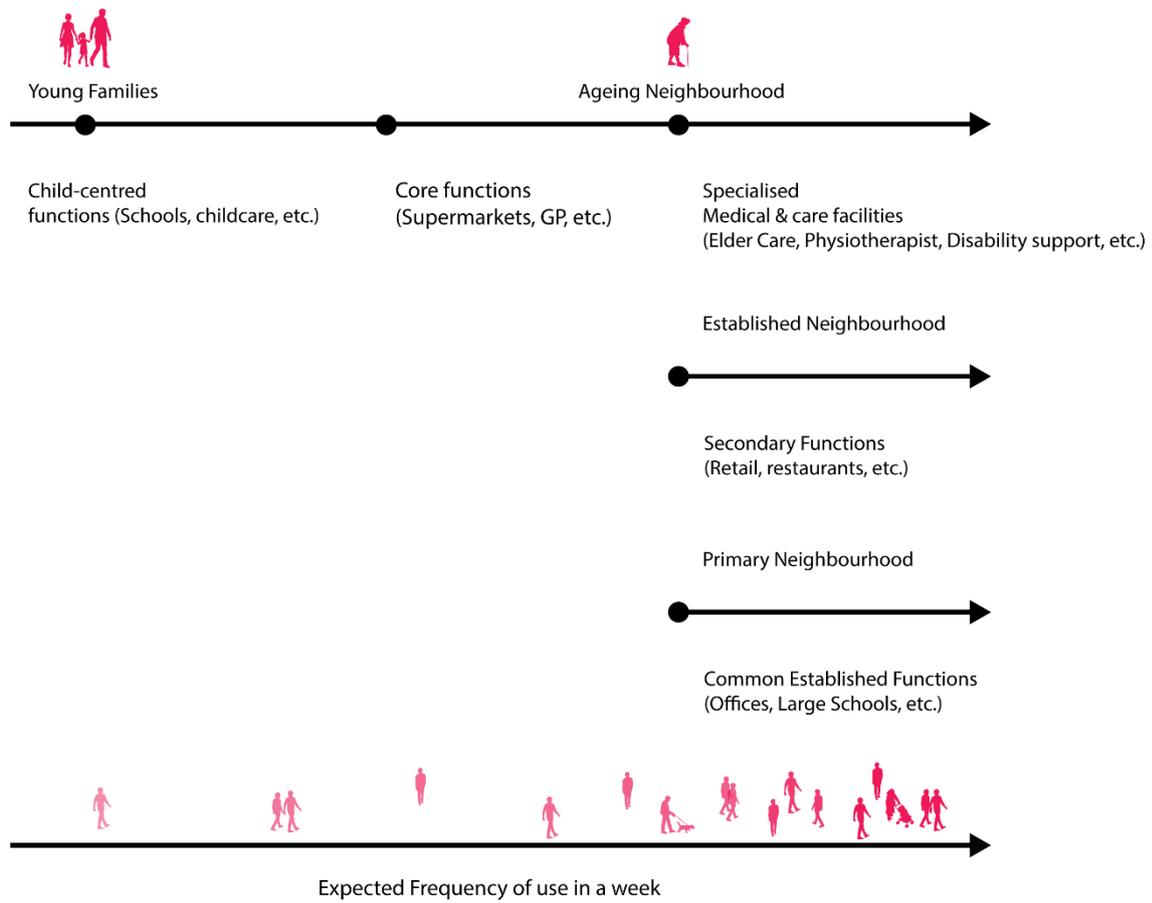Expected Frequency of use in a week

Figure 22: Progression of priority in non-residential infrastructure

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8. Appendix

Children Centred Infrastructure & Amenities

	Kindergarten				Daycare				Basisschool				Middelbaarschool				Playground			
	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition
Homeruskwartier	3	14:08	Moderate	Good	2	14:35	High	Good	5	14:02	Moderate	Good	1	13:17	Moderate	Good	5	14:02	Moderate	Good
Muziekwijk Noordwest	2	15:46	N.A.	Good	1	15:30	N.A.	Good	20	15:21	N.A.	N.A.	0	N.A.	N.A.	N.A.	7	15:40	Low	Good
De Marken	2	16:47	High	Good	1	16:53	High	Good	Multiple	16:33	Low	Good	0	N.A.	N.A.	N.A.	1	N.A.	Low	Moderate

