

Transit-oriented Development and Gentrification: Exploring Neighbourhoods Around Zaandam Station

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Master's Thesis for the Spatial Planning Programme

Specialization Urban and Regional Mobility

Nijmegen School of Management

Radboud University

24 January 2022



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Document: Master's Thesis for the Spatial Planning programme,
specialization Urban and regional mobility

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Preface

Before you lies the Master's thesis "Transit-oriented Development and Gentrification: Exploring Neighbourhoods Around Zaandam Station", the basis of which is a combination of quantitative statistical analyses, expert interviews, and desk research. It was written to fulfil the graduation requirements of the Spatial Planning Programme at Nijmegen School of Management, Radboud University. I was engaged in researching and writing this thesis from September 2021 to January 2022. Writing this thesis turned out to be difficult yet gratifying. It would have been a lonesome venture, were it not for the supervisors, colleagues, family, and friends who have guided and supported me through the past few months.

Hence, I would first like to thank my thesis supervisor Sander Lenferink for his excellent guidance during this process. Our thesis meetings were incessantly useful and always left me with new energy and ideas to continue working on my project.

At the province of Noord-Holland – where I undertook an internship while writing this thesis – I received supervision from Maaïke Alles. I like to thank her as well. Due to COVID-19-related restrictions, face-to-face meetings were few, but those that did take place allowed me to meet my colleagues and explore their activities within the *OV knooppunten* programme, making the two-hour-long train rides to Haarlem definitely worthwhile.

Furthermore, I would like to thank Pepijn, as our study sessions and (equally important) coffee break discussions served as vital motivation boosts that pushed me in the right direction.

Jasmijn, thank you for the critical read-through and quality check, preventing several typos and inaccuracies from ending up in the final product.

I also wish to thank all of the interviewees; without whose cooperation I would not have been able to conduct the qualitative analysis.

Thank you to my mother, father, sisters, and friends for their support throughout the five and a half years of student life that has now come to an end. And thank you Esmée, for always being there to make me smile, keeping me motivated, and simply being amazing.

I hope you enjoy reading this thesis.

Ruben ter Haar

Nijmegen, 24 January 2022

Summary

Transit-oriented development, or TOD, aims for a station area that is compact, mixed-use and facilitates transit connectivity through urban design, by focussing on transit-oriented growth patterns around train, light-rail, or metro stations. In this way, TOD promotes a modal shift from private cars to public transport and a reduction in automobile dependence, while at the same time ameliorating neighbourhoods' liveability.

TOD may also induce gentrification. As land values are expected to increase because of advantageous conditions for real estate investments, low-income groups living in the station area may be restricted from accessing housing and maintaining their residential locations because of higher property values and rent. This may lead to the displacement of such groups and, in turn, a replacement by better-off households within the station area. This raises concerns regarding social and economic equity.

This thesis investigates the relationship between the transit-oriented developments within project Inverdan near Zaandam Station and its potential gentrification effects. To do this, statistical analyses of demographic and housing data are combined with expert interview analyses and desk research.

The statistical analysis of neighbourhood-level demographic and housing data shows an increase in several gentrification factors between the start of the developments and today, such as population density, property value, and young residents. A difference-in-difference analysis showed that, as a result of the Inverdan developments, the income in this area has increased more than it did in other neighbourhoods of Zaanstad.

The expert interviews provided an overview of the Inverdan developments and their effects on the area. Its improved quality - as a result of the renewed public space and new housing, stores, and services - lead to an influx of people with higher incomes, often coming from Amsterdam. The TOD also impacted the housing stock and property values in the area. Displacement of low-income residents is not expected to have taken place, as the area has undergone densification, rather than a replacement of former developments.

Thus, several gentrification factors were identified to have impacted the area between the start of Inverdan and today. The developments have led to a higher quality urban area and Zaandam has since enjoyed popularity as a shopping and working area, as well as a place to live. The tendency to build more and more high-priced apartments may, however, exclude certain population groups from living in the TOD area. In order to create a mixed urban area, policymakers are therefore recommended to take into account the affordability of TOD areas.

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Gedempte Gracht and Zaandam Station (Provincie Noord-Holland, 2018)

Chapter 1: Introduction

Over the past thirty years, sustainability has evolved into a widely used concept to steer policies towards stimulating the use of more renewable resources (Padeiro et al., 2019). At the same time, a growing amount of attention is being given to the environmental damage caused by urban transport and mobility. The automobile grew more and more popular and affordable after the Second World War and in turn encouraged the sprawl of residential development and the decentralization of employment locations. This subsequently led to infrastructure serving a car-dependent lifestyle, often at the cost of public transit, which became uneconomical in low-density areas. This car-dependent infrastructure often lacked sufficient capacity for the ever-increasing number of automobiles, resulting in an increase in congestion (Badoe & Miller, 2000; van Lierop et al., 2017). As such, the development of demand management programmes has sought to reduce the mobility footprint through modal shifts and the reduction of automobile dependence (Banister, 2008). A much-used intervention for reducing the mobility footprint is transit-oriented development (TOD). By focussing on transit-oriented growth patterns around train, light-rail or metro stations, TOD aims for a station area that is compact, provides a mix of functions, and facilitates transit connectivity through its urban design (Renne, 2009). In this way, TOD promotes a modal shift from private cars to public transport and a reduction in automobile dependence, while at the same time ameliorating neighbourhoods' liveability. In other words, the integration of transport and land use in TODs may lead to "a shift of focus from [...] catering for mobility to catering for accessibility" (Bertolini et al., 2005, p. 1). Because of a TODs high density and functional mix, other sustainable travel options such as walking and cycling become more appealing ways of transport as well.

Transit-oriented developments may also induce gentrification, a concept that may be defined as "the transformation of a working-class or vacant area of the central city into middle class residential and/or commercial use" (Lees et al., 2008, p. xv). As land values are expected to increase because of advantageous conditions for real estate investments, low-income groups living in the station area may be restricted from accessing housing and maintaining their residential locations because of higher property values and rent. This may lead to the displacement of such groups and in turn, a replacement by better-off households within the station area. This raises concerns regarding social and economic equity (Padeiro et al., 2019). On the other hand, gentrified neighbourhoods attract higher incomes which may have positive cultural and economic effects on the area (Atkinson, 2002).

Research Problem

Although gentrification effects of TODs have been studied in a North-American context (e.g., Dong, 2017; Jones, 2020; Tehrani et al., 2019), only a few studies were set in a European setting (e.g., Derakhti & Baeten, 2020; Papa & Bertolini, 2015). Moreover, most existing literature regarding the gentrification of TODs concerns the effects of a newly built transit line, whereas studies on TODs around already existing stations were rarely found. Furthermore, many studies took a quantitative approach, often using statistical (census) data, resulting in the underrepresentation of qualitative research on transit-oriented development and the potential link with gentrification. For these reasons, this current study uses mixed methods to look at TODs around the train station Zaandam in the municipality of Zaanstad, located in the Dutch province of Noord-Holland. By examining demographic, economic, and housing data, analysing instruments and investments of TOD policies, and interviewing policymakers and others, this study aims to investigate whether gentrification occurs in Zaandam, what the potential relationship is between gentrification and TOD, and what this implies for future Dutch TOD policies.

Research Aim and Research Question(s)

This study aims to investigate the possible relationship between transit-oriented development in Zaandam, as a result of project Inverdan, and residential gentrification. The overarching objectives of this research are as follows:

- Describe the policies, goals, and developments related to project Inverdan;
- Investigate how these developments relate to the concept of TOD defined by academic literature;
- Analyse how neighbourhoods within the development area have changed between the start of Inverdan and now, compared to other neighbourhoods inside the municipality of Zaanstad;
- Analyse how Zaanstad has changed between the start of Inverdan and now, compared to other municipalities in the region;
- Determine to what degree the station area of Zaandam Station has gentrified as a result of Inverdan;
- Discuss what municipalities and other relevant actors may learn from the findings of the above-mentioned objectives for future transit-oriented development.

In order to achieve these objectives, a research question is formulated below, supported by three sub-questions.

Main research question:

To what degree is there a relationship between transit-oriented development and residential gentrification in Zaandam?

Sub-question 1:

To what degree do the Inverdan developments correspond with transit-oriented development characteristics defined in academic literature?

Sub-question 2:

To what degree has transit-oriented development near Zaandam Station had an effect on neighbourhood change between 2009 and 2019?

Sub-question 3:

To what degree have these neighbourhood changes led to gentrification and what can we learn from Inverdan for future transit-oriented development?

Social and Scientific Relevance of the Research

The societal relevance of this study lies in its insight into whether TOD policies may result in developments that gentrify surrounding neighbourhoods and in what way. TOD is a commonly used policy in Dutch urban development, making this case study relevant for many other Dutch cities. Unintentional displacement effects of TODs may be identified, and advice may be given to combat such effects on several levels of governance.

First, research on TOD is of national interest. In the National Strategy on Spatial Planning and the Environment (Nationale Omgevingsvisie – NOVI), which outlines national perspectives on the built and natural environment for the coming thirty years, the Dutch national government underlines the importance of building based on accessibility. Cities and regions should be accessible to prevent long-distance mobility and its negative effects on nature such as noise pollution and CO₂ emissions. Moreover, they should create shorter distances, and more public transit use, walking, and cycling. One accessibility-based approach the NOVI aims to stimulate is high-density developments in inner cities, as well as - coinciding with TOD - near public transit nodes (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2020).

For the Province of Noord-Holland specifically, where in 2019 half of newly built housing has been built around a train or major bus station, this case study may give insight into how to

improve its *OV knooppunten* ('public transit nodes') program and to find out where this integral policy may strife with municipal efforts (Provincie Noord-Holland, 2021). The program aims to contribute to sustainable urbanisation around accessible and attractive transit nodes. By concentrating spatial-economic developments in such areas, coherence is created between urbanisation and mobility. The program's main goals are using space efficiently by clustering functions, facilitating door-to-door multi-modal travel with sufficient choice of transit options, and improving the living quality around nodes by creating attractive living areas.

The Metropolitan Region Amsterdam (MRA) may also gain insights with regard to their mobility policies and objectives. Research on TOD may especially support their work on transport poverty, which concerns people spending an excessive amount of their time or money on transport, thereby inhibiting them from properly participating in society. Their research focuses on accessibility to and from work, and the sufficiency of public transit (Metropoolregio Amsterdam, 2021).

And of course, the municipality of Zaanstad gain insight into how TODs in Zaandam influence gentrification in station-adjacent neighbourhoods and whether there are policy adaptations to be made to prevent unintentional demographic, economic or housing-related changes and to improve the results of their TOD policies.

When such governmental bodies implement the insights on the link between TOD and gentrification in their planning policies, this may lead to more attractive TOD areas accessible for high- and low-income inhabitants to live, work, and recreate in.

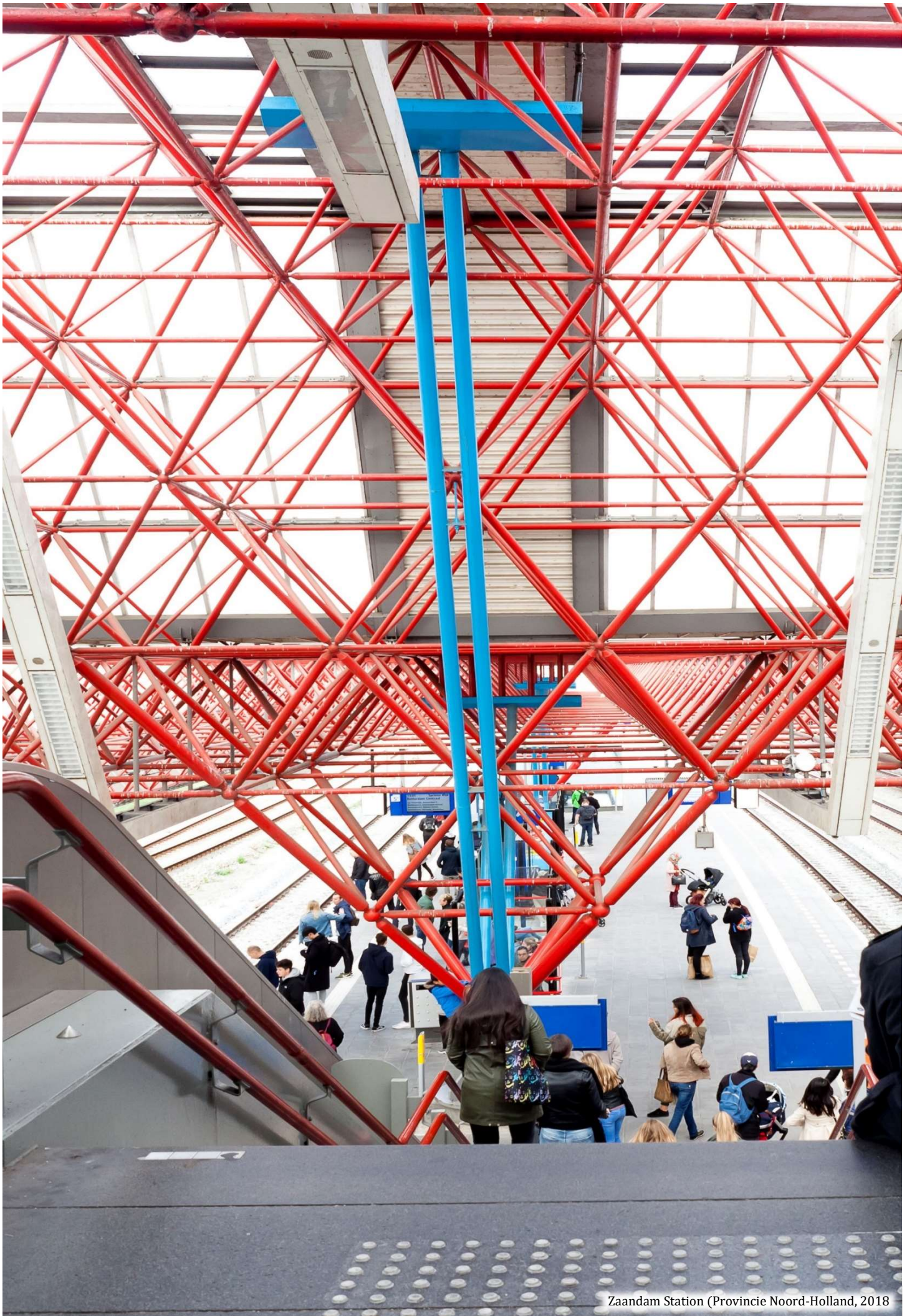
The current housing crisis adds to the relevance of the study as well.

The scientific relevance of this study lies in its relevant addition to the body of literature concerning gentrification effects of transit-oriented development. Whereas several studies have observed gentrification and displacement as results of TODs (e.g., Bardaka et al., 2018; Chapple et al., 2017; Heilmann, 2018), European cases are underrepresented in the current literature on TOD and gentrification. In the Netherlands, the aim to create 'compact cities' from the 1980s onwards, led to an increase in building density around transit nodes as a way to limit the amount of (car) mobility. New train stations were built and existing stations, as well as the area around them, were redeveloped. This compact building inevitably led to increasing land values, attracting private investors and more expensive housing (de Klerk & van der Wouden, 2021). The link between such (transit-oriented) developments and gentrification in the Netherlands is thus a pertinent matter to research. Despite this, apart from a thesis on property values in Noord-Holland being affected by TOD developments by Van Der Zwet (2019), literature specifically on the link between TOD and gentrification in a Dutch context was not found. The focus of this study being the Dutch city of Zaandam aids to diminish this imbalance. The station area of Zaandam has undergone major

redevelopments in the past fifteen years with project Inverdan, making it a suitable and topical case to research.

In addition, this study gives insight into how TODs around existing transit lines may affect gentrification phenomena, a subject yet overshadowed by studies on newly built transit lines. Lastly, in addition to quantitative data analysis, this study takes a qualitative approach, which is, as opposed to the often used quantitative statistical data-based analysis, a significantly underrepresented way of studying the link between TOD and gentrification (see Padeiro et al., 2019). As such, this study provides an in-depth exploration of the relation between TOD, policies, and gentrification, and identifies nuances that may be overlooked with merely a quantitative analysis of statistical data. Therefore, this study is an important addition to the existing body of academic literature.

The following chapter reviews the current body of academic literature concerning TOD and gentrification. Moreover, the theoretical framework and conceptual model founding this study is elaborated upon. Chapter three describes the overall research philosophy, strategy, and the reasoning behind methodological choices. Chapter four describes the quantitative, statistical study, discussing methodology, data collection, data analysis, results, and a short discussion. Chapter five describes the qualitative, interview-based study, discussing methodology, data collection, data analysis, results, and a short discussion. Finally, Chapter six contains the conclusion of the study, giving an answer to the main research question, as well as a discussion of some general limitations of this study as well as suggestions for future research.



Zaandam Station (Provincie Noord-Holland, 2018)

Chapter 2: Literature Review, Theoretical Framework, and Conceptual Model

Literature Review

The following sections provide an overview of the main academic findings regarding TOD and gentrification with the aim to present the status quo in this field of research. First, the concept of TOD is discussed. Then, the relation of TOD with several other fields of research is elaborated upon, including gentrification and travel behaviour.

Transit-oriented Development

In the past few decades, transit-oriented development (TOD) around rail transit systems has gained wide popularity all over the world, and especially in the USA (Dong, 2017). The term was coined by the American Architect Peter Calthorpe (1993), in his book *The Next American Metropolis: Ecology, Community, and the American Dream*. It is often promoted as a solution to, among other things, automobile traffic congestion, air pollution, and urban poverty. As TOD looks to mix residential and commercial land uses near transit stations, in high density, such developments may improve access to jobs and other urban activities for those living within walking distance of the station (Dawkins & Moeckel, 2016).

Although most studies on TOD and gentrification focus on train rail transit, similar gentrification effects as described above can be found for light rail transit (LRT) (Baker & Lee, 2019) as well as bus rapid transit (BRT) (Brown, 2016), indicating that TOD and its effects on neighbourhood change are not modally linked. Brown (2016) found that neighbourhoods with lower median rents, lower median household incomes, and higher proportions of rental housing before the completion of the BRT were more likely to exhibit higher degrees of change after completion than other areas. TODs have been shown to promote economic development and increase nearby property values as a result of improved transportation accessibility and a more liveable environment (Duncan, 2011). Such positive effects on property values and tax revenues are viewed as an economic benefit and a justification for the high costs of building rail transit infrastructure. However, in the past few years, concerns have arisen about TOD-induced gentrification (e.g., Derakhti & Baeten, 2020; Dong, 2017).

Transit-oriented development in the Netherlands has similar characteristics as its US counterpart, but there exist several important differences.

TOD in the US is often expansive, frequently including the development of whole new transit lines. In general, European urban areas, and Dutch in particular, tend to be more intensively built, and public transit is more ubiquitous. This leaves little room for expansive initiatives and rather asks for densification (Padeiro et al., 2019). In practice, Dutch TOD has

generally been more successful in integrating multiple land uses and multimodal transit hubs. TOD in the US tends to turn out primarily monofunctional (van Lierop et al., 2017).

Whereas TOD in the US has its origins in the concept of New Urbanism, with a focus on increasing density, mixed land use and pedestrian-friendly designs, the Dutch variant stems from the concept of Compact City, focusing less on the reduction of car use and more on regional economic development and densification around rail stations, although environmental and social components are included (Alpkokin, 2012; Burchell et al., 2000; Cervero & Kockelman, 1997). From the 1980s onwards, new train stations were built in the Netherlands. Many existing stations were redeveloped as well, as the relocation of businesses created space for new (transit-oriented) development. The new stations and station areas were intended to not only create accessible transit but also serve as attractive living spaces and urban neighbourhoods (e.g., Utrecht Centraal and Arnhem Centraal). Apartments, stores and restaurants were added, as well as new routes giving access to the city centre (de Klerk & van der Wouden, 2021, p. 214).

Currently, the province of Noord-Holland has its own TOD program named *OV knooppunten* ('Public transit nodes'). The program aims to contribute to sustainable urbanisation around accessible and attractive transit nodes. By concentrating spatial-economic developments in such areas, coherence is created between urbanisation and mobility. Three objectives are formulated for the period 2019-2023: 1) Optimize chain mobility by creating multimodal nodes with sufficient choice of modal options, and by facilitating a comfortable and fast transition between modes, safe and sensible walking and cycling routes, and accompanying chain mobility services. 2) Efficiently use the existing space around station areas by stimulating housing development, businesses, and services within the transit node. 3) Ameliorating the quality of the living environment within the node by creating future proof (sustainable mobility, climate adaptation, urban greenery), safe, and attractive transit nodes, and thereby preventing sprawl from taking up provincial landscapes (Provincie Noord-Holland, 2021).

Gentrification

Gentrification refers to the character change of a neighbourhood as a result of an influx of more affluent residents and businesses. This may lead to positive developments, as formerly economically and socially impoverished neighbourhoods may benefit from an influx of higher incomes, as facilities and services are more easily financed. The growth of such more affluent population groups, which Florida (2002) describes as the creative class, lead to creative cities (and neighbourhoods), where more money is earned, because of more idea development and more innovation.

However, neighbourhoods may also be negatively affected by gentrification because stores and services are replaced to match the demands of their new inhabitants (Zukin, 2010).

Consequently, the original inhabitants who think this undesirable may move to a new place of residence, which in turn may lead to a deterioration of the social structures in the neighbourhood. Apart from social reasons to move out, inhabitants may also leave a neighbourhood because of financial issues, often caused by an increased cost of housing. Such radical changes are defined by Zukin (2010) as the paradox of authenticity; the desire for new population groups, such as young professionals, to live in authentic places leads to a radical transformation of the neighbourhood itself (because of high real estate values, upscaling, and uniformity), and eventually to the destruction of the original 'soul' of the neighbourhood. As such, a disparity exists between a neighbourhood-oriented perspective and an inhabitant-oriented perspective: Neighbourhoods may improve because of gentrification, but inhabitants - such as those who on the one hand are compelled to remain in a gentrifying neighbourhood because of their dependence on the proximity of work, and on the other hand need to move out because of the high living costs - experience negative consequences (Alles, 2018).

Rail Transit and Gentrification

Several studies have looked at whether new rail transit in the USA leads to an increase in housing costs in the station area, regardless of TOD policies that may have been present. Some found that public transit indeed increased housing costs of owners and renters in the station area (Kahn, 2007; Pollack et al., 2010; Wardrip, 2011). A study by Pollack et al. (2010) observed a positive relationship between the share of rental houses and the degree of gentrification: the more renters in a neighbourhood, the more susceptible it was to gentrification. Kahn (2007) differentiates between new 'walk and ride' stations and 'park and ride stations', with the latter providing parking spaces to combine car travel with public transit. Communities close to a new 'walk and ride' station experience gentrification, supposedly because this way of commuting (walking + transit) fits a new urbanist lifestyle that attracts upper-income households. Communities near new 'park and ride' stations often experience an increase in poverty, supposedly because of a loss of wealthy inhabitants because of concomitant congestion, traffic, and rising crime exposure.

Transit-oriented Development and Gentrification

TOD-induced gentrification may be defined as "a process of neighbourhood change that results in economic and demographic transitions in transit-oriented neighbourhoods" (Brown, 2016, p.2). As property values increase, higher housing prices and rents may restrict low-income groups from maintaining their residential locations, potentially leading to their displacement and replacement by better-off households (Padeiro et al., 2019).

Various studies have looked at possible relations between TOD and gentrification, with varying conclusions. A literature review by Padeiro et al. (2019) found some evidence supporting TOD-induced gentrification but they underlined that conclusions were often highly questionable because of methodological flaws. All studies took a quantitative approach with the help of statistical demographical, economic, and housing data, often from a census bureau. Of the thirty-five studies included in the review, twelve reported to have identified transit- or TOD-related gentrification, fourteen had variable or unclear results, and nine did not identify transit-or TOD-related gentrification. Dong (2017), for instance, looked at rail transit in Portland, USA and found no consistent evidence for rail-transit induced gentrification, and neither for reduced home affordability for tenants nor homeowners. Padeiro et al. (2019) suggest that gentrification is more closely associated with “existing local dynamics, built environment attributes, and accompanying policies than TOD itself” (Padeiro et al., 2019, p. 749).

Chava et al. (2019) similarly state that the way in which a station area gentrifies, and the degree to which it does depend on the features of a location and the type of housing present. Their case study in Bangalore, India, showed that new residential projects in TODs led to new-build gentrification, but the existing dwellings remained ungentrified. Jones (2020) and Jones & Ley (2016) suggest that residential intensification policies are aimed at areas with lower income renters but are less likely to affect areas of single-family homes, leading to TOD planning displacing low-income households. Such households in suburban Vancouver often lose planning protection because of the TOD policy targeted at building high-density condominium towers around stations. This demonstrates how TOD and state-aided gentrification, while having environmental aspirations, can “exclude social justice from the policy register” (Jones & Ley, 2016, p.9). It is, however, beneficial to prevent low-income households from needing to be displaced for several reasons. The Center of Transit-Oriented Development (2009) argues that mixed-income TODs have additional benefits as they offer affordable housing, stabilize transit ridership, broaden access to opportunity, and relieve gentrification pressures. For mixed-income housing to become a reality and displacement to be prevented from occurring, appropriate policies must be implemented (Wardrip, 2011).

