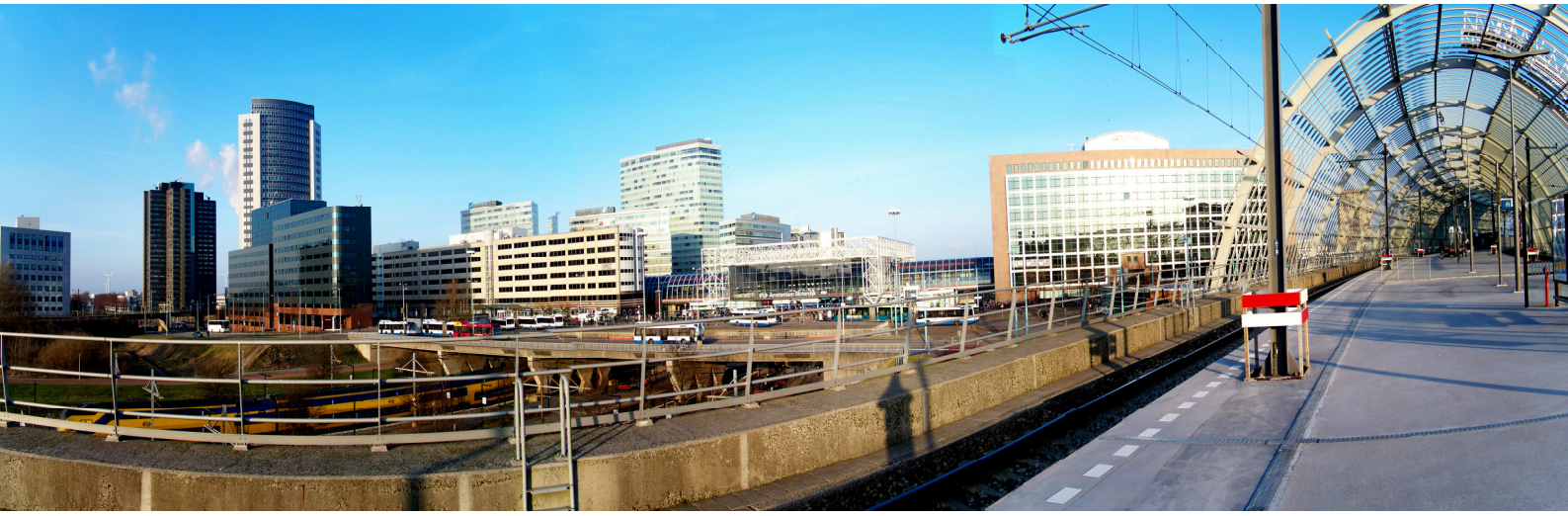


Added value of railway station areas explored

Jordy Rond

April 2011

TU Delft
Delft University of Technology

Wij brengen stationsgebieden tot leven

Colophon

Personalia

Name : Jordy Rond
Email : jordyrond@gmail.com
Date of Birth : 15/10/1982

Educational Information

University : Delft University of Technology
Faculty : Faculty of Architecture
Mastertrack : Real Estate and Housing
MSc laboratory : Real Estate Management
Student no. : 1182773

Lab coordinator : dr. ir. D.J.M. van der Voordt
Mentor REM : dr. ir. A.C. den Heijer
Mentor REM : drs. P.W. Koppels PhD
Ext. Committee : ir. R.P. Geraedts

Company : NS Poort, Utrecht
Department : Asset Development
Mentor NS Poort : dr. ir. drs. Th. S. de Wilde
Mentor NS Poort : ir. drs. J.P.A. van den Heuvel MBA

Research Question

"To what extent does real estate development in station areas generate added value for Nederlandse Spoorwegen?"

Keywords

Real estate, station area, spatial interventions, centrality, transfer quality, spatial quality inetnsity

COLOPHON

Station Delft cuurent situation (Source; Flickr)

"Added value of railway station areas explored."
J.C. Rond April 2011

New station Delft
(Source; NS Poort)

Preface

"The train takes you from an inconvenient point of origin to an inconvenient destination." A friend recently reminded me of my own argument for not using the train upon hearing that I decided to conduct my thesis research at NS Poort. It shows that I'm not exactly biased towards the use of public transport. The goal of this research is however to aid in solving half of this problem, by letting the train take you to a place where you need and want to be.

The last phase of master-track real estate and housing at the faculty of architecture, Delft University of Technology is concluded by an eleven month research project. The report lying before you is the result of this research project. The master thesis program is divided into five periods each concluded by an assessment, P1 to P5. This report, accompanied by a presentation shows the results of my research for the final assessment; P5. This report and accompanying presentation will be publicly accessible through the repository of the Delft University of Technology.

I would like to thank my two mentors from the Faculty of Architecture Alexandra den Heijer and Philip Koppels for their professional and scientific guidance and my two mentors from NS Poort. Sebastiaan de Wilde and Jeroen van den Heuvel for their practical guidance, sharing of incredible expertise and lots and lots of data. Furthermore I would like to thank Peter Mulder for providing me with the opportunity to conduct my research at NS Poort and offering me an insight into the day to day operations of the company. Finally I would like to thank my friends, family and last but certainly not least my significant other for their continued support.

Jordy Rond,
Amsterdam, April 2011

PREFACE

ABSTRACT

"Added value of railway station areas explored."
J.C. Rond April 2011

Public transport terminal Breda
(Source; ProRail

Abstract

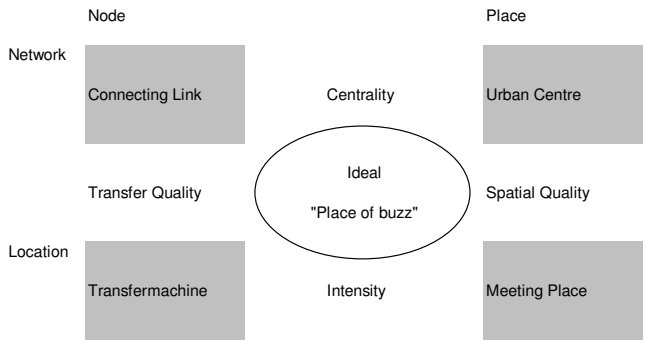
Future demand for transportation in the Randstad will increase, in order to let the infrastructure cope with additional demand, the national government wants to encourage the use of rail transport. This is reflected in the national planning policy whereby station areas have become focal point for the development of additional housing, offices and leisure functions within the existing city limits as well as redevelopment of large stations into multi modal terminals. Redevelopment of station areas provides opportunities for NS by enhancing synergy between the urban area and NS' core business.

The goal of this master thesis is to establish the effects of the attributes of a stations environment on its performance and what steps need to be taken in order to enhance performance by improving the stations surroundings. This has lead to the following research question;

"To what extent does real estate development in station areas generate added value for Nederlandse Spoorwegen?"

In order to answer the research question the aspects of both the station area and added value have to established. The aspects of the station area are taken from Peek's dissertation on synergy in the station area. Aspects of added value are established through the key performance indicators NS uses for its stations.

Synergy in station areas



Peek distinguishes four separate meta-values of the station that are able to create synergy between two aspects of the station, as this is a crucial element of the research a short description is in order.

Centrality describes the relationship between the station as a connecting link within the network and an urban centre within the city. Centrality thus may be seen as providing access to activities and population in its vicinity and to activities and population elsewhere in the network.

Transfer quality describes the relationship between the station as a connecting link within the network and as a location that enables the transfer between modalities. Transfer quality thus can be seen as the way a station is able to provide an inter-modal transfer from the city to the network and vice versa as well as the transfer within the network.

Spatial quality describes the relationship between the urban centre and a meeting place whereby quality is to provide an pleasant urban experience and avoid mono functionality.

Intensity describes the relationship between transfer machine and meeting place. Whereby the intensity of functions in the urban fabric provides a pleasant transfer to and from the stations as well as avoiding mono functionality in the stations environment. Intensity thus provides freedom of choice between activities in the station area and the ease of access to those activities.

Peek has developed three strategies that enables one to improve the four meta-values; Accelerate, adding density and adding quality. Acceleration refers to speeding up the entire transport sequence, adding density removes the need for pre- and post-transport and thus enhance micro accessibility. Finally adding quality refers to making the entire transport sequence more pleasant.

After establishing the expected sources of added value it is time to operationalize added value itself this is done by using the key performance indicators NS uses to measure the performance of its stations; real estate value, the number of passengers, retail turnover and customer satisfaction.

Real estate value is determined by the rent a tenant is willing to pay for using the object, added value thus lies in an increase in rent levels. Added value relating to the number of passengers a station hosts is expressed as additional passengers generated through the stations surroundings. Retail turnover is expressed as the amount a passenger spends at a station added value thus lies in additional spending per passenger. Increased customer satisfaction generated through the stations surroundings is the final KPI.

Literature Review

The next step is to examine current literature and establish expected relationships between each meta-value and each KPI. I will briefly describe the results obtained from a literature review.

Real estate value is positively influenced by centrality. A 4-7,5% increase has been found when located in the vicinity of a railway station. It shows a distance decay relationship. (Debrezion 2006, De Graaff et. al. 2007, Kuenen 2008) Transfer quality is shown to have a positive influence on the value of office space especially at those locations where two or more modalities interchange (De Graaff et al. 2007, Kusumo 2007). A "substantial" increase in spatial quality leads to a 2-10% rise in the value of dwellings and 5% in the case of office buildings (CPB 2009, DTZ 2006). Prices of offices and dwellings show a 5-10% increase in value caused by a substantial improvement in intensity (BCI 2010)

The number of passengers generated is positively influenced by the centrality of a station (NS prediction model). A substantial increase in transfer quality may yield an additional 25-30% more passengers (De Graaff et. al. 2007). Additional intensity is expected to generate additional passengers (NS prediction model).

No literature could be retrieved dealing with the relationship between passenger spending and the four meta-values. It is *expected* that centrality will lead to additional turnover as more people who aren't NS passengers visit the station. Transfer quality is *assumed* to have a positive relationship as an efficient transfer will prolong the time in which a passenger can be "captured".

Customer satisfaction is positively influenced by an increased transfer quality as this is the weakest link in the transport sequence where perceived time is longest, three times in comparison to the actual train journey (Wardman 2001, 2004). Safety, cleanliness, overview and the availability of information are the most important elements of spatial quality to NS (NS Poort 2009). Intensity has a positive effect on those who make use of the train, this group tends to want to live and work in the vicinity of a station (NS Poort 2009)

The literature review has led to a number of elements that describe each of the four concepts.

Centrality describes the stations ability to provide access to and from activities within the city (micro) and access to activities elsewhere in the network (macro).

This can be established by determining the number of jobs and people that are situated within a 30 and 60 minute radius from the station.

Transfer Quality described the ability of the station to provide an inter-modal transfer (network <-> city) and inter train transfers (network <-> network).

Transfer quality can be described by the existing Rail-Station Quality Index (RSQI) along with the number of BTM lines available at the station and the population within a 15 minute radius.

Spatial Quality describes the ability of the station to provide a comfortable, safe and pleasant public space in the station area, location and complex.

The quality of the public space will be defined by the "leefbaarometer" a nationwide spatial quality index from the ministry of infrastructure and the environment.

Intensity describes the ability to provide a diverse range of activities and functions in the vicinity of the station.

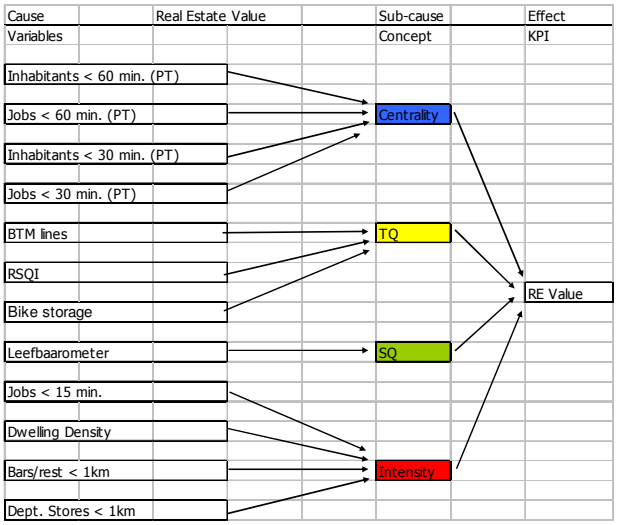
Intensity will be described based on activities; living through the number of dwellings jobs in a 15 minute radius and leisure by the number of cafés and restaurants and the number of department stores.

Test-cases

The next step is to examine a "best" and "worst" performer on each of the four key performance indicators. The goal is twofold; 1, to establish what element of the station area (centrality, transfer quality, spatial quality and intensity) is a cause for this over or under performance. 2, which aspects of each meta-value established following literature review are able to describe the relationship and serve as explanation in the generalization phase.

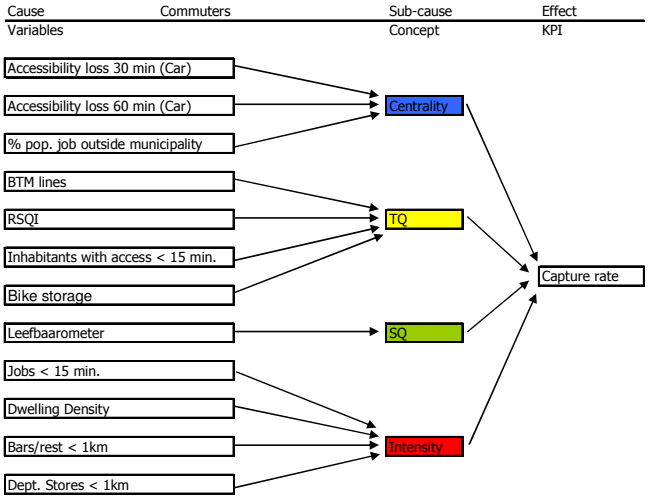
Real estate value

In the case of real estate value 's-Hertogenbosch and Leiden are compared. The goal is to establish the aspects that cause the difference in relative value between the two stations. In other words; why are tenants at 's-Hertogenbosch willing to pay 19% more compared to the city average and tenants in Leiden only willing to pay 8% less in comparison to the city average? An overview of the variables that establish this relationship is shown in the table below.



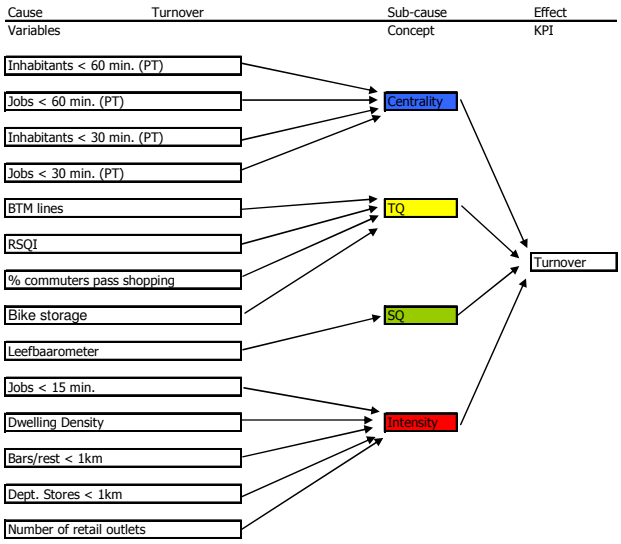
Number of passengers

To establish the effects of the four meta-values on the number of passengers a station hosts some adjustments have to be made. The production of passengers is described as the "capture rate", the percentage of possible that actually use the station. Almere has shown the highest capture rate whilst Eindhoven attracts the least possible NS customers. An overview of the variables that establish this relationship is shown in the table below.



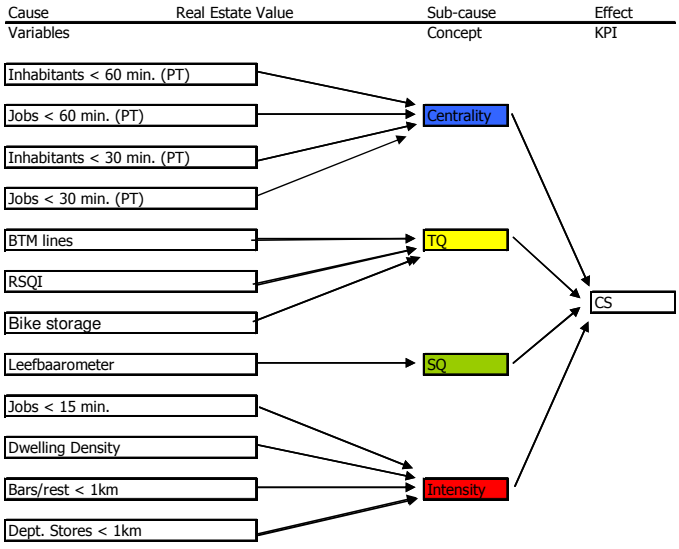
Retail Turnover

Breda is the station where retail turnover is highest, both per passenger and per square meter retail surface. Den Haag HS on the other hand boasts the lowest income per passenger. What causes this difference in turnover? The variables that explain this relationship are presented in the table below.



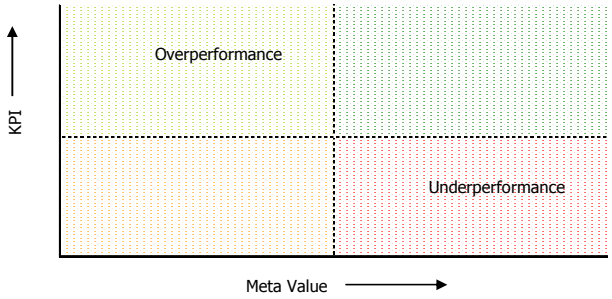
Customer Satisfaction

What is Haarlem able to offer in terms of commuter experience that Tilburg doesn't? In order to answer this question the two stations are compared according to Peek's four meta-values this has resulted in the following relationships:



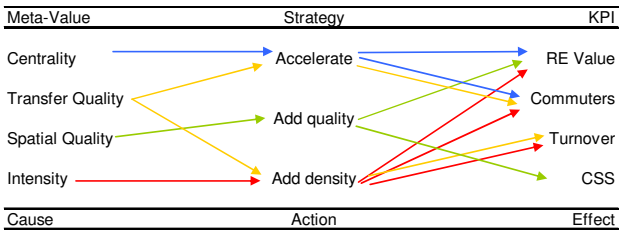
Generalization

In the generalization phase the goal is to establish generic relationships between the four meta-values and the four KPIs. In order to do this the elements established in the test cases are plotted against the four KPIs. The elements and KPIs are indexed whereby either the average or mode equals 100. This will then describe performance relative to the average, denoted by a dotted cross, and identify underperforming stations where action has to be taken in order to improve performance. A correlation coefficient R^2 shows the validity of the relationship.

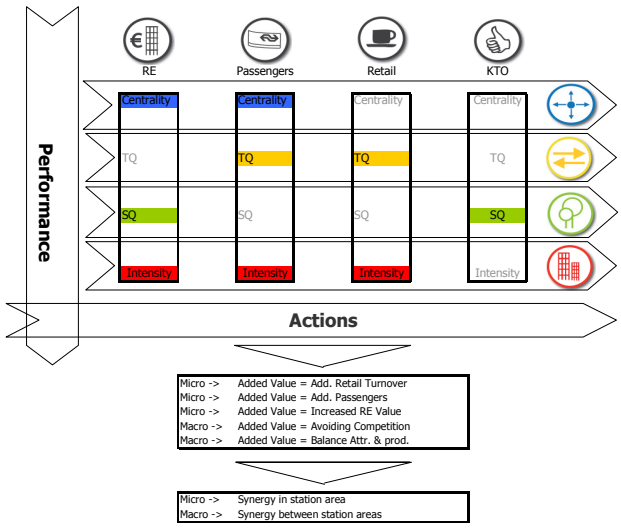


Conclusions

Conclusions are divided into two levels micro and macro. Micro relates effect of the four meta-values on single station, macro relates to the effects of the four meta-values on the performance of the station within the network.



Centrality positively influences both real estate value (micro) and the number of passengers generated. Transfer quality positively influences the number of passengers generated and retail turnover. Spatial quality has a positive influence on both the value of real estate and level of customer satisfaction. Finally, intensity of a mixed program shows a positive influence on the value of real estate, passenger production and retail turnover.



Increased centrality through acceleration will lead to additional value of existing real estate and more passengers. As mentioned before NS Poort does not control the train services NS provides. It might however be relevant to conduct further research on the phenomenon especially when keeping in mind the new high speed connection that

links Amsterdam, Schiphol and Rotterdam to Brussels and Paris.

Enhancing transfer quality will lead to additional and additional retail turnover. This indicates antagonistic effects of the "transfer machine" on one hand and a "shopping centre" on the other are not mutually exclusive in fact they tend to amplify each other; if the ease of transfer is improved within the station (area) a passenger will spend more "free" time within the station complex, increasing the period in which he or she can be "captured" by retail outlets.

Increased spatial quality leads to increased value of commercial real estate and increased customer satisfaction. This has an important implication as investments in the public space benefits two parties; the municipality and NS. The municipality will receive a higher price for land and increased real estate tax (OZB) NS on the other hand will see an increase in customer satisfaction.

Additional program in the station area generates additional revenue at two levels. First of all rent or the selling price which can be captured directly. Indirectly, additional leisure and retail functions will lead to an increase in the value of existing (office) real estate, additional attraction of passengers and additional retail turnover. Adding dwellings on the other hand will lead to additional production of passengers.

Recommendations

In the past NS Poort has focussed too much on the development and exploitation of retail at its railway stations and in the process focussing too little on the other elements that enable the passenger to experience a safe, comfortable and efficient journey. Today the focus is shifting towards both the quality of the services provided in and around the station complex and the amenities that are able to facilitate the entire transport sequence.