Medical and Care Facilities

	General Practitioner				Dentist				Physiotherapist				Pharmacies/Drug Stores				Home/Elderly care			
	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition
Homeruskwartier	3	14:16	Moderate	Good	3	14:05	Moderate	Good	1	14:13	Moderate	Good	6	14:27	Moderate	Good	1	14:30	Moderate	Good
Muziekwijk Noordwest	1	15:55	Low*	Good	2	15:40	Low	Moderate	4	15:50	Low	Good	4	16:15	Low	Good	7	15:40	Low	Moderate
De Marken	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	1	16:50	Low	Good	1	N.A.	Low	Moderate	0	N.A.	N.A.	N.A.

Culture & Recreation

	Park				Sport Facilities				Art Facilities				Religious Institutions				Restaurants			
	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition
Homeruskwartier	8	14:25	Moderate	Good	1	14:14	Low**	Good	1	N.A.	N.A.	N.A.	1	N.A.	N.A.	N.A.	13	14:27	Moderate	Good
Muziekwijk Noordwest	5	15:55	Low*	Moderate	1	N.A.	N.A.	N.A.	6	15:56	N.A.	Good	8	15:33	N.A.	Good	7	16:15	Low	Good
De Marken	4	N.A.	N.A.	N.A.	1	16:52	Low	Moderate	1	N.A.	N.A.	Good	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.

Services

	Supermarket				Neighbourhood Centre				Hardware Stores				Garage				Beauty			
	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition
Homeruskwartier	1	14:15	Low	Good	1	14:05	Moderate	Good	0	N.A.	N.A.	N.A.	1	14:30	Moderate	Good	15	14:30	Moderate	Good
Muziekwijk Noordwest	1	15:55	Low*	Good	2	15:44	Low	Moderate	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	13	14:27	Moderate	Good
De Marken	0	N.A.	N.A.	N.A.	1	16:52	N.A.	N.A.	1	16:50	Low	Moderate	0	N.A.	N.A.	N.A.	1	N.A.	Low	Moderate

Children Centred Infrastructure & Amenities

	Kindergarten				Daycare				Basisschool				Middelbaarschool				Playground			
	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition
Theo van gogh parkbuurt	2	13:20	Low	Good	6	13:21	Low	Good	2	13:07	Low	Good	1	13:17	Low	Good	8	13:12	Moderate	Good
Centrumeiland	0	N.A.	N.A.	N.A.	1	14:23	Low	Good	1	14:23	Low	Good	0	N.A.	N.A.	N.A.	1	N.A.	Moderate	N.A.
Rietelland-Oost	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	Low	Moderate

Medical and Care Facilities

	General Practitioner				Dentist				Physiotherapist				Pharmacies/Drug Stores				Home/Elderly care			
	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition
Theo van gogh parkbuurt	1	N.A.	N.A.	N.A.	2	N.A.	N.A.	N.A.	1	13:12	Moderate	Good	1	N.A.	N.A.	N.A.	10	14:33	High	Good
Centrumeiland	2	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	Low	N.A.
Rietelland-Oost	0	N.A.	N.A.	N.A.	1	N.A.	Moderate	Good	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.

Culture & Recreation

	Park				Sport Facilities				Art Facilities				Religious Institutions				Restaurants			
	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition
Theo van gogh parkbuurt	11	13:17	High	Good	2	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	10	14:40	High	Good
Centrumeiland	1	14:13	High	Moderate	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	Moderate	Good
Rietelland-Oost	2	13:29	Moderate	Good	1	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.

Services

	Supermarket				Neighbourhood Centre				Hardware Stores				Garage				Beauty			
	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition	Number	Time	Traffic	Condition
Theo van gogh parkbuurt	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	4	13:15	High	Good
Centrumeiland	0	N.A.	N.A.	N.A.	1	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.
Rietelland-Oost	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.