In the USA, concerns for inequity as a result of TOD have shown to lead to community-based, cross-sector coalitions fighting for more equitable and inclusive TOD processes, plans, and policies that aim to integrate location-based precarity (Lung-Amam et al., 2019). Sandoval (2018) looked at reactions to TOD in Latino barrios. Here, ethnic identity helped inhabitants to create meaningful spaces of participation that transformed these transit investments into community-driven projects and encouraged opportunities for community benefits. It should be noted, however, that although displacement is used as being synonymous with gentrification, Freeman (2005) argues, there exists little empirical evidence that displacement is the most important force

of change in gentrifying neighbourhoods. Instead, lower rates of intra-neighbourhood mobility and the relative affluence of new residents are driving forces for demographic change in gentrifying neighbourhoods.

Matsuyuki et al. (2020) see an increase in driving as new higher-income residents come to live in newly built condominiums in TOD areas in Bangkok. Their work is often more distant than that of the original residents, who had their workplace within motorbike/walking distance. As such, this case of TOD increases car usage around the station area and, according to the author, “preventing excessive gentrification is necessary not only from the viewpoint of equity but also to prevent traffic jams on main roads” (Matsuyuki et al., 2020, p. 1341). Chatman et al. (2019) similarly found differences in driving behaviour between high and low-income households looking at vehicle miles travelled (VMT). Higher-income households in Californian TODs reduced VMT more than poorer households did. However, TOD neighbourhoods often become more densely populated. Therefore, it is likely that the net effect of gentrification will be a regional reduction in VMT, but gentrification-induced displacement without densification will likely increase VMT (Chatman et al., 2019).

Although most studies on TOD and gentrification focus on train rail transit, similar gentrification effects as described above can be found for light rail transit (LRT) (Baker & Lee, 2019) as well as bus rapid transit (BRT) (Brown, 2016), indicating that TOD and its effects on neighbourhood change are not modally linked. Brown (2016) found that neighbourhoods with lower median rents, lower median household incomes, and higher proportions of rental housing before the completion of the BRT were more likely to exhibit higher degrees of change after completion than other areas.

Research Gap

As mentioned, this study aims to investigate whether transit-oriented developments alongside the Zaancorridor have gentrifying effects on housing in neighbourhoods surrounding the train stations, with the intent to fill at least part of the threefold research gap extracted from the literature review above:

First, of the academic literature on TOD and gentrification reviewed above, none were applied to a Dutch context. Whereas literature exists on TODs in the Netherlands (e.g., Bertolini et al., 1978; Pojani & Stead, 2014), as well as gentrification in the Netherlands (e.g. Bridge, 2014; Smets & Weesep, 1995; Uitermark et al., 2007), studies on Dutch TOD and its relation to gentrification have not been found. Many studies investigated cases in North America (e.g., Dong, 2017; Jones, 2020; Tehrani et al., 2019). Some cases were located in Asia (Chava et al., 2019; Matsuyuki et al., 2020), and even fewer in Europe (e.g., Sweden: Derakhti & Baeten, 2020). Secondly, nearly all sources study TOD as part of a newly built transit system. Research on the

effects of TOD on gentrification as part of an existing, already built transit system is currently scarce. The train stations in Zaandam (and the Zaancorridor which they are part of) are an exemplar case for such an existing transit system, as they have been built decades ago (between 1869 and 1989). Thirdly, in addition to quantitative, statistical analysis, this study takes a qualitative approach, which is, as opposed to the often used quantitative statistical data-based analysis (see Padeiro et al., 2019), a significantly underrepresented way of studying the link between TOD and gentrification. Therefore, it is an important addition to the existing body of literature.

Theoretical Framework

In the following section, several theories and concepts related to TOD and gentrification are discussed. Moreover, it is elaborated upon which theories jointly provide the theoretical framework on which this study is built.

Transit-oriented Development: the 5 Ds

In the academic literature, the urban environment of transit-oriented developments is often characterised by 'Ds'. Cervero and Kockelman (1997) used three principal dimensions, commonly referred to as the '3 Ds' to study the relationship between the built environment and travel demand: density, diversity, and design. These were later complemented by destination accessibility and distance to transit (Ewing & Cervero, 2001, 2010).

Density refers to the compactness of a TOD area, often measured in the number of people, dwellings, or jobs per unit of area. A dense urban space may lead to shorter trips, more non-motorized trips, higher vehicle occupancies, and lower cost per passenger mile, resulting in a compact and attractive area.

Diversity pertains to the mix of land uses in the TOD area. Mixing civic, commercial, and residential uses may lead to less mobility and efficient trip-chaining as well as shared parking and reduced infrastructure.

Design refers to a TOD area being a combination of a node and a place. The area is on the one hand a multimodal transit node, providing car and bicycle parking, safe bicycle paths and pedestrian zones, and other transit apart from trains, such as buses, taxis, and bike-sharing. At the same time, a station area can be a comfortable place to be, a community hub with amenities, good connectivity and pleasing aesthetics.

Destination accessibility refers to the opportunity to reach places one wants to go from the TOD area, both local and regional, such as a nearby city centre or central business district. This may be enhanced by mobility (speed between points A and B), and proximity (distance between points A and B).

Distance to transit, finally, refers to the distance between dwellings or workplaces and the nearest train station. TODs aims to have a walkable distance from the station to the travellers' destination, which, in a US context, corresponds with a catchment area of a 0.5-mile radius (Guerra et al., 2012). The catchment area is location-specific however; the Province of North-Holland, for example, uses a 1200 meter radius as a station's primary catchment area, and a 10-minute bicycle trip as a secondary catchment area (Provincie Noord-Holland, n.d.).

The 5 Ds, and other varying combinations of 'D factors', are used as a way to determine whether investments and instruments lead to successful TOD in the US, Asia, and Europe (e.g., Staricco & Vitale Brovarone, 2018). With regards to this study, they provide a framework to see

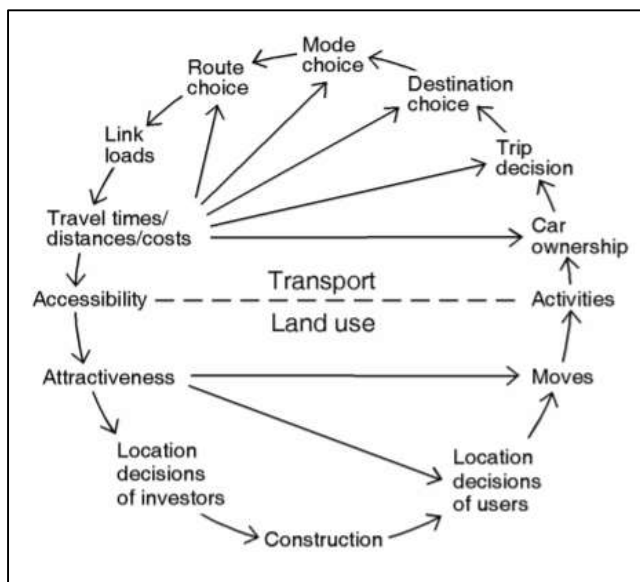
whether the developments around Zaandam Station may be defined as TOD, according to its correspondence with the characteristics given by the 5 Ds.

Land Use Transport Feedback Cycle

The land use transport feedback cycle by Wegener & Fuerst (1999) aims to explain the interaction between land use and transport, i.e. land use determining traffic flows and transport infrastructure changing land use patterns. In short, land uses (residential, industrial, or commercial) determine the locations of human activities (living, working, shopping). Such activities require transport systems to bridge the distance between locations of activities. These transport systems create opportunities for spatial interactions that may be measured as accessibility. Finally, accessibility determines location choices and leads to changes in land use (Figure 1).

Developments near train stations (and thus likewise TODs around Zaandam) are often attractive for investors as such locations are highly accessible because of the proximity of the train station (e.g., short travel times). As the cycle suggests, this may lead to the construction of new housing, in turn affecting the location decisions of users. As land values increase, rents and housing prices may rise, attracting better-off households and potentially displacing lower-income groups.

Figure 1 *The land use transport feedback cycle (Wegener & Fuerst, 1999)*



Bid rent Theory

Alonso's (1964) bid rent model (based on Von Thünen, 1826) tries to offer an explanation for the process of formation and development of urban residential, commercial, and industrial

areas. In short, the theory argues that the price and demand for real estate decrease, as the distance from a city centre increases. Households will attempt to occupy as much land as possible while staying within their accessibility requirements, meaning households with less need for the city centre will locate further away, as land prices are assumed to be lower here. It is often the poorer households that require greater accessibility to the central business district (CBD) or city centre and therefore locate nearer. There are other factors determining housing location as well. Accessibility may be higher although a location is physically further away from the city centre, for instance, due to a connecting rail line. Similarly, accessibility may be lower nearer the city centre, because of congestion. Two other factors determining housing location are the quality of the area, as well as the utility of a housing location relative to other activities (Martinez, 1992; Wegener & Fuerst, 1999).

As the developments of Inverdan have been built close to Zaandam Station, this proximity of transit is likely to increase the accessibility for people living in these neighbourhoods. Zaandam is located in the Metropolitan Region Amsterdam (MRA). The MRA spans the 'daily urban system' of Amsterdam, which is roughly "the area within which the majority of the daily commutes takes place. Within this region, there are mutual dependencies between a wide range of domains – accessibility, job market, housing market, etc. The actions of one municipality have an impact on the other municipalities" (Metropoolregio Amsterdam, n.d.). Many inhabitants living in Zaanstad work in Amsterdam, and this specific rail line is primarily used by commuters to and from the capital. The proportion of people working in Amsterdam increases with distance: the closer people live to Amsterdam, the more work in Amsterdam (Beuckens et al., 2018). Using Alonso's (1964) definitions, Amsterdam is considered to function as the regional 'CBD' for Zaanstad and other nearby municipalities. It is thus relevant to study to what degree this proximity to Amsterdam has an influence on the fashion in which neighbourhoods around Zaandam Station have changed since the start of the Inverdan developments.

Gentrification and the Rent-gap Theory

"One by one, many of the working-class quarters of London have been invaded by the middle classes- upper and lower. Shabby, modest mews and cottages- two rooms up and two down- have been taken over, when their leases have expired, and have become elegant, expensive residences. Larger Victorian houses, downgraded in an earlier or recent period- which were used as lodging houses or were otherwise in multiple occupation- have been upgraded once again... Once this process of 'gentrification' starts in a district it goes on rapidly until all or most of the original

working-class occupiers are displaced and the whole social character of the district is changed” (Glass, 1964, p. xviii).

The term gentrification was first used by Ruth Glass, in her book *London: aspects of change*, from which the quote above originates. Since then, many definitions of gentrification have been given. O’Sullivan (2005) defines gentrification simply as “the displacement of low-income households [...]” (p.1).

Kennedy & Leonard (2001) define gentrification as “the process by which higher-income households displace lower-income residents of a neighbourhood, changing the essential character and flavour of that neighbourhood” (p. 5). Throughout this study, a definition provided by (Lees et al., 2008, p. xv) will be used: “The transformation of a working-class or vacant area of the central city into middle class residential and/or commercial use”.

Rent-gap Theory. Several features describing gentrification recur in most definitions. One of them is the emphasis on viewing gentrification as a process, rather than a particular event, characterized by several transitional stages over time and at varying paces (Wyly & Hammel, 1998). Moreover, gentrification literature agrees on several predetermining factors for a neighbourhood to undergo gentrification. They have often been deteriorating for a period and have undergone disinvestment. An often-occurring reason is the deindustrialization processes of the last decades. Neighbourhoods previously destined to house industry workers, back when factories were located in the city centre, have degraded when they move elsewhere. The rent-gap theory by Neil Smith (1979, 1986) argues that when the rent gap - the discrepancy between current and potential property values and rents – is large enough for reinvestment to be profitable, gentrification may occur (Williams, 2015). When such neighbourhoods are abandoned by their residential and commercial activities, they often see an increase in physical deterioration and crime, all leading to the depreciation of land values (O’Sullivan, 2005). When these values drop significantly low, investors can afford to buy the land and invest in the redevelopment of the neighbourhood.

Subsequently, this redevelopment may attract new residents, often middle-class households. Gentrifiers are also often young, have had high education, have no children, and are at the start of their professional careers (Bader, 2011). Factors for attracting these new residents include the reasonability of housing prices, access to public transport, and commercial and recreational amenities (Helms, 2003). When middle-income households start residing in the neighbourhood, this, in turn, raises the overall rents and property values of the location. This may lead to the commercialization of the area. An array of businesses may want to settle here, bringing new and upscale products with them. In much of the gentrification literature, the presence of

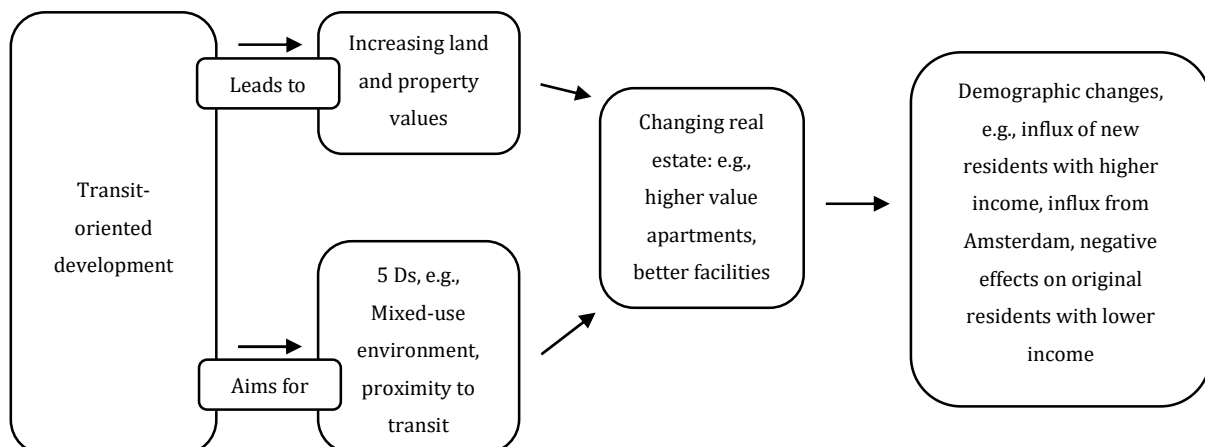
coffee shops has been used as a staple characteristic of a gentrified neighbourhood, although it is not a definitive criterion for all cases, as consumption preferences differ depending on the specific demands on the neighbourhood level (Deener, 2007; McKinnish et al., 2010). Still, it serves as an example of how the renewed commercial environment of the neighbourhood may reform its identity and reputation (Sullivan, 2007). City governments often follow with investments in public space, increasing the physical attractiveness of the neighbourhood.

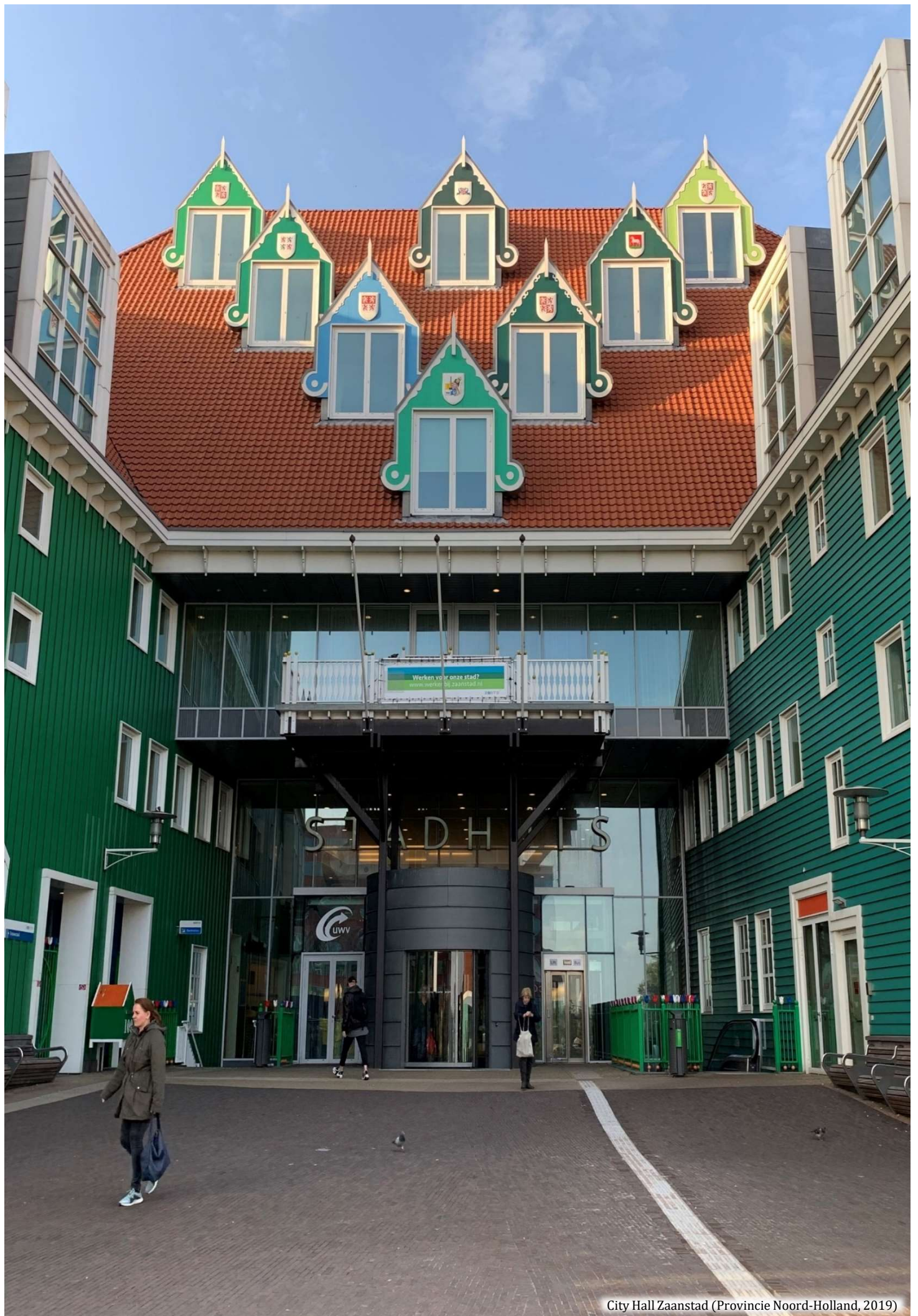
Conceptual Model

The figure below (Figure 2) presents the conceptual model on which this study is based. This model shows the main causal relations that are expected to exist between TOD and gentrification, based on the afore-described literature review and theories.

Transit-oriented development, which may be defined with the help of the five Ds (Ewing & Cervero, 2001, 2010), aims for a station area that is compact, mixed-use and facilitates transit connectivity through urban design. If the rent gap is large enough for reinvestment to be profitable, gentrification of the area may occur, according to the rent-gap theory by Smith (1979, 1986). A TOD's building density and proximity to transit may lead to an increase in land values and property values, a development which may be explained with the land use transport model by Wegener & Fuerst (1999). As a result, the newly built dwellings may differ in type as compared to existing buildings: high-rise apartments to efficiently fill in the scarce urban space around the station, combined with new stores and offices. Such higher-quality developments attract a specific audience, leading to demographic changes: new residents move in with a middle to high income. With Amsterdam as the region's 'CBD', following Alonso's (1964) bid rent theory, people working in Amsterdam are expected to move to the Zaandam Station area. Although Zaanstad may become an attractive location to move to for people working in Amsterdam, original residents with lower incomes may encounter difficulties staying in the area as a result of the high housing prices and rents.

Figure 2 *Conceptual model*





City Hall Zaanstad (Provincie Noord-Holland, 2019)

Chapter 3: Methodology

This chapter describes the philosophical considerations grounding this study, as well as the research strategy and a discussion on research methods. Further details on the methodology and data analysis of the quantitative and qualitative study will be elaborated upon in two separate chapters, Chapter 4 and Chapter 5 respectively.

Research Philosophy

Any form of research, whatever the scale, method or subject, is impacted by different philosophical considerations (Rabinowitz & Weseen, 1997). Different co-existing research paradigms can be distinguished and may be defined by their ontological, epistemological, and methodological position (van Thiel, 2014). The most widely recognized research paradigms are naturalism (or positivism/empiricism), interpretivism (or constructivism), and scientific realism (Moses & Knutsen, 2012).

This study falls under the interpretivist paradigm. A single phenomenon is believed to have multiple interpretations as reality is multi-layered and complex. Therefore, apart from using statistical data sets, the researcher aims to see the world from the participant's perspective, allowing the researcher to have multiple views for a research problem (Greener, 2008; Rashid et al., 2019). This opposes a naturalistic paradigm, which implies that the researcher is an independent observer, detached from the object of study.

With regards to ontology (*What is reality?*), this study presupposes that there exist multiple realities that are socially constructed and are not governed by natural laws (i.e., relativist ontology), contrary to realist ontology which assumes a reality that exists independent from the researcher's observations, and that this reality operates under natural laws of cause and effect (Guba & Lincoln, 2005; Rashid et al., 2019). Generally speaking, a qualitative case study (which the majority of this study is) assumes relativist ontology, considering that what we perceive are constructions of our own thinking, that the researcher's norms and values (shaped by the culture and society they live in) inevitably affect their research, and that the reality in which we live is constructed by ourselves (Rashid et al., 2019).

When looking at epistemology (*What is knowledge?*), this study sees knowledge as something that is interpreted by individuals (i.e., subjective epistemology), contrary to objective epistemology, based on the assumption that knowledge is governed by natural laws. This subjective perspective is appropriate for this research as it intended to create a "more informed and sophisticated construction, deep understanding of the social phenomenon under study, recognition of participants' subjectivity and use of own words" (Rashid et al., 2019, p.3).

Research Strategy

The city of Zaandam, located in the municipality of Zaanstad, was selected as the main case of study. In that sense, the proposed study may be defined as a single case study. A case study may be defined as “an intensive study of a single unit for the purpose of understanding a larger class of (similar) units” (Gerring, 2021, p. 342). As such, case study research allows a focus on behaviours, attributes, actions, and interactions, and are an often-used strategy for researching contemporary phenomena within a real-life context (Brewer & Hunter, 1989; Rashid et al., 2019; Yin, 1994). Within Zaandam, several neighbourhoods were investigated, which may be defined as embedded units of analysis. The first part of this embedded single-case study (definition by Yin, 2014) was primarily exploratory in character. Following the identification of the investments and instruments related to the TOD in Zaandam, the study aimed to explore whether a phenomenon (i.e., gentrification) shows itself in a specific real-life context (i.e., neighbourhoods in Zaandam) using quantitative data analysis. However, this quantitative analysis was followed by interviews intended to shed light on the ‘how’ and ‘why’ of the quantitative results, giving this research a qualitative, more in-depth, explanatory part as well. Although an interpretivist paradigm is commonly linked to qualitative research methods, quantitative methods are suitable as well (Rashid et al., 2019). Advocates of case studies encourage the use of both quantitative and qualitative methods within a research design (Harrison et al., 2017).

Research Methods

To investigate whether there is a relation between transit-oriented development in Zaandam and gentrification in its neighbourhoods, a mixed-methods approach was used.

Firstly, exploratory quantitative data analysis was performed using statistical data to observe how neighbourhoods near Zaandam station have changed between 2009-2019, in terms of their demographical and economic composition, as well as the number and types of dwellings. Neighbourhoods within the plan area of Inverdan were compared with other urbanized neighbourhoods in Zaanstad. Moreover, all urbanized neighbourhoods of Zaandam were compared to urbanized neighbourhoods in nearby municipalities. The main advantage of quantitative analysis is the possibility to identify causal relationships between TOD and gentrification effects. However, its limits lie in the inability to obtain detailed, case-specific explanations and experiences, to fully understand gentrification processes (Padeiro et al., 2019).