A focus on quality

Increased spatial quality leads to increased value of commercial real estate and increased customer satisfaction. NS Poort thus should not only improve the quality of the station complex but also focus on the quality of its surroundings and thereby preventing the creation of an "oasis in the desert". This has an important implication since investments in the public space benefits three parties; the municipality, real estate owners and NS. The municipality will receive a higher price for land and increased real estate tax, the real estate owners will an increase in rent and NS will see an increase in customer satisfaction. As three parties benefit it does not seem unreasonable that all benefactors share the costs of improving the quality of the public space that surrounds NS' stations. Station specific information that includes the actors in the station area, costs of improving quality and division of benefits therefore should be included in the analysis, strategy and business-case for each station

A focus on transfer

An increase in transfer quality not only increases the number of people that use the station but also the amount they spend at the station. Speeding up the trip to and from the station will generate additional passengers for NS. Speeding up this post- and pre-transport can be accomplished through the provision of adequate bike storage facilities, dedicated bike lanes and efficient BTM services. In the station area thus more focus has to be on providing these transfer facilities. This does not necessarily have to mean that transfer facilities and real estate development are mutually exclusive since they occupy the same valuable space, it does imply that in order to facilitate both innovative architectural are needed.

Improving transfer quality will also yield additional retail turnover. On one hand by providing time to NS passengers on the other hand by an internal efficient routing within the station complex whereby the bulk of the passengers pass by the retail outlets. This will aid in the convenience to acquire goods and services. In future redevelopments thus, the goal should be to concentrate passengers and retail in the same central space. Those stations that form a barrier in the urban fabric have additional potential of increased retail turnover if the station is able to provide an attractive route in traversing it.

Improvements in transfer quality will require additional investments in the station area. Due to the generic nature of this thesis it is at this time impossible to determine whether the additional revenues are able to cover the costs. This however can be determined in a station specific business-case. I therefore feel valuable knowledge will be developed when a specific cost and benefit analysis of transfer quality and transport sequence improvements is conducted.

Further research

Geographical influences on and within the station area cause every station to be unique. The results from this master thesis are therefore to be considered as generic. The performance graphs and relationships provide insight into the direction in which solutions to enhance performance should be sought. A prolonged measurement over several years of meta-values and KPIs will provide a more detailed insight into the creation of added value. I therefore recommend to set up an ongoing measurement of at least six stations; two of each type. The stations which are currently being redeveloped, the NSPs provide an opportunity to conduct a "before and after" analysis of performance that will provide a more in depth analysis of the influence a stations environment has on its performance.

Due to lack of reliable data this thesis only deals with a stations production in the form of its capture rate. It would be valuable to know not only where produced passengers come from but also where they are going, since this is where the motive to travel lies in the first place. Further improvements on post-transport can then be made. Identifying the needs of arriving and departing will enable NS Poort to target those groups specifically, not only in terms of pre- and post-transport but also on the supply of goods and services at each station and thus increase revenue as more services and goods are provided that match the specific demands of both groups.

Reading Guide

This master thesis can be divided into of four different parts;

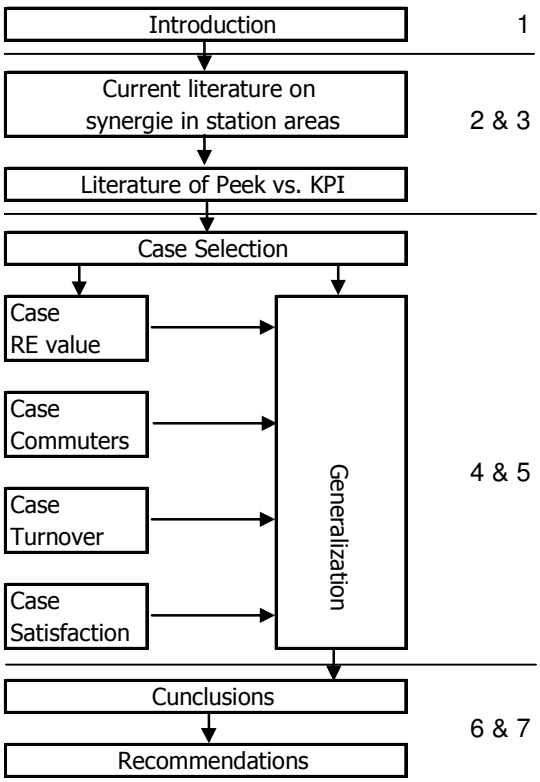
1. Introduction
2. Theory
3. Research
4. Conclusions

An introduction into the subject is given in the first chapter. The problem field, objective, research set up and methodology are elaborated on.

The second part, theory, consists of two chapters; 2&3. Chapter two deals with the definition of the station area and the theory on synergy in station areas in combination with NS Poort real estate strategy. Chapter three consists of a literature review that examines the relationships between the four meat-values (centrality, transfer quality, spatial quality and intensity) and the four key performance indicators (real estate value, number of passengers, retail turnover and customer satisfaction.

The third part, research is comprised of two chapter, 4 and 5. In it four test cases are conducted in order to test elements found in the literature review. The findings are then generalized in chapter 5.

Conclusion are presented in chapter 6, it is the answer to the research question posed in the first chapter. Chapter 7, lastly deals with recommendations on future developments.



"Added value of railway station areas explored."
J.C. Rond April 2011

Public Transport Terminal Arnhem
(Source; ProRail)

Contents

1 RESEARCH OUTLINE

Public Transport Terminal Den Haag Centraal
(Source; NS Poort)

1 Research Outline

1.1 Introduction

"*Since value depends on economic rent, and rent on location, and location on convenience, and convenience on nearness, we may eliminate the intermediate steps and say that value depends on nearness.*"
(Hurd, 1903)

In the not so distant future a growing population and population density (RPB/CBS, 2007) will lead to a growing demand for mobility in both public transport and automobile transport in the Randstad (CPB, 2006). In order to accommodate this growth political parties want to encourage the use of rail transport within the Randstad (VVD 2010) by increasing rail capacity in the Randstad and intensify the built environment surrounding railway stations.

This future growth contains opportunities for the Nederlandse Spoorwegen in the form of synergy between the urban area surrounding the station and NS' core business. The question remains how the growth of railway use can be stimulated and how to benefit optimally from this growth.

This research will explore ways in which the Nederlandse Spoorwegen can provide incentives to promote and benefit from this growth through aligning its real estate development goals with its core business and thus exploit a additional streams of revenue. And at the same time integrate the station with the urban fabric to let it become a place to stay as well as a node in the transport network.

In order to accomplish this Gert-Joost Peek's theoretical model of synergy in station areas will be operationalized in an effort to measure the effects the urban fabric has on the performance of a station and identify how to improve performance by spatial interventions.

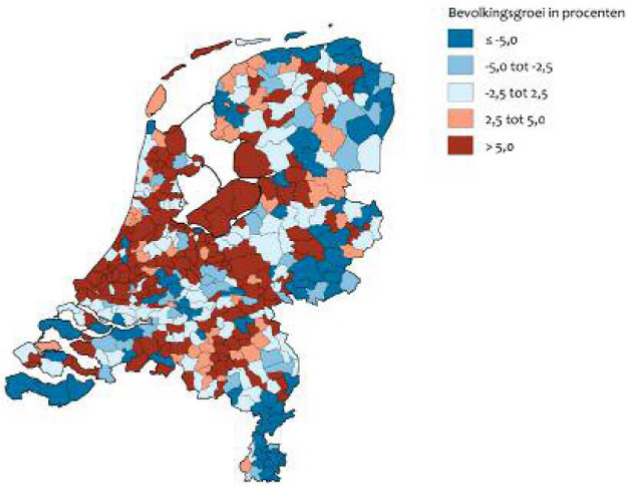


Figure 1-1; Population growth per municipality 2008 – 2040, Note the high growth in the Randstad (Source: PBL/CBS 2008)

Nederlandse Spoorwegen

Nederlandse Spoorwegen N.V. (hereafter NS). Literally the Dutch Railways plc., is the principal passenger railway operating company in the Netherlands and carries over one million passengers every day. The former sate run enterprise was privatized in 1995, the national government, more specific the ministry of finance still is NS' sole shareholder. In 2002 ownership of rail infrastructure was split off from NS and transferred back to the national government and is today managed by ProRail a state run enterprise.

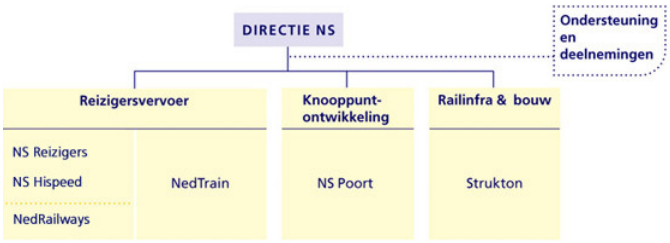


Figure 1-2; organigram of NS

As shown in figure 1 NS is made up of three main branches, Reizigersvervoer, in which NS Reizigers (NSR) deals with day to day operation of the passenger service. NS Hispeed, which runs the high speed rail services, Nedrailways which runs the overseas operations of the NS and finally NedTrain which performs maintenance on rolling stock.

Second is knooppuntontwikkeling (development of transportation hubs) carried out by NS Poort, the real estate branch of NS on which this research will focus.

And third railinfra & construction, carried out by Strukton a construction company that was until recently fully owned by NS.

NS Poort

As mentioned above NS Poort is the real estate company of NS and operates 381 stations in the Netherlands. Furthermore NS Poort controls all real estate and land owned by NS some 3500 ha. Ownership of stations and land positions was handed over to NS upon privatization in 1995, the governments idea in handing over these assets was that operating the passenger services would never become economically viable and that the operational deficit could be funded by income from real estate development.

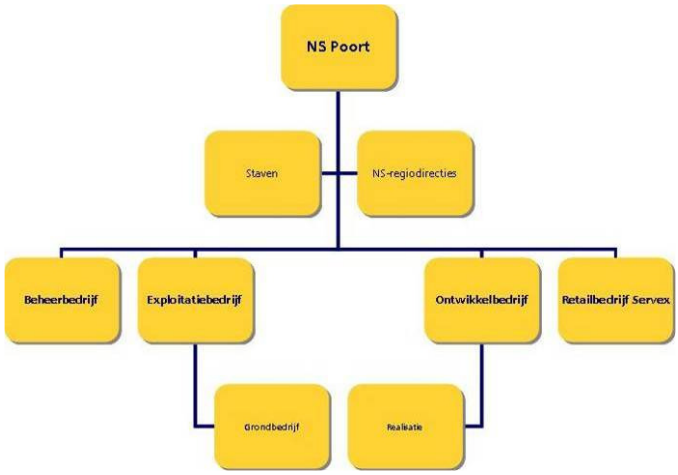


Figure 1-3; Organigram of NS Poort

Currently NS Poort is made up out of four main branches
1. Beheerbedrijf which is the operational manager of NS Poort and operates the stations in the Netherlands.
2. Exploitatiebedrijf which is the asset and investment management branch, the land issuing company is part of the Exploitatiebedrijf.
3. Ontwikkelingsbedrijf, which focuses on development of real estate surrounding NS stations
4. Retailbedrijf Servex operates all retail activities on and surrounding the stations through a number of formulae (AH to GO, Starbucks etc.) all employees in these shops work directly for Servex.

"We want to develop, operate and manage stations and there surrounding areas in order to create a pleasant, vibrant and sustainable place to stay, work and live in such a way that our customers want to use our services and businesses are drawn to our stations." (Mission statement NS Poort)

The goal of NS which lies behind this statement is to 1. Increase use and capacity utilization of the trains which will lead to higher number of sold tickets, the NS core business. And 2. Increase the number of people and time spent by people on NS stations in order to raise sales through its Servex retail outlets.

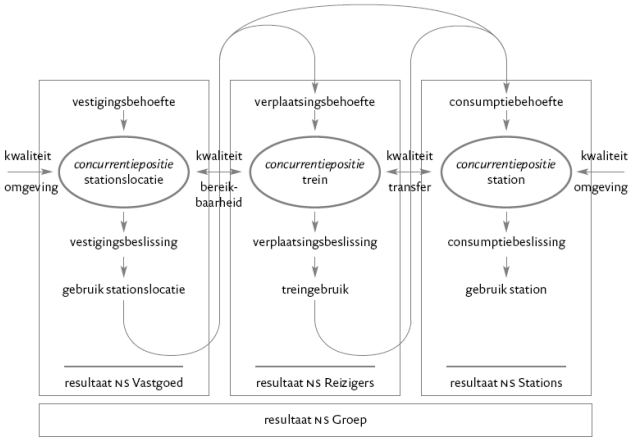


Figure 1-4; Synergy model of NS Group (adapted from Peek, 1999)

Both of these goals can be described as direct value capturing and contribute directly to the net profit of the organization. However within this organizational structure there are opportunities in which NS can utilize indirect value capturing and supplement its revenue stream. Since NS Poort is owner as well as operator of the retail outlets, the rent of these shops are thus unlikely to rise when the turnover and profit of its operator rise due to higher sales which in turn is caused by a larger number of passers by. However this illustrates the way in which this company can induce a cyclical process of value creation by itself which is illustrated in Figure 1-4.

In order to achieve this the goals of real estate development should be aligned with the core business of NS which is passenger rail transport, and thus real estate development should be focussed on increasing ticket sales and optimize capacity utilization of NS' rolling stock.

Figure 1-5; Passengers journey and the role NS subsidiaries play in it.

1.2 Problem Statement and Research Question

A growing body of knowledge deals with ways to capture future value, a gap in knowledge however exists in ways add value to infrastructure hubs and how to maximize this added value. Peek has laid the groundwork in his dissertation on location synergy, in which a model is presented that represents an ideal station area comprised of the relationship between four meta-values. This theoretical model however, is not operationalized and thus the connection between the meta-values, strategies and performance are left open to interpretation.

NS has defined the station area, through this definition the combined area of all station areas is approximately 3500 ha. Of this total 16% is owned by NS or around 470 ha. (Kuenen, 2008). NS aims for influence in the station areas in order to create synergy between the area and its core business which is operating trains. In order to have influence in the station area a position in the form of ownership is required, this is not case in all areas. If more influence is required investments are needed.

Influence in a station area will result in developing functions in the area either by NS Poort or third parties. A position also enables NS to steer what functions are developed in the area by other parties as well as influence on the quality of the station area. Keeping in mind the goal of influence in the station area which is adding value to NS' core business and the profitability of the NS group it would, among others, be valuable to know what functions generate passengers and what functions generate retail turnover. In other words insight in the possibilities of synergy in station areas This leads us to the main research question;

"To what extent does real estate development in station areas generate added value for Nederlandse Spoorwegen?"

In order to answer this question a number of sub questions will have to be answered. These will categorized according to the three most important terms in the main research question; "real estate", "station areas" and "added value".

Real Estate

- What is the definition of real estate applicable to this research?
- What functions in the station area generate an additional flow of passengers?
- What functions in the station area generate a higher retail turnover at the station retail outlets?
- What functions surrounding the station improve the quality and image of the station area?

Station Area

- What is the definition of the station area?
- What are the current views of experts on synergy in station areas?
- What is the current strategy of NS Poort concerning station areas?

Added Value

- What is the definition of added value?
- What is the influence of a station on the value of office space in the station area?
- What is the influence of a station on the value of dwellings in the station area?
- What is the influence of a station on the value of retail space in the station area?
- What tools does NS posses in order to capture added value?

1.3 **Clarification of terms**

In this section I will clarify the three important terms used in the main research question and the way they are applicable in the course of this research.

Real Estate

In the course of this research real estate refers to the built environment in the station area. Which along with the actual station complex and surrounding square facilitating transport sequence amenities (Dutch: ketenvoorzieningen) is made up of structures that contain offices, dwellings, retail and leisure functions. And lastly the public space in between the structures situated in the station area.

Station Area

The station area refers to the urban area surrounding the station complex. An exact definition of the station area will be provided in chapter 2 "The Station Area"

Added Value

NS possesses three ways to capture value directly within the station area. These revenues are the main income for NS;

1. Sale of tickets.
2. Sale of goods in retail outlets.
3. Rent generated from ownership of real estate.

More income is generated when revenues from these three main sources increases through 1. a higher number of , 2. higher turnover in retail outlets and 3. higher rent levels. Added value thus lies in the synergy between real estate programme surrounding NS stations, retail at these stations and NS' core business, passenger rail transport. A review of NS' 2009 financial statement shows that the average income generated from one commuter is +/- €4,50 from ticket sales and +/- €0,90 from retail turnover. Real estate development thus, in theory can add €5.40 per extra commuter per day to NS' total income.

A fourth non financial "value" is just or even more important as the ones mentioned above; customer satisfaction. Higher quality of services and surroundings are expected to increase all three values therefore customer satisfaction is considered to be an extra value generating element which is an integral part of the three aforementioned values.

1.4 **Aim of the research**

The goal of this research is to gain understanding in the relationship between the urban fabric surrounding NS stations and the performance of these station in terms of generated revenues and customer satisfaction. More specifically the effect interventions in the urban fabric have on the performance of a station. Insight in this relationship is valuable for the applicability of the NS Poort strategy concerning station areas and specifying this strategy for each station separately.

1.5 **Products**

The findings of this research will be documented in a master thesis report that explains the relationship between meta-values and key performance indicators. An overview of station performance will provided in combination with its meta-values. The relationships between those two elements will enable the formulation of actions to specifically target each performance indicator.

1.6 **Relevance**

Theoretical Relevance

The main question revolves around adding value to NS' core business, the theoretical relevance lies within this question. It will provide insight into the factors that generate value around transport hubs and how they should be utilized in doing so. The body of knowledge on the relationship between transport hubs and real estate value will be expanded and the knowledge that Peek created in specific

will be refined and expanded by transforming Peek's four meta-values centrality, transfer quality, spatial quality and intensity into operationalized concepts.

Practical Relevance

This thesis on the performance of station areas in relation to their surroundings will provide generic knowledge on these relationships. The knowledge gained about the relationships between transport hubs and its surrounding area is aimed to benefit the NS Poort Asset Development research program depicted in the table below.

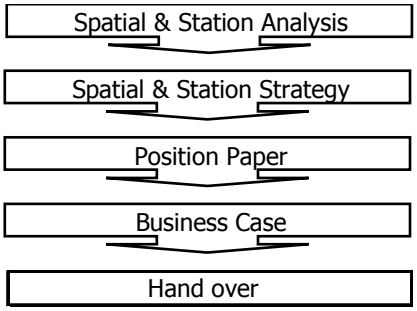


Table 1-1; Simplified overview of NS Poort Asset Development research program

The collected data on station performance and composition of the urban fabric may be considered as input in the first phase; analysis of the urban fabric and station complex. It identifies station performance relative to the average and thus identifies areas in which performance can or has to be improved and thereby answer the question; what do I want?

The generalized findings are input for the second step; spatial and station strategy as it gives an indication on how to improve a stations performance by altering the urban fabric it is situated in. In other words it aids in answering the question; how do I get there?

1.7 **Research Outline**

In this section the research outline is described by organizing the sub questions mentioned in section 1.2 in a logical manner.

The first step is to define the station area from both literature and NS' own description this serves as a physical demarcation of the research. After the station area is defined a brief summary on current views on synergy in station locations is given followed by a description of NS Poorts current strategy on station areas. This information is presented in the next chapter. This part deals with the three sub questions related to the "station areas" mentioned in paragraph 1.2

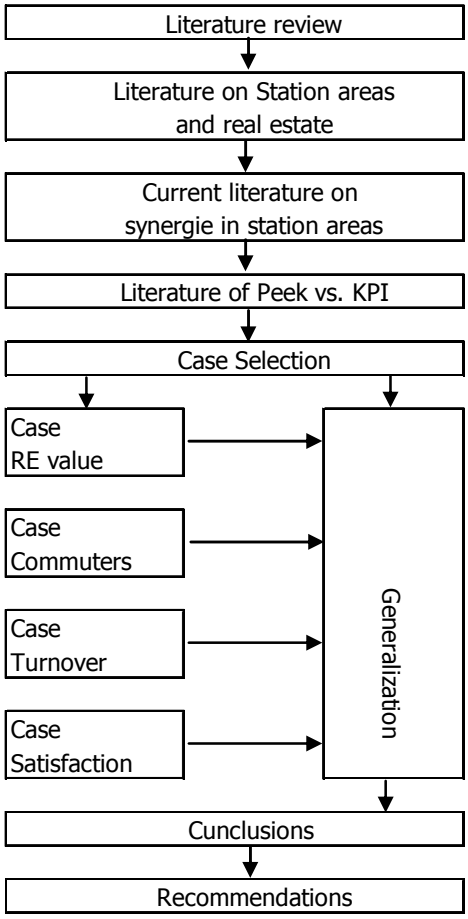


Table 1-2; Research setup

After determining the station area and its possibilities for synergy literature about this phenomenon will be reviewed. Relationships between the key performance indicators of the station areas and the four meta-values from peek will described from existing literature. When possible quantifiable indicators of these relationships are presented, these will serve as benchmark when the performance of the different stations is compared in case studies. In this section of the research sub questions related to "added value" will be answered, in the form of positive or negative value creating relations.

The four case studies based on the influence of meta-values on the four KPIs used by NS are of a descriptive nature. In the four cases the best and worst performing station area are investigated per KPI. The outcomes serve as explanations and insight for the overall statistical analysis of all top 30 station areas.

The next step is to do statistical analysis of all top 30 stations, the goal is to find significant relationships between a stations KPIs and the four meta-values taken from Peek's dissertation.