Total Population

	Total Population
Homeruskwartier	8020
Muziekwijk Noordwest	1675
De Marken	2995

	Total Population
Theo van gogh parkbuurt	13716
Centrumeiland	1120
Rietelland-Oost	315

Appendix A-1: Summary of Data from Site visits

Specialised Medical Centres / Disability Support & Services

Specialised Medical Centres				Disability Support & Services				Total	per capita
Number	Time	Traffic	Condition	Number	Time	Traffic	Condition		
2	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	17	0.0021119701
14	15:59	High	Good	2	15:59	High	Good	28	0.016716418
4	N.A.	N.A.	N.A.	1	16:51	Moderate	Good	7	0.002337229

Retail / Café

Retail				Café				Total	per capita
Number	Time	Traffic	Condition	Number	Time	Traffic	Condition		
5	14:23	Moderate	Good	1	14:27	High	Good	33	0.004114713
7	16:02	Moderate	Moderate	1	N.A.	N.A.	N.A.	30	0.0179104448
0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	7	0.002337229

Total (not including playgrounds)	per capita
12	0.0014962509
6	0.00358209
7	0.002337229

Specialised Medical Centres / Disability Support & Services

Specialised Medical Centres				Disability Support & Services				Total	per capita
Number	Time	Traffic	Condition	Number	Time	Traffic	Condition		
5	13:22	Moderate	Good	0	N.A.	N.A.	N.A.	13	0.0009477798
0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	0	0
0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	1	0.003174603

Retail / Café

Retail				Café				Total	per capita
Number	Time	Traffic	Condition	Number	Time	Traffic	Condition		
4	14:46	Moderate	Good	2	N.A.	N.A.	N.A.	30	0.002187227
0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	2	0.0017785714
0	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	2	0.0063349206

Total (not including playgrounds)	per capita
19	0.0013885244
2	0.0017785714
0	0

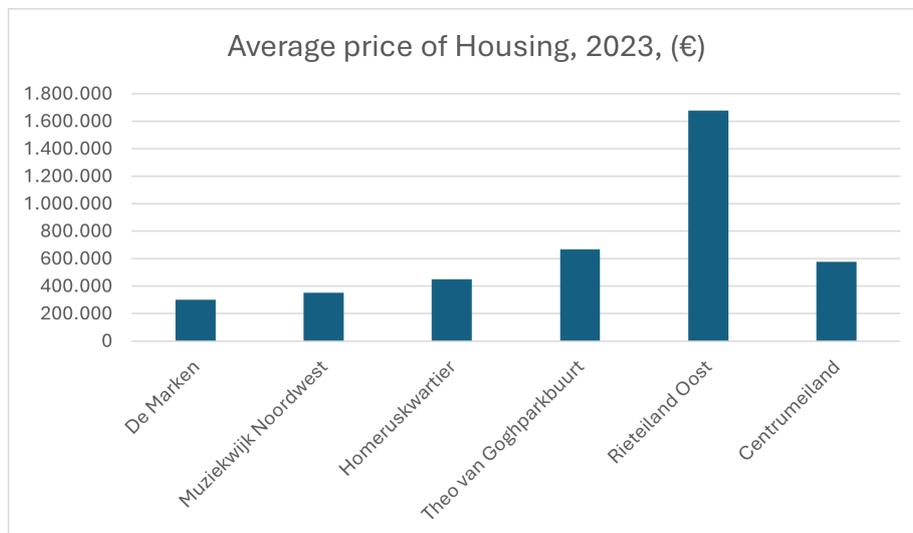| Total	per capita
14	0.0010207706
0	0
0	0