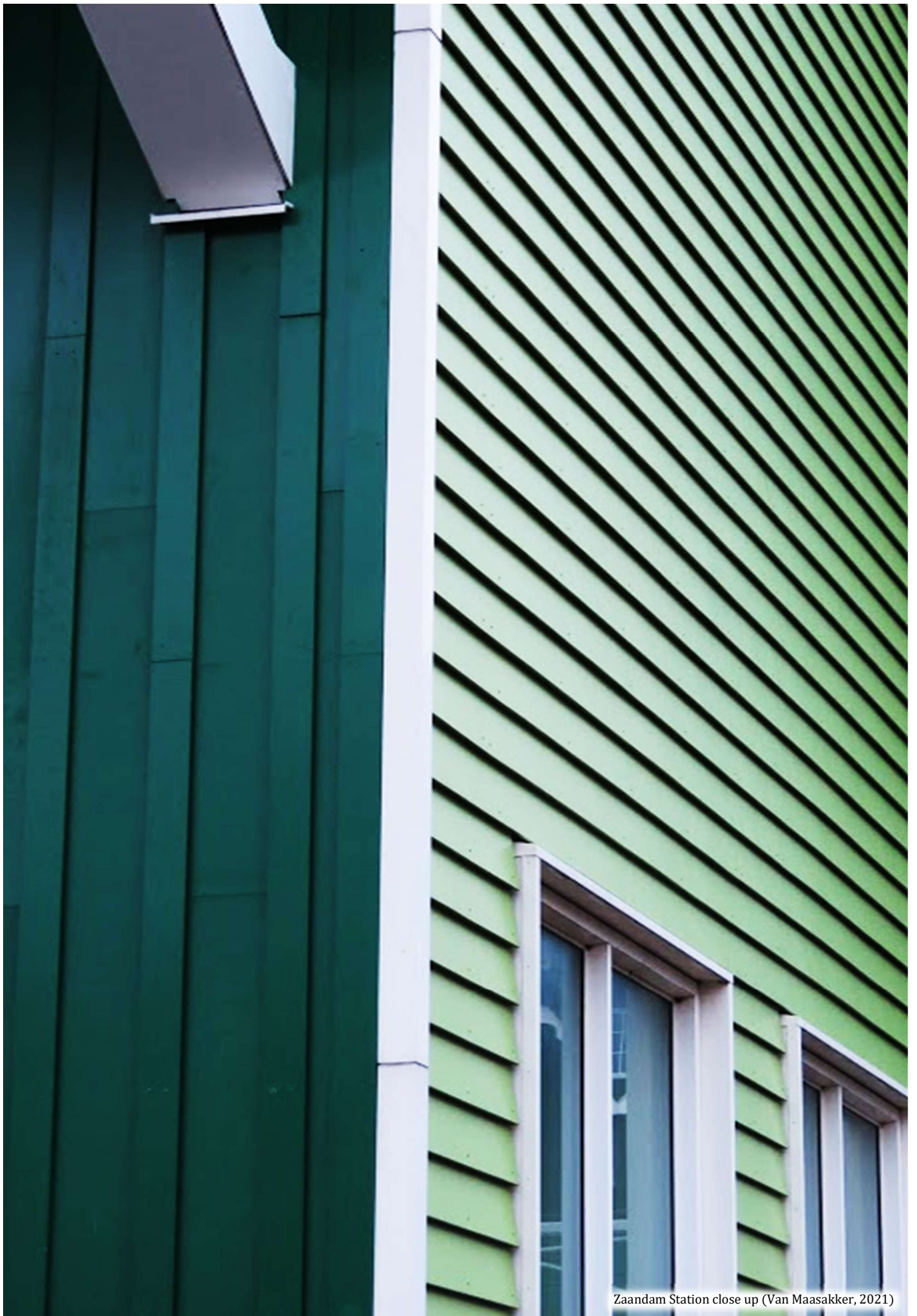
Secondly, therefore, expert interviews combined with desk research were used to identify the origins of the TOD project Inverdan: the ideas and motivation behind the plan, its content and its socioeconomic, demographic, and housing-related effects. Apart from giving a general overview of the Inverdan plan, findings were used to identify whether the observed changes were perceived as gentrification and to shed light on the relation between neighbourhood change and

transit-oriented development in Zaandam. Finally, based on these findings and plans for future residential development, an estimation was made on how neighbourhoods in the catchment area of the station will change in the next twenty years, and whether it is likely for gentrification to occur in this period.

Deduction + Induction = Abduction

As such, this study uses both a deductive and an inductive approach. The quantitative data analysis takes theory as a starting point (gentrification may be identified by a set of demographic and housing variables) and then tests whether this theory holds true in the specific case of Zaandam Station and its surrounding neighbourhoods. The qualitative interview analysis, on the other hand, takes the Zaandam case as a starting point, and by coding and analysing the interview data, tries to form a more general theory on how neighbourhoods change as a result of TOD and whether gentrification takes place. Following Rashid et al. (2019), this approach is comparable to what the authors define as abduction, where the researcher investigates “the relationship between everyday language and concepts (theories)” (p. 4). Abduction accepts existing theory, unlike induction, yet simultaneously forms a “tentative idea of what a theory may look like” (p. 4), which may improve the theoretical strength of the study. It is, thus, a sort of ‘systemic’ combining, which, according to Dubois & Gadde (2002), is a useful strategy when developing new theories and providing a platform for future research.

In the following chapters, the qualitative and quantitative approaches used for this study are further elaborated on (each in a separate chapter), discussing in more detail the methods, data collection, data analysis, results, and conclusions.



Zaandam Station close up (Van Maasakker, 2021)

Chapter 4: Quantitative Data Analysis

This chapter describes the methodological decisions made for the quantitative data analysis, as well as information on the data collection and analysis. Then, the results of the analysis are discussed and put in perspective with relevant TOD and gentrification literature.

Methodology

Secondary neighbourhood-level statistical data was analysed to observe how neighbourhoods near Zaandam station have changed between 2009-2019, in terms of their demographical and economic composition, as well as the number and types of dwellings. Neighbourhoods within the plan area of Inverdan were compared with other urbanized neighbourhoods in Zaanstad. Moreover, all urbanized neighbourhoods of Zaandam were compared to urbanized neighbourhoods of nearby municipalities. For this purpose, descriptive statistical analyses, as well as difference-in-differences analyses, were executed.

Design

A quasi-experimental design was used to compare neighbourhoods over time, within Zaandam (micro level) and between Zaandam and other municipalities (macro level). As usual in a quasi-experimental design, for both levels, a comparison is made between “treatment” and “control”, referring to groups of observation that are either subjected to or are not subjected to some kind of intervention (Bardaka et al., 2018). As such, the observations are neighbourhoods (operationalized in several socioeconomic and housing variables), and the intervention is transit-oriented development (as defined in sub-question 1).

The micro level is used to investigate neighbourhoods around Zaandam station that have undergone TOD. For this, the neighbourhoods that had undergone developments as a result of project Inverdan were selected: Russische buurt, Spoorbuurt, and Westerspoor (treated group). These neighbourhoods are compared to the rest of the neighbourhoods in Zaanstad (control group).

The macro level is used to investigate Zaanstad as a whole (treated group), compared to three other municipalities in the province of Noord-Holland (control group), as the developments within the Inverdan area are expected to have spill-over effects on nearby neighbourhoods. For example, such infill developments may have spillover effects on housing prices in other neighbourhoods of Zaanstad (Ooi & Le, 2013). Amstelveen, Purmerend, and Haarlemmermeer were chosen, based on their relatively similar size as well as their similar proximity to Amsterdam, compared to Zaanstad. The distance from Amsterdam is an important factor, as Amsterdam is considered to function as the region’s ‘central business district’ (CBD), and, following the bid rent model by Alonso (1964), the distance to a CBD influences price and demand for property. Also,

many inhabitants of Noord-Holland work in Amsterdam. The closer a municipality is located from Amsterdam, the greater the proportion of inhabitants working in Amsterdam (Beuckens et al., 2018).

As gentrification generally pertains to urban neighbourhoods (e.g., Atkinson, 2002), all included neighbourhoods met the condition that they are at least moderately urbanized, which means having at least 1000 addresses per km² (*'matig stedelijk'*, CBS, 2021). See Appendix A for two maps providing an overview of the relevant neighbourhoods and municipalities for the micro and macro level analysis.

On both the micro and macro level, several measures of neighbourhood change were compared between 2009 and 2019, for both the treated and control group. Then, a difference-in-difference model was formulated, and a regression analysis was carried out for two factors of gentrification (income and property value) to see whether TOD has had gentrification effects on neighbourhoods in Zaanstad.

Data Collection

With the intention to investigate to what degree the Inverdan developments had an effect on neighbourhood change between 2009 and 2019 (sub-question 2), the main data source for this quantitative data analysis was secondary data on demographics, income, and housing on a neighbourhood scale. This data was collected and provided by the Dutch central bureau of statistics (Centraal bureau voor de Statistiek [CBS]).

A neighbourhood (in Dutch terminology: *buurt*) is the smallest regional subdivision, decided upon by the corresponding municipality. It is a part of a municipality, homogeneously demarcated based on the number of buildings or its social-economical structure. Often one function is dominant in a neighbourhood (residential, working, recreational), but they may occur as mixed as well. A district (*wijk*) is an accumulation of one or more neighbourhoods, and a municipality (*gemeente*) consists of multiple districts. The municipality of Zaanstad consists of nineteen districts and fifty neighbourhoods (CBS, 2021).

CBS records from the year 2009 provide baseline pre-TOD development data, as most of the transit-oriented development near Zaandam station was realised from this year onwards. The year 2009 was also the earliest year for which sufficiently complete data was available for the variables that were investigated. CBS records from the year 2019 provide the most current data available on the selected variables and thus allow for the greatest time lapse between the first finished buildings as part of TOD and today. Sufficient time must pass to observe land use patterns and neighbourhood characteristics, as they often occur slowly over a longer period (Pérez et al., 2003). Although still relevant to observe first indications of gentrification, the relatively short study period of ten years may be seen as a limitation to the validity of the proposed study.

Variable Definitions. As mentioned, this study uses the definition of gentrification by Lees et al. (2008, p. xv): “the transformation of a working-class or vacant area of the central city into middle class residential and/or commercial use”. In the literature, many different variables are used to identify gentrification. Despite the many different approaches and definitions of gentrification in academic literature, two indicators are common for various manifestations of gentrification (K. Williams, 2015):

1. Physical and social changes
2. A move in of higher-class households

As such, variables used to study gentrification should represent these two indicators. There are two other criteria to consider when deciding on variables. First, to improve the replicability of this research, variables should not be culturally linked. For example, coffee shops are found to be a sign of gentrification in Chicago, but not necessarily elsewhere (Papachristos et al., 2011). Secondly, although displacement is a well-known phenomenon strongly linked with gentrification, it cannot be used as an indicator for it. Not all gentrified areas lead to displacement. For example, a neighbourhood may have enough room for middle-class households to live alongside the original (less affluent) residents (Brown et al., 2016; Wyly & Hammel, 1998). Displacement is thus a potential result of gentrification, but not a defining characteristic (Freeman, 2005).

Bardaka et al. (2018) summarized the most widely used variables as being educational attainment, managerial occupation, household income, and housing values. Based on these studies and the limited availability and accessibility of neighbourhood-level data, two dependent variables were selected.

First, the socioeconomic variable ‘mean income per inhabitant’ was selected. According to the used definition of gentrification, higher-income households are expected to move into vacant areas or areas with a lower socioeconomic status. As such, the overall income in that area is expected to increase (see Galster & Peacock, 1986; Glick, 2008; Hammel & Wyly, 1996; Knotts & Haspel, 2006; McKinnish et al., 2010; Pegler et al., 2020; Neil Smith, 1979). Therefore, an increase in mean income per inhabitant may indicate gentrification.

Secondly, the housing variable ‘mean property value per dwelling’ was selected. Gentrification arises from a rapid increase in property values and rent values. These values rise as a result of the move-in of higher-income residents accompanied by reinvestment and (re)development, thereby increasing housing demand (see Galster & Peacock, 1986; Hammel & Wyly, 1996; Knotts & Haspel, 2006; Marcuse, 1985).

There are several advantages of using more than one variable. Firstly, individual variables that potentially indicate gentrification are dissimilar to each other, in the sense that the degree of change in one variable (between 2009 and 2019) is not the same as on a different variable,

resulting in varying predicting powers. Examining a single variable to determine gentrification thus may be superficial. Moreover, variables may be temporally sensitive and by themselves may give inconsistent results. Finally, using multiple variables helps to distinguish gentrification and urban reinvestment from other types of neighbourhood change (Keating & Smith, 1996; Slater, 2004; Williams, 1986).

For both 'mean income per inhabitant' and 'mean property value per dwelling', the value in euros pertaining to 2009 were normalized to 2019 by using an inflation calculator tool that calculates the time value of money based on historical inflation and Consumer Price Index values¹. These, and other socioeconomic variables that were selected from the CBS data to observe neighbourhood change between 2009 and 2019, are shown in Table 1.

¹ <https://www.inflationtool.com/euro-netherlands>

Table 1 *Description of variables*

| Dependent variable name | Definition | Literature |
|--|--|--|
| Income | The average income per inhabitant in each neighbourhood (x 1000 euros) | Glick (2008); McKinnish et al. (2010); Smith (1979) |
| Property value | The average property value of residential buildings in each neighbourhood (x 1000 euros) | Knotts & Haspel (2006); Marcuse (1985); Smith (1979) Bardaka et al. (2018) |
| Control variable name | Definition | Literature |
| No. of inhabitants | The number of inhabitants in each neighbourhood | Deka (2017); Helms (2003) |
| Age 25-45 | The proportion of inhabitants between 25 and 45 years old in each neighbourhood | Freeman (2005); Helms (2003); Pacione (2009) |
| Population density | The average number of people per square kilometre in each neighbourhood | Deka (2017); Helms (2003) |
| No. of dwellings | The number of dwellings in each neighbourhood | Deka (2017); Helms (2003) |
| Owner-occupied | The proportion of owner-occupied dwellings in each neighbourhood | Bardaka et al. (2018); Neil Smith (1979) |
| Total rental | The total proportion of rental dwellings in each neighbourhood | Nelson et al. (2010); Smith (1986) |
| Cooperative-owned rental | The proportion of cooperative-owned rental dwellings in each neighbourhood | Nelson et al. (2010); Smith (1986) |
| Other-owned rental | The proportion of other-owned rental dwellings in each neighbourhood | Nelson et al. (2010); Smith (1986) |
| Built after 2000 | The proportion of housing built after the year 2000 in each neighbourhood | Brown et al. (2016); Williams (2015) |
| Households below/around social minimum | The proportion of households below or around social minimum (legal minimum level of subsistence) in each neighbourhood | Hammel & Wyly (1996); Knotts & Haspel (2006); Veldboer et al. (2011) |
| No. of cars (total) | The total number of cars in each neighbourhood | Dominie (2012) |
| No. of cars (per household) | The number of cars per household in each neighbourhood | Dominie (2012) |

Descriptives: Neighbourhood Change Between 2009 and 2019

A descriptive analysis was carried out comparing multiple socioeconomic and housing variables to investigate how neighbourhoods changed between 2009 and 2019. This was done for both the micro level (TOD neighbourhoods vs. rest of Zaanstad) and the macro level (Zaandam vs. other municipalities). As such, it could be observed whether the socioeconomic situation changed differently for the treated group compared to the control group. Means and standard deviations were reported, as well as the proportional change between 2009 and 2019 for the treated and control group. A t-test was executed to test the significance of this change. The variables used, their description, and supporting literature can be found in Table 1.

Difference-in-differences Model: Gentrification Effects of TOD Between 2009 and 2019

Although the descriptive analysis may provide insight into how TOD neighbourhoods changed in comparison to the control neighbourhoods, they do not indicate whether such changes are actually a consequence of transit-oriented development. To see whether TOD has had gentrification effects on neighbourhoods in Zaanstad, a difference-in-difference analysis was carried out.

The Difference-in-difference Model. As mentioned, the TOD developments around Zaandam Station are considered the ‘treatment’, and neighbourhoods that have undergone treatment are compared with neighbourhoods that had not (control). Economists often compare variables before and after treatment to evaluate policies. A straightforward way to do this is calculating for the treated area the difference of a certain variable before and after treatment. However, this method does not represent potential effects accurately, because the environment itself changes with time as well. In other words, the observed difference may contain effects of factors that were not observed by only considering the treated area. To overcome this, a difference-in-differences model (DID model) may be used. This model measures treatment effects not only by calculating the differences in the treatment area but also by looking at differences in time in a control group. The DID model is a much-used model to measure the effects of public interventions on relevant outcome variables (Abadie, 2005). Other types of analysis can be found in academic literature to quantitatively study the link between TOD and gentrification, such as analysis of variance, multiple linear regression, survival analysis, and longitudinal methods. The DID analysis was found to be most common (39% of analysed research papers) according to a review study by Padeiro et al. (2019).

As mentioned, this study investigates two time periods: before TOD and after². Socioeconomic and housing data on the neighbourhood level, provided by CBS, will be used for this purpose.

The DID model was implemented in a regression model. The DID formula had the following shape:

$$y = \beta_0 + \beta_1 D + \beta_2 T + \beta_3 D \circ T + \beta_4 X + \varepsilon \quad (1)$$

Where

D : group dummy variable. $D_i = 1$ indicates that neighbourhood i is in the treated group, $D_i = 0$ indicates that it is in the control group;

T : time dummy variable. $T_t = 1$ indicates the period after treatment, $T_t = 0$ indicates the period before treatment;

² Or, more specifically, the most recent year of which sufficient data is available, as developments are still ongoing around Zaandam station.

$D \circ T$: development dummy variable. The product of D and T ;

X : the vector of control variables;

$\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$: regression coefficients;

ε : error term

The DID model is based on several assumptions, such as:

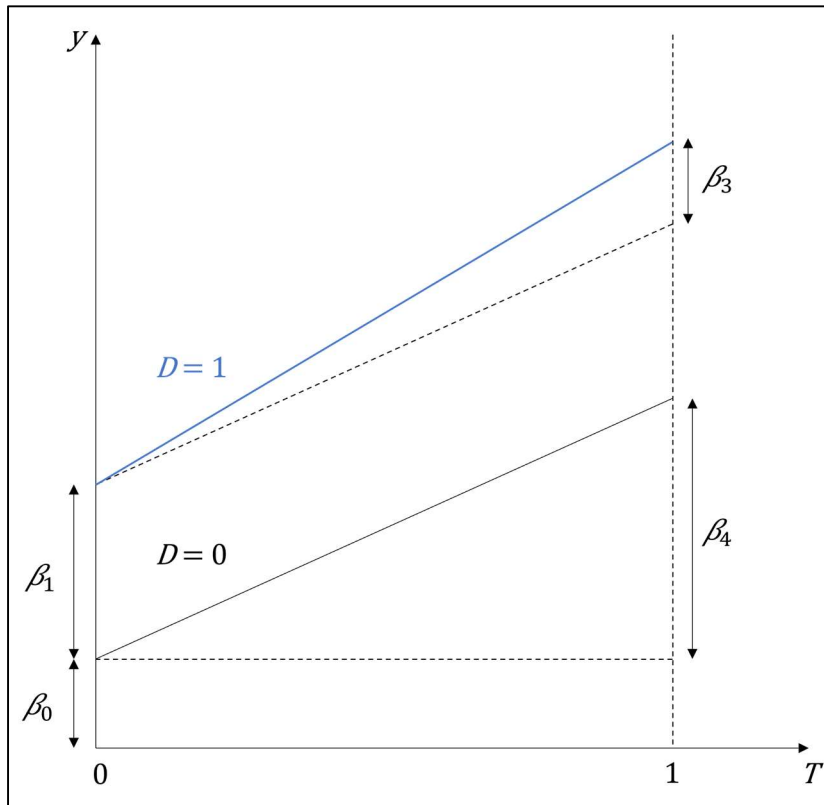
- The parallel trend assumption: without the presence of treatment, the average values of the treated and control group would have followed a parallel path through time (Abadie, 2005). As such, the parallel trend assumption makes sure variations in the environment are considered in the model.
- Stable unit of treatment value assumptions (SUTVA): treatment on one unit does not affect the outcome of a different unit. As such, SUTVA prevents the possibility that units interfere with each other.
- Linearity in parameter specification: All parameters in the DID model are linear, as this is a condition of a (linear) regression model to give accurate outcomes.

Based on these assumptions it is possible to calculate the DID estimator or average treatment effect (ATE, the ‘TOD-effect’) (Delgado & Florax, 2015).

$$\begin{aligned}
 ATE &= (\bar{Y}_{treat,after} - \bar{Y}_{treat,before}) - (\bar{Y}_{control,after} - \bar{Y}_{control,before}) \\
 &= [E(y|D = 1, T = 1) - E(y|D = 1, T = 0)] - [E(y|D = 0, T = 1) - E(y|D = 0, T = 0)] \\
 &= [\beta_2 + \beta_3] - [\beta_2] \\
 &= \beta_3
 \end{aligned}$$

The DID model is graphically represented in Figure 3. The blue line represents the observed outcome trend in the treatment group. The black line represents the outcome trend in the control group.

Figure 3 Graphical representation of difference-in-differences regression model



For both the micro level (TOD neighbourhoods vs. the rest of Zaanstad) and the macro level (Zaanstad vs. other municipalities), the DID model was implemented in a linear, ordinary least squares, regression model.

The model was first used to see to what degree transit-oriented development has had an effect on income. As such, the dependent variable was 'income per inhabitant', and the independent variables were D , T , and $D \circ T$. 'Population density', 'age 25-45', and 'owner-occupied dwellings' were added as exogenous control variables.

Then, the linear model was used to see to what degree transit-oriented development has had an effect on property value. As such, the dependent variable was 'property value', and the independent variables were D , T , and $D \circ T$. 'Population density', 'age 25-45', 'owner-occupied dwellings', and 'built after 2000' were added as exogenous control variables.

Results Quantitative Analysis

Below, the results of the quantitative analysis of CBS neighbourhood data are described. The results are concurrently compared to theories findings in the academic literature on gentrification and TOD as described in Chapter 2.

Descriptive Analysis

Micro Level. Table 2 presents the means, standard deviations, and change between 2009 and 2019 for the population characteristics of thirty-five neighbourhoods in Zaanstad. Two groups can be distinguished: the treated group, existing of neighbourhoods in which TOD has taken place between 2009 and 2019 (see sub-question 1), and the control group, existing of all other neighbourhoods of Zaanstad, providing that they are at least moderately urbanized. This means that they have at least 1000 addresses per km² ('matig stedelijk', CBS, 2021), as gentrification generally pertains to urban neighbourhoods (e.g., Atkinson, 2002).

The table shows that the proportion of owner-occupied dwellings has increased at a similar rate in both groups. The values for the number of inhabitants population density, the number of dwellings, proportion of other-owned rental dwellings, the proportion of housing built after 2000, and the total number of cars have increased considerably more in the treated group compared to the control group. Proportion age 25-45, mean property value, the proportion of other-owned rental dwellings, and mean income per inhabitant increased in the treated group but decreased in the control group. The opposite is true for the proportion of households below or around the social minimum and number of cars per household. Proportions of rental dwellings, total and cooperative-owned, have decreased in both groups.

An independent t-test for time (2009-2019) for both the treated and control group was performed. In the treated group, none of the variables changed significantly at the 0.05 level between 2009 and 2019. The change in *income per inhabitant* was significant at the 0.1 level ($t = -3.03, p = .056$). The thirteen per cent increase may indicate that the average income per inhabitant increased comparatively fast, which is a commonly mentioned sign of gentrification in academic literature (e.g., Glick, 2008; McKinnish et al., 2010).

In the control group, the *proportion of age 25-45* decreased significantly at the 0.5 level ($t = 3.05, p = .003$), which may indicate that people of this age group moved elsewhere. Although it is unclear what has caused this, possibly some of them moved to the Inverdan area, attracted by the newly built apartments and services targeting young professionals. This would align with the literature on demographic change caused by gentrification (Freeman, 2005; Helms, 2003).

The *proportion of other-owned rental dwellings* decreased significantly at the 0.5 level ($t = 2.33, p = .023$). The change in the *proportion of owner-occupied dwellings* and *proportion of rental dwellings (total)* was significant at the 0.1 level ($t = -1.75, p = .086$; $t = 1.73, p = .090$). The fact that the proportions of all types of rental dwelling decreased, whereas the proportion of owner-occupied dwellings increased, may assume that the ownership of former rental homes has been converted to private ownership, or that the actual rental dwellings have been demolished to make place for new owner-occupied dwellings. These developments would correspond to identified gentrification effects (Bardaka et al., 2018).