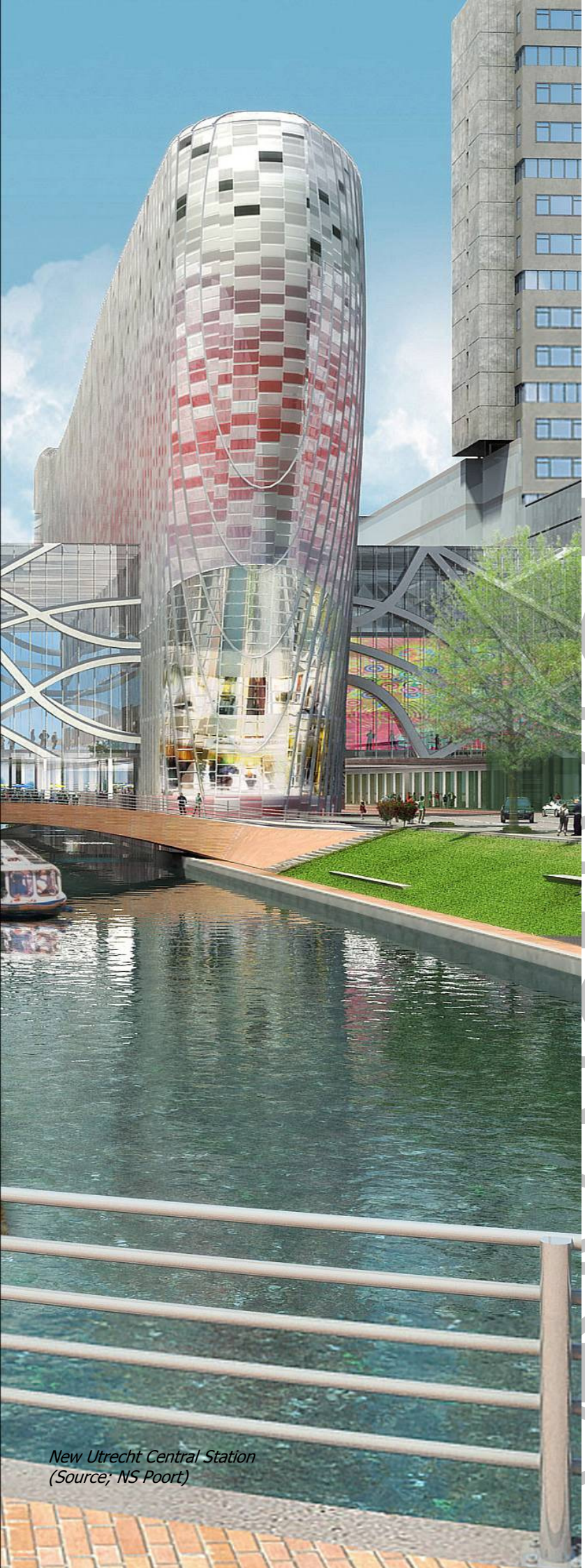
The final part is to draw conclusions from the statistical analysis and compare these with the results from the four case studies in order to draw conclusions on drivers of value in station areas.

1.8 **Demarcation**

Railway station areas can be seen as a playground with many actors, municipalities, provinces, the national government, ProRail, real estate developers, inhabitants, users, interest associations and of course NS. In the course of this research I've chosen to view the problem from NS' standpoint. The NS is an owner, user and developer of real estate in station areas and NS' core business also depends on the performance of the station areas.

Physical demarcation of the urban areas analysed is the size of the station area, this size differs per station. Insight into the way this physical area is established is given in chapter 2. Real estate functions consist of dwellings office space and retail. Rent levels of these functions are fairly easy to retrieve and more influenced by the market. Rent levels of more public related functions such as schools and hospitals are harder to retrieve less influenced by the market. Nevertheless these functions tend to generate a lot of passengers and are therefore expected to influence "top" performing station areas in terms of retail turnover and passengers. And will surface in the case study phase of the research.

Retail turnover in the station area will be represented by turnover of Servex outlets at NS stations. Data from these outlets is available within NS and turnover directly contributes to the result of the NS group .



New Utrecht Central Station
(Source; NS Poort)

2 STATION AREA

2 Station Area

In this chapter I will start with defining what is meant by the station area, first from literature and then from the definition and operationalization of NS Poort. After this current knowledge on synergy in station locations is treated (Bertolini & Spit, 1998) & (Peek, 2006) and followed by the current NS Poort strategy on which the dissertation of Peek is based.

2.1 Definition of Station Area

This research is focussed on one type of location; the railway station area. In order to utilize this term it has to be determined what is meant by the station area this is the first step in this research. First some definitions from existing literature are mentioned thereafter the definition of the station area according to NS is treated, and finally a definition of the station area is given that is relevant to this research derived from literature and the NS definition.

Much has been written about stations as a place, however the line that denotes the separation between the station and the rest of the city seems to move in combination with the interest and topic treated by the author. Bertolini and Spit (1998 p. 12) divide the descriptions into four categories;

1. *The walkable radius;* following this approach, the railway station area is identified as the circular area radiating from the railway station that is considered 'walkable' distance. Either a radius of no more than 500m or a 10 minute walk from the station.

2. *Functional-historical elements;* the station area is the area that has a direct functional connection with the station itself and is encircled by roads, water or other objects.

3. *Topographic*; from this point of view the railway station area is the surface included within an arbitrary section of a map. The location and extension of this window are determined by a commonsense evaluation of which elements to include in the analysis.

4. *A development perimeter;* In this approach the station area is defined as area included in the perimeter of a specific redevelopment initiative.

Bertolini and Spit (1998 p. 15) manage to combine the descriptions above into one definition that describes the station area;

"All built and open spaces together with activities they host, contained within the perimeter designed by a 'walkable radius' centred on the railway station building, as amended to take account of case specific physical-psychological, functional-historical and development features."

The quote above suggests that that there is no definition that is applicable for every station area, except that the area is defined by a "walkable radius". The other features tend to differ between the different station areas and since psychological elements play a role, such as experience of time and space the experience of the station area and thus its definition differs for every individual.

Since this research is concentrated in NS is seems logical to utilize the definition of the station area as NS describes it, not in the least because NS' internal real estate management software is based on the description.

The Station Area according to NS

In defining the station area NS does not use a standard distance or radius. NS defines the station area much as Bertolini and Spit suggest. The principles of the physical definition are described, this way a station area is described by its own physical and qualitative elements. NS distinguishes different parts of the station area which are shown in Figure 2-1.

Station complex

The station building encompasses the (roofed) rails, platforms and amenities such as shops, tickets & service, toilets etc. It can be described as the area in which everyone has to be in possession of a valid ticket. The station building provides the transfer function.

Station location (Dutch: Stationslocatie)

The station location encompasses the station building along with all other services related to the rail transport, the so-called transport sequence amenities (Dutch: ketenvoorzieningen) these are amenities that provide pre- and post train travel. The station location encompasses the following;

- Station complex
- Station square
- Transport sequence amenities
    - Bus station
    - Tram station
    - P+R
    - Kiss & Ride
    - Bicycle parking
    - Taxi area

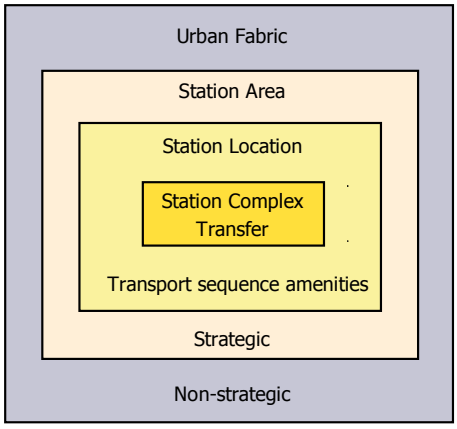


Figure 2-1; Definition of station area (Stationsgebied) (Source; NS Poort 2002)

Station area (Dutch: Stationsgebied)

The largest layer in the definition is the station area which the area that is of strategic importance to NS du to its proximity and physical relationship with the station complex.

Definition of the station area is done along the lines of Bertolini and Spit, all station areas are assessed by NS employees who are familiar with the area and a line is drawn on a map encompassing the station. This line defines the station area. In defining the exact location of the line three factors are taken into account;

1. Strategy of NS.
2. Station location as a dominant factor in a coherent area.
3. Influence on the quality of the station location.

The only rule is that the station *area* is at least the size of the station *location.* Furthermore four guidelines are to be considered when defining the station area;

1. Commuter experience
2. Manageable and accessible
3. Influence and politics
4. Quality as a node and a place

Commuter experience

For NS the commuter is the customer therefore his or her view of the station area is relevant. When entering the station area visual links are an important factor as commonly the first obstacles for instance a "wall" buildings surrounding the square in front of the station is associated with the station area. This means that the visual quality of the square and that of the surrounding objects determine the visual quality of the area.

Manageable and accessible

The station area is most preferably an uninterrupted and manageable area in which location management can take place efficiently. The area has to be a transit area for the city and should not be obstacle in the urban fabric. In the case of a railway barrier in the city, the station should function as a connecting "place" which forms a natural connection between both sides of the railway track.

Influence and politics

NS real estate strategy requires influence in station areas; this can be achieved through ownership of property or through arrangements with partners such as municipalities, ProRail and local businesses. It should be clear to the shareholders of NS (Dutch Government), politicians and municipalities that NS is focusing on its core business, i.e. real estate development has to add value to the rail transport activities in order to generate support for its plans

Quality as a node and a place

The area should inhibit both qualities as a node, thus providing different modalities of transport, and as a place containing mixed functions, safety, amenities etc. In other words it has to be a transfer machine and a meeting place at the same time.

An important factor in the combination between place and node is that these two properties of a station have to be balanced. One can imagine that a lot of shops terraces inside the station inhibit an efficient flow of people on the other hand a "machine" that transports people like cattle is not a very pleasant place to stay.

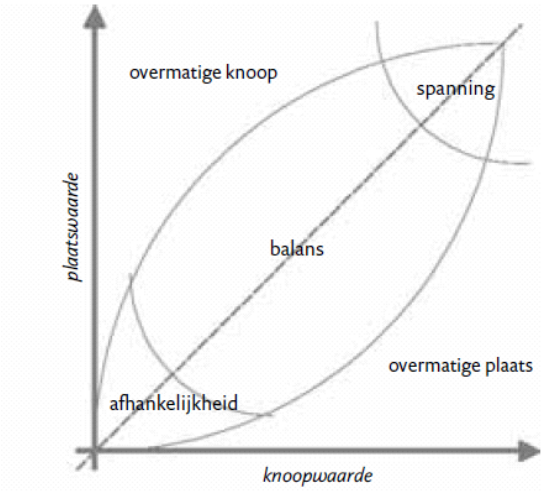


Figure 2-2; Node and place model (Bertolini, 1998)

Definition

The definition of the station area used by NS as a guideline will suffice in the course of this research as it is used to describe the station area of every station NS owns. Therefore the definition of Bertolini and Spit shall be used in the course of this research which been Operationalized by NS Poort and is stored in GeoPoort, The figure below shows the station *area* (blue line) of Leiden. The dotted pink line denotes the station *location* and the pink dot in the centre of both is the station complex.

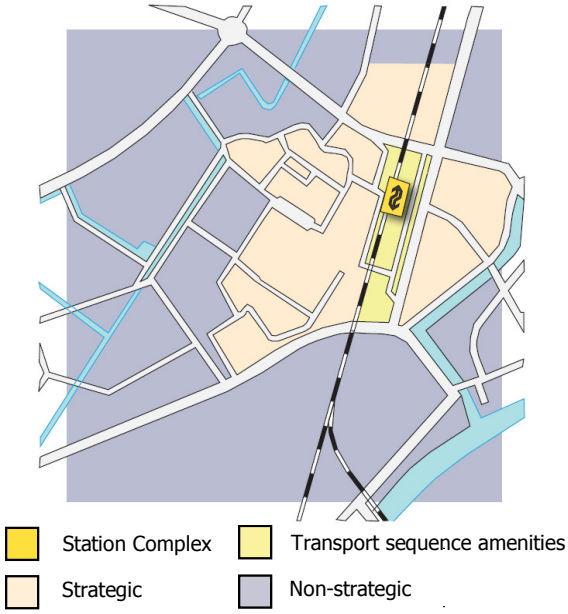


Figure 2-3; Strategic area of Leiden CS

Station typologies

In order to determine the development of station areas, NS and Holland Railconsult devised a method of categorizing stations throughout the Netherlands. The goal of this exercise was to determine development of stations throughout the years. Categorizing is based on 13 criteria which are formed from a balanced mix between micro and macro accessibility of a station. Micro criteria encompass the interaction of the station with its direct surroundings, the consist of;

1. (3) Centre or peripheral location (enclosed by urban fabric or not?)
2. (2) Production or attraction
3. (3) Large city (>200.000) middle (>75.000) small (<75.000)
4. (2) Share of Bus/Tram/Metro in pre-transport
5. (2) Share of P+R in pre-transport
6. (2) Share of walking in pre-transport

Macro criteria tell something about the way the station functions within the (inter)national rail network;

7. (2) No. of on and off
8. (3) Highest status of station (HSL/IC/Sneltrein/Sprinter)
9. (3) Cities main station or peripheral stop?
10. (2) Service formula? (Maximum Service, Service in shop, Basic)
11. (2) Percentage of trips that do not require a transfer
12. (1) No. of transferring passengers
13. (1) International connection (long haul)

After assigning all criteria to each station the weighing factor (indicated by the number between the brackets) determined the maximum score at 28 points. Finally all stations are assigned to the type 1 to 6 in which they have scored highest.

Type 1: Very large station in the centre of a large city. (Utrecht CS)
Type 2: Large station in the centre of a medium sized city. (Den Bosch)
Type 3: Peripheral station of large city with transfer function. (Rotterdam Alexander)
Type 4: Station in centre of small city or town. (Zwijndrecht)
Type 5: Peripheral station of large city without transfer function. (De Vink)
Type 6: Station in periphery of small city or town. (Lage Zwaluwe)

Figure 2-4 shows the stations with their respective areas of influence , note that Lage Zwaluwe shows a large area of influence this coincides with the fact that pre-transport of P+R is high since there is no alternative way of transport (BTM) or another station close by. De Vink shows a small area of influence this is because people in Leiden do have an alternative station; Leiden Centraal.

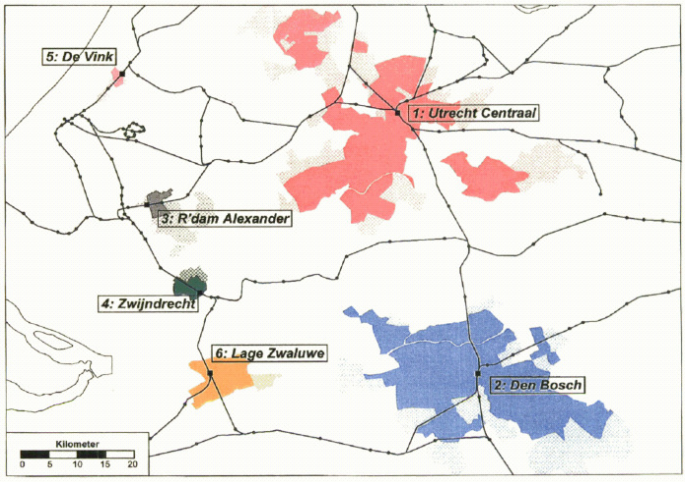


Figure 2-4; Area of influence of different stations (NS Commerce 2002)

bedieningsstatus	plaats		
	centrum	*stadsrand*	*buiten*
HST /IC, intercity, sprinter	type 1 zeer groot station in centrum grote stad	—	—
intercity, sprinter	type 2 groot station in centrum middelgrote stad	type 3 voorstadstation met knoopfunctie	—
sprinter	type 4 station bij centrum kleine stad/dorp	type 5 voorstadstation zonder knoopfunctie	type 6 station in buitengebied bij kleine stad/dorp

Figure 2-5; Station typologies (NS Commerce 2002)

The strategies for developing station locations are connected to the type of station. For types 1&2 emphasis is on real estate development, in the case of types 4, 5 & 6 emphasis is on investment into parking facilities (P+R, bicycles, Kiss & Ride). In the case of type 3 emphases is on both RE development and expansion and improvement of parking facilities (Peek 2006 p. 158).

The differentiation between station types is interesting since they tend to vary based on their location and accessibility from other stations in the rail network. Types 1 to 4 tend to be located within a spacious station area whilst types 5 and 6 tend to be situated in station area almost equal to the area of the station location.

The different type of stations thus provide different incentives for the users of real estate, an office building located near a type 1 station for instance is suited for functions that receive a lot of clients that make use of public transport because city centres are often poorly accessible from a highway not mention places to park. Whereas a building located near a type 3 station is also accessible for car users since it is mostly located in the periphery of a large city and thus accessible from the highways as well as by train.

In the course of this research stations of types 1 to 3 are most suitable for research purposes, mostly because they are situated in the centre or periphery of large or medium sized cities and they tend to be integrated into the national rail and local BTM network (indicated by the node function in Figure 2-2). Of these three types 1 and 2 are mostly located in city centres, and generally speaking, are located in a dense urban fabric. Stations of type 3 on the other

hand, are mostly located on the edge of a city indicating a less dense urban environment and thus more opportunities to add objects and function in the station area.

Stations which are now located in centre of a city where at the time they were constructed on the edge of the (old) city, usually accompanied by a small neighbourhood around the station. The figure below represents a generic representation of this process; (1) Construction of a railway corridor alongside the edge of the old city which in some cases still was a city wall. (2) Construction of a holding yard. (3) Construction of buildings that cannot be placed in the city centre due to their size or function. (4) Opening up the station with a road that connects the station to the city centre (stationsweg) and the surrounding settlements.

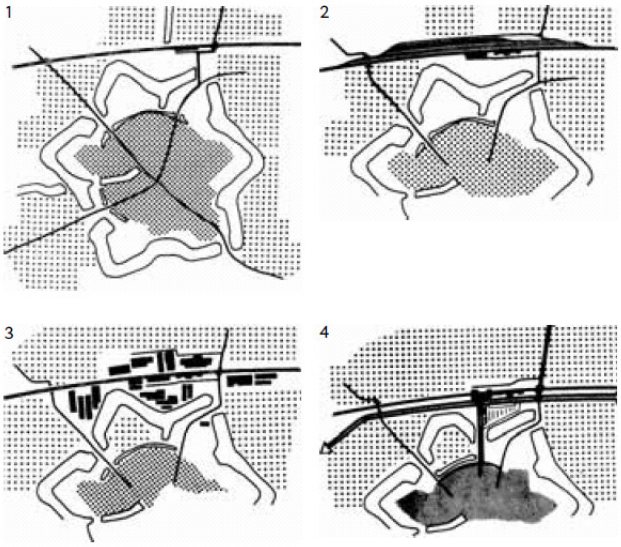


Figure 2-6; Development of inner-city station areas (Peek, 2006 adaptation from Zandvoort, 1986)

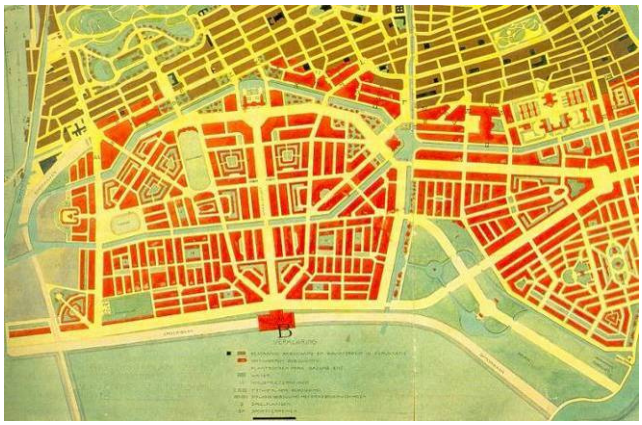


Figure 2-7; Example of a planned station in a new development, on the edge of the city. Minerva Station, Plan Zuid by H.P. Berlage 1917

Since the population of the Randstad will increase and the urban fabric will grow ever denser, it is likely that this process will continue in areas surrounding type 3 peripheral train stations. In the wake of this process it is not surprising that this type of station has shown fastest growth of passenger numbers in the last decade (Bron NS) and will continue to grow in the near future. Therefore stations of type 3 located in the periphery of a large or medium city will be included in this research.

2.2 Synergy in station areas: Current Affairs

The first step in creating synergy in station areas is to integrate its two main aspects which Bertolini and Split (1996) describe in the form of; nodes and places: nodes of networks and places in the city. A station is or can be both a node and a place. In Cities on Rails (1998) Bertolini describes the role of station locations along the lines of Castells *Network Society*;

On the one hand, stations offer a (potential) connection to several of material and immaterial flows that create value in the current "informational" (Castells 1989) mode of development. Stations are (or may become) important nodes in both transport and non-transport (e.g. business, consumption) networks. The connection to ever denser, faster and further reaching transportation systems, as well as the development there of office complexes and shopping centres are materializations of this global dimension of station locations.

On the other hand, stations identify a "place", a both permanently and temporarily inhabited area of the city, a dense and diverse conglomeration of uses and forms accumulated through time, that may or may not share in the life of the node. The mixture of housing, small business premises and informal public spaces of the stations neighbourhood is an expression of this local dimension'

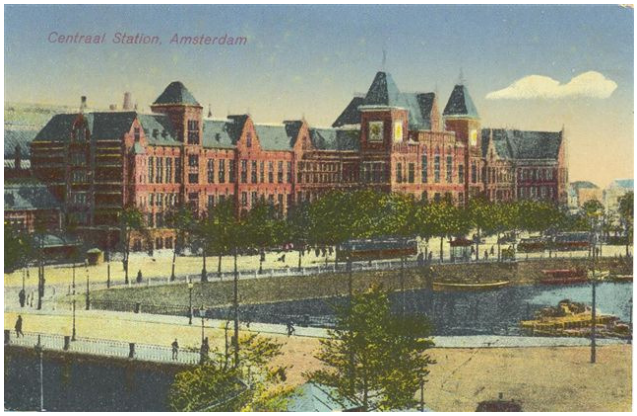


Figure 2-8; Amsterdam Central Station 1917, a mono-functional node on an "island", not integrated with urban fabric.

In his doctoral thesis *Location Synergy*, Geert Joost Peek (2006) describes the added value of nodes and places which are categorised in four actor based discourses based on the work of van Uum and de Boer (2003).

1. Transportation planning discourse: station location as a connection link
2. Engineering technology discourse: station location as a transfer machine
3. Urbanism economic discourse: station location as an urban centre.
4. Political cultural sociological: station location as a meeting place.