Appendix B-2: Summary of Data from Site visits
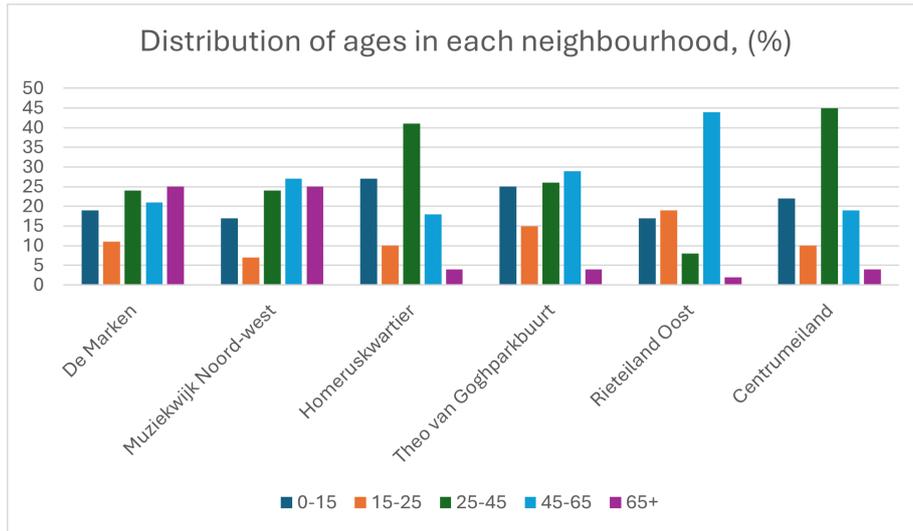
Appendix B: Distribution of Ages of Case Studies
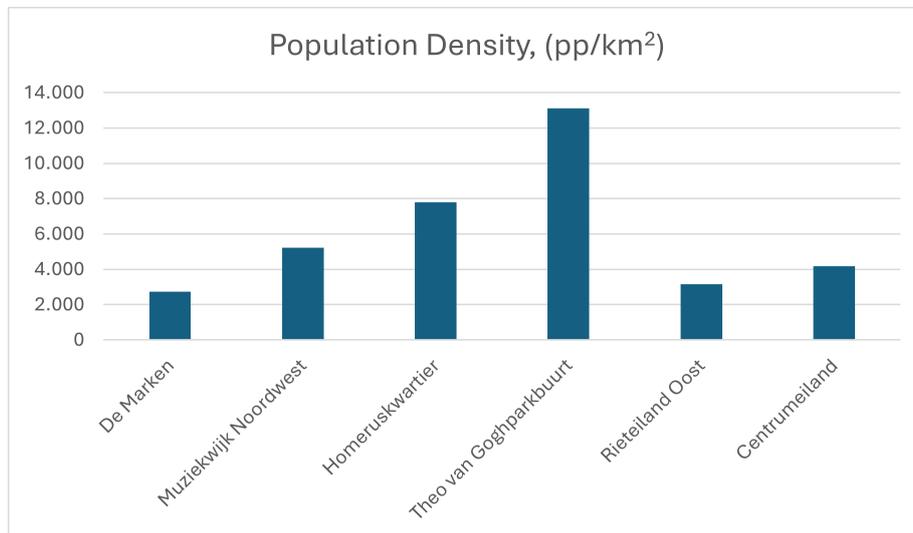
Appendix D: Population Density in each Case Study

Appendix C: Average Price of housing in each Case Study

Appendix E: Homeruskwartier, Central Neighbourhood Park

Appendix E-1: Homeruskwartier, Basisschool, constructed out of quick construction

Appendix E-2: Homeruskwartier, Main Supermarket with Demountable Construction

Appendix E-3: Homeruskwartier, Experimental Demountable Housing

Appendix F: Muziekwijk, Central Green Corridors

Appendix F-1: Muziekwijk, Active Places of Worship

Appendix F-2: Muziekwijk, Heavy Vehicular Use and Parking

Appendix F-3: Muziekwijk, Specialised Medical Centres (Heart centre)

Appendix F-4: Muziekwijk, Care centres, Physiotherapists and Elderly Care

Appendix F-5: Muziekwijk, Neighbourhood Shopping Centre

Appendix F-4: Muziekwijk, Care centres, Physiotherapists and Elderly Care

Appendix F-6: Muziekwijk, Neighbourhood Centre, containing a supermarket, physiotherapist and dentist

Appendix G: De Marken, Cauliflower neighbourhood Centre

Appendix G-1: De Marken, Derelict empty neighbourhood shop spaces

Appendix G-2: De Marken, Cauliflower neighbourhood Centre, programmed with Neighbourhood Sport functions