Table 2 *Descriptive statistics of socioeconomic and housing variables for treated and control groups for 2009 and 2019 (micro)*

| | 2009 | | | | 2019 | | | | | |
|---|---------|-------|---------|------|---------|---------------------|-------|---------|---------------------|-------|
| | Control | | Treated | | Control | | | Treated | | |
| | Mean | SD | Mean | SD | Mean | Change ¹ | SD | Mean | Change ¹ | SD |
| No. of inhabitants | 3783 | 2328 | 1663 | 907 | 4008 | 0.06 | 2669 | 2382 | 0.43 | 1580 |
| Proportion age 25-45 | 0.29 | 0.06 | 0.30 | 0.04 | 0.24 | -0.17** | 0.07 | 0.33 | 0.11 | 0.08 |
| Population density | 5485 | 2564 | 2553 | 2163 | 5675 | 0.03 | 2801 | 3286 | 0.29 | 2483 |
| No. of dwellings | 1667 | 1011 | 750 | 360 | 1752 | 0.05 | 1116 | 1185 | 0.58 | 799 |
| Mean property value | 232.57 | 51.13 | 220.49 | 7.92 | 229.27 | -0.01 | 52.70 | 222.27 | 0.01 | 15.40 |
| Proportion of owner-occupied dwellings | 0.47 | 0.18 | 0.36 | 0.07 | 0.56 | 0.18. | 0.20 | 0.42 | 0.17 | 0.10 |
| Proportion of rental dwellings (total) | 0.53 | 0.18 | 0.63 | 0.07 | 0.44 | -0.16. | 0.20 | 0.58 | -0.08 | 0.10 |
| Proportion of cooperative-owned rental dwellings | 0.43 | 0.20 | 0.51 | 0.14 | 0.37 | -0.13 | 0.20 | 0.43 | -0.17 | 0.15 |
| Proportion of other-owned rental dwellings | 0.09 | 0.05 | 0.12 | 0.06 | 0.07 | -0.29* | 0.05 | 0.15 | 0.28 | 0.07 |
| Proportion of housing built after 2000 | 0.11 | 0.21 | 0.11 | 0.03 | 0.18 | 0.69 | 0.28 | 0.26 | 1.36 | 0.26 |
| Mean income per inhabitant | 25.53 | 3.49 | 25.65 | 1.33 | 25.52 | -0.00 | 3.45 | 29.01 | 0.13. | 0.94 |
| Proportion of households below or around social minimum | 0.07 | 0.04 | 0.10 | 0.02 | 0.07 | 0.02 | 0.04 | 0.08 | -0.14 | 0.03 |
| No. of cars (total) | 1404 | 789 | 752 | 513 | 1610 | 0.15 | 990 | 1005 | 0.34 | 749 |
| No. of cars (per household) | 0.85 | 0.15 | 0.90 | 0.26 | 0.91 | 0.07 | 0.17 | 0.77 | -0.15 | 0.12 |

¹ Change between 2009 and 2019*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, . $p < 0.1$.

Macro Level. Table 3 presents the means, standard deviations, and change between 2009 and 2019 for the population characteristics of the municipalities Zaanstad, Amstelveen, Haarlemmermeer, and Purmerend. Two groups can be distinguished: the treated group, existing of thirty-five neighbourhoods located in Zaandam, and the control group, existing of 105 neighbourhoods located in either Amstelveen, Haarlemmermeer or Purmerend. All neighbourhoods meet the condition that they are at least moderately urbanized, which means having at least 1000 addresses per km² ('matig stedelijk', CBS, 2021) as gentrification generally pertains to urban neighbourhoods (e.g., Atkinson, 2002).

The table shows that the proportion of housing built after 2000 has increased considerably more in the treated group compared to the control group. The values for the number of inhabitants, the number of dwellings, the proportion of owner-occupied dwellings, the proportion of households below or around the social minimum, the total number of cars and the number of cars per household have increased in the treated group but have decreased in the control group. The opposite holds for mean property value and proportion of rental dwellings, both total and

other-owned. The proportion of age 25-45 and proportion of cooperative-owned rental dwellings has decreased in both groups.

An independent t-test for time (2009-2019) for both the treated and control group was performed. In the treated group, the *proportion of age 25-45* decreased significantly between 2009 and 2019 ($t = 2.66, p = .010$). The fact that all urbanised neighbourhoods in Zaanstad on average have decreased in the proportion of people 25-45 does not necessarily contradict the gentrification literature, as, according to the micro level analysis, the proportion of people aged 25-45 actually increased by eleven per cent in the neighbourhoods within the development area, as is expected in gentrifying neighbourhoods (Helms, 2003). The change in the *proportion of owner-occupied dwellings, total rental dwellings, and other-owned rental dwellings* was significant at the 0.1 level ($t = -1.84, p = .071$; $t = 1.81, p = .076$; $t = 1.81, p = .075$).

In the control group, the *proportion of households below or around the social minimum* decreased significantly ($t = 2.47, p = .015$). The change in the *number of inhabitants* and *population density* was significant at the 0.1 level ($t = 1.78, p = .078$; $t = -1.67, p = .098$). As on the micro level, t proportions of all types of rental dwelling decreased, whereas the proportion of owner-occupied dwellings increased, which may assume that the ownership of former rental homes has been converted to private ownership, or that the actual rental dwellings have been demolished to make place for new owner-occupied dwellings.

Table 3 *Descriptive statistics of socioeconomic and housing variables for treated and control groups for 2009 and 2019 (macro)*

| | 2009 | | | | 2019 | | | | | |
|---|---------|-------|---------|-------|---------|---------------------|--------|---------|---------------------|-------|
| | Control | | Treated | | Control | | | Treated | | |
| | Mean | SD | Mean | SD | Mean | Change ¹ | SD | Mean | Change ¹ | SD |
| No. of inhabitants | 3381 | 2478 | 3590 | 2312 | 2785 | -0.176. | 2078 | 3869 | 0.078 | 2618 |
| Proportion age 25-45 | 0.27 | 0.10 | 0.29 | 0.06 | 0.26 | -0.035 | 0.11 | 0.25 | -0.145** | 0.07 |
| Population density | 4731 | 2297 | 5219 | 2642 | 5333 | 0.127. | 2536 | 5464 | 0.047 | 2824 |
| No. of dwellings | 1439 | 1031 | 1584 | 1003 | 1223 | -0.150 | 832 | 1703 | 0.075 | 1095 |
| Mean property value | 324.19 | 85.27 | 231.43 | 48.76 | 325.47 | 0.004 | 112.75 | 228.64 | -0.012 | 50.36 |
| Proportion of owner-occupied dwellings | 0.59 | 0.18 | 0.46 | 0.17 | 0.58 | -0.020 | 0.21 | 0.55 | 0.181. | 0.19 |
| Proportion of rental dwellings (total) | 0.40 | 0.18 | 0.54 | 0.17 | 0.42 | 0.059 | 0.21 | 0.45 | -0.154. | 0.19 |
| Proportion of cooperative-owned rental dwellings | 0.27 | 0.18 | 0.44 | 0.20 | 0.27 | -0.019 | 0.20 | 0.38 | -0.137 | 0.20 |
| Proportion of other-owned rental dwellings | 0.12 | 0.11 | 0.10 | 0.05 | 0.15 | 0.225 | 0.16 | 0.07 | -0.231. | 0.05 |
| Proportion of housing built after 2000 | 0.14 | 0.28 | 0.11 | 0.20 | 0.18 | 0.314 | 0.30 | 0.19 | 0.748 | 0.27 |
| Mean income per inhabitant | 28.64 | 5.20 | 25.54 | 3.34 | 29.71 | 0.037 | 4.98 | 25.84 | 0.012 | 3.44 |
| Proportion of households below or around social minimum | 6.40 | 4.60 | 0.07 | 0.04 | 5.06 | -0.209* | 2.46 | 0.07 | 0.003 | 0.04 |
| No. of cars (total) | 1439 | 1028 | 1344 | 785 | 1235 | -0.142 | 970 | 1558 | 0.159 | 978 |
| No. of cars (per household) | 1.01 | 0.29 | 0.86 | 0.16 | 1.01 | -0.006 | 0.27 | 0.90 | 0.051 | 0.17 |

¹ = (value 2019 - value 2009) / value 2009

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, . $p < 0.1$.

Difference-in-differences Analysis

Micro Level.

Property Value. For the difference-in-difference analysis, a linear regression was used to test if property value changed significantly more in TOD neighbourhoods (treated) compared to the rest of Zaanstad (control). Based on the output of the regression analysis presented in Table 5 (descriptives can be found in Table 4), the fitted regression model can be denoted in the form of the above-mentioned formula (1):

$$5.462 + .135 \times (D) - .197 \times (T) + .160 \times (D \circ T) + .000 \times (\text{Population density}) - 1.876 \times (\text{Proportion age 24} - 45) + .751 \times (\text{Proportion of owner} - \text{occupied dwellings}) + .295 \times (\text{Proportion of dwellings built after 2000})$$

The overall regression was statistically significant ($R^2 = .81, F(7, 57) = 34.44, p < .000$), meaning that the model with the predictor variables fits the data better than a model without them would.

A positive correlation between $D \circ T$ (the difference-in-difference comparison of treated vs. control neighbourhoods between 2009 and 2019) and property value was found, suggesting that the mean property value per dwelling increased more in TOD areas compared to the control neighbourhoods between 2009 and 2019. However, the correlation was not significant at the .05 level ($\beta = .160, p = .051$). With a p-value of 0.51, the likelihood of the increase of property values being independent of the TOD developments is expected to be small. In other words, the TOD developments between 2009 and 2019 may have contributed to increasing the property values of housing in the TOD area, which corresponds with gentrification literature, such as (Bardaka et al., 2018) who found similar results in a study on gentrification effects near light rail development.

On itself, disregarding time trends between 2009 and 2019, D (whether a neighbourhood had undergone TOD) significantly predicted property value ($\beta = .135, p = .24$), suggesting that property values were overall higher in TOD areas than in the control neighbourhoods. Furthermore, T indicates that overall, disregarding groups, home value decreased significantly between 2009 and 2019 ($\beta = -.197, p < .000$).

It was also found that *proportion of owner-occupied dwellings*, *proportion of dwellings built after 2000*, and *proportion age 25-45* significantly predicted property value ($\beta = .751, p < .000$); $\beta = .295, p < .000$; $\beta = -1.876, p < .000$). These results are expected, as owner-occupied dwellings are in general more expensive compared to rental dwellings, and newly built dwellings generally are more expensive than older dwellings. The negative correlation between property value and *proportion 25-45* suggests that the higher the value of a house, the fewer people from this age group tend to live in it. *Population density* also significantly correlates with *home value*, but its beta-value is practically zero ($\beta < .000, p < .000$).

Income. For the difference-in-difference analysis, a linear regression was used to test if income per household changed significantly more in TOD neighbourhoods (treated) compared to the rest of Zaanstad (control). Based on the output of the regression analysis presented in Table 5, the fitted regression model can be denoted in the form of the above-mentioned formula (1):

$$3,224 + .059 \times (D) - .082 \times (T) + .201 \times (D \circ T) - .000 \times (\text{Population density}) - .774 \times (\text{Proportion age 24 – 45}) + .539 \times (\text{Proportion of owner – occupied dwellings})$$

The overall regression was statistically significant ($R^2 = .66, F(7, 57) = 34.44, p < .000$). A significant correlation between $D \circ T$ and income was found ($\beta = .201, p = .019$), suggesting that income increased more in TOD areas compared to the control neighbourhoods between 2009 and 2019.

In itself, T significantly predicted income ($\beta = -.082, p = .004$), indicating an overall decrease of income per inhabitant between 2009 and 2019. D did not significantly correlate with income ($\beta = .059, p = .333$).

It was also found that *proportion of age 25-45* and *proportion of owner-occupied dwellings* significantly predicted income ($\beta = -.774, p < .000$; $\beta = .539, p < .000$). This suggests that overall, the proportion of people aged 25-45 declined as income increased and that homeowners had a higher income compared to other inhabitants (i.e., those living in rental homes). *Population density* did not significantly correlate with *income* ($\beta < .000, p = .295$).

Following Halvorsen & Palmquist (1980) on semi-logarithmic equations, the marginal effect of $D \circ T$ (the TOD effect) was:

$$\% \frac{dy}{y} = 100 \times (e^{\alpha_3} - 1)$$

The treatment effect estimate was only significant in the ‘income per inhabitant’ model. As such, it can be estimated that neighbourhoods that had undergone TOD near Zaandam Station experienced a $100 \times (e^{0.201} - 1) = 22.26\%$ increase in mean income per inhabitant following the transit-oriented development projects between 2009 and 2019.

Notwithstanding that the treatment effect estimate in the ‘property value’ model was not significant at the 5% level ($p = .051$), its results may suggest that neighbourhoods that had undergone TOD near Zaandam Station experienced a $100 \times (e^{0.160} - 1) = 17.35\%$ increase in mean income per inhabitant following the transit-oriented development projects.

Table 4 *Descriptive Statistics of variables for regression model (micro)*

| | <i>N</i> | Minimum | Maximum | Mean | Median | <i>SD</i> |
|--|----------|---------|---------|--------|--------|-----------|
| Income | 54 | 17.81 | 34.42 | 25.66 | 25.93 | 3.35 |
| Property value | 67 | 141.57 | 381.89 | 230.01 | 216.16 | 49.21 |
| Proportion of inhabitants age 25-45 | 67 | 0.00 | 0.48 | 0.27 | 0.27 | 0.07 |
| Proportion of owner-occupied dwellings | 66 | 0.05 | 0.89 | 0.50 | 0.50 | 0.19 |
| Proportion of dwellings built after 2000 | 66 | 0.00 | 1.00 | 0.15 | 0.06 | 0.24 |

Table 5 *Parameter estimation results of DID model (micro).*

| | ln(property value) ³ | <i>SD</i> | ln(income per inhabitant) | <i>SD</i> |
|--|---------------------------------|-----------|---------------------------|-----------|
| Intercept | 5.462*** | 0.070 | 3.224*** | 0.068 |
| D | 0.135* | 0.059 | 0.059 | 0.060 |
| T | -0.197*** | 0.027 | -0.082** | 0.027 |
| D◦T | 0.160. | 0.081 | 0.201* | 0.083 |
| Population density | 2.139E-5*** | 0.000 | -4.872E-6 | 0.000 |
| Proportion age 25-45 | -1.876*** | 0.206 | -0.774*** | 0.193 |
| Proportion of owner-occupied dwellings | 0.751*** | 0.070 | 0.539*** | 0.067 |
| Proportion of dwellings built after 2000 | 0.295*** | 0.059 | | |
| R ² | 0.809 | | 0.655 | |
| Adjusted R ² | 0.785 | | 0.611 | |
| N | 66 | | 68 | |
| RMSE | 0.090 | | 0.08454 | |

*** $p < 0.001$,** $p < 0.01$,* $p < 0.05$,. $p < 0.1$.**Macro Level.**

Property Value. For the difference-in-difference analysis, a linear regression was used to test if property value changed significantly more in Zaandam (treated) compared to Amstelveen, Haarlemmermeer, and Purmerend (control). Based on the output of the regression analysis presented in Table 7 (descriptives can be found in Table 6), the fitted regression model was:

$$5.565 - .250 \times (D) - .012 \times (T) - .067 \times (D \circ T) - .000 \times (\text{Population density}) - .409 \times (\text{Proportion age 24 - 45}) + .494 \times (\text{Proportion of owner - occupied dwellings}) + .158 \times (\text{Proportion of dwellings built after 2000})$$

The overall regression was statistically significant ($R^2 = .41$, $F(7, 230) = 23.13$, $p < .000$), meaning that the model with the predictor variables fits the data better than a model without them would.

³ As to hold to the *linearity in parameter specification* assumption of the DID model, the natural logarithmic functions of 'property value' and 'income per inhabitant' were used (corrected for inflation).

A negative correlation between $D \circ T$ and property value was found, suggesting that over time, property value increased more in the control municipalities than in Zaanstad. However, the correlation was not significant at the .05 level ($\beta = -.067, p = .321$).

In itself, disregarding time trends between 2009 and 2019, D (Zaandam vs. other three municipalities) significantly predicted property value ($\beta = -.250, p < .000$), suggesting that property values were overall lower in Zaandam than in the control municipalities. There was no significant correlation between T and property value ($\beta = -.012, p = .741$).

It was also found that *proportion of owner-occupied dwellings*, *proportion of dwellings built after 2000*, and *proportion age 25-45* significantly predicted property value ($\beta = .494, p < .000$); $\beta = .158, p = .005$; $\beta = -.409, p = .012$). These results are expected, as owner-occupied dwellings are in general more expensive compared to rental dwellings, and newly built dwellings generally are more expensive than older dwellings. The negative correlation between property value and *proportion 25-45* suggests that the higher the value of a house, the fewer people from this age group tend to live in it. *Population density* did not significantly correlate with *home value* ($\beta < .000, p = .463$).

Income. For the difference-in-difference analysis, a linear regression was used to test if income per household changed significantly more in Zaandam (treated) compared to Amstelveen, Haarlemmermeer, and Purmerend (control). Based on the output of the regression analysis presented in Table 7, the fitted regression model was:

$$3,134 - .070 \times (D) + .032 \times (T) - .023 \times (D \circ T) - .000 \times (\text{Population density}) + .069 \times (\text{Proportion age 24} - 45) + .429 \times (\text{Proportion of owner} - \text{occupied dwellings})$$

The overall regression was statistically significant ($R^2 = .350, F(6, 169) = 15.16, p < .000$).

A negative correlation between $D \circ T$ and income was found, suggesting that over time, property values increased more in the control municipalities than in Zaanstad. However, the correlation was not significant at the .05 level ($\beta = -.023, p = .658$).

On their own, neither D nor T significantly correlated with income ($\beta = -.070, p = .069$; $\beta = .032, p = .243$).

It was also found that *proportion of owner-occupied dwellings* significantly predicted income ($\beta = .429, p < .000$). This suggests that overall homeowners had a higher income compared to other inhabitants (i.e., those living in rental homes).

Population density also significantly correlated with *income*, but its beta-value was practically zero ($\beta < .000, p = .003$). *Proportion age 25-45* did not correlate significantly with *income* ($\beta = .069, p < .576$).

Table 6 *Descriptive Statistics of variables for regression analysis (macro)*

| | <i>N</i> | Minimum | Maximum | Mean | Median | <i>SD</i> |
|--|----------|---------|---------|--------|--------|-----------|
| Income | 177 | 12.85 | 45.68 | 28.02 | 27.73 | 4.90 |
| Property value | 238 | 141.57 | 927.84 | 299.00 | 284.15 | 99.73 |
| Proportion of inhabitants age 25-45 | 253 | 0.00 | 1.00 | 0.26 | 0.25 | 0.10 |
| Proportion of owner-occupied dwellings | 244 | 0.00 | 0.92 | 0.56 | 0.59 | 0.20 |
| Proportion of dwellings built after 2000 | 244 | 0.00 | 1.00 | 0.16 | 0.03 | 0.28 |

Table 7 *Parameter estimation results of DID model (macro).*

| | ln(property value) ⁴ | <i>SD</i> | ln(income per inhabitant) | <i>SD</i> |
|--|---------------------------------|-----------|---------------------------|-----------|
| Intercept | 5.565*** | 0.083 | 3.134*** | 0.064 |
| D | -0.250*** | 0.050 | -0.070. | 0.038 |
| T | -0.012 | 0.035 | 0.032 | 0.027 |
| D◦T | -0.067 | 0.068 | -0.023 | 0.052 |
| Population density | -4.464E-6 | 0.000 | -1,393E-5** | 0.000 |
| Proportion age 25-45 | -0.409* | 0.162 | 0.069 | 0.122 |
| Proportion of owner-occupied dwellings | 0.494*** | 0.081 | 0.429*** | 0.061 |
| Proportion of dwellings built after 2000 | 0.158** | 0.055 | | |
| R ² | 0.413 | | 0.350 | |
| Adjusted R ² | 0.395 | | 0.327 | |
| N | 244 | | 244 | |
| RMSE | 0.229 | | 0.151 | |

*** $p < 0.001$,** $p < 0.01$,* $p < 0.05$,. $p < 0.1$.

Discussion Quantitative Analysis

Several neighbourhood changes that were identified conform with several steps of the land use transport feedback cycle (Wegener & Fuerst, 1999), which states that the presence of new investors leads to construction, which has an effect on location decisions of users (people move to the area), which in turn affects their moves and activities, determining car ownership. Similarly, as a result of several investing parties, the Inverdan area saw an increase in new housing (built after 2000), an increase in dwellings and population, as well as an increase in cars, according to the results described above.

Returning to the research questions of the study, the results may provide a tentative answer to the second sub-question (To what degree has transit-oriented development near Zaandam Station had an effect on neighbourhood change between 2009 and 2019?). As the results above describe, several findings correspond with gentrification effects documented in academic

⁴ As to hold to the *linearity in parameter specification* assumption of the DID model, the natural logarithmic values of 'property value' and 'income per inhabitant' are used (corrected for inflation).

literature, such as the increase of income, property value, young people, and new housing in the developed neighbourhoods. On the other hand, few results were deemed statistically significant. Those that were demonstrated causality between TOD and neighbourhood change, such as the fact that the Inverdan area saw an increase in income per inhabitant as a result of TOD that was greater than its surroundings. Increases in gentrification factors such as property value, new dwellings, population density, and young people suggest that there may be a connection between the transit-oriented developments of Inverdan and gentrification, but the results are an insufficient basis to provide an answer to the main research question. Accordingly, the qualitative study in the next chapter will aim to add to these quantitative results in order to provide answers to the main and sub-questions of this study.

Limitations of Quantitative Data Analysis

The use of quantitative data sets, such as those provided by the CBS brings with it some limitations, as do the performed analyses.

Firstly, indicators do not necessarily provide insight into the actual process of gentrification. They simply note residential change (Atkinson, 2002) and do not distinguish gentrification from other factors that may explain changes within a neighbourhood (Kennedy & Leonard, 2001).

A second limitation has to do with solely measuring a starting year and most recent year (2009-2019): annual changes and fluctuations remain unexamined and undetected (Freeman, 2006). Moreover, with regard to the DID analysis, it could not be confirmed that the treated and control group followed a parallel trend prior to the start of the TOD developments, which is an assumption for the DID model (Abadie, 2005). Also, a DID analysis assumes that outcomes for one neighbourhood do not influence the outcomes of another neighbourhood. As such, indirect treatment effects, or spill-over effects between neighbourhoods are not taken into consideration. Delgado & Florax (2015) propose a DID model that overcomes this limitation which the author recommends being used in future research.

Thirdly, due to the dependence of this study on one source of databases (i.e., CBS), not all relevant factors to measure gentrification are included. In the academic literature, many other variables are defined as being indicators of gentrification effects. The level of education is a prominent factor (e.g., Galster & Peacock, 1986; Knotts & Haspel, 2006; McKinnish et al., 2010), but several others such as the proportion of professionals in a neighbourhood (e.g., Eckerd, 2010; Hammel & Wyly, 1996; Knotts & Haspel, 2006) and the employment rate (e.g., Atkinson, 2000; Hammel & Wyly, 1996) are often studied factors in gentrification literature. As such, the validity of this study (how accurately the method measures what it is intended to measure) is considered mediocre. As the present quantitative study is exploratory in character, however, this lack of

thoroughness may be considered permissible. Nonetheless, future research including the now missing variables is encouraged.

However, an advantage of using CBS data is that it is suitable for a universal operationalisation of gentrification (because it is quantitative and objective in nature). The disinvestment filter helps to distinguish gentrification from other ecological changes (Galster & Peacock, 1986). Thus, although the results may be case-specific, they are expected to be generalisable to cases with similar TOD developments, particularly in the Netherlands. To tackle many of the above-mentioned limitations, this research included qualitative analyses as well, as will be described in the next chapter. An additional advantage of this combination of quantitative and qualitative methods is the higher level of reliability of the study (Abowitz & Toole, 2010). As Williams (2015) states: "Qualitative examinations of gentrification are crucial to understanding how reinvestments unfold, how it progresses over time, and how it affects community outcomes [...]".



Inntel Hotels Zaandam (Provincie Noord-Holland, 2019)

Chapter 5: Qualitative interview analysis

The following chapter describes the methodological decisions made for the qualitative data analysis, as well as information on the data collection and analysis. Then, the results of the analysis are discussed and put in perspective with relevant TOD and gentrification literature.

Methodology

The second part of this study consisted of conducting and analysing several interviews. This qualitative approach was considered an added benefit to the afore-discussed quantitative study. Although the quantitative results showed some general patterns with regards to neighbourhood change and its relation to TOD, the results were deemed insufficient to properly answer the research question of this study. This second, qualitative study provides context to those results, as well as in-depth information on the reasoning behind the Inverdan developments and several social and cultural (soft) effects, that the quantitative study may have overlooked. As mentioned in Chapter 3, this abduction approach, where a deductive approach (quantitative study to test theory) is combined with an inductive approach (qualitative study to make inferences based on observations) may improve the theoretical strength of the study (Rashid et al., 2019)

Data Collection

With the intention to investigate to what degree project Inverdan has resulted in transit-oriented development in Zaandam, to what degree neighbourhood change led to gentrification, and what can we learn from them for future TOD (sub-questions 1 and 3), nine people were interviewed over the course of three weeks. These people, such as policy advisors, aldermen, and the project's architect, were concerned with the developments within project Inverdan. Table 8 presents the full list of interviewees, hereafter referred to as 'experts. Several experts were suggested by colleagues from the Province of Noord-Holland. Some were suggested by other interviewed experts, others were found by searching on websites and LinkedIn profiles related to the Inverdan project. The potential participants were invited to take part in the interview via either email or a LinkedIn message. In some cases, there was a follow-up phone call to discuss further details or questions. The interviews were held for each expert individually, with the exception of one, as two experts proposed to participate in an interview together. The interviews were executed with the help of videocall software, such as Teams and Zoom, with the exception of one, which was held via a telephone call. The interviews were semi-structured. This means "a core of common questions was posed to all participants and additional questions were tailored to each individual participant" (Luo & Wildemuth, 2009, p.235). In total, each interview took between 20 and 50 minutes.