Peek takes these four ideal types a step further and describes the way in which they add value to station locations through synergy between node and place;

1. For the ideal "*connecting link*", synergy is expressed in a *contribution* to efficient and effective transportation infrastructure through *added value* of a local transport demand, which ensures off peak capacity usage and anti rush hour peak usage (tegenspits). Which is a result of the *coherence* between linking node within the meaning of network position, and place in terms of presence of origins and destinations.

2. In the case of the "*transfer machine*", synergy is expressed in a contribution to *seamless* multi modal mobility for the end user through the *added value* of a lower *transfer resistance*. Which improves the connection between the different levels of public transport. This originates from the *coherence* between node in the sense of different modalities and place in terms of available transfer facilities.

3. For the "*urban centre*" location synergy is expressed in a contribution to economic growth and spatial quality of the city through *added value* of a concentration of diversity and intensity which originates from the *coherence* of the node in the sense of accessibility and place in terms of concentration and multi-functionality.

4. For the "*meeting place*" synergy expressed in a contribution to the individual choice of the user through *added value* of meetings and events arising from a *coherence* between node in terms of *accessibility* and place in terms of the *available public space* which anchors the station in the urban experience.

The four discourses described above taken from Peek's doctoral thesis will form the basis of the research into added value of station locations, they describe the conditions that future developments will have to satisfy in order to create synergy between real estate development and NS' core business. One could argue that they form the basis of a future programme of requirements.

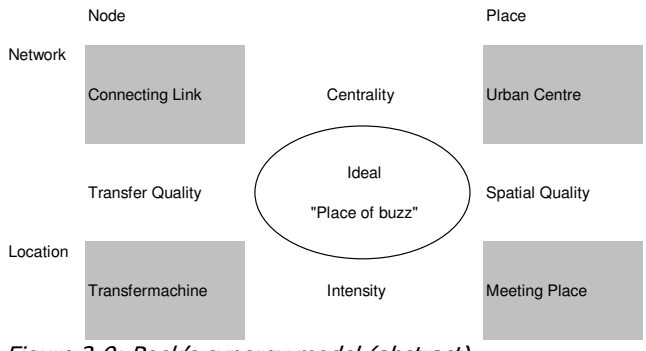


Figure 2-9; Peek's synergy model (abstract)

The four discourses are connected through 4 meta-values; centrality, transfer quality, spatial quality and intensity.

Centrality is the meta-value that describes the synergetic and antagonistic effects between the ideal types 'connecting link' and 'urban centre'. Multimodal accessibility is the positive effect of the connecting link on the urban centre since this will increase the value of real estate. The positive effect of the urban centre upon the connecting link such that the centre will provide a steady stream of passengers which spreads demand for transport (tegenspits & dalvulling)

Antagonistic effects are; a primary focus on transport efficiency which will hamper the development of an urban centre (connecting link -> urban centre) and vice versa; the fact that an intensive urban centre will cause an sub optimal efficiency of transport (urban centre -> connecting link)

The meta-value **Transfer Quality** contains positive effects (connecting link -> transfer machine) in a way that multimodal connections and a uniform stream of passengers lead to an even use of the station which in turn leads to efficient use of space and exploitation of this space. A better match between modalities contribute to an efficient network and thus to public transport competitiveness (transfer machine -> connecting link)

Antagonistic effects; focussed on efficiency between modalities not on end user and exploitation of the area (connecting link -> transfer machine) and; Competitiveness in exploitation which leads to inefficiency when companies compete over timeslots and slots on platforms. (transfer machine -> connecting link)

Spatial quality; Intensity and diversity of functions lead to an urban experience and provide choices, read; places to spend money, to its users (urban centre -> meeting place). This also works the other way around; places to meet and public events contribute to quality and economic activity of an urban centre (meeting place -> urban centre).

An emphasis on financial feasibility of redevelopment for instance by adding office space can lead to a mono-functional area (urban centre -> meeting place) on the other hand a focus on places to meet will not contribute to the feasibility of redevelopment (meeting place -> urban centre).

Intensity, (transfer machine -> meeting place); Integration of transport networks contributes to an urban experience and enhances the freedom of choice of the users. Places to meet and public events contribute the

quality of the commuting-chain and provide a safe and pleasurable transfer (meeting place -> transfer machine).

Emphasis on integrating networks can result in a true machine not at all connected to the human scale and thus not providing any urban experience for the commuter and deprives the surrounding area of the passengers (transfer machine -> meeting place). Focussing on meeting may lead to a concentration of marginal groups whom evoke an unsafe feeling among passengers (meeting place -> transfer machine).

In order to use the four meta-values for measuring performance each meta-value has to be operationalized into variables that describe its meaning to the relevant point of view.

2.3 NS Real Estate Strategy

Ambition NS

NS has the ambition to become one of the leading European rail operators in terms of reliable and customer friendly passenger transport via train and other modalities. This has led NS to the following mission statement;

"Meer reizigers veilig, op tijd en comfortabel vervoeren via aantrekkelijke stations." (Visie 2020, NS, 2006)

Translated as;

Offer safe, punctual and comfortable transit to more passengers through appealing stations.

In order to achieve these ambitions especially the appealing station part, NS has a subsidiary concerned with real estate management; NS Poort, which has the following mission statement;

"Stations en stationsgebieden ontwikkelen, exploiteren en beheren om aangename, levendige en duurzame plaatsen voor verblijven, werken en wonen te creëren, zodat onze klanten graag gebruik maken van onze diensten en bedrijven zich rond stations willen vestigen. Wij kunnen dit door onze posities in stationsgebieden, de unieke portfolio van activiteiten en de relatie met het vervoersbedrijf van NS." (Mission statement NS Poort)

This can be translated as;

We want to develop, operate and manage stations and there surrounding areas in order to create a pleasant, vibrant and sustainable place to stay, work and live in such a way that our customers want to use our services and businesses are drawn to our stations. We are able to do so through our positions in station area, a unique portfolio of activities and the relationship with NSR.

The focus of this mission is managing real estate in the station areas in such a way that it is able to generate added value for NSR and the NS group as a whole. However it does not exclude adding value to real estate as such. Real estate development isn't a goal of NS Group it is a mean towards a goal.

Funding

Spatial interventions in the station area and complex require the allocation of resources. These resources are obtained by liquidating non strategic real estate assets. Non strategic assets are those that are located outside the strategic station area as shown in Figure 2-1. The revenues obtained through liquidation are divided into two equal parts of which 50% is allocated for investment by NS Poort into the strategic station areas. The remaining 50% is allocated to NS group which in turn may allocate it however she sees fit.

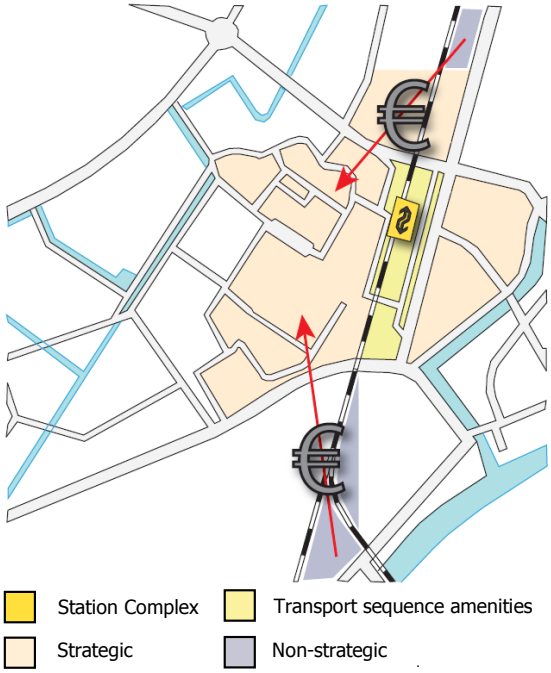


Figure 2-10; Funding of spatial interventions by liquidating non-strategic real estate assets

Real estate strategy

Peek's dissertation is in part based on NS' real estate strategy which he helped to develop when NS was privatized and ownership and responsibilities were split between NS Poort and ProRail. This strategy of creating added value in redevelopment of station locations is based on creating added value for the commuter. Added value for the commuter is expressed in his or hers personal space-time budget which is measured by one variable; time.

Time, however is measureable by the well known, SI approved, seconds. However a difference is made between the actual seconds and the perception of time by the commuter. The time it takes to perform different parts of a journey; pre-transport, transferring, train, transferring and post-transport, are valued more or less. Activities that are of low value seem to take longer than productive or fun activities. It is not surprising that waiting on a platform for a train is perceived as a low quality activity and thus seems to take forever. Appreciation of activities that take place during a typical trip are shown in the figure below.

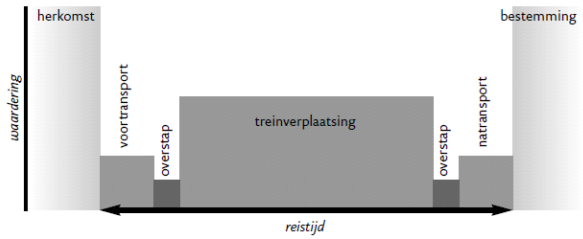


Figure 2-11; Appreciation of activities during a typical trip, (adapted from Peek, 2006)

Accelerate, add density and add comfort

Peek described these strategies using the three Vs (versnellen, verdichten en veraangenamen) which in Dutch are quite catchy. In English I will name them the three As; Accelerate, Add density, Add quality. Adding density and adding comfort are relevant to this research since they involve management of real estate and the urban area by NS Poort whilst accelerating is influenced by NS Reizigers and ProRail.

Accelerate

The accelerate strategy decrease total travel time. This can be done by introducing less time needed for a transfer, this should be achieved by implementing Ruimte op de Rails in the next few years (ProRail 2007), or speeding up the average speed of a train. This is the traditional way of improving rail travel. It usually costly and doesn't generate more revenues. For instance the recently introduced Fyra high speed train, which reduces the travel time between Amsterdam and Rotterdam with 20 minutes is not very popular this is probably caused by its increased ticket price.

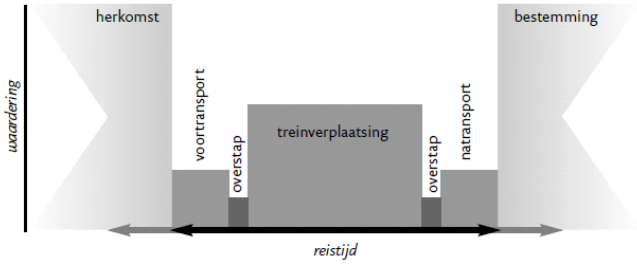


Figure 2-12; Accelerate (adapted from Peek, 2006)

Add density

Add density involves situating new and more functions and thus activities close by the station or in a higher density surrounding the station. These functions; dwellings, offices, retail and leisure, will reduce the total travel time, by either less pre- or post-transport. Since the functions are placed within walking distance from the station transferring to the BTM network will not be necessary. This usually concerns capital intensive investments but if the micro-accessibility of station is improved and the number of residents in the vicinity of the station grows, it is expected that the number of passengers will rise and with it revenues from ticket sales and retail turnover.

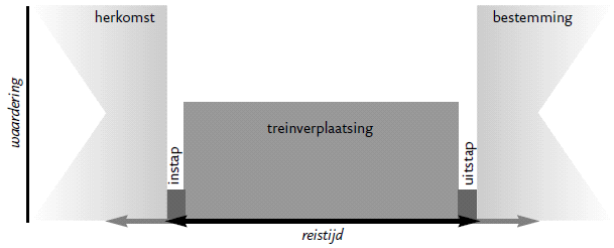


Figure 2-13; Add density (adapted from Peek, 2006)

Add quality

By adding quality the goal is to improve the least appreciated aspect of the trip, waiting for the train, and the journey provided by NS as a whole. By either adding comfort or add usefulness to the time spent in the train and at the station. This can be achieved by providing the commuter with high valued activities in high quality environments. These moderate investments tend to yield a visible effect in the eyes of the user and this should reflect in a higher number of passengers and an increase in retail turnover at the station.

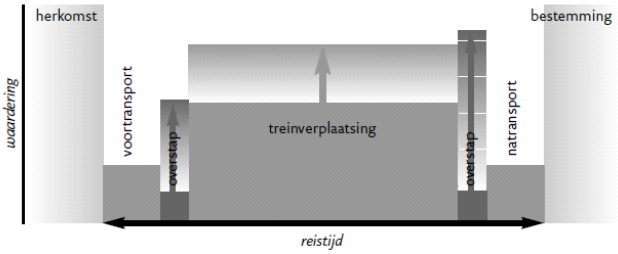


Figure 2-14; Add comfort (adapted from Peek, 2006)

The strategies are, as mentioned, designed to add value to the NS core business; passenger transport. Adding comfort and adding density are the strategies NS Poort is concerned with, accelerating is done by NSR. The performance of implementing this strategy is measured by NS Poort, measurement is based on four key performance indicators;

1. Number of at a station
2. Turnover of retail outlets at a station
3. Real estate prices in station area
4. Customer satisfaction with aspects of a station

The relationship between the strategies of the three Vs and the meta-values that describe Peek's synergy model is shown in the figure below.

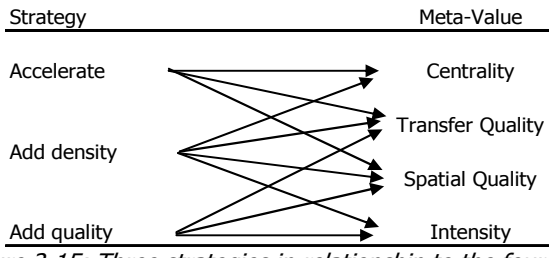
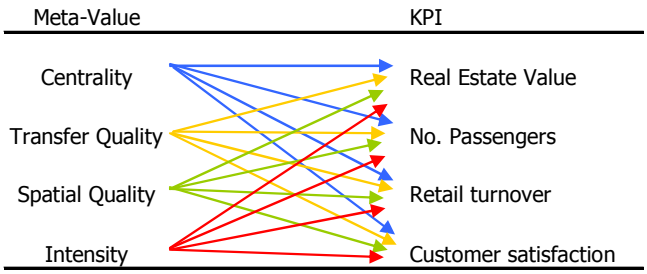


Figure 2-15; Three strategies in relationship to the four meta-values (adapted from Peek, 2006)

The meta-values in turn show effects on the value of real estate, number of passengers and spatial and economic

quality of the area, in other words the aforementioned Key performance indictors.



The next step in this research is to identify the top and worst performing stations in each of the four KPIs in an attempt to uncover what are the drivers behind the performance or underperformance of each station based on the theory provided by Peek. In order to compare stations there KPIs have to be measured relative to their surroundings and size this will tell us something about its performance. Apart from comparing the "best" and "worst" performer we would also like to know what "best" is i.e. we would like to know what relationship is *expected* between between KPIs and meta values. This is the subject of the next chapter, 3. Added value: What to expect?

3 ADDED VALUE

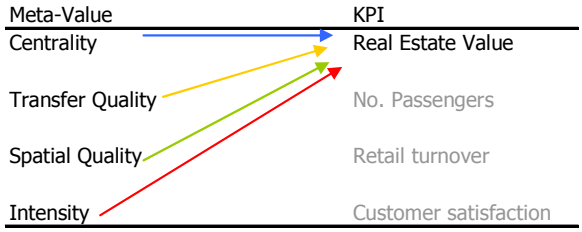
Public Transport Terminal Rotterdam Centraal
(Source; NS Poort)

3 Added value: What to expect

This chapter shows the search for proof of the influence of Peek's four meta-values on the performance indicators of a station area. The goal of this exercise is to find out what to expect and what to look for when two station areas are to be compared in the case study phase. The methodology used is devised by BCI in a study performed for NS Poort and a number of Dutch municipalities. Each meta-value is broken down into a number of aspects based on Peek's description and literature describing the relation is retrieved. It will be presented in the form of short quotes taken from the relevant literature. Conclusions will be presented in the last paragraph in the form a KPI-meta matrix which gives an overview of the positive and negative influences.

3.1 Influences on real estate value

The following section deals with the influence centrality, transfer quality, spatial quality and intensity have on the value of real estate in the station area. An overview of available literature is given followed by a conclusion containing "expected" values that serve as a benchmark in the comparison of the two stations with the highest and lowest real estate value.



3.1.1 What is the influence of centrality on real estate?

De waarde van de kantooromgeving - Planbureau voor de Leefomgeving (2009)

- The closer an office is situated near a highway ramp, bus stop or railway station, the higher the rent. A reduction in distance of 1 kilometre to the railway station leads to an average rent increase of 0.6 percent.
- The presence of a railway station will mainly influence the rent level of offices situated within a kilometre of the railway station.

Kennisplatform Verkeer en Vervoer (2009)

- The most expensive office locations in the Netherlands are characterised by the proximity of excellent public transport facilities en few to no parking places.
- A building that isn't accessible is worthless.

De stationsomgeving als beleggingslocatie – Kuenen (2008)

- The total return on investment in office space in station areas show a lower yield prior to 2002 (between 1 and 3%) compared to investments outside station areas. (See figure below)
- Between 2002 and 2006 there is no significant difference.
- From 2007 on, investments within station areas show a significantly higher yield of 15,5% (up 2,5 %), however the time span is to short to derive any conclusions.

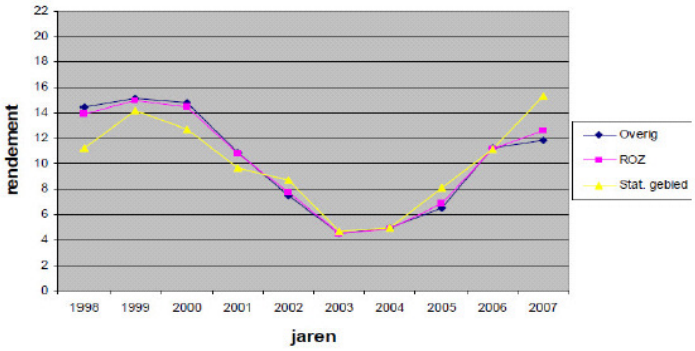


Figure 3-1; Yield of offices in station areas compared to ROZ/IPD index (Kuenen, 2008)

Invloed transportvoorzieningen op vastgoedprijzen - ABF Valuation (2008)

- Research shows that opening a metro station has a positive effect on the value of real estate.
- The presence of a metro station has a greater effect on prices of offices and retail than that of dwellings.

Effect of metro stations on value of real estate in Amsterdam;

Retail	(100-300 m - 300-500 m)	4,9%
Offices	(100-300 m - 300-500 m)	4,1%
Dwellings	(200-600 m - 600-1000 m)	2,3%

De invloed van bereikbaarheid op vastgoedwaarden van kantoren - De Graaff et al. / Vrije Universiteit (2007)

- A higher on average rent of 7,5% when located within 500m radius of a railway station compared to a location outside a 2km radius.
- A higher on average rent of 4,5% when located in a 500 - 1000m radius of a railway station compared to a location outside a 2km radius.
- Office tenants are willing to pay more for proximity if the office is located within walking distance of a railway station. The presence of a railway station will therefore mainly affect offices within a maximum 1km radius after which the effect rapidly decreases.

Debrezion et. al. 2006

- A dwelling located 500m away from a railway line is worth 5% more compared to a dwelling located 250 away from the same line and worth 3,8% more that a dwelling located within 250 to 500m from that line.
- A dwelling in the Netherlands is worth 28,7% more when located within a 250m radius of a railway

station compared to a dwelling that is located 10km away from the same station.
- The value of a dwelling in a 250 m radius of a railway station is on average worth 4% more than a dwelling located at least 5km away.

Distance Trains/day	< 250m	< 5 km	< 10 km
50	119,6	112,9	107,4
100	123,0	115,2	108,7
200	126,5	117,5	110,1
400	130,0	119,8	111,4
800	133,4	122,1	112,7

Figure 3-2; Influence of railway station on RE prices (Debrezion, 2006)

What is the influence of transfer quality on real estate?

De invloed van bereikbaarheid op vastgoedwaarden van kantoren, De Graaff et al. / Vrije Universiteit (2007)

- Office space located near a high quality railway station in the form of higher accessibility has a significantly higher price
- Quality of a station is determined by its RSQI
- An increase in x percent RSQI will show the same x percent increase in rent.

Railway station centres and markets: Change and Stability in Patterns of Urban Centrality, Kusumo 2007

- Commercial activities tend to be significantly found on locations where two or more layers of transport are well integrated.

What is the influence of spatial quality on real estate?

De waarde van de kantooromgeving, Planbureau voor de leefomgeving (2009)

- A substantial improvement of spatial quality will lead to an increase in house prices between 2 - 10% in radius between 150 to 500m.

Locatie, locatie, locatie; een onderzoek naar de fundamenten van de BAR, DTZ Zadelhoff/Nyenrode (2006)

- In the case of office space accessibility, parking, building features and the size of the city are the most important factors that tenants are willing to pay for. An increase in spatial quality can lead to an increase in rent up to 5%

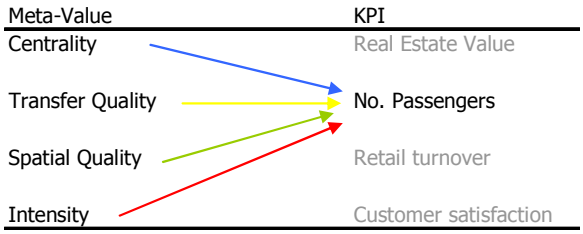
What is the influence of intensity on real estate?

Buck Consultants International (2010)

- Prices of dwellings show an increase of 5-10% on a "substantial improvement"
- Office rents show an increase of 2-5% on a "substantial improvement"

3.2 **Influences on the number of**

When a new station opens NS in advance is able to predict the number of passengers it will attract, in fact NS knows exactly how many inhabitants in each zip code use the train and what station they use. It therefore makes sense to use this models prediction as the "expected" value when comparing two stations on there relative number of passengers since this is NS' core business it seems likely that they posses the most reliable data.



What is the influence of centrality on the number of passengers?