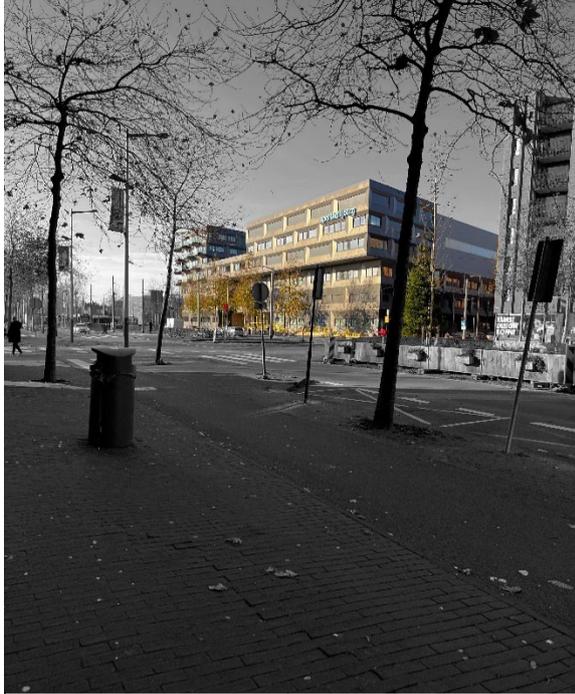*Appendix G-3: De Marken, Industrial Services within the Neighbourhood*

Appendix G-4: De Marken, New neighbourhood supermarket infrastructure

Appendix G-5: De Marken, Neighbourhood Kindergartens

*Appendix H: Almere-Pampus, Empty plot to house the future Neighbourhood*

Appendix I: Theo van Goghparkbuurt, Multi-purpose
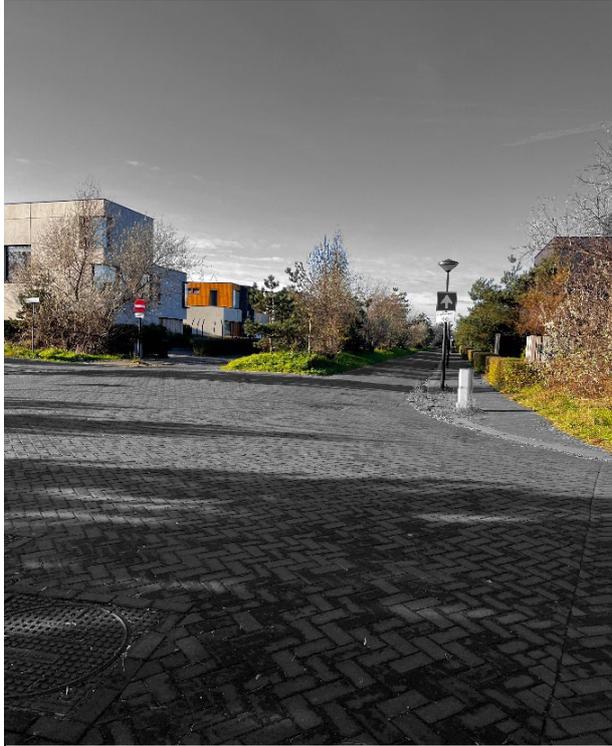Middelbareschool, Sport Centre and Dwellings Infrastructure