All the interviews were conducted in Dutch. After each interview, the author prepared a transcript, also in Dutch. To minimize the risk that the contextual aspects of data are unintentionally left out, the interview transcripts were not translated into English. Only the results of the data analysis were written in English. Names of experts and others that were mentioned during the interviews were anonymised securing that the privacy of the people in question would not be impacted. The experts were told what the interview was to be used for, and what the research was about. All interviewees received the final thesis by email after it was completed.

Table 8 *List of interviewed experts and their positions with regards to Inverdan*

| Expert | Function Inverdan |
|----------|--|
| Expert A | Strategic advisor urban development, former senior policy advisor housing & residential development. |
| Expert B | Policy advisor regional and national collaboration. |
| Expert C | Former process manager urban development, i.a. Inverdan West |
| Expert D | Former urban planner Inverdan |
| Expert E | Former alderman, i.a. Inverdan |
| Expert F | Developer, i.a. developments Burano and Zaanse Helden |
| Expert G | Former plan developer, planning economist, and program manager Inverdan |
| Expert H | Former alderman, i.a. Inverdan |
| Expert I | Architect Inverdan |

Data Analysis

The interviews were transcribed and thematically analysed with the help of qualitative analysis and research software ATLAS.ti. Thematic analysis is a method for “identifying, analysing, and interpreting patterns of meaning (“themes”) within qualitative data” (Clarke & Braun, 2017, p. 298). Other types of analysis exist which may be used to analyse interviews, such as discourse analysis, which is used to see how language is used to create meaning in different social contexts, and content analysis, most often used to determine the goals and messages in communication ((Breakwell et al., 2020, p. 287-291). Thematic analysis was deemed most suitable for the purpose of collecting knowledge, experiences, and opinions on the research topic.

The analysis and its preparation consisted of several steps. Firstly, all interviews were transcribed: The recorded audio from the interviews was listened to and written down in a text file (the complete set of interview transcripts may be requested as a separate document). Secondly, each text file was carefully read, and codes were applied to pieces of text that were deemed relevant. Codes are “the smallest units of analysis that capture interesting features of the

data (potentially) relevant to the research question” (Clarke & Braun, 2017, p. 298). Next, the codes were checked for duplication and similarities and combined or deleted. Fourthly, codes were grouped into themes: “(larger) patterns of meaning, underpinned by a central organizing concept – a shared core idea” (Clarke & Braun, 2017, p. 298). These themes then formed a framework for the structure and organization of the reporting of the findings. See Appendix C for an overview of the codes and themes. Fifthly, the findings were analysed with the aim to answer the research question of this study.

The findings from the expert interviews were complemented by desk research on a variety of sources, such as project websites, policy documents, and other literature. Most sources were found with the help of the Google search engine, some were internal documents accessible through the author’s internship at the Province of Noord-Holland, others were provided by several policy officers with whom the author had conversations regarding this study, either in person or via video call software such as Teams or Zoom. These documents and conversations were then used to extract information on the developments within project Inverdan. This combination of desk research and expert interviews identified the origins of project Inverdan: the ideas and motivation behind the plan, its content and its socioeconomic, demographic, and housing-related effects. Apart from giving a general overview of the Inverdan plan, findings identified whether the Inverdan developments may in fact be categorized as TOD, with the help of the 5 Ds by Ewing & Cervero (2001, 2010, see Chapter 2). They also shed light on whether the observed neighbourhood changes were perceived as gentrification as well as on how these neighbourhood changes are related to the (TOD) developments of Inverdan. Finally, the findings gave insight into how neighbourhoods near Zaandam station are likely to change in the coming years.

Results Interview Analysis

The following paragraphs present an overview of the results extracted from the expert interviews. Firstly, a description is given of the station area of Zaandam before the developments of Inverdan, followed by the developments building up to the first masterplan. The second part of the results section describes several factors of neighbourhood change that were reported by the experts. Thirdly, thoughts on the future of the area are discussed, and finally, a relation is made between the results and theory on TOD and gentrification described in Chapter 2.

The Inverdan project is one of the many links in a chain of local, regional, and national land use-transport developments that have changed the Dutch landscape for decades. Hence, for the interested reader, some main developments in national land use and transport policy before and during the developments of Inverdan are described in Appendix B.

Zaandam Before Inverdan

The City. Zaandam was originally an old workers town. However, contrasting to big cities at the time, such as Enschede or Manchester, it was not a big, industrial city, but rather a countryside populated with factories. After the world wars, the industry declined, and due to a move out of the higher-class industrials, the Zaan area found itself in a ‘mood of misery’ in the 70s and 80s (Expert E). With a declining economy and no middle-class, with ideas on how to change the city to act, the city’s general appearance suffered. Two interviewees mentioned recalling a former mayor who compared the city centre of Zaandam to Grozny, a Russian city that was heavily bombed in the First Chechen War (“Het Grozny van de Zaan”, Expert B & H). Interviewees described the city centre as follows: concrete, grey, and worn out (Expert E), very ugly and quite sad, as well as having a worthless appearance (Expert B), and a cheerless environment (Expert D). Generally, the city centre was characterised by old office buildings, such as a tax office and a financial services office. Around the canal (Gedempte Gracht), which was filled in at the time (see Figure 4), several shops and old residential buildings were located, and apart from a small cinema, there were few cultural establishments (Expert E). As a result of the declining attractiveness of the city, the shopping street was overrepresented by shawarma shops, mobile phone stores, and stores selling mattresses, instead of a more attractive diversity of shops (Expert G). Expert G refers to this as a ‘Catch 22 problem’: Attractive stores stay away if there’s a lack of (well-off) customers, but customers stay away if there is a lack of attractive stores. Expert H shared his first experience in the city centre:

“I moved to Zaanstad in 2000, just before Inverdan. I can remember that- organized by the school at which I taught- after three weeks or so we had a meeting for new teachers, a team-building day. We went out for dinner in the centre of Zaandam. [...]”

and- after three weeks- I found myself on the Gedempte Gracht and thought "I'm at the wrong place, this is not the centre of a city with 140.000 inhabitants [...]". "I'm at the wrong place", I thought. So, it really was that bad there" (Expert H).

The west side of Zaandam, on the other side of the train station, was mostly residential. There were also (often vacant) office buildings, a college for post-secondary vocational education, some grass fields, and much infrastructure, such as the busy provincial road and the railway line, cutting off the west part of Zaandam from the city centre (Expert C). Zaandam had a car-oriented design, neglecting pedestrians, closed facades, as was typical for buildings built in the 1960s (Expert D). On the whole, the station area was rather empty in terms of buildings. Expert G mentioned recalling that sheep were still grazing only two hundred metres from the train station.

Figure 4 Shopping area Gedempte Gracht at the end of the 1990s (De Orkaan, 2018)



The People and Their Attitude Towards New Plans. Compared to other Dutch municipalities, the average income in Zaanstad was relatively low. This also held true compared to other municipalities in the Metropolitan Region Amsterdam, such as Haarlemmermeer, Amstelveen, Haarlem, and Amsterdam (Expert B, E & G). This was reflected in the type of housing, which was for a large part relatively affordable and small (Expert B & G). Many were built several decades ago housing for workers. The population of Zaanstad had a relatively low educational

attainment (Expert B). For instance, compared to other cities, more children went to preparatory secondary vocational education [*VMBO*], and fewer went to senior general secondary education [*HAVO*] or university preparatory education [*VWO*] (Expert E).

Despite the evident need to develop Zaandam, there existed a general sentiment of scepticism among its inhabitants. To illustrate this, Expert E used the phrase *“It was nothing, it is nothing, and it will not become anything better”*. *“Digging out the [formerly filled-in] canal would only result in a dirty ditch”* seemed to be the general agreement. Formerly failed plan-making added to this negativity towards new development plans (Expert E). For decades, Zaanstad had been a comparatively poor municipality with little land ownership or capital. In the seventies, it had bought several plots of land which shortly after were assigned to be Nature 2000 areas, resulting in a significant decrease in land value. As such, the municipality’s active land policy led to its own bankruptcy. Another development that damaged the reputation of the municipality was a plan for residential development near a factory in Krommenie. With several dwellings already built and sold, the Council of States declared the project to be unacceptable, as many houses were built within the ‘environmental circle’ [*milieucirke*] of the factory, risking negative effects on the future residents’ health. These events led to a loss of confidence among the municipal staff. Expert I illustrates how colleagues reacted to the fact that he and his team started making new plans:

“When we would sit down in the restaurant [of the city hall] to eat a sandwich, everyone else in the restaurant turned their back to us. And you could see them talking to each other, like ‘It’s those lunatics who are starting a project again, which will fail fatally. That was the mood” (Expert I).

The First Plan

The Inverdan Masterplan. The municipality of Zaanstad started working on new plans for the city centre around the year 1999-2000. This was done as a public-private partnership (PPP). A PPP is a collaboration between public and private parties, which was a common approach in the nineties, but has become rare after the financial crisis of 2008. A PPP is based on mutual gains between the municipality, ensuring governmental continuity, and private developing parties, ensuring financial continuity (Expert I). By trying to match the interests of all parties, on matters like the number and type of dwellings, shops, and parking spaces, a mutually approved plan could be created.

In the greater picture, Inverdan was part of the urbanisation strategy of the municipality of Zaanstad, but for the region and the province as well. Thus, the Metropolitan Region Amsterdam, as well as the Province of Noord-Holland, were involved on a strategic level, e.g., with vision making and putting Inverdan on the agenda (Expert A). At the time, the province of Noord-

Holland was developing their own transit-oriented development strategy which, as it were, coalesced with that of Zaanstad. Several years later, around 2013, Noord-Holland would publish *Maak Plaats!*, together with Vereniging Deltametropool, on which its current policy on public transit nodes is based (Provincie Noord-Holland & Vereniging Deltametropool, 2013). The Dutch Railways (*NS*) were also involved, as they aimed at increasing traffic around Zaandam Station.

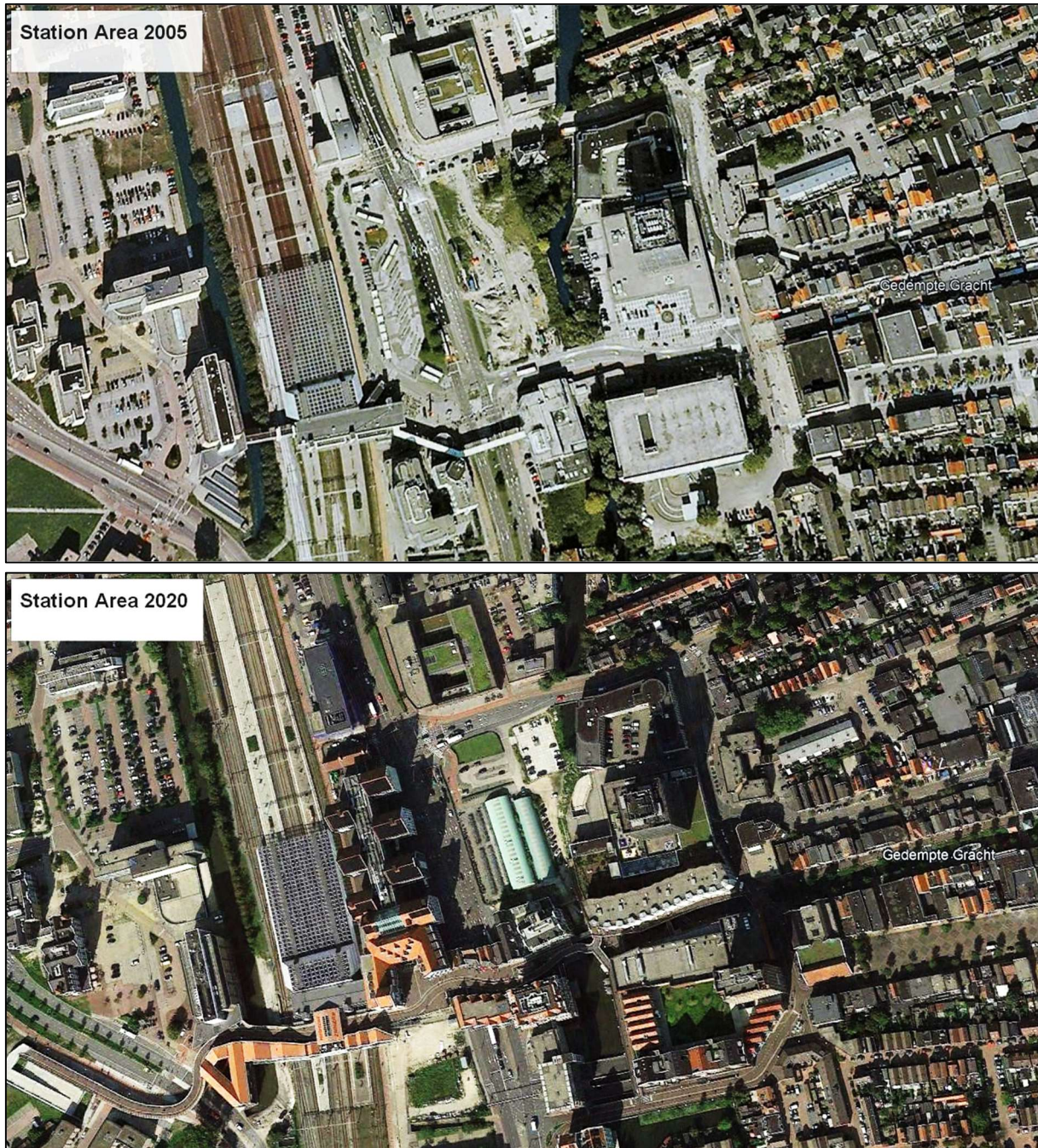
Notwithstanding the scepticism that the municipality had experienced when making development plans, the Inverdan master plan was approved in 2003. The master plan focussed on how to make a pedestrian- and bicycle-friendly area, on the westside crossing the multiple lane provincial highway, as well as the railroad tracks at Zaandam Station (see Figure 5). The plan also included some information on how and where new stores would be positioned, proposing the two-level design, connected by walking bridges. (Expert I). Expert E explained how books by Richard Florida, such as *The Rise of the Creative Class* (2002) played an important role in the vision making of the plan. The main idea was that in creative cities, more money is earned, because of more creativity, more idea development, and more innovation. At the time, the municipality of Zaanstad wondered: 'If our industry is declining, and China is producing everything for a lower price, what do we do?'. Based on Florida's ideas, the municipality's response was developing the urban environment, building cinemas and theatres to keep in the creative people. They were expected to want to live in a modern city centre with cafes and 'silly houses'. The industry that was left in Zaandam needed creative people too. So, giving such people a place in the city will prepare it for successful development, for gentrification (Expert I). In this context, Expert E also underlines the importance of Zaandam's proximity to Amsterdam:

"We need to get closer to Amsterdam, which is why we need this transit-oriented development around the station because from here it is ten minutes by train to the city [of Amsterdam]. [...] So, Inverdan is actually a sort of statement: We are proud of our region, and because we are so proud, we dare to be a part of the bigger dynamic development of the Randstad" (Expert E).

The municipality was again planning to actively develop land and started off buying up land and houses. This was a large investment, and the area development was loss-making, so with the approval of the plan, the municipal council indicated to counter this loss with its own financial resources. Still, the general attitude towards the plans remained sceptical:

"When I did the first presentations on the plans [...], I remember people coming up to me, pinching me in the arm and saying "Ah, Mr. [I], Surely you don't actually believe the plans yourself, do you?" (Expert I).

Figure 5 Aerial photographs of the Zaandam Station area in 2005 and 2020, displaying the railway and rail station (left), provincial highway (middle), and shopping area Gedempte Gracht (right) (Adapted from Google, n.d.)



Getting the Land. Much of the land within the plan area was owned by private parties, especially west of the station. The real estate branch of NS and the national railway network infrastructure organisation, ProRail, owned several plots around Zaandam Station. The municipality of Zaanstad wanted to take ownership of many of these plots as a way to 'boost' the plan-making process (Expert E). This was an ambitious and expensive process, and around 2005,

the financial loss of the municipality was significant. The crash of the office market around 2004-2005, which led to a decrease in value for office spaces, led to 35.000 to 40.000 square metres of office space being cut from the plan, negatively impacting its business case (Expert G). Much of the office plans would be replaced by housing (Expert D). Some argued it would be better for Zaanstad to give up some of its lands to stabilise the financial situation. This was not done, however, as it would mean selling the plots for a lower value compared to its cost when the municipality had purchased them (Expert E).

The next several years were spent on demolishing several buildings, making the land ready for construction, and decontaminating soil, as the former industry had left its mark (Expert G). From 2008 onwards, developments stagnated as a result of a worldwide financial crisis, which left its mark on the Dutch real estate market (Expert A). Several developing parties such as housing cooperatives and NS started to withdraw from their part of the development (Expert G). Still, as a result of very difficult negotiations, and the municipality giving in substantially, the first large-scale projects started to be developed from 2009 onwards, such as the new city hall building. (Expert E). Financially, the municipality has been the most prominent actor, having invested approximately 85 million euros, by estimation of Expert I. Moreover, many market parties have invested through the years, and the province of Noord-Holland as well as the national government have assisted financially by means of funding (Expert I).

The Architecture. The new city hall and many developments built thereafter are characterized by their green facades. The quality plan (*beeldkwaliteitsplan*), written shortly after the 2003 Masterplan, proposed to design the developments of Inverdan in a way that was specific to its location (*genius loci*), and which was not something that anyone, anywhere in the world could do. Something daring to give the city its own identity, to make its citizens proud to live there. As such, to capture the architectural style of the Zaan region, it was decided to incorporate the traditional green 'Zaans' house in the façades of several new developments. Another example is the Zaanhotel, a hotel of which the façade is made up of stacked-up traditional green houses (Expert I)⁵.

Municipality also developed the overpass, as well as several shops near the entrance to Zaandam Station. Zaanstad also gave in a lot, in order to make developments happen. Especially when building the cinema, as it was deemed very important for the quality and identity of

⁵ The proposition for the 'Zaans' appearance comes from renowned architect Sjoerd Soeters, who has been committed to the Inverdan project since his first plans around the year 2000, and still is.

Zaandam (Expert D). According to Expert D, this turned out to be a successful development that attracted a lot of new young visitors to the city centre.

Neighbourhood Change

Demolition and Densification. Several buildings were demolished to make room for new developments. An old logistic centre near the train tracks has made room for new housing developments. Moreover, among others, a tax office, an old hotel, a parking garage, and a *hideous and socially unsafe* shopping centre have been taken down (e.g., Expert A, F, G & I). Housing near the provincial road (*Noordschebos*), built around the 1920s and no longer meeting requirements concerning noise hindrance and air quality, was demolished as well (Expert I). The exact number of demolished dwellings is unclear. Expert G indicates that in the city centre, about 100 to 150 houses, part cooperative-owned, part privately-owned, are expected to have been demolished. Expert E, however, thinks that in total, at most forty houses have been demolished, near Zaandam station. According to most experts, little housing has been demolished, mainly because many new developments have been built on formerly unbuilt plots (e.g., Expert A, B, C & D). For this reason, Expert G defines Inverdan as a densification project rather than a restructuring project.

“Inverdan is often seen as an inner-city restructuring, but I actually think that to be a misrepresentation of the situation. Because, when you look at old aerial photographs, you see that it was quite an empty place. So, I think Inverdan is not really an urban restructuring, not urban renewal, but [...] really, it has been a densification project” (Expert G).

Property value and Housing. During the past ten years, the city centre of Zaandam has become increasingly more attractive as a result of the developments following the Inverdan master plan. Many new dwellings have been built, often of better quality and in a higher segment than the already existing housing (Expert B). For developers, building small apartments that can be sold for a (medium-) high price, is often the most profitable option (Expert D). According to Expert B, this may have led property values of new as well as existing housing in the city centre to have increased faster than in the outskirts of the municipality. People that would have been able to buy a house there, cannot anymore. In comparison, the prices have increased more than the rest of the Zaan region, says Expert E. Expert D remembers how happy she was when she saw that some plots were sold for €650000, which was very abnormal for Zaanstad.

Apart from the increasing attractiveness of Zaandam, another important factor pushing up the property values indirectly comes from Zaanstad’s big neighbour: Amsterdam. Since around 2012-2014, the housing shortage has become a major issue for the city of Amsterdam. Property

values are increasingly high and many of its citizens are looking for a place to live elsewhere. Prior to the Inverdan developments, many Amsterdam citizens were averse to living in the Zaan area, perhaps because of the Coentunnel between Amsterdam and Zaandam, which was notorious for its traffic jams (Expert I). But now, with its new, high-quality city centre in close proximity to the station to avoid congestion, Zaanstad - which was generally more affordable than Amsterdam - started to attract new residents coming from Amsterdam (Expert F & G). In the last two or three years, however, this increase in property values recently made its way to surrounding municipalities, such as Diemen, Amstelveen, as well as Zaanstad (Expert A, B, E, G & H).

The municipality of Zaanstad and the national government aim to keep the housing stock affordable, which is an increasing challenge with regards to the exploding housing market in Amsterdam (Expert B). For example, the municipality demands thirty per cent of residential development to be social housing from developers that want to build on municipal-owned land, so this part will be managed by a housing cooperative instead of the initial developer (Expert H), and at least ten per cent should be mid-priced (*middelduur*). The main justification for this is the fact that it needs to attain at least fifty per cent affordable housing in order for the municipality to obtain funds from the 'housing impulse regulation' (*woningbouwimpuls regeling*) provided by the Ministry of the Interior and Kingdom Relations, which serves to speed up housing development. However, the municipality does not have as big of a say when it comes to existing housing and property owned by private parties, so - because of the housing pressure in Amsterdam and the attractiveness of Inverdan - the values in Zaanstad have increased significantly in the last few years, which currently makes it very difficult for starters to buy a house in Zaanstad (Expert H). This mitigated power of the local government ties in with the writings of Musterd et al. (2016) according to whom the neoliberalisation of the housing market is the driving force behind gentrification. The speed at which gentrification takes place is dependent on existing structures and facilities. National and local aspects may temper gentrification, for example, the degree to which tenants are protected (Van Gent, 2013).

Inhabitants and Housing. To give a 'quality boost' to the city centre of Zaandam, formerly characterized by lower incomes and concrete buildings, the Inverdan project focussed on the middle category in terms of house prices (Expert B & D), although about all developments included social housing as well (Expert B, D & H), and some included starter houses (Expert H). More specifically, newly built dwellings were targeted at 'social climbers' (or '*opwaarts mobielen*'), a term adopted by Zaanstad from market research agency Motivaction, referring to "career-oriented individualists with a pronounced fascination for social status, new technology, risks, and excitement" (Hengstz, n.d.; Expert G). As such, it became possible for people in their 20s and 30s, having just started off their career (young urban professionals) to find a home in

Zaandam. This new target group called for different housing types than those that were available in Zaanstad: Smaller, single household apartments, such as those in residential development Murano (Expert B and C). Low-rise housing was also built, for example on the Spoorstrip, consisting of studios and single-family homes. A different type of residential development can be found on Zaanse Eilanden, where empty plots were directly sold to individual buyers. Expert C mentioned that this 'self-built' concept (*zelfbouw*) attracted many non-western residents, whereas Expert H states they were mostly occupied by high-income households. A recently completed project, Burano, comprised of mostly nursing homes (Expert F).

Zaanstad always had some people coming their way from Amsterdam, although these generally had a lower income, having been pushed out of gentrifying neighbourhoods. In the last few years, however, Zaanstad has been attracting more high-income Amsterdam residents, mainly near the city centre of Zaandam, in Zaandam-West (Expert E). Expert B underlines that the proximity to transit (Zaandam Station) plays an important role as well, as this makes the city centre of Zaandam even more attractive for (well-off) people from Amsterdam, also compared to other neighbourhoods of Zaanstad.