NS' commuter flow prediction model "De Kast" provide estimates on the number of passengers that are to be expected for each station specifically.

What is the influence of transfer quality on the number of passengers?

A substantial increase in RSQI may generate an additional 25%-50% passengers. (De Graaff et. al., 2007)

What is the influence of spatial quality on the number of passengers?

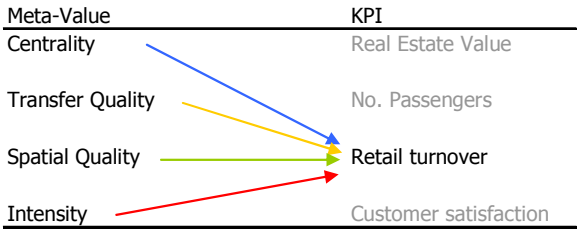
No literature found concerning this relationship. It is however probable that an increase in spatial quality of the station area will enhance it is a "place to stay" and thus attract people. It then has an indirect relationship through which demand for real estate can be an explanatory variable.

What is the influence of Intensity on the number of passengers?

NS prediction model "De Kast" might provide insight, it however seems logical that more intensive use of the area involves more people and thus generates more passengers this is however an indirect relationship in which population density, number of jobs, number of retail outlets etc. are explanatory variables.

3.3 Influences on retail turnover

Not much literature has been written about retail at railway stations, in this case NS stations can only be benchmarked against each other. A new internal study on retail development consists of detailed information on the performance of each station this shows that the stations of 's-Hertogenbosch and Breda are in the so called "sweetzone", with €1.35 and €1.50 per commuter respectively.



What is the influence of centrality on retail turnover?

Purpose visitors spend on average €3.50, train passengers €1, BTM passengers €0.5 and passers by €0.33. (BCI, 2010)

More centrality > More passengers > More amenities > More spending

What is the influence of transfer quality on retail turnover?

Turnover is directly influenced by the number of passengers; more passengers > higher turnover

Turnover per commuter is expected to increase with an improvement in transfer quality.

What is the influence of spatial quality on the retail turnover?

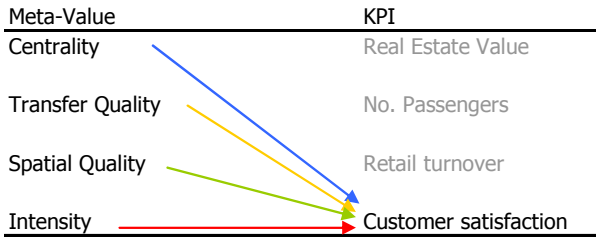
An increase in spatial quality is expected to improve retail turnover. This expectation is based on the fact that a higher spatial quality will generate a higher number of passengers and thus higher turnover.

What is the influence of Intensity on retail turnover?

Direct link with number of passengers

3.4 Influences on customer satisfaction

NS Reizigers conducts extensive and frequent surveys among passengers concerning all aspects of their trip. Besides quantifying usage of NS services this also gives insight into appreciation of the commuter of the station. Each station is awarded an overall mark (0-10). A number of relevant results are shown in the paragraphs below.



What is the influence of centrality on customer satisfaction?

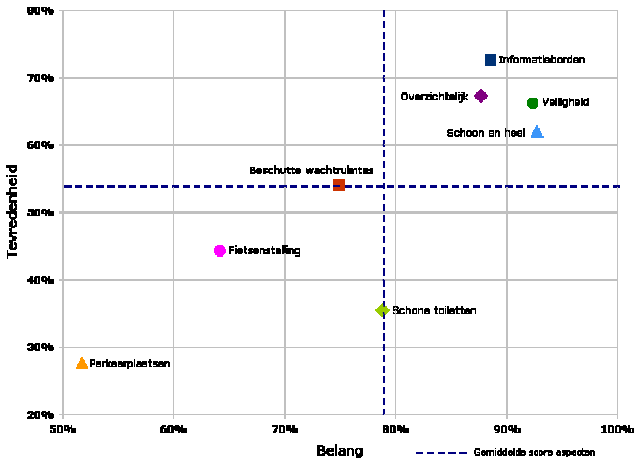
No relevant existing literature could be retrieved from the public domain. The expected relationship is a positive one, as more centrality provides the passenger with access to more activities. Generally speaking this increased access is expected to be reflected in higher satisfaction from the viewpoint of the passenger. In the case of the individual commuter this does not have to be the case as most passengers tend to travel to the same location every working day thus for this group the choice between activities to which the station provides access is irrelevant.

What is the influence of transfer quality on customer satisfaction?

Locatiesynergie, Peek (2006)

- Pre- and post train transport and transfer (perceptive) time are the weakest links in the commuting chain (2 respectively 3 times longer compared to the train trip itself) (Peek 2006, from Wardman 2001, 2004)

What is the influence of spatial quality on the customer satisfaction?



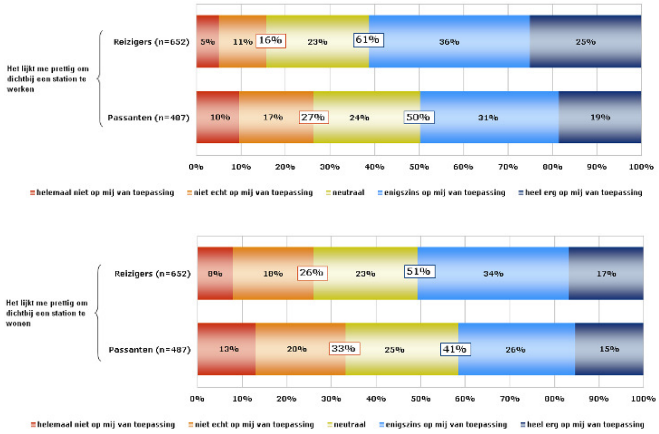
Graph 3-1; Importance and score of elements relating to the station complex and surroundings (Source; NS Poort 2009)

The graph above shows the relationship between the importance and performance of eight aspects of the station (area). Safety, cleanliness, overview and the availability of information are the most important issues within the station complex. The elements facilitating the transport sequence (note that BTM connection is missing) are deemed to be of less importance. However it are those that the station surroundings supplies. The assumption may also be made that safety, cleanliness and overview do not apply to the

station complex alone but also to its immediate surroundings.

What is the influence of Intensity on customer satisfaction?

The two graphs below show the willingness of passengers to respectively work and live in the vicinity of a railway station. It becomes clear that actual NS show a higher appreciation (62% & 50%) for living and working close to a station in comparison to passers-by (51% & 41%). The conclusion thus may be drawn that activities in the vicinity of a station have a positive influence on the customer satisfaction of NS as the need for post and pre transport is diminished.



Graph 3-2; Customer satisfaction with living and working in the vicinity of a station (Source; NS Poort 2009)

3.5 **Wrap Up**

The influences the four meta-values have on each KPI are generally speaking hard to quantify, however in most cases a positive relation can be found. The finding of each of the for KPIs are presented in the form of a table.

Real estate value

Dwellings and office space show a value increase when located within a 500m radius from a train station. Based on Kuenen we can also conclude that yield on office space is higher (2,5%) when located within the station area. We can thus conclude that added value has a positive relationship with proximity to a railway station. Or vice versa, a distance decay relationship; as proximity to the station decreased so does the value of commercial real estate.

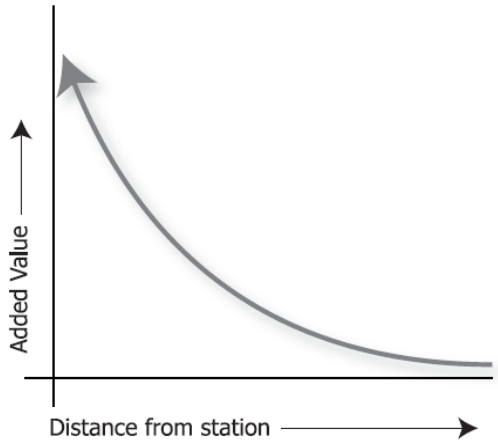


Figure 3-3; assumed relationship between added value of real estate and proximity.

Influences of meta-values on real estate value			
Centrality	Transfer Quality	Spatial Quality	Intensity
Value of dwellings show an average increase of value of 4% if < 250 m of station compared to >5km (Debrezion,	An increase in x precent RSQI will show the same x percent increase in rent (De Graaff et. al., 2007)	A substantial improvement of spatial quality will lead an increse in house prices between 2 - 10% in radius between 150 to 500m (CPB, 2009)	Prices of dwellings show an increase of 5 10% on a "substantial improvement" (BCI, 2010)
Office space on average 7.5% increae in rent if <500m compared to >2000m from station (De Graaff et. al., 2007)	Commercial activites tend to be signifacantly found on locations where two or more layers of transport are well integrated (Kusumo, 2007)	In the case of office space accessibility, parking, building features and the size of the city are the most important factors that tenants are willing to pay for. An increase in spatial quality can lead to an increase in rent up to 5% (DTZ,	Office rents show an increase of 2-5% on a "substantial improvement" (BCI, 2010)
on office space is significantly higher (19%) when located in the station area 13 - 15,5 % respectively (Kuenen, 2008)			

Table 3-1; Overview of meta-values vs. real estate values according to existing literature

Added value on office space seems to be greater compared to dwellings this can be explained by the difference in the volume of displacement costs between a family home and an office building (O'Flaherty 2005) as well as the fact that no one wants to have a railway running through their backyard. This leads to a critical distance, in the form of a line surrounding NS stations where commercial functions become equally valuable to dwellings and a mix of functions will exist. When travelling further from the station more and more dwellings will dominate the program. Maximized added value of real estate in the vicinity of a station lies in commercial real estate.

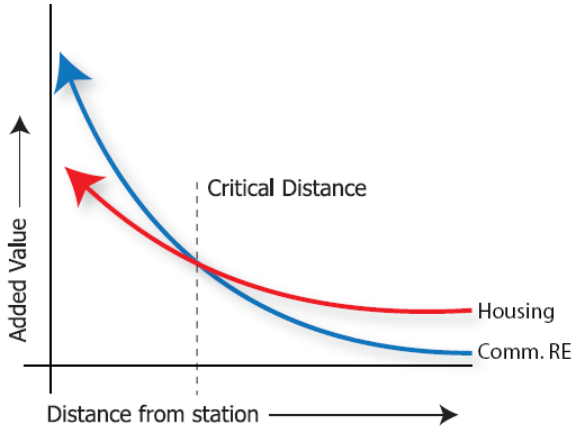


Figure 3-4; Assumptions on functions, added value and proximity

Research by de Graaff, Rietveld & Debrezion (2007) suggests a linear relationship between a stations RSQI and the value of real estate in the station area, this is supported by Kusumo who finds that more layers of transport i.e. transfer quality attracts businesses.

The relationships between spatial quality and real estate value show a positive trend CPB estimates a 2-10% increase on a "substantial" improvement within a 150 - 500m radius. Although "substantial" is a vague term we can establish a positive relationship, DTZ research supports this.

Research performed by BCI shows a positive relationship between intensity and real estate value, this is however to be expected since an increase in intensity drives demand. The difference in estimated added value between offices and dwellings 2-5% and 5-10% respectively is unexpected but might be connected through accessibility preferences of office space users.

Number of passengers

Influences of meta-values on number of passengers

Centrality	Transfer Quality	Spatial Quality	Intensity
NS prediction model "De Kast"	A substantial increase in RSQI may genrate an additional 25%-50% commuters. (De Graaff et. al., 2007)	An improvement in spatial quality is expected to generate a higher number of commuters.	NS prediction model "De Kast"

Table 3-2; Overview of meta-values vs. number of according to existing literature

The NS model "de Kast" is used to predict the number of at a station. Further analysis of this model is needed in order to produce some expectations on the relationships. A rise in RSQI will increase the number of by 25-30%.

Retail turnover

Literature concerning this relationship is limited to say the least. A new study of NS Poort on railway station retail turnover might however shed some light on the issue. The retail real estate development plan (Retailvastgoed Ontwikkelings Plan, ROP) charts the performance of all top 50 stations.

The following graph shows the presumed relationship between added value of retail turnover and the number of passing through an NS station daily. It is assumed that added value and number of passengers do not have a linear relationship e.g. that there are limits towards growth of added value. One can imagine that too much crowdedness will limit the areas ability to serve as a pleasant place to stay. NS Poort ROP study reflects this assumption.

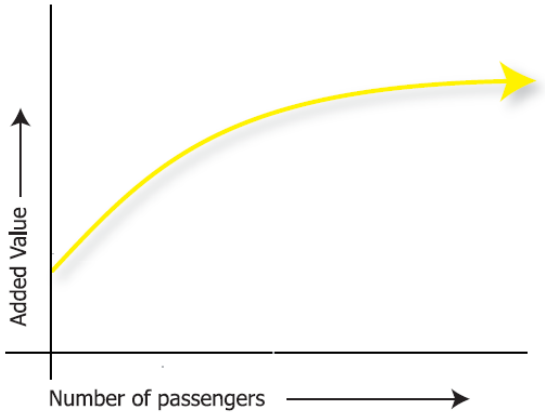


Figure 3-5; Assumptions about added value and number of passengers per day.

BCI research estimates that purpose visitors spend €3.50 per visit compared to passengers' €1,- this leads to believe that attracting purpose visitors will be lucrative, thus centrality adds value by drawing in more purpose visitors.

A rise in transfer quality will increase the number of passengers and their wallets thus increasing the total turnover through a higher number of passengers in the same way in increase in intensity is expected to aid in a rise in turnover.

Influences of meta-values on retail turnover

Centrality	Transfer Quality	Spatial Quality	Intensity
More centrality > More passengers > More amenities > More spending	Turnover is directly influenced by the number of commuters; more commuters > higher turnover	An increase in spatial quality is expected to improve retail turnover. This expectation is based on the fact that a higher spatial quality will generate a higher number of commuters and thus higher turnover.	Direct link with number of commuters
Prupose visitors spend on average €3.50, train commuters €1, BTM commuters €0.5 and passers by €0.33. (BCI,	Turnover per commuter is expected to increase with an improvement in transfer quality.		

Table 3-3; Overview of meta-values vs. retail turnover according to existing literature.

Customer satisfaction

Centrality will probably increase customer satisfaction, since more people will be able to reach the station easily thus eliminating post and pre transport. These are considered to be the weak links in customer satisfaction (Peek, 2006). A recent survey (MetrixLab, 2010) shows that spatial quality is valued through safety by 93% as being very important. Cleanliness and clean toilets complete the top 3 of most important factors. Concerning intensity, 61% percent of the passengers would like to work in the vicinity of a station, and 51% would like to live near one. This is linked to the meta-value centrality and might give an estimate of demand for dwelling and office space in station areas.

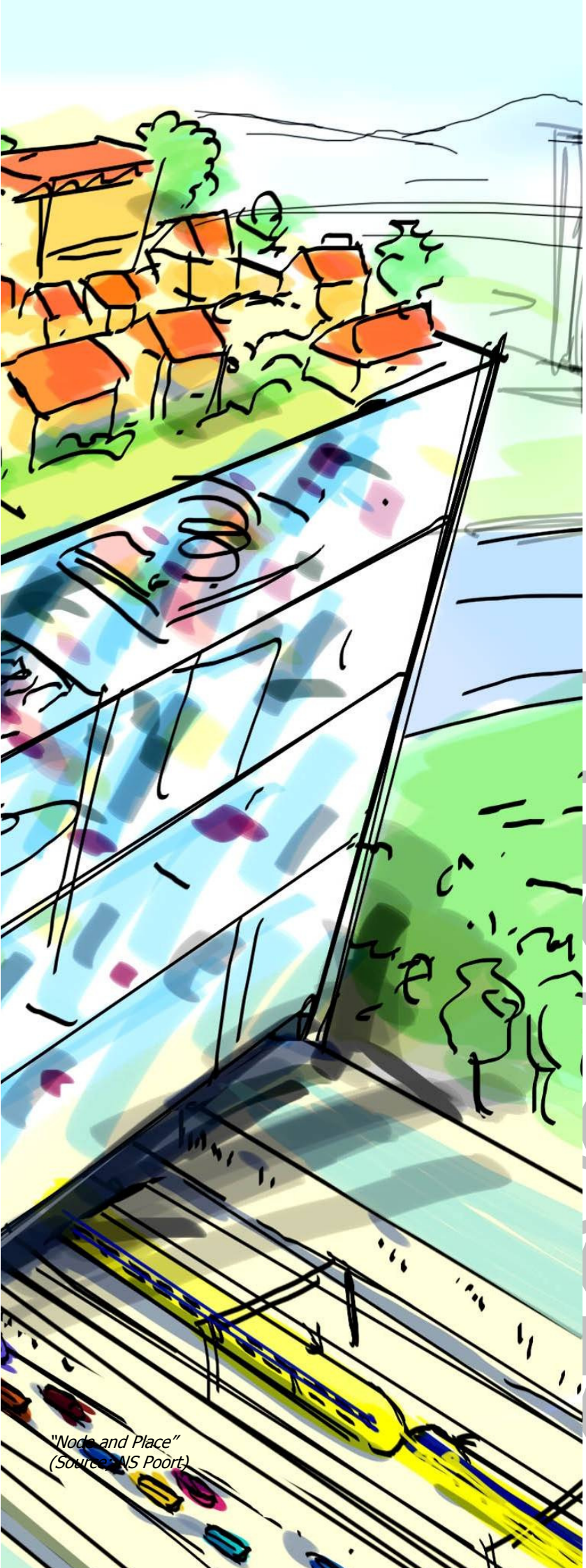
Influences of meta-values on customer satisfaction

Centrality	Transfer Quality	Spatial Quality	Intensity
	NS KTO surveys	NS KTO surveys	NS KTO surveys
No literature available, it is expected that an improvement in centrality will improve customer satisfaction.	Pre- and post train transport and transfer (percepted) time are the weakest links in the commuting chain (2 resp 3 times longer compared to the traintrip itself) (Peek 2006, from Wardman 2001, 2004)	Safety (93%), cleanliness (58%) and clean toilets (53%) are considered to be very important by large number of commuters (NS Survey)	61% of commuters, 50% of passers by would like to work near a station. 51% of commuters 41 of passers by would like to live near a station

Table 3-4; Overview of meta-values vs. customer satisfaction

Customer satisfaction of NS is highly influenced by delayed trains due to break downs of rolling stock, malfunctions in ProRail equipment and the (in) famous leaves on the rails during fall. Reliability of the train service is not part of this research, however the place in which have to wait is. Therefore measures to prevent waiting or ease the time spent waiting should be taken into consideration in this research.

When delays occur the passenger has two options, wait or use alternate form of transport. The location should be able to provide both in order to break the negative cycle, easy access to tram, metro, bus, taxi etc. and an attractive place to wait and maybe work at the same time for example an airport lounge. Transfer quality and spatial quality can be instruments in which the station helps to improve customer satisfaction of NSR.



"Node and Place"
(Source: NS Poort)

4 TEST CASES

4 Test Cases

Four test cases of an explanatory nature will be conducted. The goal of performing these four case studies, one for each key performance indicator is twofold; 1. To gain information and a "feeling" for the relationship between the KPIs and Peek's four meta-values. Results from the case studies will be used to determine what factors drive added value in the generalization phase 2. The case studies serve as a clarification for the outcomes of generalization, in other words a significant relationship found in statistics can be confirmed by real life examples.

Demarcation

The station has to be either type 1,2 or 3. As mentioned before, real estate development is only feasible in these three categories since they are located in an inner city or in the periphery of a large city. Another advantage is that postal codes surrounding inner city or peripheral are usually physically smaller than in rural areas making CBS data in four digit codes better applicable.

The station has to be situated on the "Ruimte op Rails" network. This has two reasons; 1. This way it is possible to smooth out the relative location and accessibility in the rail network, since transportation economics and planning is not a part of this research. 2. Stations located on the "Rondje Randstad" are also location where the largest population growth is expected by CBS, thus demand for real estate will be stable and the number of passengers is not expected to decline.

Figure 4-1; Geographic location of relevant stations within the Netherlands

Name	Code	PC	Pass/day
Alkmaar	AMR	1815 CB	21317
Almere Centrum	ALM	1315 KT	20010
Amersfoort	AMF	3818 LE	36544
Amsterdam Amstel	ASA	1097 DN	23311
Amsterdam Bijlmer ArenA	ASB	1102 BT	17676
Amsterdam Centraal	ASD	1012 AB	165670
Amsterdam Sloterdijk	ASS	1043 DT	41612
Amsterdam Zuid	ASDZ	1077 XV	34872
Arnhem	AH	6811 KM	40066
Breda	BD	4811 BB	25427
Delft	DT	2611 AC	27667
Den Haag Centraal	GVC	2595 AA	78883
Den Haag HS	GV	2515 BW	36029
Dordrecht	DDR	3311 JV	20579
Duivendrecht	DVD	1115 BZ	12587
Ede-Wageningen	ED	6711 PN	16568
Eindhoven	EHV	5611 AC	55251
Gouda	GD	2803 PG	20457
Groningen	GN	9726 AE	34999
Haarlem	HLM	2011 LR	37841
Hertogenbosch 's	HT	5211 BP	42946
Leiden Centraal	LEDN	2312 AJ	60962
Maastricht	MT	6221 BT	20825
Nijmegen	NM	6512 AB	37785
Rotterdam Blaak	RTB	3011 GA	13587
Rotterdam Centraal	RTD	3013 HA	90964
Tilburg	TB	5038 CB	28364
Utrecht Centraal	UT	3511 CE	164383
Zwolle	ZL	8011 CW	34597

Table 4-1; Relevant stations (Source; NSR 2009)

Station Selection

Selection of the eight units, two in each case, will be done according to the four key performance indicators;

1. Real estate value in a station area
2. Number of passenger making use of a station
3. Turnover at retail outlets
4. Customer satisfaction with aspects of a station area

Real estate value in a station area

The influence of "nearness" to a railway station on value of real estate has been researched by many (Rietveld, Debrezion), quantifying this relationship has been proven difficult. In order to use this KPI, rent levels of offices will be compared to the average price levels in the city concerned. This will tell us something about the development of real estate prices surrounding the stations *relative* to that of the city and smoothes out the difference between office space markets. An overview of these relationships will be presented in the next chapter.