Appendix I-1: Theo van Goghparkbuurt, Strong Presence of
Public Transport lines

Appendix I-2: Theo van Goghparkbuurt, Residential Buildings
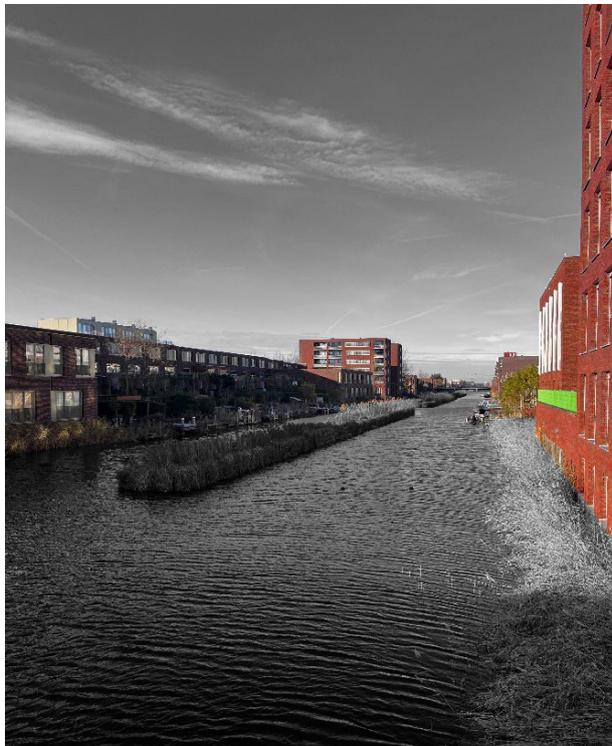with non-residential functions in its plinth
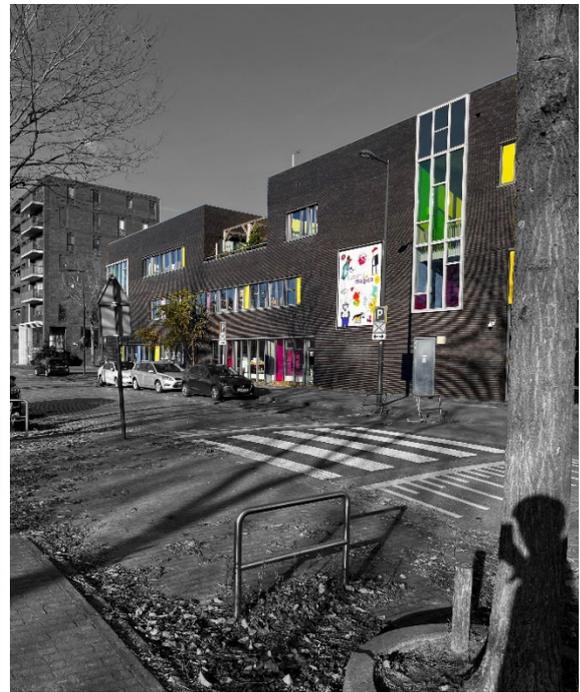
Appendix I-3: Theo van Goghparkbuurt, Basisschool, high traffic
functions located by the central park

Appendix J: Rieteiland Oost, Main Neighbourhood Street

Appendix J-1: Rieteiland Oost, Sole Non-residential Infrastructure, the tennis courts

Appendix J-2: Rieteiland Oost, The separation between Neighbourhoods and how the residences connect to the water

Appendix K: Centrumeiland, De Warren, strong presence of self-built collective residences

Appendix K-1: Centrumeiland, Modular Units and still under Construction

Appendix K-2: Centrumeiland, The First introduction of non-residential functions like gyms

Appendix K: Centrumeiland, Neighbourhood Daycare and Basisschool

Catalyst/Trigger	Ageing Demographic	Changing Family Compositions	Changing Neighbourhood Population Size	Change in Surrounding Neighbourhoods
	As neighbourhoods fail to retain their youth and as the life expectancy increases the overall demographic has aged	As a family ages the composition within the family changes as children are born and eventually move out.	As the population of a neighbourhood changes the amount of non-residential infrastructure should correspond to it and be able to support its population.	Especially in neighbourhoods sharing non-residential infrastructure, the manner in which its surroundings change will implicate the strategies undertaken in adopting non-residential infrastructure.
Building Scale Strategies	Adaptive Housing Structure	Mixed Functions	Demountable Construction	Low-cost Construction
	The provision of a framework that allows the adjustment of living space.	The sequential introduction of functions, allowing to correspond to the demands of its residents. As well as to provide a diverse range of non-residential functions within a small space.	Semi-temporary construction, built quickly and pre-emptively to support the neighbourhood for its first few years with the option for demounting or adapting with minimised environmental impact.	Quickly assembled construction that fulfils the budget within a neighbourhood
Urban Scale Strategies	High Traffic Non-Residential Infrastructure	Strong Green Corridor Network	Infrastructure based on Frequency of Use	Attractive Core Functions
	Through this injection, increased activity is triggered, increasing the vibrancy surrounding these areas.	Green networks through neighbourhoods promotes biodiversity as well as reinforcing foot and bike traffic routes through neighbourhoods.	The sequential introduction of non-residential functions based on their expected frequency of use in a week by its residents	The concentration of functions that would increase traffic from both within and outside the neighbourhood.

Appendix L: The Overall Observations and Strategies through the Site visits