The municipality of Zaanstad received multiple requests to build hotels in the station area. These hotels were expected to attract people with business in Amsterdam, because only six minutes from Amsterdam Sloterdijk Station by train, the station area of Zaandam Station was deemed a perfect place. Although many requests aimed to develop on the westside of the station, the municipality of Zaanstad preferred to develop hotels on the east side. This way, it would be easier for hotel-goers to spend time in the city centre of Zaandam as well, as opposed to merely going directly back to the station from their hotel (Expert D).

As the municipality of Zaanstad is obliged to offer their social housing stock regionally, these attract people from Amsterdam as well. About 15 to 30 per cent of owner-occupied housing and around 25 to 30 per cent of social housing are inhabited by people having formerly lived in Amsterdam (Expert A & B). A quarterly report by Hoorn Makelaarsgroep states that from all the people who moved to an apartment in the Zaan region in 2020, 31% came from the greater Amsterdam area (*groot Amsterdam*). The percentage decreased slightly to 25% in 2021. Of all people who moved to a single-household home in the Zaan region in 2020, 26,9% came from the greater Amsterdam area. In 2021, the percentage was 27,7% (Hoorn, 2021)⁶.

In the context of people from Amsterdam who moved to the west of Zaandam, Expert D reflected on the importance to know for whom the houses are being built:

⁶ Most migrations in took place within the Zaan area itself, around 61% of the total number of migrations. About 1,5% came to the Zaan area from IJmond-Alkmaar, 2,5% from Kennemerland, 1,3 % from Waterland, 1% from elsewhere in North-Holland, and 5,3% from elsewhere in the Netherlands (Hoorn, 2021).

"I think much of the discussion was: For whom am I building? What target group is coming to live in West? If you do not create a liveable, nice neighbourhood with its own identity and a sort of extra quality, you are actually building a suburb of Amsterdam, where people spend their social life and all in Amsterdam, and merely reside in Zaandam" (Expert D).

Expert D mentioned that the same applies to other parts of the station area as well: "You have to take on the quality of the area and the public space because that is where people live and move, which is what Inverdan has done really well."

Quality. Apart from new housing development, the improvement of the quality of Zaanstad could be seen in its collection of stores and recreational services. As new categories of residents were to be housed in and around the city centre of Zaandam, it was deemed important to reflect their needs and wants in the provision level of the city (Expert G). Expert H mentioned the influx of coffee bars, something that was unimaginable twenty-five years ago. Other examples are the new cinema, consumer electronics store (Mediamarkt) and Albert Heijn grocery store that were built as part of the new Rustenburg complex. Moreover, an old building that houses a C&A clothing store was renovated, which now serves as one of the flagship stores for C&A (Expert H). Zaanstad was also one of the first municipalities to house a Primark store. The municipality was at first dissatisfied with this, as they had preferred a more exclusive clothing store, but it soon became clear that the Primark store attracted an enormous amount of traffic to the city centre and "put Zaandam and Inverdan on the map" (Expert G).

The municipality also invested considerably in its public space. Take, for example, the shopping district at the Gedempte Gracht, a canal with shops, restaurants, and other services on both sides. This canal had been previously filled in, but to increase the attractiveness of the area, the municipality decided to dig it out again. The result is a pedestrian-friendly shopping area, with several walking bridges crossing the canal. This investment, in turn, led to the attractiveness of housing that had been built afterwards (Expert G). By building a new parking garage and with-it new shops on the westside of de Gedempte Gracht, the street gained a second source point for people to walk to the shopping area, increasing its accessibility (Expert I).

Social Cohesion. Residential development resulted in an increase of single-household homes in neighbourhoods mostly comprising of family households, which may have effects on the social cohesion in the neighbourhood (Expert B).

In the last few years, it has become more difficult to buy a house in Zaanstad because of the aforementioned increase in property values. The fact that people from Amsterdam take up a

portion of this scarce housing stock has led to a general discontent among others in the Zaan region (Expert B & F). This is not expected to lead to negative effects on social cohesion on a street level, however. "Social cohesion is always a problem in some neighbourhoods, not necessarily because more people from Amsterdam move there", Expert B explains. Expert H does mention, however, how the increase in dwellings results in parking scarcity. This led to some complaints of existing residents, wondering why they were inconvenienced because of the influx of new residents.

Other Developments. Expert D mentioned that outside of the Inverdan area, in the east of Zaanstad, similar densification plans are being made as a solution to create a better balance between the existing majority of social housing and other housing types, without the need to demolish social housing.

The Russische Buurt, a neighbourhood bordering the city centre of Zaandam, was mentioned by several interviewees (Expert B, C & E). The neighbourhood has undergone some major problems regarding liveability. This is mainly due to the fact that many houses underwent '*verkamering*', a process where one or more rooms that were formerly part of one large house, are separately offered for rent as individual smaller homes. These small homes are often (not always legally) occupied by high numbers of (Eastern-European) migrant workers, and the neighbourhood was faced with nuisance from drug use, among others (Expert E). According to Expert B and C, this neighbourhood has the potential to undergo gentrification, to become a trendy neighbourhood, similar to how the Jordaan neighbourhood in Amsterdam had changed. In fact, according to Expert C, 'if it were in Amsterdam, gentrification would set in immediately'. Its proximity to the city centre, as well as its attractive houses and canals, would add to its potential. Ideas have been proposed to stimulate such a development but did not take off (Expert C). The liveability of the Russische Buurt is however something the municipality is working on at the moment (Expert B). Expert E expects housing values to already have risen as a result of the developments and increasing attractiveness of the area because of Inverdan.

The district Rosmolenwijk, north-east of the city centre was brought up by Expert G as an example of government-steered gentrification. This district consisted almost completely of social housing. When Zaanstad started to redevelop the district, some was replaced by more expensive housing, which meant that some of its original residents could not live there anymore. Some degree of gentrification had thus taken place in the Rosmolenwijk. Expert G mentioned that this is often the case with urban renewal: many times, of the hundred per cent social housing, about thirty per cent stays that way. The other seventy per cent becomes private rental. Although gentrification often has a negative undertone, this is not always right, he says. A different district in Zaanstad, called Poelenburg currently consists of almost a hundred per cent social housing,

with a one-sided population composition, many foreign-born residents. Urban renewal with a replacement of some of the social housing by private rental would have positive effects on what is now described as a 'problem district' (*probleemwijk*) (Expert G).

The Future of Inverdan

Peperstraat. In line with the transition to the Environment and Planning Act (*Omgevingswet*) which is expected to come into force in July 2022, the municipality of Zaanstad is working on integrally connecting Inverdan (now MAAK.Centrum) with other areas of Zaanstad with the help of the upcoming Strategy on Spatial Planning and the Environment (*Omgevingsvisie*) (Expert D). The MAAK.Centrum plan area will be expanded on the east side of the Gedempte Gracht. As such the Peperstraat will be included which will undergo large-scale redevelopment. The street currently has an entry for car traffic on the east side, which will be blocked off to create a pedestrian-centred street, combined with a new parking garage (Expert I). Much of the outdated, concrete buildings will be demolished and 400 to 500 new dwellings will be built, contrasting what had been done in Inverdan, which was mostly densification as compared to replacement (Expert B & E). Here, the discussion around displacement is actively present, with people wondering whether they can afford to live there after the development. The municipality argues such developments are in the interest of the city, providing higher-quality housing as well as densifying the area to be able to build more housing while using less space. Residents living in a to be demolished flat, however, are negatively affected, nonetheless. It is also difficult, especially now with the current housing shortage, for housing cooperatives to guarantee residents a return to their original housing location, despite the municipality's effort to realise at least thirty per cent of residential developments as social housing in new developments (Expert B).

Apartments and COVID-19. To build large quantities of dwellings within an urban area like the Zaandam Station area, it is unavoidable to build high-rise apartments. Expert A foresees a tendency to build more and more small apartments for higher prices, which according to him should be monitored closely as not to create a one-sided housing stock, as has happened to some degree on the westside of the station. The municipality of Zaanstad can to a certain degree influence this development: As a result of the national 'housing impulse regulation' (*woningbouwimpuls regeling*), municipalities are stimulated to build fifty per cent of their new housing stock as 'affordable' (Expert A)

Expert H discussed the potential effects of the ongoing COVID-19 pandemic that started at the beginning of 2020. As mentioned, much of the newly built housing in Zaanstad (and in other cities in the Netherlands as well) consists of apartments. Such relatively small dwellings suit young

professionals who “have the world at their feet, work hard, earn a lot of money, and eat out many times a week”. But now that people work from home as a measure to contain the spread of the COVID-19 virus, people may start wanting (back) a larger dwelling, with, for instance, a bigger kitchen, and a “garden to walk around in between meetings”. As such, this may in time have an effect on the demand for housing with regards to the type and size of dwelling (Expert H).

Housing Shortage. Expert I discusses what he thinks is one of the main drivers behind the present housing shortage. Nowadays, the government has withdrawn and has given space for market parties to take over the housing market. But often when a market party proposes a new development, the government in question (i.e., the municipality of Zaanstad) rejects the plan or requests adaptations. In many cases a government does not have sufficient capacity to judge and approve plans, slowing down the process. So, the problem is, according to Expert I:

“On the one hand, we have a housing shortage, so the enormous building task we want to realise, but on the other hand, we have both small and large municipalities that are heavily understaffed to look at plans in the first place” (Expert I).

In addition, rules and regulations have become more complex, with many environmental regulations, for example (Expert I).

Expert I also reflects on the fact that many citizens from Amsterdam take up a portion of the available housing stock of Zaanstad. Very recently, an alderman of Zaanstad has proposed the possibility for new housing to be offered to people living in the Zaan region, in advance of offering it to a larger public. Although this may help people from the Zaan region to find a house in Zaanstad, there still exists a risk that residents will sell their house to a non-local anyways after a year or two. So, without secure supervision, this may not be a suitable solution, Expert I says.

Discussion Qualitative Analysis

Transit-oriented Development

It is important to properly distinguish TOD from other forms of urban development, such as what Hale (2014) defines as transit-adjacent development or TAD, referring to less-successful TOD efforts that do not deliver a sustainable travel majority and lack functional connectivity to transit (Renne, 2009).

In the master plan, Inverdan is described as “a concentration of economic and social functions around a public transit node” and as combining “diverse functions in the area between the station and city centre” (Gemeente Zaanstad, 2003, p. 4-5).

The results from the expert interviews give insight into whether the developments of Inverdan conform to the 5 Ds of successful TOD (Ewing & Cervero, 2001, 2010) and as such may provide an answer to the first sub-question of this study (To what degree do the Inverdan developments correspond with transit-oriented development characteristics defined in academic literature?). By using this commonly used framework, it is possible to compare the Inverdan developments with other TOD literature:

Density. In general, housing and other developments have been added to the existing built area and little has been replaced. Housing was built on unbuilt land or occasionally in the place of old offices (Expert B). The total number of dwellings per square kilometre has thus increased, and neighbourhoods have become more densely built. The building of high-rise apartments made possible an even more densely built area and with it an increase in population density. Many new offices and shops have been built as well, which in turn is expected to increase the job density of the area as well. Future plans in the added plan area will add about 400 to 500 more dwellings in and around the Peperstraat.

Diversity. A diverse array of uses has been combined as a result of the Inverdan developments. The main shopping area (*Gedempte Gracht*) simultaneously serves as a living area with several high-rise apartments and dwellings on the upper floors of the stores' buildings. Housing is mainly destined for middle and higher incomes, but affordable and social housing is included (Expert D). It serves as a working area as well as a result of newly developed office space. Moreover, a new cinema, city hall, and hotels were built. The number of restaurants and coffee shops has also increased (Expert E)

Design. Apart from new buildings, the public space has been addressed as well. Attention to public space is also one of the objectives of the public transit nodes (OV knooppunten) policy of the Province of Noord-Holland (Provincie Noord-Holland, 2018). As a switch from priority to

cars to priority to pedestrians was envisaged, this had several spatial consequences (Expert D). For example, the canal running through the main shopping area which had been formerly filled in was dug out and traversed with several walking bridges. The area from the entrance/exit of Zaandam station to the end of the main shopping area (*Gedempte Gracht*) was made a pedestrian-only zone with shops and apartments on both sides.

Distance to Transit and Destination Accessibility. The Zaandam train station is located in the middle of the Inverdan plan area. The plan area, in turn, falls within the 1200-meter radius catchment area of the station, proposed as the station's primary area of influence (*primaire invloedsgebied*) by the Province of Noord-Holland. The whole of the Inverdan plan area is also less than 10 minutes away from the station by bicycle; the station's secondary area of influence (*secundaire invloedsgebied*, Provincie Noord-Holland, n.d.).

Every five to ten minutes, you can take a train to Amsterdam Central, a trip of about ten minutes (Expert D). The station is part of several train lines, such as the Intercity train lines Maastricht – Den Helder and Nijmegen - Den Helder, as well as the Sprinter train lines (regional trains) The Hague Centraal – Hoorn Kersenboogerd, Uitgeest – Rotterdam Centraal, and Uitgeest Veenendaal Centrum. The station also provides large bicycle parking, rental bikes (*OV fiets*), park and ride parking, car-sharing (*Greenwheels*), a taxi service (*NS Zonetaxi*), and a bus station for regional bus routes (*Connexxion*) (NS, n.d.).

Bike paths and bridges that cross the railroad and the provincial highway, such as De Slinger, have increased the accessibility from the station to the city centre (*Gedempte Gracht*) as well as from the station to Zaandam West.

See Figure 6 for a visual representation of the location of the plan area in relation to Zaandam station and its catchment area.

Figure 6 Map of the initial Inverdan plan area, the 1200-meter radius around Zaandam Station (primary area of influence), and the 10-minutes by bicycle area around Zaandam Station (secondary area of influence). Adapted from Gemeente Zaanstad (2003) and Provincie Noord-Holland (n.d.).



Gentrification

According to the rent-gap theory Neil Smith (1979, 1986) described in Chapter 2, deteriorated areas that have undergone disinvestment are likely to overcome gentrification, as the rent-gap - the discrepancy between current and potential property values and rents - is large enough for reinvestment to be profitable. The degraded state of the centre of Zaandam corresponds with this description and therefore appears to confirm this theory. Because of its proximity to the station, as well as the relative affordability of housing, the transit-oriented development around Zaandam Station attracts (often high-income, young) people who want to work in Amsterdam but live elsewhere. These are often coming from Amsterdam, an amount comparatively high compared to other parts of Zaandam, but also from elsewhere in Zaanstad and the Zaan region (Expert A, B & H). The strengthened connection between the station and Zaandam West increased the value potential for this area as well. Overall, the quality and attractiveness have increased significantly over the past twenty years, which in turn led to higher property values. The addition of new developments and quality to the city centre, combined with its proximity to the station are thought to be the driving factors for this. Several cultural aspects of gentrification are also mentioned, such as the new cinema, coffee shops and restaurants, and higher quality shops.

The TOD developments in Zaandam juxtapose many of the American cases where the investments in infrastructure (e.g., new metro line) leads to increasing property values, eventually pushing low-income residents out of their houses (Expert B). The unique regulations on social housing play an important role in this as governments can in some circumstances demand social housing to be included in developments, something that is not expected to happen in the US, according to Expert F. Moreover, as the developments mostly took shape as densification, people who already lived in the area could stay there, contrasting gentrification examples from Amsterdam, where neighbourhoods such as De Pijp en De Baasjes were largely demolished and reconstructed (Expert C)

The housing shortage and very high property values in Amsterdam seem to be the most important external factors on neighbourhood change in Zaandam, leading to well-of citizens from Amsterdam moving to Zaanstad and taking up a portion of the available housing stock, in turn pushing up property values. In Expert B's words, this gentrification has nothing to do with transit-oriented development but is a market-caused effect that you cannot do much about except 'build, build, build. That is the solution'. Still, one would argue that the proximity of Zaandam station does in fact play a role, as its train lines to Amsterdam bring the TOD area closer to the capital compared to other more distant neighbourhoods of Zaanstad, according to the bid-rent theory (Alonso, 1964). The quantitative study (Chapter 4) seems to confirm this nuance, as property values have increased faster in the Inverdan area compared to other neighbourhoods of Zaanstad.

Several positive effects of gentrification were also mentioned. Densification and its consequential gentrifying effects lead to a bigger support base for the level of facilities. When a formerly lower-income neighbourhood is 'filled-in' with higher income, it becomes easier for a municipality to afford facilities and services such as swimming pools, libraries, and sports facilities (Expert A & D). This, according to Expert A, is a win-win situation.

Thus, gentrification is welcome in some areas, where there is a large group of people with a lower income and much social housing (Peperstraat in Zaanstad East). By densifying, you can create a better balance without necessarily removing existing (social) housing.

Referring back to the books of Richard Florida (2002), attracting creative people was seen as the key to successful gentrification; to turn downgraded, used-up locations, such as dilapidated industrial sites to new successful living areas (Expert I). Expert I underlines the necessity of gentrification, using a forest as a metaphor: high trees eventually die and give place to new growth. Likewise, old urban areas should make place for new developments.

According to Expert E, Inverdan's main goal was to combat the local housing shortage and provide new quality to the area. Its goal was not to attract a new group as a response to a poor and little developed population.

Limitations of Qualitative Data Analysis.

Although the expert interviews have provided relevant in-depth data on the Inverdan developments and their effects on neighbourhood change, several limitations with regards to the methods of data collection and analysis have been identified.

The main limitation of this research is the fact that it is a single case study, the station area of Zaandam. Choosing a single case study has resulted in obtaining a degree of depth and richness that has led to insights into the intricate details of urban developments and neighbourhood change. As a consequence, however, findings cannot really be extended beyond the scope of this study (Zaandam), limiting its generalisability. The interview analysis aimed to give a detailed description, based on the opinion and perception of the participants, with the potential drawback that most of the results apply to this specific population. Some findings occurred on a national level, however, such as the discussions on the previous financial crisis and the current housing crisis, which may apply to other (transit-oriented) developments as well. Moreover, having made connections between this study and existing academic literature has increased its generalisability somewhat, the external validity of the results is thereby increased.

Secondly, with a total of nine expert interviews, a limited variety of perspectives on the Inverdan developments have been covered. Among the participants were policy advisors, aldermen, an urban planner, a plan developer, a process manager, and an architect. However, some important groups were thereby left out. Representatives from housing cooperatives could

have added relevant information on the effects of Inverdan on the number and quality of social housing. Inhabitants and entrepreneurs living and or working in the area could have shared the effects of the Inverdan developments from people being there daily.

Thirdly, the findings are dependent on the accuracy and intensity of the participants' responses. Responses may be incorrect, either deliberately, when the participant may want to give a socially desirable answer or accidentally when the participant misremembers certain information or misinterprets the question.



Bicycle parking De Droogschuur (Van Maasakker, 2021)

Chapter 6: Conclusion and Discussion

This study aimed to investigate the possible relationship between transit-oriented development in Zaandam, as a result of project Inverdan, and residential gentrification. For this purpose, a research question was formulated supported by three sub-questions. Below, the results are reflected upon in relation to the mixed-method approach and the theories outlined in Chapter 2. Then, an attempt is made to answer the questions based on the knowledge that has been created with the two studies described in Chapters 4 and 5, as well as the founding literature outlined in Chapter 2. Furthermore, several limitations of this study are discussed. Finally, recommendations on possible future research are proposed.

Reflection on Methodology and Theory

An important motivation for having done both a quantitative and a qualitative study is that

- while quantitative statistical data-based analysis is an often-used approach (Padeiro et al., 2019)
- qualitative studies on the relation between TOD and gentrification are significantly underrepresented in academic literature.

A substantial advantage of combining two approaches is the possibility to compare the results of the two separate studies: A quantitative data analysis that took theory as a starting point and then tested whether this theory holds true in the specific case of Zaandam Station and its surrounding neighbourhoods, and a qualitative interview analysis, that took the Zaandam case as a starting point, and by coding and analysing the interview data, tried to form a more general theory on how neighbourhoods change as a result of TOD and whether gentrification takes place.

Many findings from the quantitative study corresponded with findings from the qualitative study. For instance, the increase of property values and the attraction of new population groups were some of the main developments that defined the results of the statistical analyses, as well as some of the most frequently discussed themes in the expert interviews.

The results from the quantitative study did not conflict or contradict with findings from the qualitative study, but both studies provided additional insights to their counterpart. For instance, the quantitative study provided the possibility to make inferences on the causality between TOD and gentrification effects on neighbourhoods. Moreover, it provided numerical data on the proportions of owner-occupied, rental, and social housing, as well as age, density, and newly built housing. At the same time, the interview analysis provided in-depth information on the increasing quality of the area (e.g., the public space, housing, and shops) and shed light on the effects of external factors such as the financial crisis around 2008 and the current housing crisis in Amsterdam.

In Chapter 2, several theories were discussed which were expected to be foundational to the processes and developments that this study was aimed to investigate.

As discussed in Chapter 5, the Inverdan developments were compared to TOD characteristics defined by the 5 Ds: density, diversity, design, destination accessibility, and distance to transit (Ewing & Cervero, 2001, 2010). The results suggested that the 5 Ds may serve as a framework for successful TOD in the Netherlands.

The land use transport feedback cycle by Wegener & Fuerst (1999) was also discussed as a relevant theory, concerning the interaction between land use patterns and traffic flows. Looking back at the Inverdan developments, a correspondence can be found with the feedback cycle between transport system, accessibility, land use, and activities: Zaandam station and its railway services connecting to the rest of the Netherlands (*transport system*) increase the *accessibility* of residents living and working in the station's catchment area. This has resulted in *land use* investments in this area. New and improved housing, workplaces, and shops have in turn led to changes in who lives, works, and shops in the area (*activities*). The case of Inverdan does differ from the model with regards to the sequence of events: The model argues that the degree of accessibility affects the attractiveness of a location, and consequently location decisions of investors and the construction of new buildings and infrastructure. This then leads to location decisions of users, their moves, et cetera. However, in the case of Inverdan, long periods of disinvestment and a municipal effort to revitalize the area led to investments. Only after the construction and renovation of buildings and infrastructure did the area become more attractive, impacting the location decisions of users.

The case of Inverdan thereby also corresponds with the rent gap theory by Smith (1979, 1986) as regards the investments following a period of degradation. According to this theory, such investments are likely to lead to gentrification, a development which, according to the results of Chapters 4 and 5, indeed holds true for the Inverdan area.

Lastly, Chapter 2 discussed how Amsterdam may serve as a regional 'central business district' because of its centrality in the daily urban system of the Metropolitan Region Amsterdam, which Zaanstad is part of. Following the bid rent theory by Alonso (1964), locations in proximity to Amsterdam would see high prices and high demand for real estate, and this effect would decrease the further a place is located from the capital. However, the high accessibility of Zaandam caused by its railway connection to Amsterdam was expected to have effects on real estate prices as well. The results of this study suggest that real estate prices in Zaandam are affected by economic developments in Amsterdam. Amsterdam's soaring prices as a result of the housing shortage seemed to have slowly pushed up the prices in Zaandam as well. Moreover, the twelve-minute train ride from Zaandam Station to Amsterdam Central Station increased the attractiveness of the Inverdan area as a place to live in for people working in Amsterdam. Future

research on how these effects compare to municipalities further away from Amsterdam and how this relates to the bid rent theory is encouraged.

Answering the Research Questions

Sub-question 1: To what degree do the Inverdan developments correspond with transit-oriented development characteristics defined in academic literature?

The Inverdan developments have led to a substantial increase in density, mixed uses, accessibility, pedestrian and bicycle friendliness, and overall quality, meeting the criteria of successful TOD (5 Ds). Although building in proximity to transit was one of the reasons for the Inverdan developments, its main purpose was giving the area a quality boost and to densify in order to make room for new population groups.

Sub-question 2: To what degree has transit-oriented development near Zaandam Station had an effect on neighbourhood change between 2009 and 2019?

The developments have had positive effects on the property value of housing and the income of inhabitants living in the Inverdan neighbourhoods. Several other factors, such as population density and the number of dwellings increased as well, potentially indicating gentrification effects. However, other factors are expected to play a role in this too, of which the housing crisis in Amsterdam was deemed predominant.

Sub-question 3: To what degree have these neighbourhood changes led to gentrification and what can we learn from Inverdan for future transit-oriented development?

Gentrification has occurred in the sense that higher-income people have moved to Zaandam, which has had led to higher-quality services, and for example more luxury shops and coffee bars. On the other hand, it has not been the case that low-income residents were displaced as a result, and very little housing has been demolished for new developments, as the aim was to densify, rather than replace.

There is a tendency to build more and more small, high-rise apartments. It is important for future transit-oriented developments and in-fill developments in general, to prevent monotonous developments with only these small apartments because that way you attract only one portion of the population (yuppies, people without children) and miss out on others (families with kids, perhaps social housing residents).

Main research question: To what degree is there a relationship between transit-oriented development and residential gentrification in Zaandam?