Number of passengers at a station

It is easy to provide a list of passenger getting on and off a train at a station each day. Amsterdam CS and Utrecht CS

generate by far the largest amount of passengers, around 165.000 daily, or over 50 million each year. This however, does not say anything about the performance of these stations. In order to determine performance of a station it will be represented by its capture rate, the percentage of possible clientele a station is able to attract.

Turnover of retail outlets at a station

It is not surprising that Amsterdam CS and Utrecht CS boast the highest retail turnover among all stations due to their passenger numbers. In order to compare the different stations turnover will be measured with two indicators; Turnover per passenger (€/passenger) this will tell us something about the turnover that is extracted from the market. In order to measure the performance of retail outlets at a station, turnover per square meter of retail outlets is used (€/m²).

Customer satisfaction

NS is eager to find out how customers appreciate its service, customer satisfaction surveys are therefore carried out periodically. NS Poort has started doing its own surveys in order to find out how NS passengers value the different stations in the form of a grade between one and ten the *assumption* is made that the goal is to obtain a score of seven or higher, similar to that of NSR surveys. Data from these surveys will be used and the best and worst performer compared to the average will emerge.

All stations that fall in the demarcated group will be listed in excel and subsequently the four KPIs added to them. The "best" and "worst" will then be identified. This will lead to eight units, however these eight do not necessarily have to be eight different station areas since the overall performance of a station area is linked to all four KPIs

Method

In each case study twelve questions will be asked, these are linked to the variables in the generalization phase that will follow. The questions are divided into four groups based on Peek's four meta-values. Before presenting those questions a short recap of the meaning of the four meta-values seems to be in order.

Centrality describes the stations ability to provide access to and from activities within the city (micro) and access to activities elsewhere in the network (macro).

This can be established by determining the number of jobs and people that are situated within a 30 and 60 minute radius from the station. Data is available through the "Bereikbaarheidskaart".

Transfer Quality described the ability of the station to provide an inter-modal transfer (network <-> city) and inter train transfers (network <-> network).

Transfer quality can be described by the existing Rail-Station Quality Index (RSQI) along with the number of BTM lines available at the station and the population within a 15 minute radiu.s

Spatial Quality describes the ability of the station to provide a comfortable, safe and pleasant public space in the station area, location and complex.

The quality of the public space will be defined by the "leefbaarometer" a nationwide spatial quality index from the ministry of infrastructure and the environment.

Intensity describes the ability to provide a diverse range of activities and functions in the vicinity of the station.

Intensity will be described based on activities; living through the number of dwellings (CBS), jobs in a 15 minute radius (Bereikbaarheidskaart), and leisure by the number of cafés and restaurants and the number of department stores (CBS).

Results

The results from statistical analysis between a meta-value and a KPI of one station are then expected to fall within the football shaped cloud that is demarcated by the results of the "best" and "worst" performer. The case study will show whether the "best" or "worst" performer is an outlier and at the same time answer the question what causes it to be an outlier. The test cases will also indicate whether the variables that comprise one meta-value are reliable and useful or if variables have to be left out or altered in order to describe the overlying concept.

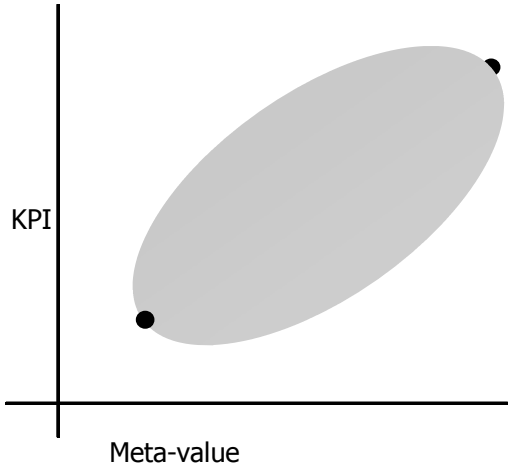


Figure 4-2; Expected "landing zone" of stations compared to "best" and "worst".

Existing measurement tools explained

Bereikbaarheidskaart, RSQI and Leefbaarometer what does it mean and how does it work? I will answer these questions in the following section before utilizing the tools in the four test cases.

The Bereikbaarheidskaart, literally "accessibility map" is a tool developed by Goudappel Coffeng based on findings from the Transumo project; a program in which over 150 Dutch companies, knowledge institutes and governments have cooperated in order to study the future of sustainable mobility. A mobility model based on OmniTRANS is able to calculate the number of jobs and population that is accessible *from* or have access *to* any four digit postal code in the Netherlands within 15, 30, 60, 90 and 120 minutes. Calculations can be made for transport by car or public transport in the current situation and for a 2020 forecast.

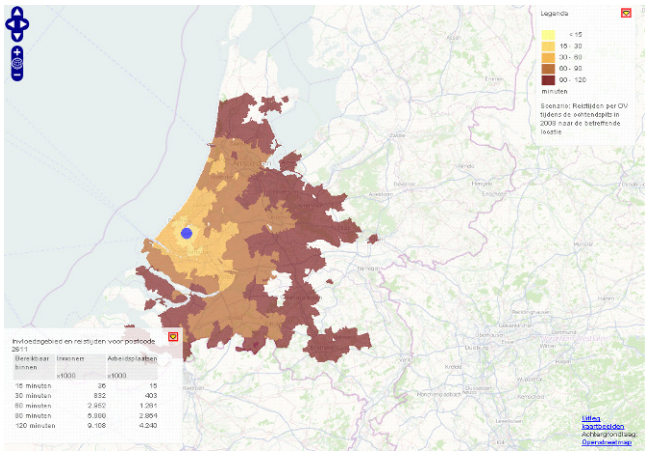


Figure 4-3; Accessibility of PC 2611, Delft by public transport (Source; Bereikbaarheidskaart 2008)

The large type 1 stations show the highest level of accessibility. Smaller stations in proximity to large type 1 stations thus benefit from this accessibility which they do not obtain from their own connections but through those of the large type 1 stations.

RSQI

The RailStation Quality Index or RSQI is a calculation method developed by Debrezion (2007) that determines, as the name suggests, the quality of a railway station. More specifically the quality of the transfer at the destination (attraction). The quality of the transfer at an attraction station is assumed to depend on three elements.

1. The number of trains that depart from the producing station, the point of origin of the passenger. This indicates the importance of the connections to other stations.
2. The average travel time between each producing station and the attraction station. This travel time depends on the average waiting time, actual time spent in the train and transfer time. An additional time "penalty" is added for each inter train transfer.
3. A ratio composed of the travel time between the two stations and the distance between those stations. This will indicate if the train takes a detour, whereby other modalities become more appealing.

The stations that show high RSQI scores are all situated in the Ranstad this is caused by the fact that they are situated in relatively close proximity to each other. Stations that have a direct connection to the large type 1 stations thus show a relatively high RSQI because they are close to that particular station.

Leefbaarometer

The Leefbaarometer is a spatial quality index developed by VROM, now a part of the ministry of infrastructure and the environment (I&M). It determines spatial quality of an area at a 6 position postal code level which usually encompasses only a single street. This enables the tool to show spatial quality at different levels ranging from a municipality to part of a neighbourhood.

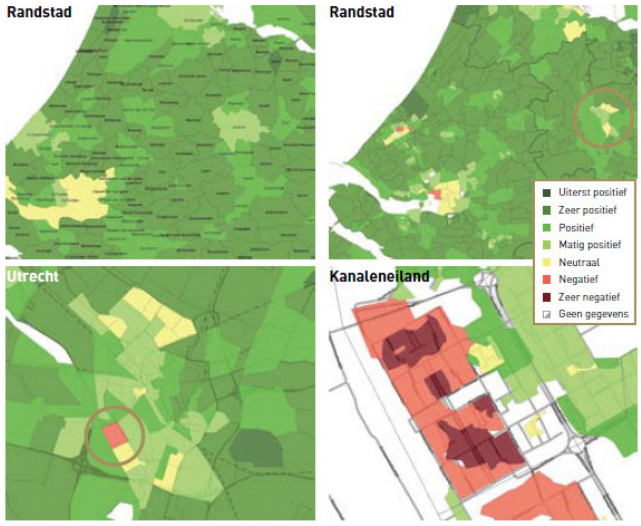


Figure 4-4; The Leefbaarometer at different levels (Source; VROM 2008)

Spatial quality is determined by opinions and behaviour of the population in other words derived from questionnaires and statistical data retrieved from CBS. The score that

ranges from "extremely positive" to "very negative" is made up out of 6 elements.

1. Quality of the housing stock
2. Quality of the public space
3. Level of amenities
4. Demographics
5. Social cohesion
6. Safety

Each element shows a score relative to the national average that ranges from -50 to +50 whereby 0 denotes the national average.

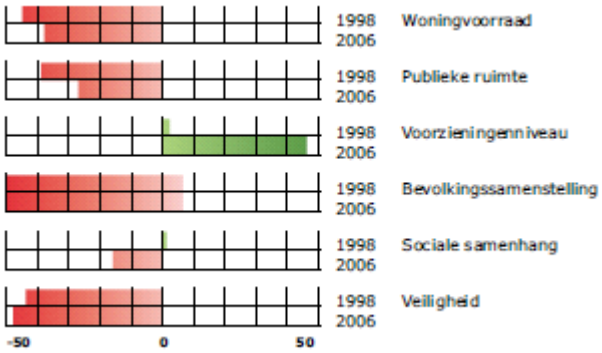
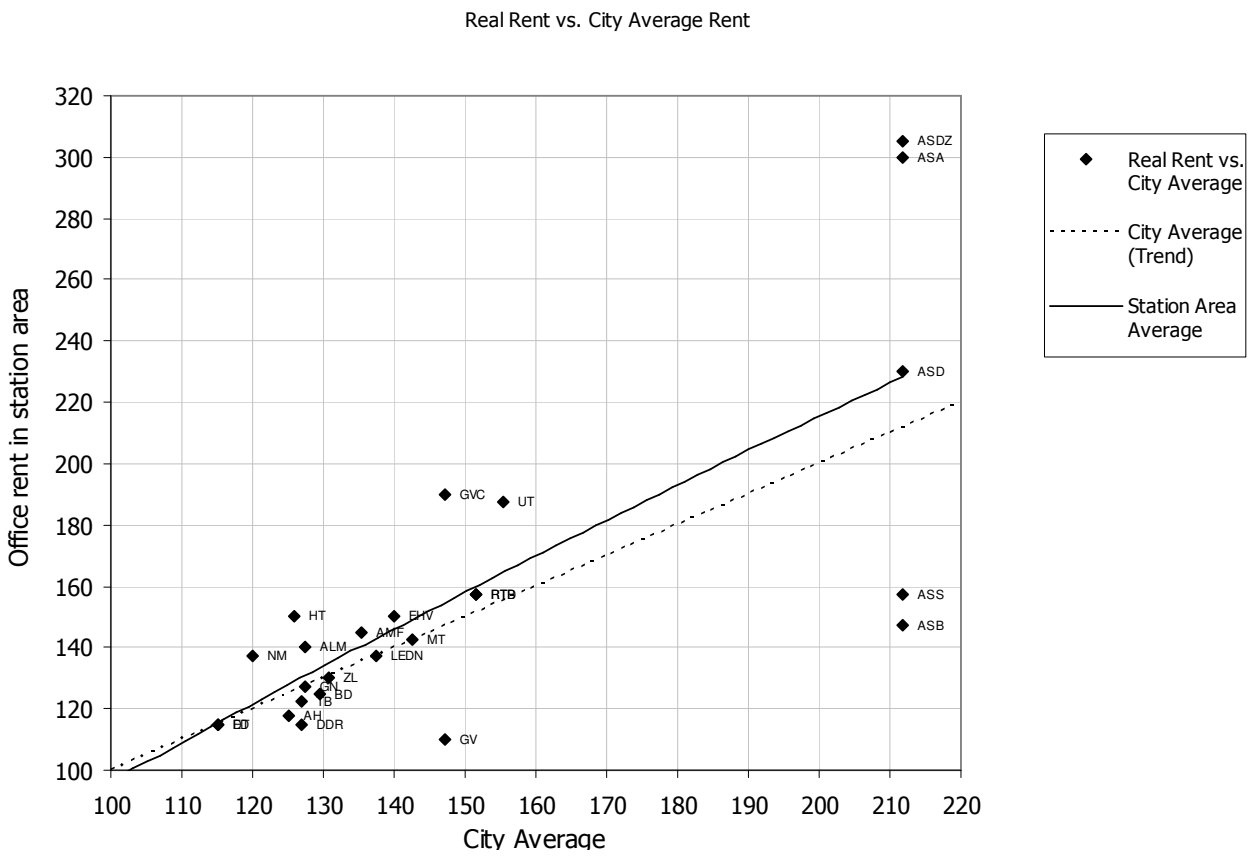


Figure 4-5; Elements that make up the "Leefbaarometer" (Source; VROM 2008)

When looking at the surroundings of a railway station only the relevant elements will be used; the quality of the housing stock for instance is not that important to an NS passenger who does not live in that particular area.



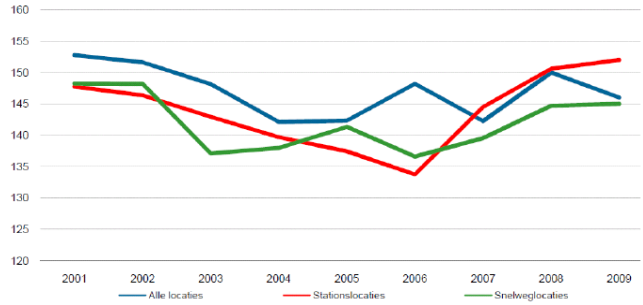
Graph 4-1; Office rent levels in station areas vs. city averages mid 2010 (Adapted from DTZ, 2010).

4.1 Test Case 1; Real Estate Value

4.1.1 Station Selection

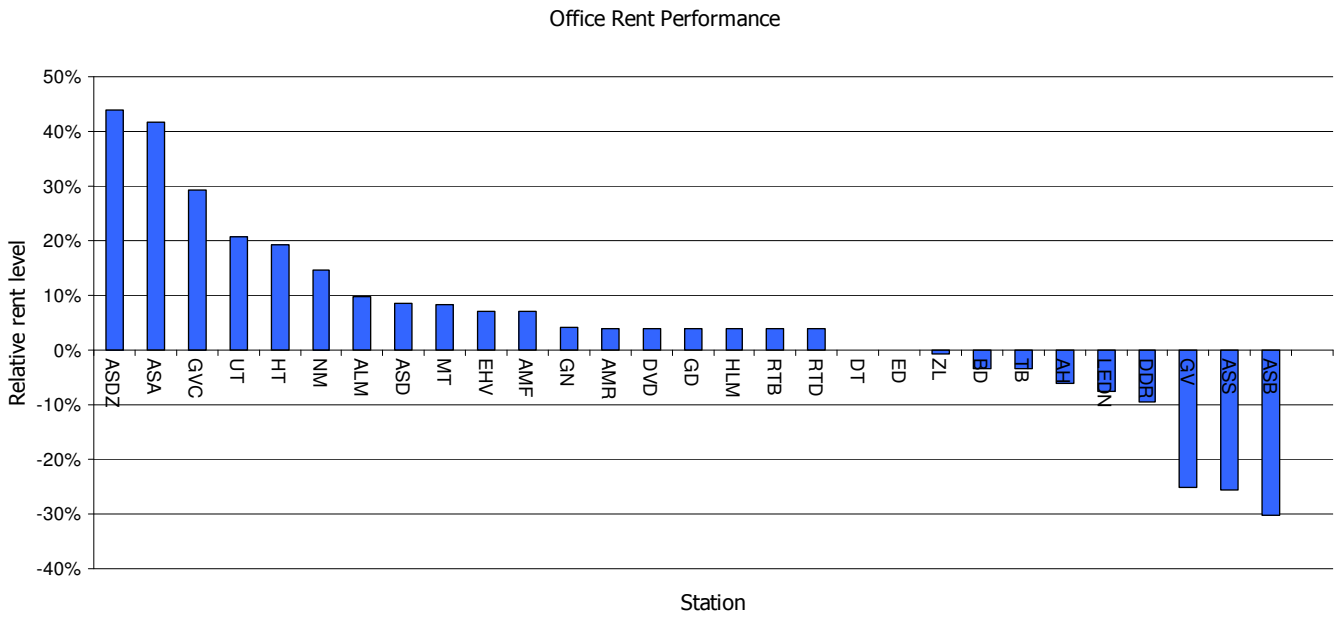
Graph 4-1 shows average office rent levels in station areas plotted against the average rent level in the same city. The dotted line denoted the barrier where rent levels in the station area are equal to the average rent level in the city. The blue dots above the dotted line denote station areas that outperform the city average, those under the dotted line, inversely denote stations areas in which rent levels underperform in comparison the city average.

The polynomial trend line indicates that office space rents in station areas are currently *generally* higher in comparison to the city average. This follows the conclusions made by, among others, De Graaff (2007), Kuenen (2008) and a recent study done by DTZ (see Graph 4-2). The trend line seems to be heavily influenced by the five Amsterdam stations; however underperformance at Sloterdijk (ASS) and Bijlmer ArenA (ASB) cancels high rent levels at Zuid (ASDZ) and Amstel (ASA). In other words when Sloterdijk, Bijlmer ArenA, Zuid and Amstel are removed from the graph the trend line remains unaffected.



Graph 4-2; Office rent performance highway location vs. station areas. (Source DTZ, 2010)

In order to determine a "best" and "worst" performer another type of ranking seems to be in order. Graph 4-3 shows the relative performance of station area office space rent levels depicted as a percentage increase or decrease over the city average. The spread in Amsterdam is clearly shown as well as the spread between Den Haag HS (GV) and Den Haag Centraal (GVC). The two Rotterdam stations Centraal and Blaak show similar rent levels and similar, although small, increases. This can be explained by the fact that these two stations are located on the fringe of the same office district.



Graph 4-3; Relative performance of station area office space rent levels mid 2010 (Adapted from DTZ, 2010).

The goal of this exercise is to find out why office space tenants are willing to pay a relatively higher rent at station x compared to station y. In order to do so, both office markets and stations have to comparable. This excludes Amsterdam since its office market as a whole is in a league of its own both in terms of square meters and rent levels, when comparing it to any other station in the country is unlikely to wield any meaningful results. The Hague has an office market which is heavily influenced by government organisations, occupying nearly half the total floor space (DTZ 2009). This leaves us, when working from left to right, with Utrecht not a very suitable candidate as well since its station is the nations second largest in terms of passengers and serves as the hub of the railway network.

's-Hertogenbosch, the next in line, has a medium sized and independent office market as well as a significant floor space in the station area. A suitable candidate on the side of the underperformers in terms of comparability seems to be Leiden, which has a similar sized station and an independent medium sized office market of which a substantial amount is located near the station.

4.1.2 **'s-Hertogenbosch vs. Leiden**

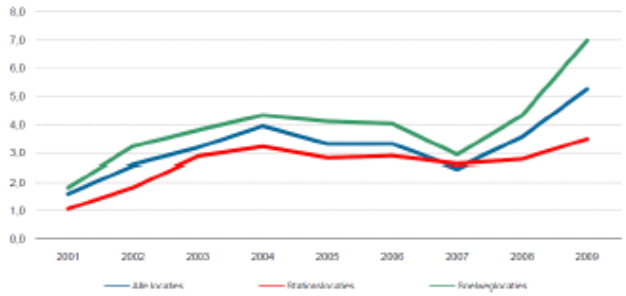
The goal in this test case is to establish whether Peek's four met-values serve as an explanation for the difference in *relative* office space rents in both station areas. Office space tenants are willing to pay 19% more compared to the city average to be located near station 's-Hertogenbosch whilst in Leiden, tenants are wiling to pay 8% less compared to the city average. The question is; Why?

In order to answer this, the two stations, 's-Hertogenbosch and Leiden will be compared separately for each meta-value. The first step in doing so, is determining whether the variables that where assumed to describe the different meta-values actually do so, and thus are able to explain the differences. If the variables do not explain the difference, an attempt is made to explain what does, and convert these findings into new variables that will be used in the next phase of this research.

First a comparison of the two stations based on their KPIs, shows a fairly large difference in passengers per day. Leiden, a type 1 station accommodates +/- 61.000 per day. 's-Hertogenbosch, in terms of passengers, the largest type 2 station accommodates +/- 43.000 passengers per day. The additional 18.000 passengers at Leiden are not translated into additional "willingness to pay" for office space. Supply and demand of office space in the station area thus is a crucial factor.

KPI	's-Hertogenbosch	Leiden
RE Value	19%	-8%
Passengers/Day ('08)	42946	60962
Turnover / Commuter[1]	114	88
Turnover / m²[2]	107	85
KTO	7,3	7,2

Table 4-2; Key performance indicators, 's-Hertogenbosch & Leiden Centraal . (Source; DTZ 2010, NSR 2008 & NSP 2010)



Graph 4-4; Supply/absorption ratio 2004 – 2010 (Source; DTZ 2010)

[1] *Confidential data, expressed as index, average equals 100.*

[2] *Confidential data, expressed as index, average equals 100.*

Although office rent performance is measured in comparison to the city average a look at supply and demand at both stations seems to be in order. Graph 4-4 shows supply/absorption ratios for different locations, the average ratio for station areas being 3.2%. A 1.5% percent ratio is believed to represent a balanced market (DTZ 2010) since it provides room for expansion and relocation.