TOD is related to residential gentrification in Zaandam in the sense that the developments have led to a higher quality urban area that gave room to higher-income residents, as is shown by the absolute and relative increase in income per person. Other gentrification factors such as an increase in density, number of dwellings, and young people since the start of Inverdan suggest a relationship between TOD and gentrification as well. The renewed facilities, shops, and public spaces have given Zaandam back its identity and many people from Amsterdam and the Zaan region have moved there since. The effects of the housing crisis that started in Amsterdam a few years ago have pushed-up property values in Zaanstad, and in addition, the Inverdan TOD developments resulted in a significantly faster value increase in the TOD area compared to the rest of the municipality. Whereas TOD-related gentrification in the US often leads to displacement of lower-income households, in this Dutch context, the developments have taken shape as densification rather than replacement, and the regulations of social housing keep some of the rents from rising. The predominance of small apartments in transit-oriented development may, however, attract only a specific segment of the population which may undermine its objective of a mixed urban area.

Recommendations for Praxis

TOD is a commonly used policy in Dutch urban development. On a national scale, cities are stimulated to develop near public transit nodes in high-density. Based on the findings of this study, municipalities and provinces are recommended to identify how the redevelopment and densification of a station area may affect the affordability of housing, as this has direct consequences on the demographics of the location. The methodological steps taken in this study may serve as guidelines as to how to achieve this. Unintentional displacement effects may thereby also be identified.

The tendency to build primarily small, often expensive, apartments in TOD areas may prevent other population groups from moving here as well to create mixed urban spaces, which is, nevertheless, an often-wished-for outcome of TOD developments. It is thus vital for Zaanstad to take this into consideration in their future developments of MAAK.Zaanstad. The Metropolitan Region Amsterdam as well as the Province of Noord-Holland - whose programme 'public transit nodes' (OV knooppunten) aims to create accessible stations stimulating modal shifts, as to prevent urban sprawl from taking up nature areas or agricultural plots - are recommended to monitor the affordability of housing in station areas to prevent conflict in its integral policies.

Limitations and Future Research

The methods of data collection and analysis brought with it some limitations. For instance, the quantitative analysis did not consider annual fluctuations in data and makes use of a limited time frame of ten years, whereas the qualitative part was based on a limited set of interviews. For more details on limitations specific to the quantitative methods and data analysis, see Chapter 4. Chapter 5 concludes with limitations specific to the qualitative methods and data analysis.

This study has looked at the effects of TOD by looking at housing, economic, and demographic variables. Although this was sufficiently broad to answer the research question, several aspects were beyond the scope of this study. As such, the study lacks a behavioural component. Travel behaviour, for instance, has been little discussed, in spite of the case study being a train station.

In a more general sense, the phenomena of neighbourhood change and gentrification have been researched based on existing literature related to social geography, economy, and urban planning. However, to get a complete picture of the effects of neighbourhood change on its inhabitants, an in-depth sociological or psychological analysis is needed that reaches beyond the objectives and scope of this research. For example, gentrification has been linked with negative health effects, primarily in low-income residents, by Mehdipanah et al. (2018). Such findings may serve as a point of departure for research on health-related effects of TOD-induced gentrification.

As previously discussed, the generalisability of this study is deemed low, as it revolves around a single case, the station area of Zaandam. It would therefore be interesting to apply the study's research methods to other municipalities that have recently experienced TOD, other transport-related and/or densification developments. Comparing results gives insight into location-specific nuances that may be overlooked in the current case study.

Moreover, in relation to its proximity to Amsterdam and daily urban system, it would be relevant to compare how the results for Zaanstad compare to other stations close to Amsterdam, as well as areas further away (such as Uitgeest or Alkmaar). In that way, it is possible to gain in-depth knowledge on the effects that the capital has on its surroundings as well as its limits.

Most studies on TOD and gentrification have thus far investigated cases where a station or train line itself is newly built. This study has contributed to scientific literature as being one of few that has investigated the gentrification effects of TOD developments around a station that was already built. The author, therefore, encourages future research on other cases of TOD around an existing transit station, preferably in a non-US location, as TOD literature is overrepresented by cases of American transit nodes.

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Gedempte Gracht (Provincie Noord-Holland, 2018)

Appendix A. Maps of Neighbourhoods

Figure A 1 *Map of neighbourhoods (micro level)*

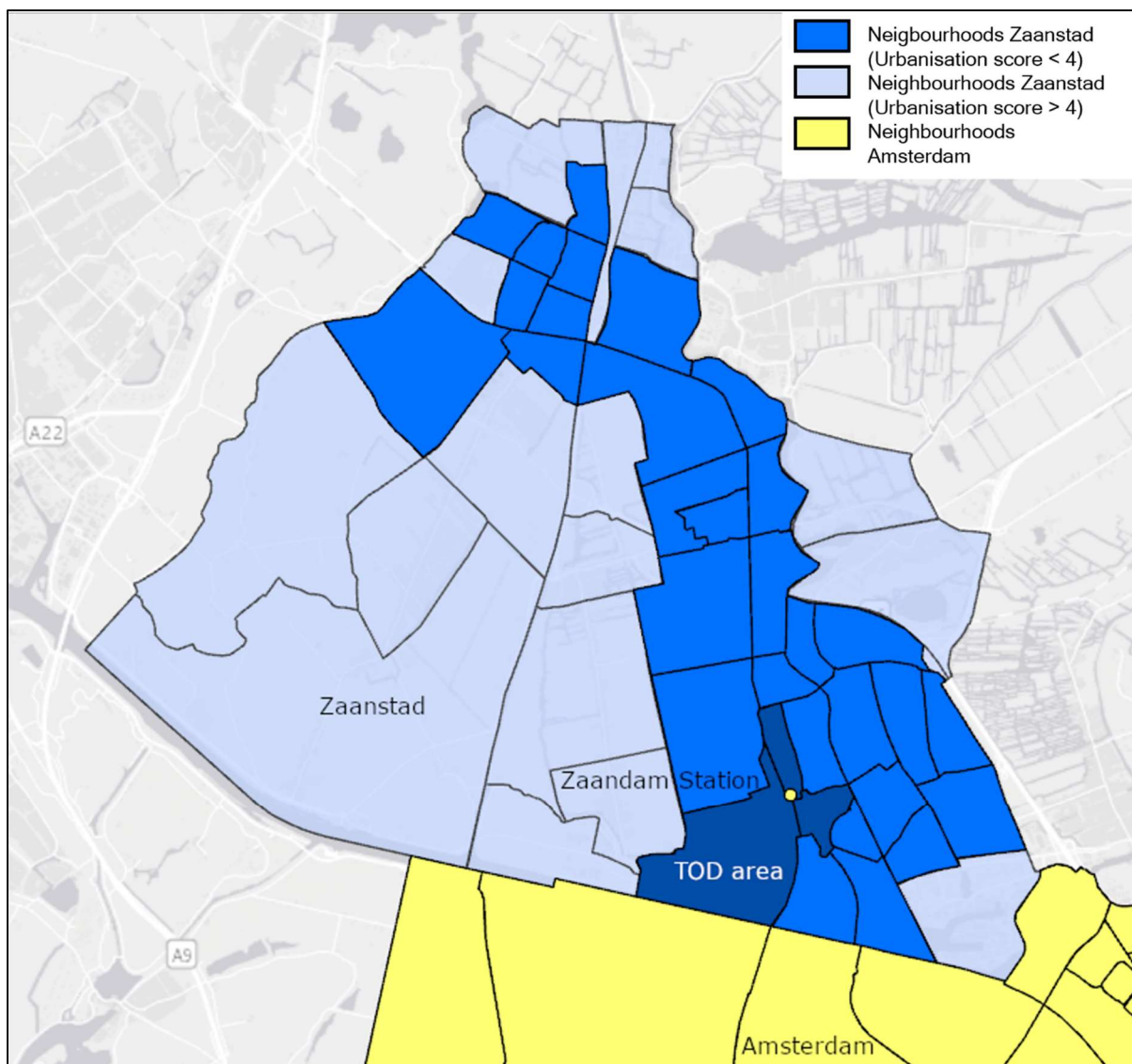
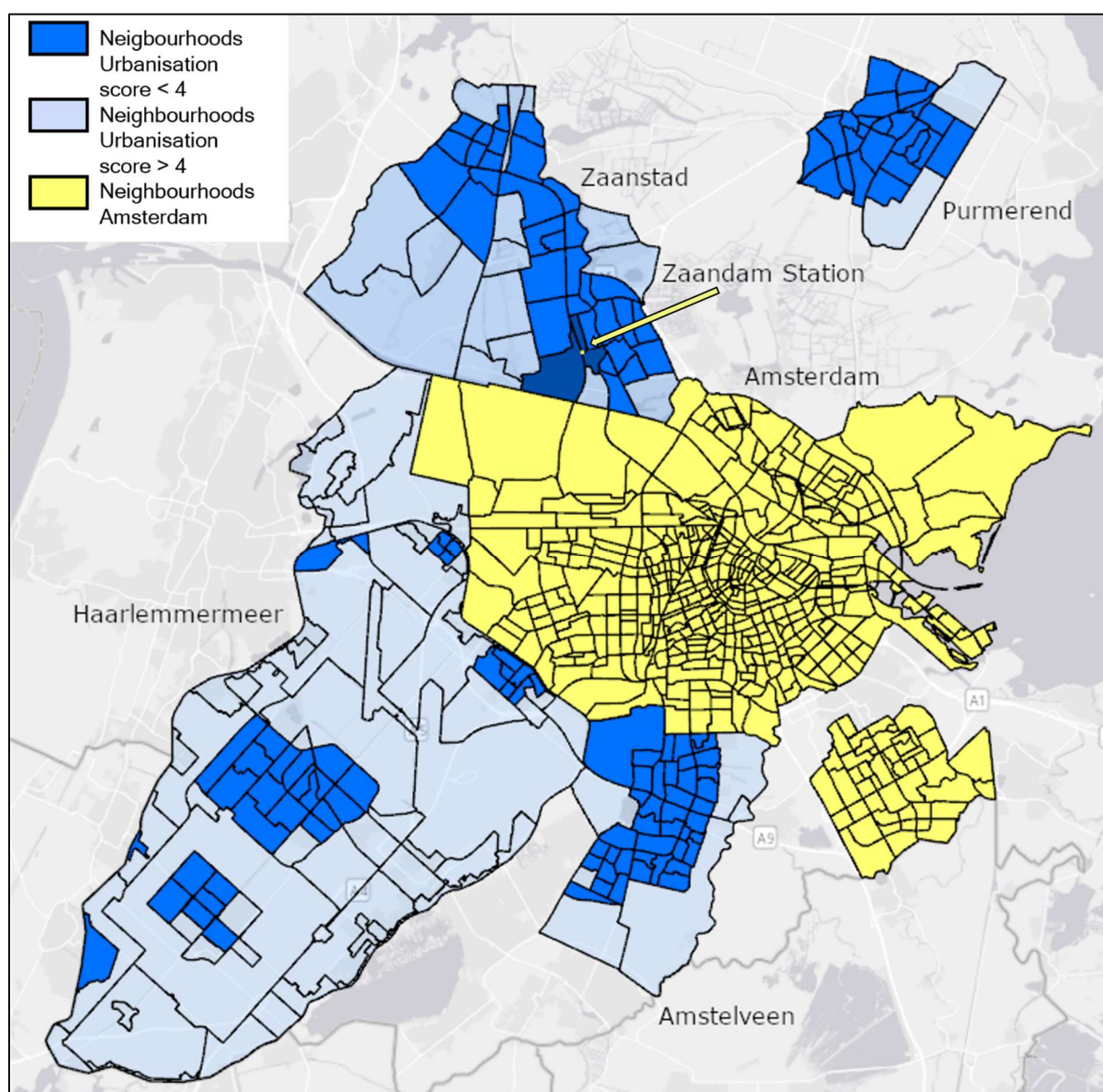


Figure A 2 *Map of neighbourhoods (macro level)*



Appendix B. Dutch Land Use and Transport Policy

A Word on Dutch National Land Use and Transport Policy

Until recently, infrastructure and transit-oriented development have not played a major role in Dutch planning tradition. Although National Road plans (Rijkswegenplannen) were developed in the 1920s (the first time a national infrastructure plan was made since the Napoleonic reign), the vision on infrastructure remained subservient to mainly the five 'National Policy Documents on Spatial Planning' (Nota's Ruimtelijke Ordening). The first three of these policies aimed mainly at the building of new housing, for instance by determining new centres for growth (groeikernen). The location of new cities was rarely determined on the basis of their position in relation to the existing transit and road system (Needham, 2014).

At the end of the 1980s, the Fourth National Policy Document on Spatial Planning (Vierde Nota over de Ruimtelijke Ordening) moved its attention from new centres for growth to the idea of a compact city. Development near transit nodes now for the first time played an important role. The so-called ABC policy appointed three types of settlement locations for businesses, A meaning near central transit stations, B meaning near multi-modally accessible transit stops in a city's periphery, and C meaning business parks barely accessible by public transit. This policy aimed to locate businesses at places accessible with public transport, so A locations as well as B locations to a lesser degree (Jansen et al., 1997). The Supplement on the Fourth National Policy Document on Spatial Planning (Vierde Nota over de ruimtelijke ordening Extra) further elaborated on the vision of a compact city. Apart from appointing locations for new residential neighbourhoods near central cities (VINEX-wijken), several national key projects were appointed as well. These key projects were seen as crucial transformation projects in cities envisioned to strengthen the position of medium- and large-sized cities on the European playing field. Many of these projects concerned locations close to stations within the existing city. In the 1990s these key projects became part of urban area development, in which the National government was now engaged in the form of a public-private partnership (Bruinsma & Koomen, 2018).

With the National spatial strategy (Nota ruimte), which was published in 2004, spatial planning became more decentralized. Domains that were previously directed nationally, such as housing and mobility, were now under the authority of the provinces and regions. Public transit improved significantly with the help of new high quality, regional transit lines, such as the high-quality bus connections of the Zuidtangent between Amsterdam and Haarlem. As provinces now had their own spatial policies, Noord-Holland laid out a contour representing the Existing Built-up Area (Bestaand Bebouwd Gebied). Developments outside of this area are seen as new urbanization and are discouraged with strict requirements (Provincie Noord-Holland &

Vereniging Deltametropool, 2013). In a sense, forms of transit-oriented development gradually took over the preceding ABC policy (Gerrits et al., 2012)

In 2012 the National spatial strategy was replaced by the National policy strategy for infrastructure and spatial planning' (Structuurvisie infrastructuur en ruimte). The document serves as the National government's vision on the Netherlands in 2040. The implementation of this vision was, however, done by the provinces and municipalities. A main goal of the strategy was the improvement of accessibility by ameliorating chain mobility and strengthening multi-modal nodes, for instance by improving existing and building new park and ride locations. Existing infrastructure was ought to be used more efficiently as well, resulting in the expansion of cycle parking around train stations. The National policy strategy also introduced the Ladder for sustainable urbanization (Ladder voor Duurzame Verstedelijking). This instrument has as goal efficient use of (scarce) space and is mandatory to apply on new developments. As such, developments need to be shown to have sufficient regional demand, and if possible, should be located within an existing urban area. If not possible, the location should be (made) multi-modally accessible (Ministerie van Infrastructuur en Milieu, 2012).

The national attention towards multimodality offered opportunities for the transit nodes in Noord-Holland. For example, an increase in the frequency of several train lines in Noord-Holland and a resulting increase in accessibility lead to opportunities for more efficient land use around the train station.

Appendix C. Codes and Themes

Table C 1 *Overview of codes and themes thematic analysis*

| | Themes | | | | | | | | | |
|---|--------|---------|--------|----------------|----------------------|---------------------|---------|-----------------|----------|-----|
| | 5 Ds | Context | Future | Gentrification | Neighbourhood change | Outside of Inverdan | Parties | Pre-development | Timeline | TOD |
| 2005: not much development, but signing contracts, etc. | | | | | | | | | x | |
| 5Ds: Density | x | | | | | | | | | |
| 5Ds: Design | x | | | | | | | | | |
| 5Ds: Destination accessibility | x | | | | | | | | | |
| 5Ds: Distance to transit | x | | | | | | | | | |
| 5Ds: Diversity | x | | | | | | | | | |
| Accessibility/transit/station does not play a major role in neighbourhood change | | | | | | | | | | x |
| Approval of masterplan | | | | | | | | | x | |
| Characteristics Zaanstad pre-development: attitude towards developments | | x | | | | | | x | | |
| Characteristics Zaanstad pre-development: culinary | | x | | | | | | x | | |
| Characteristics Zaanstad pre-development: education | | x | | | | | | x | | |
| Characteristics Zaanstad pre-development: general appearance and existing buildings | | x | | | | | | x | | |
| Characteristics Zaanstad pre-development: housing | | x | | | | | | x | | |
| Characteristics Zaanstad pre-development: income | | x | | | | | | x | | |
| Characteristics Zaanstad pre-development: municipal land policies | | x | | | | | | x | | |
| Characteristics Zaanstad pre-development: people | | | | | | | | x | | |
| Characteristics Zaanstad pre-development: social cohesion | | x | | | | | | x | | |
| Characteristics Zaanstad pre-development: stores | | x | | | | | | x | | |
| Current issues housing shortage | | | | | x | | | | x | |
| Densification allows for services to be funded | | | | | x | | | | | |
| Developments attract investors | | | | | x | | | | | |
| Developments do not lead to displacement | | | | x | x | | | | | |
| Developments lead to change in social cohesion | | | | | x | | | | | |
| Developments lead to demolishing | | | | | x | | | | | |
| Developments lead to densification | | | | | x | | | | | |
| Developments lead to increase in housing price | | | | | x | | | | | |
| Developments lead to increase in quality | | | | | x | | | | | |
| Developments lead to increase in visitors | | | | | x | | | | | |
| Developments lead to indirect consequences in adjacent neighbourhoods | | | | | x | | | | | |
| Developments lead to other demographics | | | | | x | | | | | |
| Developments lead to other functions | | | | | x | | | | | |
| Developments lead to other income groups | | | | | x | | | | | |
| Developments lead to other types of housing | | | | | x | | | | | |
| Developments speed up after financial crisis (2014-2018) | | | | | x | | | | x | |
| Distance to station influences neighbourhood change | | | | | x | | | | | x |
| External factors: Financial crisis slows down developments (2008-2011) | | x | | | x | | | | | |
| External factors: Increasing housing prices Amsterdam and housing shortage | | x | | | x | | | | | |
| External factors: Office crisis (2004-2005) slows down developments | | x | | | x | | | | x | |
| Future: COVID-19 | | | x | | x | | | | x | |
| Future: Demolishing housing may affect existing residents | | | x | x | | | | | | |
| Future: densification leads to high-rise, small apartments, high prices | | | x | x | | | | | | |
| Future: Plans | | | x | | | | | | x | |
| Gentrification in Inverdan: positive or negative | | | | x | | | | | | |
| Gentrification in Inverdan: yes or no | | | | x | | | | | | |
| Green facades | | | | | | | | | x | |
| Inverdan is PPS | | | | | | | | x | x | |
| Inverdan is TOD | | | | | | | | | | x |
| Inverdan versus Zaanstad | | | | x | | x | | | | |
| Involvement parties Inverdan: Developers | | x | | | | | x | | | |
| Involvement parties Inverdan: Housing cooperative | | x | | | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Involvement parties Inverdan: Individual initiatives | x | | | x | | |
| Involvement parties Inverdan: Metropolitan Region Amsterdam | x | | | x | | |
| Involvement parties Inverdan: Municipality of Zaanstad | x | | | x | | |
| Involvement parties Inverdan: National government | x | | | x | | |
| Involvement parties Inverdan: NS | x | | | x | | |
| Involvement parties Inverdan: ProRail | x | | | x | | |
| Involvement parties Inverdan: Province of Noord-Holland | x | | | x | | |
| Land ownership pre-development | | | | | x | x |
| Literature | | | | | | |
| Meaning "Inverdan" | x | | | | | |
| Municipal policies ensure affordable housing in new developments | | | x | | | |
| New inhabitants lead to opposition | | x | x | | | |
| Other neighbourhoods: Developments | | | | x | | |
| Other neighbourhoods: Effects of demolishing | | | | x | | |
| Plan preparation (2000) | | | | | x | x |
| Projects: Housing | | | x | | | x |
| Projects: services | | | x | | | x |
| Quote | | | | | | |
| Russische Buurt | | x | | x | | |
| The importance of collaboration between societal and physical domains | | | | | x | x |
| TOD is a win-win situation | | | | | | x |
| West versus Centrum | | x | x | | | |
| Zaandam versus Amsterdam | | x | | x | | |
| Zaandam versus USA | | | | x | | |

Appendix D: Interview Guide

The interview guide below was used to shape the interview dialogues and make sure that several themes were discussed that were deemed important by the researcher. The statements and questions below are to be seen as an example, the guide is not intended to be followed word for word. The order of asking questions may differ per conversation, some questions may be left out, and others may be added depending on where the participants lead the conversation.

Introduction

Thanks

- "Nog dank voor de (snelle) reactie, heel tof dat ik je mag interviewen. "
- "Zal ik beginnen met mezelf voor te stellen? Daarna vertel ik wat meer over het onderzoek. Daarna kunnen jullie je ook even voorstellen. Ok?" Maar eerst ->

Anonymity & recording of the interview

- "Ik heb eerst even een paar vragen omtrent anonimiteit. "
- "Ik zou graag het interview willen opnemen. Zo kan ik naderhand de opname goed transcriberen en analyseren."
- "Informatie uit het interview kan verwerkt worden in de scriptie, dit doe ik anoniem. Bijv: "Expert A, beleidsadviseur ruimte..."

Who am I?

- "Masterstudent Spatial Planning, specialisatie Urban and Regional Mobility. Radboud Universiteit Nijmegen. "

What am I doing?

- "Momenteel bezig met afstudeerscriptie over transit-oriented development (TOD/knooppuntontwikkeling) en gentrificatie in Zaandam. Hiervoor loop ik ook stage bij de provincie Noord-Holland, bij OV-knooppunten. "

Aim of the interview

- "Meer te weten te komen over de ontwikkelingen rondom station Zaandam van de afgelopen paar jaar, de link met gentrificatie, en ook de plannen voor de toekomst van dit gebied en andere stationsgebieden. "

Time needed

- "Ik verwacht dat het interview een half uur tot drie kwartier duurt. "

What will happen with results?

- "De resultaten: zoals gezegd wordt de informatie uit dit interview verwerkt in mijn scriptie met als uiteindelijk doel mijn hoofdvraag te beantwoorden (*in hoeverre is er een relatie tussen TOD rondom Station Zaandam en gentrificatie?*), kom ik later op terug. Ik houd meerdere interviews en ook deskresearch en

Themes, subjects

Voorstellen interviewee

- Functie, organisatie, werkzaamheden en projecten

Knooppuntontwikkeling

- Kunt u iets vertellen over uw betrokkenheid bij Inverdan? Andere knooppuntontwikkeling bij station Zaandam?
 - o Welke partijen waren betrokken bij deze ontwikkelingen?
- Naast overheden en ontwikkelaars, ook oorspronkelijke en toekomstige bewoners?

Woningbouw

- Kunt u iets vertellen over de woningen die zijn gebouwd i.h.k.v. Inverdan?
 - o Koop? Huur? Sociaal?
 - o Wat stond er eerst qua verbouwing? Is er gesloopt? Zo ja, ook woningen? Wat voor woningen?

Resultaten CBS data

De analyse van CBS data (kort uitleggen) laat zien dat tussen 2009 en 2019 de gemiddelde woningwaarde sneller is gestegen in de buurten waar ontwikkelt is i.h.k.v. Inverdan, ten opzichte van de rest van Zaanstad.

- Waardoor komt dit, denkt u?
 - o Relatie tussen woningwaarde en ontwikkeling?
 - o Follow-up

De analyse van CBS buurt data (kort uitleggen) laat zien dat tussen 2009 en 2019 het gemiddelde inkomen per huishouden sneller is gestegen in de buurten waar ontwikkelt is i.h.k.v. Inverdan, ten opzichte van de rest van Zaanstad.

- Waardoor komt dit, denkt u?
 - o Relatie tussen inkomen en ontwikkeling?
 - o Follow-up

Gentrificatie: "een leegstaand gebied of een gebied gekenmerkt door lage inkomens (in een stedelijk centrum) wordt getransformeerd tot een gebied met hogere inkomensgroepen, gepaard met stijgende prijzen van woningen en commerciële voorzieningen.

In de (m.n. Amerikaanse) academische literatuur vind je voorbeelden van knooppuntontwikkeling waarbij de desbetreffende buurten gentrificatie ondergaan. De flink gestegen grond- en woningwaarde zorgen in die casussen ervoor dat lage inkomensgroepen die hier oorspronkelijk wonen hun woning of huur niet meer kunnen betalen en elders moeten gaan wonen.

- In hoeverre zie je dit terug in de knooppuntontwikkeling rondom station Zaandam?
- In hoeverre is dit wenselijk? Gunstig? Te vermijden?

- Want, is hier eigenlijk op geanticipeerd? Hoe?
- Heeft de oorspronkelijke bevolking een plekje teruggekregen? En waar dan?

De literatuur beschrijft ook hoe nieuwe inwoners met een kleine portemonnee na zo'n ontwikkeling soms geen betaalbare woning meer kunnen vinden in de buurt van het station, waardoor ze afhankelijker worden van hun auto. Dit ondermijnt één van de doelen van knooppuntontwikkeling: zoveel mogelijk mensen met het OV/fiets/lopend te laten reizen.

- In hoeverre zie je dit terug in de knooppuntontwikkeling rondom station Zaandam?
- In hoeverre is dit wenselijk? Gunstig? Te vermijden?
- Zijn er voldoende betaalbare (sociale) woningen voor lage inkomensgroepen binnen het stationsgebied van Zaandam? Of (zo niet) voldoende voor en natransport (van en naar station)

(Als derde) zie je dat de instroom van hogere inkomens in een gebied met voorheen voornamelijk lagere inkomens soms leidt tot een verstoring van sociale cohesie en gemeenschappen. Denk ook aan voorzieningen: luxere supermarkten, toegespitst op nieuwe bewoners, maar duur voor oorspronkelijke bewoners.

- In hoeverre zie je dit terug in de knooppuntontwikkeling rondom station Zaandam?
- In hoeverre is dit wenselijk? Gunstig? Te vermijden?

Toekomst

- Wat wordt er momenteel ontwikkeld rondom station Zaandam? En wat zijn de (woning)bouwplannen voor de toekomst?
 - o Gepaste mix van koop/huur/sociaal?

Closure

- Summarizing conversation
- Ask for other potential interview partners and data on housing etc.
- Any questions now? And give contact details for further questions later
- Thank you

Appendix E: T-test Outputs

Micro level Analysis

Table E 1 *Independent samples t-test for treated group (micro level)*

| | | <i>Levene's Test for Equality of Variances</i> | | <i>t-test for Equality of Means</i> | | | | | | |
|---|-----------------------------|--|-------------|-------------------------------------|-----------|-----------------------------|----------------------------|----------------------------------|--|--------------|
| | | <i>F</i> | <i>Sig.</i> | <i>t</i> | <i>df</i> | <i>Sig. (2- tailed)</i> | <i>Mean Difference</i> | <i>Std. Error Difference</i> | <i>95% Confidence Interval of the Difference</i> | |
| | | | | | | | | | <i>Lower</i> | <i>Upper</i> |
| No. of inhabitants | Equal variances assumed | 0,696 | 0,451 | -0,683 | 3,190 | 0,541 | -718,33333 | 1051,98886 | -3639,12265 | 2202,45598 |
| Proportion age 25-45 | Equal variances not assumed | | | -0,683 | 3,190 | 0,541 | -718,33333 | 1051,98886 | -3956,28292 | 2519,61625 |
| Population density | Equal variances assumed | 3,294 | 0,144 | -0,665 | 4 | 0,542 | -0,03333 | 0,05011 | -0,17246 | 0,10580 |
| No. of dwellings | Equal variances not assumed | | | -0,665 | 2,891 | 0,555 | -0,03333 | 0,05011 | -0,19627 | 0,12961 |
| Mean property value | Equal variances assumed | 0,125 | 0,741 | -0,386 | 4 | 0,719 | -733,00000 | 1901,30067 | -6011,85693 | 4545,85693 |
| Proportion of owner-occupied dwellings | Equal variances not assumed | | | -0,386 | 3,926 | 0,720 | -733,00000 | 1901,30067 | -6051,22235 | 4585,22235 |
| Proportion of rental dwellings (total) | Equal variances assumed | 1,533 | 0,283 | -0,859 | 4 | 0,439 | -434,66667 | 505,96355 | -1839,44668 | 970,11335 |
| Proportion of cooperative-owned rental dwellings | Equal variances not assumed | | | -0,859 | 2,778 | 0,458 | -434,66667 | 505,96355 | -2120,14664 | 1250,81331 |
| Proportion of other-owned rental dwellings | Equal variances assumed | 1,031 | 0,367 | -0,178 | 4 | 0,867 | -1,78173 | 9,99623 | -29,53572 | 25,97226 |
| Proportion of housing built after 2000 | Equal variances not assumed | | | -0,178 | 2,990 | 0,870 | -1,78173 | 9,99623 | -33,65700 | 30,09353 |
| Mean income per inhabitant | Equal variances assumed | 0,134 | 0,732 | -0,851 | 4 | 0,443 | -0,06000 | 0,07047 | -0,25567 | 0,13567 |
| Proportion of households below or around social minimum | Equal variances not assumed | | | -0,851 | 3,581 | 0,448 | -0,06000 | 0,07047 | -0,26505 | 0,14505 |
| No. of cars (total) | Equal variances assumed | 0,099 | 0,769 | 0,774 | 4 | 0,482 | 0,05333 | 0,06888 | -0,13791 | 0,24457 |
| | Equal variances not assumed | | | 0,774 | 3,729 | 0,485 | 0,05333 | 0,06888 | -0,14350 | 0,25017 |
| No. of inhabitants | Equal variances assumed | 0,132 | 0,735 | 0,736 | 4 | 0,502 | 0,08667 | 0,11771 | -0,24015 | 0,41348 |
| Proportion age 25-45 | Equal variances not assumed | | | 0,736 | 3,958 | 0,503 | 0,08667 | 0,11771 | -0,24153 | 0,41486 |
| Population density | Equal variances assumed | 0,093 | 0,776 | -0,625 | 4 | 0,566 | -0,03333 | 0,05333 | -0,18141 | 0,11474 |
| No. of dwellings | Equal variances not assumed | | | -0,625 | 3,905 | 0,567 | -0,03333 | 0,05333 | -0,18285 | 0,11618 |
| Mean property value | Equal variances assumed | 4,608 | 0,098 | -0,982 | 4 | 0,382 | -0,15000 | 0,15275 | -0,57411 | 0,27411 |
| Proportion of owner-occupied dwellings | Equal variances not assumed | | | -0,982 | 2,070 | 0,427 | -0,15000 | 0,15275 | -0,78647 | 0,48647 |
| Proportion of rental dwellings (total) | Equal variances assumed | 1,192 | 0,355 | -3,031 | 3 | 0,056 | -3,35574 | 1,10719 | -6,87931 | 0,16783 |
| Proportion of cooperative-owned rental dwellings | Equal variances not assumed | | | -3,031 | 2,886 | 0,048* | -3,35574 | 1,01407 | -6,65644 | -0,05503 |
| Proportion of other-owned rental dwellings | Equal variances assumed | 0,715 | 0,446 | 0,606 | 4 | 0,577 | 0,01367 | 0,02256 | -0,04896 | 0,07629 |
| Proportion of housing built after 2000 | Equal variances not assumed | | | 0,606 | 3,370 | 0,583 | 0,01367 | 0,02256 | -0,05385 | 0,08119 |
| Mean income per inhabitant | Equal variances assumed | 0,341 | 0,591 | -0,483 | 4 | 0,654 | -253,33333 | 524,22429 | -1708,81331 | 1202,14664 |
| Proportion of households below or around social minimum | Equal variances not assumed | | | -0,483 | 3,539 | 0,657 | -253,33333 | 524,22429 | -1786,75755 | 1280,09088 |
| No. of cars (total) | Equal variances assumed | 3,226 | 0,147 | 0,800 | 4 | 0,469 | 0,13333 | 0,16667 | -0,32941 | 0,59607 |
| | Equal variances not assumed | | | 0,800 | 2,735 | 0,487 | 0,13333 | 0,16667 | -0,42734 | 0,69400 |

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, . $p < 0.1$.

Table E 2 *Independent samples t-test for control group (micro level)*

| | | <i>Levene's Test for Equality of Variances</i> | | <i>t-test for Equality of Means</i> | | | | | | |
|---|--------------------------------|--|-------------|-------------------------------------|-----------|-----------------------------|----------------------------|----------------------------------|--|------------|
| | | <i>F</i> | <i>Sig.</i> | <i>t</i> | <i>df</i> | <i>Sig. (2- tailed)</i> | <i>Mean Difference</i> | <i>Std. Error Difference</i> | <i>95% Confidence Interval of the Difference</i> | |
| No. of inhabitants Proportion age 25-45 | Equal variances assumed | 1,121 | 0,294 | -0,354 | 60 | 0,725 | -225,77083 | 637,90100 | -1501,76282 | 1050,22115 |
| | Equal variances not assumed | | | -0,356 | 59,701 | 0,723 | -225,77083 | 635,06605 | -1496,22278 | 1044,68112 |
| Population density No. of dwellings | Equal variances assumed | 0,335 | 0,565 | 3,045 | 59 | 0,003*** | 0,04877 | 0,01602 | 0,01672 | 0,08082 |
| | Equal variances not assumed | | | 3,06758,880 | | 0,003*** | 0,04877 | 0,01590 | 0,01695 | 0,08059 |
| Mean property value Proportion of owner- occupied dwellings | Equal variances assumed | 0,506 | 0,480 | -0,275 | 59 | 0,784 | -189,34946 | 688,12981 | -1566,29404 | 1187,59511 |
| | Equal variances not assumed | | | -0,27658,823 | | 0,784 | -189,34946 | 687,11918 | -1564,35858 | 1185,65965 |
| Proportion of rental dwellings (total) Proportion of cooperative- owned rental dwellings | Equal variances assumed | 0,522 | 0,473 | -0,312 | 60 | 0,756 | -84,58333 | 271,05443 | -626,77293 | 457,60626 |
| | Equal variances not assumed | | | -0,31359,933 | | 0,755 | -84,58333 | 270,17856 | -625,03327 | 455,86660 |
| Proportion of other-owned rental dwellings Proportion of housing built after 2000 | Equal variances assumed | 0,242 | 0,625 | 0,243 | 57 | 0,809 | 3,29178 | 13,52364 | -23,78884 | 30,37241 |
| | Equal variances not assumed | | | 0,24456,999 | | 0,808 | 3,29178 | 13,51658 | -23,77471 | 30,35828 |
| Mean income per inhabitant Proportion of households below or around social minimum | Equal variances assumed | 0,345 | 0,559 | -1,746 | 58 | 0,086. | -0,08501 | 0,04868 | -0,18246 | 0,01245 |
| | Equal variances not assumed | | | -1,75157,977 | | 0,085. | -0,08501 | 0,04854 | -0,18217 | 0,01216 |
| No. of cars (total) | Equal variances assumed | 0,404 | 0,528 | 1,725 | 58 | 0,090. | 0,08453 | 0,04899 | -0,01354 | 0,18259 |
| | Equal variances not assumed | | | 1,73157,946 | | 0,089. | 0,08453 | 0,04883 | -0,01321 | 0,18227 |
| No. of inhabitants Proportion age 25-45 | Equal variances assumed | 0,003 | 0,953 | 1,096 | 58 | 0,278 | 0,05671 | 0,05176 | -0,04691 | 0,16032 |
| | Equal variances not assumed | | | 1,09657,745 | | 0,278 | 0,05671 | 0,05176 | -0,04691 | 0,16033 |
| Population density No. of dwellings | Equal variances assumed | 0,019 | 0,892 | 2,327 | 58 | 0,023** | 0,02773 | 0,01191 | 0,00388 | 0,05158 |
| | Equal variances not assumed | | | 2,32857,786 | | 0,023** | 0,02773 | 0,01191 | 0,00389 | 0,05158 |
| Mean property value Proportion of owner- occupied dwellings | Equal variances assumed | 2,948 | 0,091. | -1,180 | 58 | 0,243 | -0,07491 | 0,06349 | -0,20199 | 0,05218 |
| | Equal variances not assumed | | | -1,19155,550 | | 0,239 | -0,07491 | 0,06290 | -0,20093 | 0,05112 |
| Proportion of rental dwellings (total) Proportion of cooperative- owned rental dwellings | Equal variances assumed | 0,151 | 0,699 | 0,006 | 47 | 0,995 | 0,00645 | 1,00969 | -2,02478 | 2,03768 |
| | Equal variances not assumed | | | 0,00641,342 | | 0,995 | 0,00645 | 1,00733 | -2,02738 | 2,04027 |
| Proportion of other-owned rental dwellings Proportion of housing built after 2000 | Equal variances assumed | 0,482 | 0,490 | -0,168 | 57 | 0,867 | -0,00171 | 0,01021 | -0,02216 | 0,01874 |
| | Equal variances not assumed | | | -0,16856,765 | | 0,867 | -0,00171 | 0,01020 | -0,02213 | 0,01871 |
| Mean income per inhabitant Proportion of households below or around social minimum | Equal variances assumed | 2,032 | 0,159 | -0,903 | 60 | 0,370 | -206,18750 | 228,28660 | -662,82869 | 250,45369 |
| | Equal variances not assumed | | | -0,91058,523 | | 0,367 | -206,18750 | 226,62359 | -659,73753 | 247,36253 |
| No. of cars (total) | Equal variances assumed | 0,001 | 0,972 | -1,465 | 57 | 0,148 | -0,06161 | 0,04206 | -0,14584 | 0,02262 |
| | Equal variances not assumed | | | -1,46856,457 | | 0,148 | -0,06161 | 0,04197 | -0,14566 | 0,02245 |

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, . $p < 0.1$.

Macro level Analysis

Table E 3 *Independent samples t-test for treated group (macro level)*

| | | <i>Levene's Test for Equality of Variances</i> | | <i>t-test for Equality of Means</i> | | | | | | |
|---|--------------------------------|--|-------------|-------------------------------------|-----------|-----------------------------|----------------------------|----------------------------------|--|------------|
| | | <i>F</i> | <i>Sig.</i> | <i>t</i> | <i>df</i> | <i>Sig. (2- tailed)</i> | <i>Mean Difference</i> | <i>Std. Error Difference</i> | <i>95% Confidence Interval of the Difference</i> | |
| No. of inhabitants Proportion age 25-45 | Equal variances assumed | 0,824 | 0,367 | -0,465 | 66 | 0,644 | -279,00000 | 600,45889 | -1477,85486 | 919,85486 |
| | Equal variances not assumed | | | -0,466 | 65,728 | 0,642 | -279,00000 | 598,24535 | -1473,52773 | 915,52773 |
| Population density No. of dwellings | Equal variances assumed | 0,971 | 0,328 | 2,658 | 65 | 0,010* | 0,04181 | 0,01573 | 0,01040 | 0,07322 |
| | Equal variances not assumed | | | 2,688 | 63,484 | 0,009** | 0,04181 | 0,01556 | 0,01073 | 0,07289 |
| Mean property value Proportion of owner- occupied dwellings | Equal variances assumed | 0,367 | 0,547 | -0,367 | 65 | 0,715 | -245,15775 | 668,65445 | -1580,55291 | 1090,23740 |
| | Equal variances not assumed | | | -0,367 | 64,914 | 0,715 | -245,15775 | 667,98039 | -1579,24004 | 1088,92454 |
| Proportion of rental dwellings (total) Proportion of cooperative- owned rental dwellings | Equal variances assumed | 0,448 | 0,505 | -0,468 | 66 | 0,641 | -119,35498 | 255,12897 | -628,73640 | 390,02644 |
| | Equal variances not assumed | | | -0,469 | 65,948 | 0,641 | -119,35498 | 254,46170 | -627,41167 | 388,70172 |
| Proportion of other-owned rental dwellings Proportion of housing built after 2000 | Equal variances assumed | 0,259 | 0,612 | 0,227 | 63 | 0,821 | 2,79625 | 12,30011 | -21,78356 | 27,37606 |
| | Equal variances not assumed | | | 0,227 | 63,000 | 0,821 | 2,79625 | 12,29393 | -21,77121 | 27,36371 |
| Mean income per inhabitant Proportion of households below or around social minimum No. of cars (total) | Equal variances assumed | 0,487 | 0,488 | -1,837 | 64 | 0,071. | -0,08342 | 0,04541 | -0,17414 | 0,00730 |
| | Equal variances not assumed | | | -1,843 | 63,920 | 0,070. | -0,08342 | 0,04527 | -0,17387 | 0,00703 |
| | Equal variances assumed | 0,585 | 0,447 | 1,806 | 64 | 0,076. | 0,08235 | 0,04561 | -0,00876 | 0,17347 |
| | Equal variances not assumed | | | 1,812 | 63,861 | 0,075. | 0,08235 | 0,04546 | -0,00846 | 0,17317 |
| No. of inhabitants Proportion age 25-45 | Equal variances assumed | 0,005 | 0,942 | 1,244 | 64 | 0,218 | 0,05982 | 0,04808 | -0,03624 | 0,15587 |
| | Equal variances not assumed | | | 1,244 | 63,773 | 0,218 | 0,05982 | 0,04808 | -0,03624 | 0,15587 |
| Population density No. of dwellings | Equal variances assumed | 0,265 | 0,609 | 1,812 | 64 | 0,075. | 0,02248 | 0,01241 | -0,00231 | 0,04727 |
| | Equal variances not assumed | | | 1,819 | 63,681 | 0,074. | 0,02248 | 0,01236 | -0,00221 | 0,04718 |
| Mean property value Proportion of owner- occupied dwellings | Equal variances assumed | 4,444 | 0,039* | -1,384 | 64 | 0,171 | -0,08153 | 0,05889 | -0,19917 | 0,03612 |
| | Equal variances not assumed | | | -1,398 | 60,281 | 0,167 | -0,08153 | 0,05833 | -0,19820 | 0,03515 |
| Proportion of rental dwellings (total) Proportion of cooperative- owned rental dwellings | Equal variances assumed | 0,603 | 0,441 | -0,319 | 52 | 0,751 | -0,29884 | 0,93586 | -2,17678 | 1,57909 |
| | Equal variances not assumed | | | -0,317 | 44,340 | 0,752 | -0,29884 | 0,94146 | -2,19583 | 1,59814 |
| Proportion of other-owned rental dwellings Proportion of housing built after 2000 | Equal variances assumed | 0,337 | 0,563 | -0,025 | 63 | 0,980 | -0,00023 | 0,00955 | -0,01931 | 0,01884 |
| | Equal variances not assumed | | | -0,025 | 62,788 | 0,980 | -0,00023 | 0,00953 | -0,01929 | 0,01882 |
| Mean income per inhabitant Proportion of households below or around social minimum No. of cars (total) | Equal variances assumed | 1,934 | 0,169 | -0,990 | 66 | 0,326 | -213,61472 | 215,84326 | -644,55970 | 217,33026 |
| | Equal variances not assumed | | | -0,996 | 64,410 | 0,323 | -213,61472 | 214,45874 | -641,99272 | 214,76329 |
| | Equal variances assumed | 0,095 | 0,759 | -1,068 | 63 | 0,290 | -0,04375 | 0,04098 | -0,12564 | 0,03814 |
| | Equal variances not assumed | | | -1,069 | 62,862 | 0,289 | -0,04375 | 0,04093 | -0,12554 | 0,03804 |

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, . $p < 0.1$.

Table E 4 *Independent samples t-test for control group (macro level)*

| | | <i>Levene's Test for Equality of Variances</i> | | | <i>t-test for Equality of Means</i> | | | | | |
|---|--------------------------------|--|-------------|----------|-------------------------------------|-----------------------------|----------------------------|----------------------------------|--|------------|
| | | <i>F</i> | <i>Sig.</i> | <i>t</i> | <i>df</i> | <i>Sig. (2- tailed)</i> | <i>Mean Difference</i> | <i>Std. Error Difference</i> | <i>95% Confidence Interval of the Difference</i> | |
| No. of inhabitants Proportion age 25-45 | Equal variances assumed | 7,102 | 0,008** | 1,783 | 184 | 0,076. | 596,11111 | 334,29476 | -63,43257 | 1255,65479 |
| | Equal variances not assumed | | | 1,743 | 155,232 | 0,083. | 596,11111 | 341,92922 | -79,32353 | 1271,54576 |
| Population density No. of dwellings | Equal variances assumed | 0,015 | 0,903 | 0,606 | 184 | 0,545 | 0,00932 | 0,01537 | -0,02101 | 0,03966 |
| | Equal variances not assumed | | | 0,609 | 174,395 | 0,544 | 0,00932 | 0,01532 | -0,02091 | 0,03956 |
| Mean property value Proportion of owner- occupied dwellings | Equal variances assumed | 0,041 | 0,840 | -1,661 | 182 | 0,098. | -601,49327 | 362,11991 | -1315,98631 | 112,99977 |
| | Equal variances not assumed | | | -1,683 | 177,131 | 0,094. | -601,49327 | 357,47780 | -1306,95681 | 103,97027 |
| Proportion of rental dwellings (total) Proportion of cooperative- owned rental dwellings | Equal variances assumed | 9,244 | 0,003** | 1,579 | 184 | 0,116 | 215,60882 | 136,58925 | -53,87364 | 485,09128 |
| | Equal variances not assumed | | | 1,536 | 151,278 | 0,127 | 215,60882 | 140,37472 | -61,73928 | 492,95692 |
| Proportion of other-owned rental dwellings Proportion of housing built after 2000 | Equal variances assumed | 2,432 | 0,121 | -0,081 | 171 | 0,935 | -1,27543 | 15,66366 | -32,19445 | 29,64360 |
| | Equal variances not assumed | | | -0,085 | 170,969 | 0,933 | -1,27543 | 15,05572 | -30,99446 | 28,44360 |
| Mean income per inhabitant Proportion of households below or around social minimum | Equal variances assumed | 2,190 | 0,141 | 0,403 | 176 | 0,688 | 0,01190 | 0,02956 | -0,04643 | 0,07023 |
| | Equal variances not assumed | | | 0,411 | 172,100 | 0,681 | 0,01190 | 0,02893 | -0,04521 | 0,06901 |
| No. of cars (total) | Equal variances assumed | 2,899 | 0,090. | -0,800 | 176 | 0,425 | -0,02358 | 0,02950 | -0,08180 | 0,03463 |
| | Equal variances not assumed | | | -0,818 | 172,722 | 0,414 | -0,02358 | 0,02882 | -0,08047 | 0,03331 |
| No. of inhabitants Proportion age 25-45 | Equal variances assumed | 0,111 | 0,739 | 0,176 | 176 | 0,860 | 0,00512 | 0,02902 | -0,05216 | 0,06239 |
| | Equal variances not assumed | | | 0,178 | 167,685 | 0,859 | 0,00512 | 0,02870 | -0,05155 | 0,06178 |
| Population density No. of dwellings | Equal variances assumed | 4,077 | 0,045* | -1,320 | 176 | 0,188 | -0,02788 | 0,02112 | -0,06956 | 0,01380 |
| | Equal variances not assumed | | | -1,392 | 174,908 | 0,166 | -0,02788 | 0,02003 | -0,06742 | 0,01165 |
| Mean property value Proportion of owner- occupied dwellings | Equal variances assumed | 1,589 | 0,209 | -0,974 | 176 | 0,332 | -0,04331 | 0,04448 | -0,13110 | 0,04448 |
| | Equal variances not assumed | | | -0,984 | 167,632 | 0,326 | -0,04331 | 0,04400 | -0,13019 | 0,04356 |
| Proportion of rental dwellings (total) Proportion of cooperative- owned rental dwellings | Equal variances assumed | 0,677 | 0,412 | -1,133 | 121 | 0,260 | -1,07067 | 0,94512 | -2,94178 | 0,80043 |
| | Equal variances not assumed | | | -1,144 | 103,454 | 0,255 | -1,07067 | 0,93619 | -2,92729 | 0,78594 |
| Proportion of other-owned rental dwellings Proportion of housing built after 2000 | Equal variances assumed | 3,356 | 0,069. | 2,468 | 172 | 0,015* | 1,33838 | 0,54237 | 0,26783 | 2,40893 |
| | Equal variances not assumed | | | 2,284 | 105,785 | 0,024* | 1,33838 | 0,58591 | 0,17674 | 2,50003 |
| Mean income per inhabitant Proportion of households below or around social minimum | Equal variances assumed | 2,692 | 0,103 | 1,390 | 184 | 0,166 | 204,73545 | 147,25099 | -85,78199 | 495,25289 |
| | Equal variances not assumed | | | 1,380 | 167,026 | 0,169 | 204,73545 | 148,36293 | -88,17284 | 497,64374 |
| No. of cars (total) | Equal variances assumed | 0,100 | 0,753 | 0,138 | 171 | 0,890 | 0,00588 | 0,04259 | -0,07818 | 0,08994 |
| | Equal variances not assumed | | | 0,137 | 152,292 | 0,892 | 0,00588 | 0,04306 | -0,07919 | 0,09094 |

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, . $p < 0.1$.



Gedempte Gracht and Zaandam Station (Provincie Noord-Holland, 2019)