Intensity	's-Hertogenbosch	Leiden Centraal
Supply 2009	13800 m²	28900 m²
Absorption 2009	22600 m²	12300 m²
Ratio Station	0,6	2,3
City vacancy	8%	11%

Table 4-3; Location specific data for 's-Hertogenbosch and Leiden (Source; DTZ 2010)

As Table 4-3 shows the supply/absorption ratio at both 's Hertogenbosch and Leiden is below the station area average let alone the national and highway location averages. 's-Hertogenbosch' ratio indicates that demand exceeds demand at the Paleiskwartier. This reflects the higher rent levels shown earlier and indicates low vacancy rates in comparison to the city average. Specific vacancy rates surrounding stations are unavailable however the objects in NS' Basisfonds Stationslocaties, which consists only of office space within station areas show a vacancy rate of 0,3% in 2009 (NS Poort Asset Development 2010)

In order to continue, the *assumption* is made that vacancy rates do not affect office rent levels in these two station areas and willingness to pay is determined by the characteristics of the location in relationship to alternatives within the city limits.

4.1.3 **Centrality**

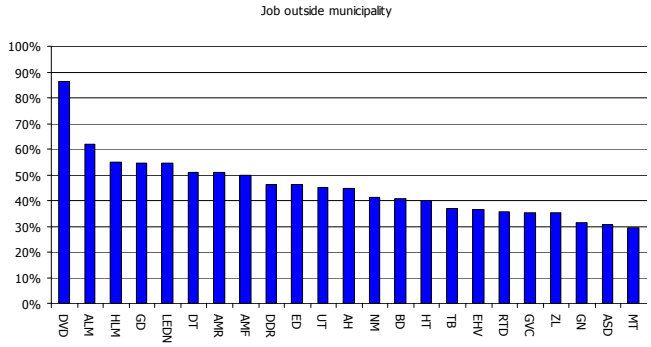
Added value of real estate in terms of centrality is described as access to skilled labour and customer base. A tenant is willing to pay more, if the location provides increased access to its potential labour force and clients. The meta-value centrality is described by the variables shown in Table 4-4.

Centrality	s-Hertogenbosch	Leiden Centraal
Inh. 30 min. (x1000)	263	654
Inh. 60 min. (x1000)	2390	3751
Jobs 30 min. (x1000)	128	300
Jobs 60 min. (x1000)	1196	1839
Attraction	61%	44%
Production	39%	56%

Table 4-4; Variables describing centrality (Source; Nationale Bereikbaarheidskaart 2008, NSR 2008, De Graaf et. al. 2007)

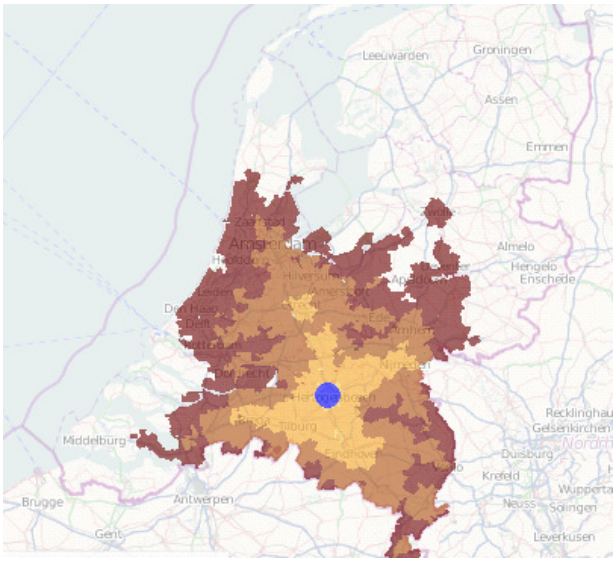
The number of inhabitants that are able to reach the station within 30 and 60 minutes by public transport are shown. The location is determined by the stations four digit postal code. The table also shows the number of jobs that can be accessed from the same point, by public transport within 30 and 60 minutes. A substantially larger group of inhabitants is able to access Leiden in comparison to 's-Hertogenbosch, A logical explanation for this difference is the fact that unlike 's-Hertogenbosch, Leiden is situated within the densely populated Randstad. The same argument is true for the number of Jobs which are accessible from both stations.

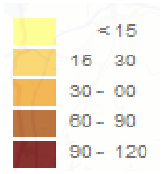
Production and attraction ratios show that 's-Hertogenbosch is destination for 61% of its passengers. Leiden on the other hand leans towards being a point of origin for its passengers with a 44% attraction ratio. This is reflected in the percentage of inhabitants working outside the municipality of residence, shown in Graph 4-5.



Graph 4-5; Precentage of population working outside the municipality of residence (Source; LISA 2009)

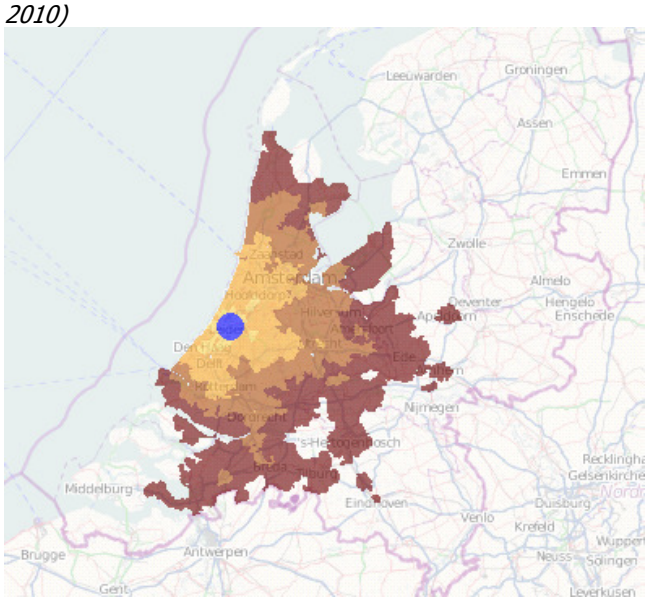
Although attraction and production ratios appear to influence rent levels, they will not be included in an overall comparison as they are a macro effect of centrality dependant on activities that are facilitated on a micro level.

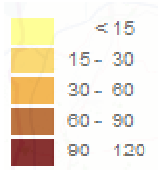




Accessible Within	Inhabitants x1000	Jobs x1000
15 minutes	13	18
30 minutes	263	155
60 minutes	2.390	1.247
90 minutes	6.729	3.411
120 minutes	11.708	5.469

Table 4-5; Number of inhabitants and jobs that have access to station 's-Hertogenbosch (Source; Bereikbaarheidskaart 2010)





Accessible Within	Inhabitants x1000	Jobs x1000
15 minutes	26	12
30 minutes	654	304
60 minutes	3.751	1.842
90 minutes	6.523	3.064
120 minutes	9.072	4.185

Table 4-6; Number of inhabitants and jobs that have access to Leiden station (Source; Bereikbaarheidskaart 2010)

The additional access Leiden Central provides to office space tenants over 's-Hertogenbosch is reflected in terms of absolute rents. Average office space rent in Leiden is €149/m² compared to €126/m² in 's-Hertogenbosch. This does not come as a surprise as this is proven most notably by Debrezion, De Graaff and Rietveld in a number of studies on the relationship between accessibility and office space rents.

The question remains why tenants are willing to pay more for a location near 's-Hertogenbosch station compared to other locations in the city and tenants in Leiden aren't willing to pay more to be located in the vicinity of the railway station. Centrality does not provide the answer to this question. This was to be expected since two office markets are being compared, in which local characteristics determine supply and demand and with it, value. The answer thus lies in local elements of both office markets and both station areas, in this case described by Peek's meta-values spatial quality and intensity.

Leiden's centrality does also imply its office market is in competition with other cities nearby, especially The Hague which is only 15 minutes away by train. In this sense Leiden's station area competes directly with those at The Hague Centraal and The Hague HS which both provide even better accessibility to the rest of the country and the Randstad in particular. In 's-Hertogenbosch this choice between stations is not offered to possible tenants of office space since it has less competition in the region.

Accessibility represented by population and jobs within 30 and 60 minutes seems to describe absolute rent levels as such they will be used in the next phase when the case findings are generalized.

4.1.4 **Transfer Quality**

As mentioned in the previous section dealing with the relationship between centrality and real estate value, absolute rents are dependant on macro scale meta-values. When looking at relative rent performance micro scale or local meta-values are important. Transfer Quality in the sense of access is a macro scale meta-value dealing with the access a station provides to its users. Therefore the relationship between transfer quality and relative rent performance is not expected to yield any results. For the sake of completeness I will present it anyway in order to compare real rent levels in the next phase.

Transfer Quality	s Hertogenbosch	Leiden Centraal
BTM/Day	21000	21000
Inter train transfers	15065	16351
RSQI attraction	1,33	1,82
RSQI production	0,953	1,285
KTO grade	6	6,6
BTM Lines	9	13

Table 4-7; Variables describing transfer quality (Source; NSR 2008, De Graafl et. al. 2007, CBS 2009)

As was to be expected based on research by De Graaff et. al. (2007) a higher RSQI does lead to higher absolute rent levels (€126/m² in 's-Hertogenbosch vs. €149/m² in Leiden). As Table 4-7 shows higher RSQI does also increase a passengers appreciation for a stations transfer quality depicted by the KTO grades. A higher RSQI which leads to a higher transfer appreciation does not seem to lead to additional transfers since inter train transfer and BTM transfers are almost equal at both stations. Since appreciation of transfer facilities is an effect of the facilities provided it will be omitted in the next phase.

Both the number of BTM transfer and the inter train transfers show equal levels implying little effect on real estate value. The number of transferring passengers is an effect of transfer capacity or vice versa, in order to prevent double measuring among variables and circle reasoning the assumption is made that transfer quality is determined by

the facilities the station provides and not by the number of that utilize them. Thus, RSQI and the number of BTM lines available determine capacity as such these three variables will be the only ones that will be included in the next phase.

4.1.5 **Spatial Quality**

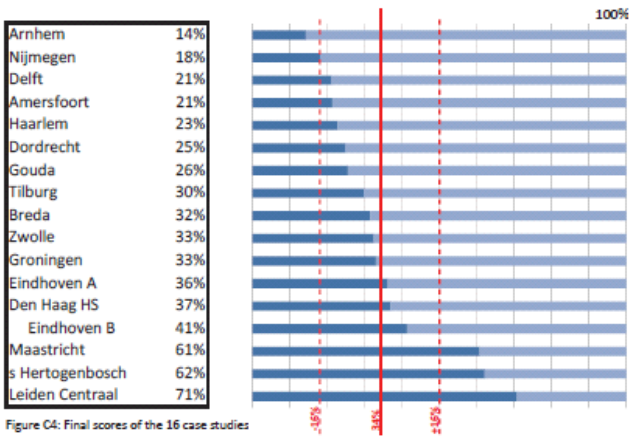
As studies performed by DTZ (2006) and the Netherlands Environmental Assessment Agency PBL (2009) have shown increased spatial quality has a positive influence on the value of real estate objects. Exact figures are unknown and both DTZ and PBL mention a "substantial" increase in spatial quality *might* cause an increase in rents between 2% and 10%. The conclusions presented by both DTZ and PBL are "soft" to say the least and therefore hard to prove, disprove or form a basis for real estate policy.

In order to answer the question; What do I want in terms of spatial quality in a stations surroundings? It seems logical to compare the quality of the station areas in both 's-Hertogenbosch and Leiden. Furthermore, since the rent is compared to the city average the quality of the stations surroundings will have to be compared to other office locations within the same city.

Spatial Quality	's-Hertogenbosch	Leiden Centraal
Spatial quality overall	62%	71%
Liveliness	9,67	10,5
Safety & comfort	13	14
Leefbaarometer	3	3
KTO overall	7,3	7,2

Table 4-8; Variables that determine spatial quality (Source; Brouwer 2010, CBS 2008)

Table 4-8 shows the variables that describe spatial quality, the top three are taken from "Fixing the Link" (Brouwer, 2010). Surprisingly, the two stations under consideration are the two stations with the highest spatial quality score out of the sixteen assessments Brouwer performed. The criteria safety & comfort shows far above average scores in both Leiden and 's-Hertogenbosch



Graph 4-6; Spatial quality scores of 16 links to city (Source; Brouwer 2010)

The fourth variable "Leefbaarometer", literally the quality of life index is a tool used by the Dutch ministry of Infrastructure and the Environment to measure quality of life in a number of geographical scales, in this research the smallest scale available, neighbourhood is used. The index gives an ordinal score to each geographical area based on surveys among people who live or work in that particular area. Each area is then

The neighbourhoods in which the stations Leidenand 's-Hertogenbosch are located both received a "positive" score, this is composed of the scores shown in Figure 4-7 and Figure 4-10 respectively.

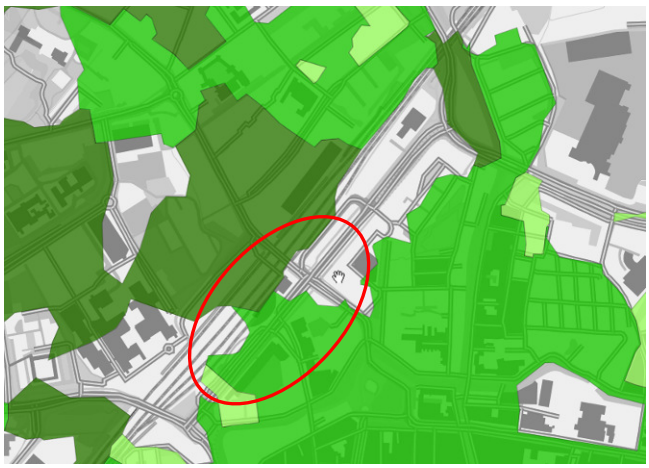


Figure 4-6; Leefbaarometer showing Leiden, neighbourhood Stationskwartier is circled (Source; Leefbaarometer 2008)

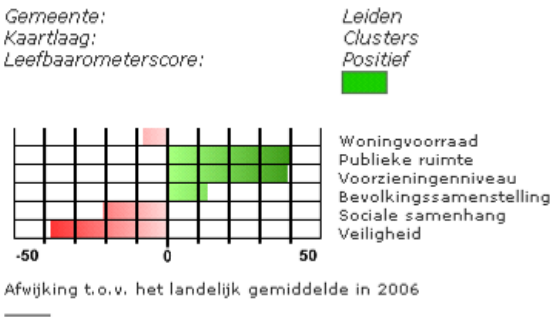


Figure 4-7; Score composition of station area Leiden Centraal (Source; Leefbaarometer 2010)

The fifth and last variable shown in Table 4-8 is the overall customer satisfaction grade for both stations. NS Poort conducts regular surveys in order to determine customer satisfaction of the services provided at and the quality of its stations. The questions encompass items ranging from cleanliness, safety to the availability of parking spaces and retail outlets. Currently the goal is to elevate the overall satisfaction grade of each station above seven. In both 's-Hertogenbosch and Leiden this goal has been achieved. Of all stations under consideration in this research 's-Hertogenbosch is ranked 4th whilst Leiden is ranked 5th Satisfaction again is an effect of spatial quality and thus not applicable in the next phase.

The variables presented in Table 4-8 do not explain the relative differences in office space rents. Spatial quality of

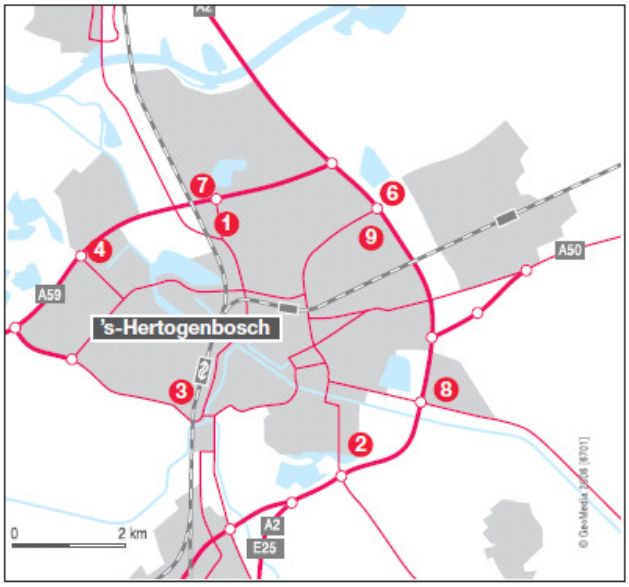
the station areas in Leiden and 's-Hertogenbosch is above average compared to all stations under consideration. Based on Brouwer, Leefbaarometer and NS Poort surveys the conclusion can be drawn that the quality of both stations is not only above average but con be considered "equal".

Since rent performance is measured in a percentage of the city average it is necessary to look at local spatial quality differences. Based on Brouwer, Leefbarometer and NS Poort surveys the conclusion has been drawn that both stations' spatial quality does not vary enough to explain the difference in rent levels. In 's-Hertogenbosch the offices in the Station and Paleiskwartier area show the highest rents in the city. Following PBL and DTZ this implies that these locations are the city's "highest" spatial quality office locations. Inversely, Leiden's station area shows below average rents implying that a higher quality office location is available within the city.

Quality of office locations in 's-Hertogenbosch and Leiden

In this section office locations from both cities will be compared with the spatial quality index of the neighbourhood of that particular location. A higher spatial quality index should indicate higher rent levels, explaining part of the difference between average office space rents in both cities.

In 's-Hertogenbosch DTZ distinguishes 8 different office locations shown in Figure 4-8. All but the Paleiskwartier area are located near highway ramps on the A2 and A58 highways and thus provide excellent accessibility by car.



Kantorenlocaties

'S-HERTOGENBOSCH

1 High Tech Parc
2 Pettelaarpark
3 Paleiskwartier
4 Rietvelden/De Vutter
6 Brabantpoort
7 Maaspoort
8 De Brand
9 De Herven

Figure 4-8; Office locations in and around 's-Hertogenbosch (Source; DTZ 2010)

When the locations on the DTZ map are compared to the map retrieved from the Leefbaarometer it becomes clear that non of the highway locations in 's-Hertogebosch achieve the same spatial quality index as the Paleiskwartier area. Thus it seems that this location indeed is the highest spatial quality office location available in 's-Hertogenbosch and is able to command the city's highest rent even though it is not easily accessible from the highways that surround the city.

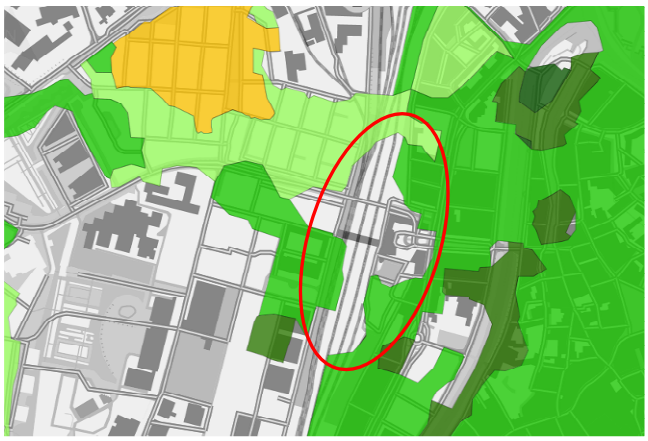


Figure 4-9; Leefbaarometer showing 's-Hertogenbosch, neighbourhood Paleiskwartier is circled (Source; Leefbaarometer 2008)

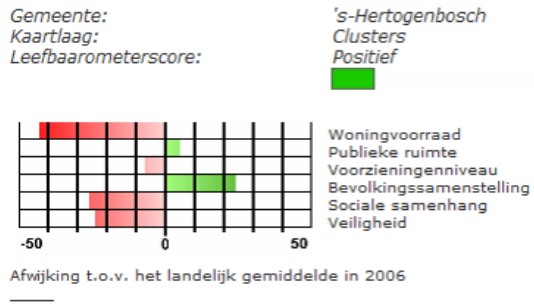


Figure 4-10; Score composition of station area 's-Hertogenbosch (Source; Leefbaarometer 2010)

DTZ distinguishes two office locations in Leiden, Central Station and Bio science-park shown by respectively 1 and 2 in Figure 4-11. The offices located in the central station area are located on the city side of the railway track, the bioscience-park stretches from the station to the A44 highway. When comparing this image to Figure 4-6 it becomes clear that bioscience-park has a "very positive" spatial quality index rating. This shows that Leiden indeed offers a higher quality office location in comparison to the station area and thus is, in part, a reason for higher rent levels.

Figure 4-11; Birdseye view of Leiden Bioscience Park stretching from station Leiden located on bottom right to highway A44 (Source; Leiden Municipality 2010)

Rent is higher when spatial quality index is higher
Leiden offers a higher quality office location compared to the station surrounding, this location bioscience-park is located on the west side of the station. Part of this area is within walking distance from the station.

4.1.6 **Intensity**

Added value of office space through intensity, what does this mean? First of all intensity in the form of a group office buildings which leads to nearness of competition, nearness of business to business clientele, sharing of knowledge sharing of facilities etcetera. This alone is not a recipe for a successful office district, as for instance the surroundings of Amsterdam Sloterdijk prove. This mono-functionality, however intense it may be, does not create liveliness in the area since it does not encourage the use of public space. Intensity adds value to an area when it consists of a functional mix in other words an intensity of functions that, besides office space, consist of dwellings, retail, leisure, public and cultural functions. Interaction between these different functions stimulate the use of public space and with it create liveliness within the area.

's-Hertogenbosch and Leiden Centraal are both located on the edge of the historic inner city traditionally characterized by mixed of functions. Offices surrounding both stations thus, should have easy access to a variety functions which are within a walkable distance. In order to answer the question; What does 's-Hertogenbosch offer in terms of intensity that Leiden doesn't? In order to find an answer first an overview of "intensity" is presented and reviewed variable by variable in an attempt to find a conclusive difference.

Intensity	s-Hertogenbosch	Leiden Centraal
Dwell./km²	2108	3029
Pop./km²	3733	5706
Adress/km²	1991	1161
Jobs 15 min. (x1000)	126	138
Inh. 15 min. (x1000)	1247	1842
Dept. Stores < 1km	4	5
Cafe/Rest < 1km	34,2	42,3

Table 4-9; Variables that determine intensity (Source; CBS 2008, Nationale Bereikbaarheidskaart 2008)

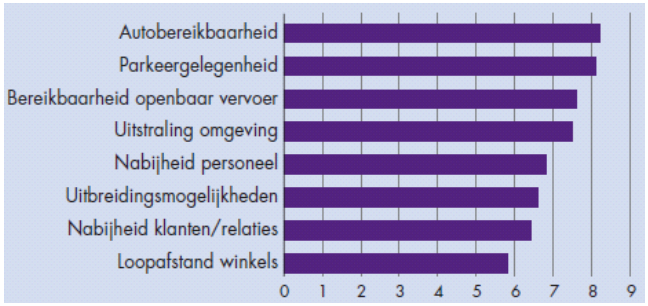
The first three variables give an idea of density in the two postal codes. Density which is an *effect* of (land) value is not be confused with intensity which is a *cause* of value. The number of dwellings in both areas do not differ much, in terms of density Leiden shows 30% more dwellings per square kilometre, this also reflected in population density.

When looking at the address density, which covers a one kilometre radius from the centre of the neighbourhood postal code, it shows that the 1km radius which encloses 's-Hertogenbosch' station area contains almost double the number of addresses in comparison to Leiden. This indicates less mono-functionality in comparison to Leiden. The number of inhabitants and especially jobs accessible from Leiden is higher; this was to be expected due to Leiden's location in the centre of the Randstad. Finally the availability of leisure functions, in this case, shopping and restaurants is almost equal at both locations.

As mentioned in the spatial quality section, Leiden offers a different type of intensity in the bioscience-park. This office park is destined as the prime location for bio-tech companies in the Netherlands. Bio-tech companies can benefit from the facilities Leiden University, its Academic Hospital LUMC and the companies themselves provide. This makes clustering attractive for potential tenants since bio-tech companies require high initial investments in, among others, equipment. High intensity of colleague corporations and public facilities improves the business case of the potential tenant and with it, willingness to pay.

The variables presented in Table 4-9 do not show significant differences in terms of intensity in the station areas of 's-Hertogenbosch and Leiden in a way that is able to explain the difference in office space rent that a tenant is willing to pay in comparison to city average. When comparing all station in the next phase of the research, one element per activity will be included to describe intensity of the built environment. "Living" will consist of the number of dwellings per square kilometre, "working" by the number of jobs within 15 minutes of the station, "shopping" by the number of department stores within a kilometre radius and finally "leisure" by the number of cafés and restaurants within a one kilometre radius

Figure 4-12; New 30.000m² Achmea office next to Leiden station (Source; VVKH Architecten 2010)



Graph 4-7; Most important decision criteria for office locations (Source; Bak 2009)

4.1.7 **Wrap Up**

The goal of this test case was to establish which variables are relevant and applicable in describing the effect of the four meta-values on the *relative* value of real estate in this case rent of office space. None of the meta-values have shown clear differences that enable to pinpoint a cause and effect relationship between the meta-values and relative rent. In terms real rent levels differences become clear when looking at macro properties, centrality and transfer quality. It therefore seems reasonable to include both real and relative rent in the next phase.

In the next phase where the objective is to generalize the finding of this test-case centrality is described by access to customers and skilled labour represented by jobs and population accessible within 30 and 60 minutes. Transfer quality is described by the way a station is able to facilitate inter modal transfers represented by the railway station quality index (RSQI) and the number of available BTM lines. Spatial quality is described by the "Leefbarometer". Finally Intensity is described by the availability of four activities, living represented by the number of dwellings per km², working by the number of jobs accessible within 15 minutes, shopping by the number of department stores within a one kilometre radius and lastly leisure represented by the number of cafés and restaurants within a one kilometre radius. An overview of the variables to be used is shown in Table 4-10.

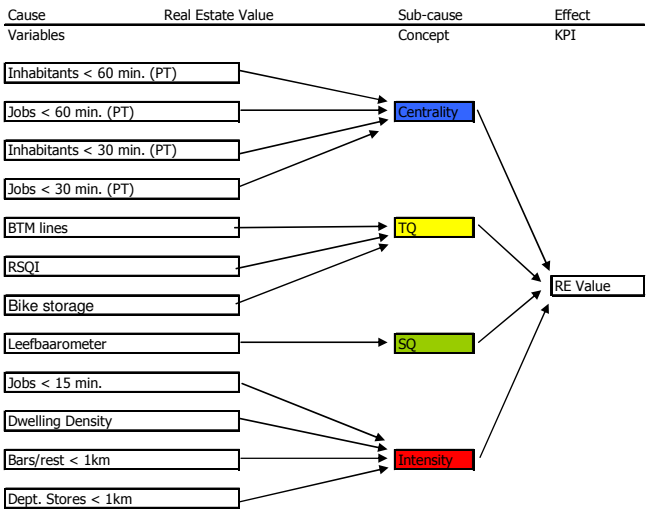
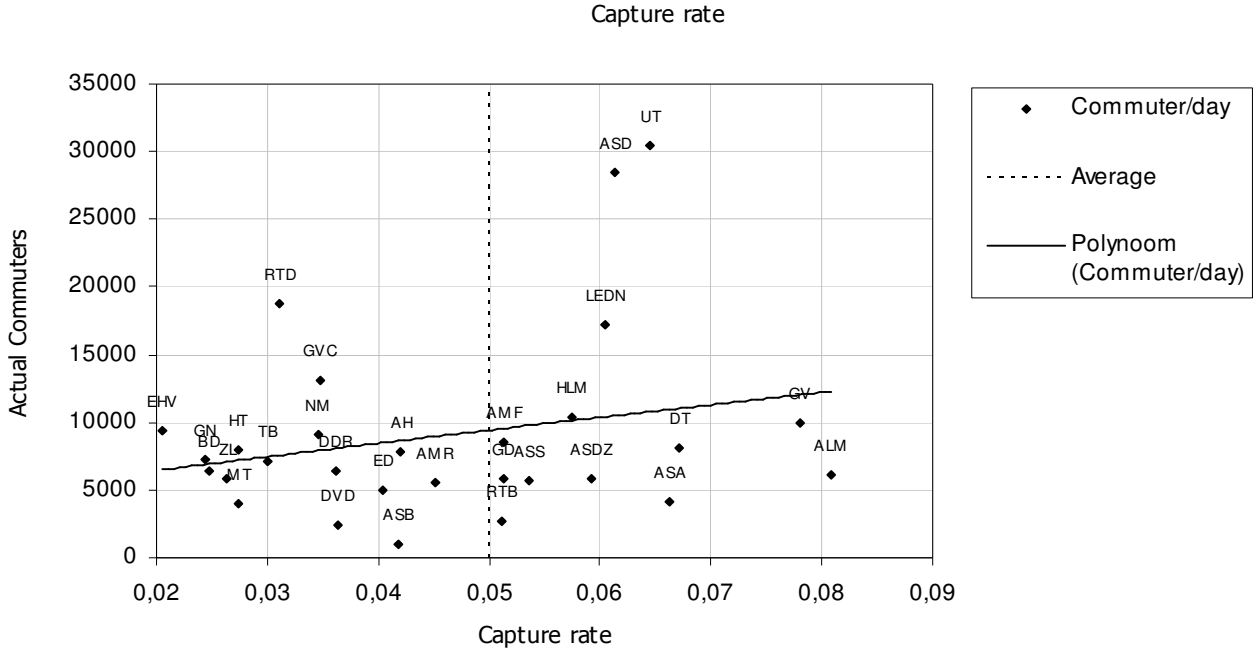


Table 4-10; Overview of variables describing the four meta-values.



Graph 4-8; Capture rates of all stations under consideration

4.2 **Test Case 2; Number of passengers**

4.2.1 **Station selection**

When comparing two stations on the number of passengers generated it is not useful to do so in absolute numbers. Amsterdam Central station, the busiest in the Netherlands, accommodates 160.000 passengers each day, whilst Duivendrecht for instance only accommodates around 12.000 each day. In order to compare a stations performance we then have to look at its capture rate. In other words how many passengers does the station capture from its potential customers.

This potential number of passengers is then divided into two segments; production and attraction. The term production describes the passengers that use the station as the starting point of their train journey. Attraction inversely refers to the number of passengers that pass through the stations as the destination of their train journey.

Production

In the case of production we can describe a stations capture rate as the number of that the station produces in relation to the number of potential NS customers that live in the stations service area. A stations service area is made up of a number of four digit postal codes. Through surveys NS has determined the percentage of passengers originating from each of these postal code areas, this has resulted in a dataset that describes station usage for each Dutch postal code. In other words for every postal code it is known that X% of its population is likely to use station 1 and Y% uses station 2 etc. This data is multiplied by the number of inhabitants of each PC obtained from CBS resulting in an absolute number of possible passengers for each station.

When expressing the number of passengers a station produces as a percentage of its possible "market", we can thus determine a capture rate for each station, resulting in Graph 4-6. The graph shows two extremes, Eindhoven (EHV) with a capture rate of 2% and Almere (ALM) with a capture

rate of 8%. In the Netherlands the share of rail in total yearly passenger kilometres is 9.1% (Eurostat, 2009) thus on average 4.6% of all daily passengers use the train. The average capture rate of all stations under consideration is 5% the difference can be explained by the capacity of the stations involved since the stations under consideration are the countries largest.

Before comparing the "best" and "worst" performing station, an overall analysis of all stations under consideration is in order. Graph 4-8 shows capture rates of all stations, at first glance a few observations can be made;

All stations that show above average capture rates are also stations located in cities that are interconnected by notoriously congested highways. All large stations in Noord-Brabant for instance show below average capture rates whilst most station in the Randstad show above average rates. Another striking difference is the fact that Den Haag CS (GVC) and Den Haag HS (GV) show very different capture rates, 3.5% and 7.8% respectively. In Amsterdam on the other hand, all five stations (ASD, ASS, ASDZ, ASB & ASA) are fairly concentrated between 4.2% and 6.7%.

4.2.2 **Eindhoven vs. Almere Centrum**

In this test-case an effort is made in finding out whether Peek's four meta-values serve as an explanation for the difference in attracting passengers. Eindhoven has a capture rate of 4% whilst Almere Centrum captures four times as much passengers from its service area. First I will start by presenting the key performance indicators for both stations.

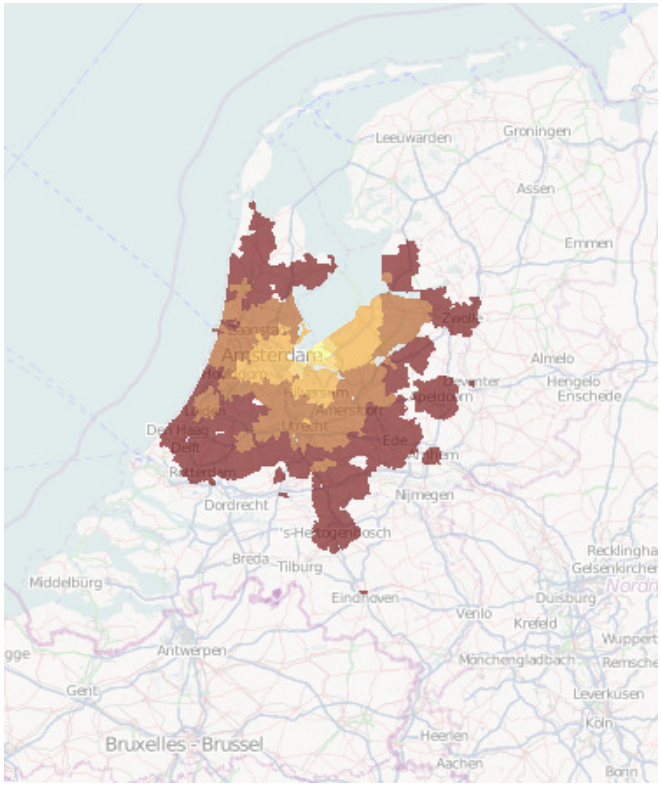
KPI	Eindhoven	Almere Centrum
RE Value	7%	10%
Passengers/Day ('08)	55251	20010
Turnover / Commuter[3]	124	60
Turnover / m²[4]	114	75
KTO	7,1	6,9

Table 4-11; KPIs of Eindhoven and Almere Centrum (Source; DTZ, 2010, NSR, 2008, NS Poort, 2010)

Table 4-11 shows that Eindhoven is host to 55.000 passengers everyday compared to 20.000 in Almere Centrum. Table 4-12 shows the variables that describe the meta-value centrality, it shows the production and attraction ratios for both stations. When multiplied with the number of daily passengers the number of people who use the station as point of origin is determined.

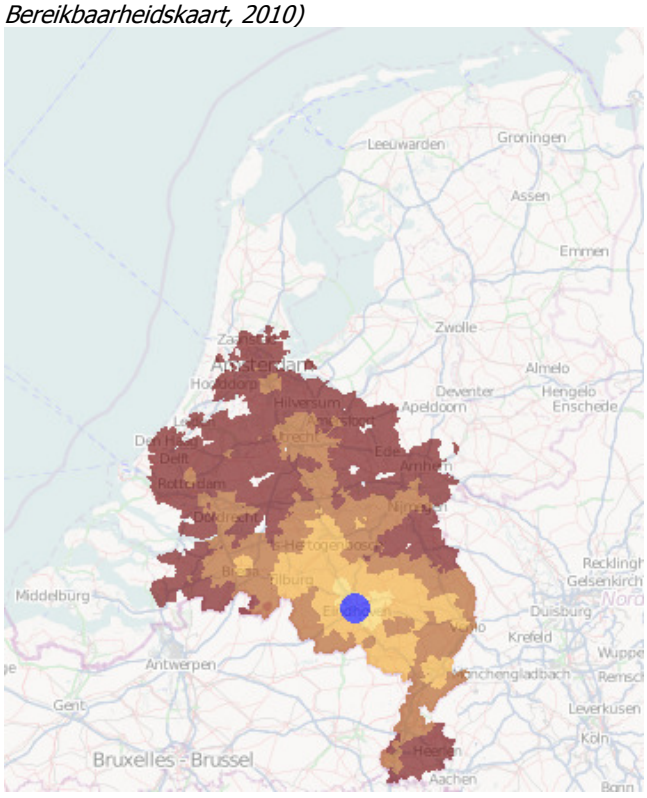
4.2.3 **Centrality**

Centrality is perceived to be the main cause of commuter numbers since it provides "access" to activities; a more central "place" is thus able to provide more "access" within the network. Centrality thus is measured by the number inhabitants that can reach the station and the number of jobs that can be reached *from* the station within 30 and 60 minutes.



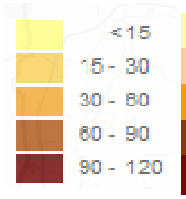
Accessible Within	Inhabitants x1000	Jobs x1000
<15		
15 minutes	81	41
15 - 30		
30 minutes	194	79
30 - 60		
60 minutes	1.581	933
60 - 90		
90 minutes	3.759	1.897
90 - 120		
120 minutes	7.508	3.57

Figure 4-13; Number of inhabitants and jobs accessible from Almere Centrum by public transport (Source; Nationale Bereikbaarheidskaart, 2010)



[3] *Confidential data, expressed as index, average equals 100.*

[4] *Confidential data, expressed as index, average equals 100.*



Accessible Within	Inhabitants x1000	Jobs x1000
15 minutes	11	28
30 minutes	383	210
60 minutes	1.592	835
90 minutes	4.441	2.221
120 minutes	9.809	4.67

Figure 4-14; Number of inhabitants and jobs accessible from Eindhoven by public transport (Source; Nationale Bereikbaarheidskaart, 2010)

Centrality	Eindhoven	Almere Centrum
Inh. 30 min. (x1000)	412	194
Inh. 60 min. (x1000)	1658	1564
Jobs 30 min. (x1000)	210	79
Jobs 30 min. (x1000)	835	933
Attraction	64%	35%
Production	36%	65%

Table 4-12; Variables that determine centrality (Source; Bereikbaarheidskaart, 2010 & NSR, 2009)

At first glance it seems Eindhoven provide access to twice the number of jobs compared to Almere and twice the number of inhabitants have access to it, this is reflected in passenger numbers, this is only true for the 30 minute radius. When considering the 60 minute radius of both stations it shows that Almere provides access to slightly more jobs, and almost an equal number of inhabitants have access to Almere Centrum, this is not translated in equal commuter numbers.

	Eindhoven	Almere Centum
Population Service Area	922840	268890
Potential Passengers in SA	458407	75701
Commuter Production	19658	12977

Table 4-13; Commuter production (Source; NSR, 2009)

Table 4-13 shows population in both service areas, along with the number of potential passengers and actual production. In combination with Table 4-12, it becomes apparent that Eindhoven services a larger area, far beyond the 30 minute radius, whilst in Almere this is not the case. This can be explained by the number of railway stations in Almere; 5. The number of potential passengers is explained in the same manner, since anyone in Almere can choose between 5 stations as starting point for their train journey.

Overall we can conclude that the variables shown in Table 4-12 do describe the number of passengers. The variables are however unable to explain the stations capture rates. Alterations to the variables will have to be made in order to describe a stations capture rate. In the next few paragraphs I will try to find an answer to the following question;

How is Almere Centrum able to capture 17% of its potential passengers whilst Eindhoven only manages to capture 4%?

Congestion

Whilst Eindhoven boasts the lowest capture rate, the stations in the other three "large" cities in Noord-Brabant, Breda, 's-Hertogenbosch and Tilburg show below average capture rates as well, 5, 6 and 6% respectively. The stations located in the north wing of the Randstad all show above average capture rates.

A probable explanation for the differences in production capture rates related to centrality is highway congestion. Increasing congestion decreases centrality by automobile. The highways that focus on the four large Dutch cities suffer from high congestion, most notably the highways A1, A2, A4, A10, A13 and A20. Figure 4-16 shows a map of the Randstad and the highways that notoriously congested during peak hours.

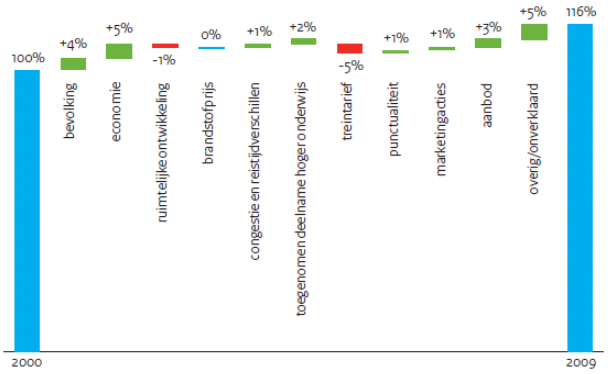


Figure 4-15; Increase of passenger rail usage between 2000 and 2009 explained (Source; KiM, 2010)

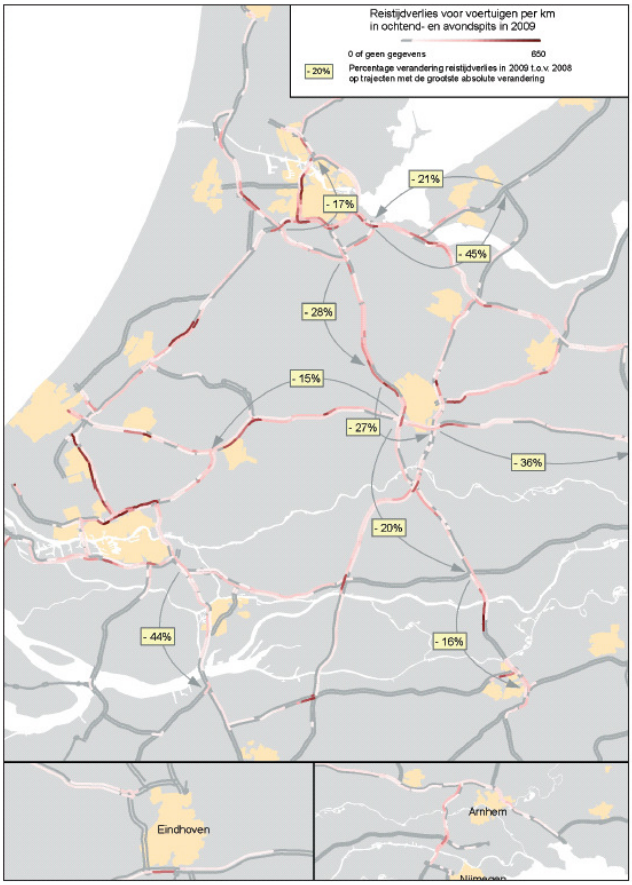
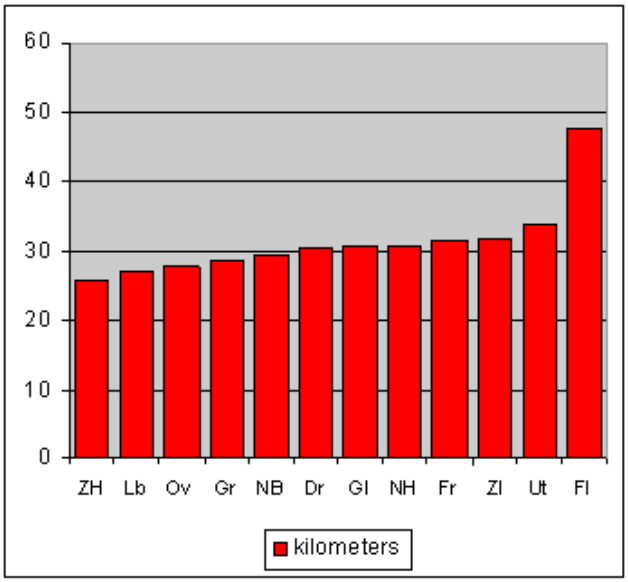


Figure 4-16; Congestion 2008 – 2009, The economic crisis is the main cause of decreasing congestion (Source; KiM, 2010)

The highways surrounding the four abovementioned cities in Noord-Brabant show considerable less congestion in comparison to those in the Randstad. Since congestion is an incentive to use alternative modes of transport, more congestion is expected to increase the number of passengers (Transumo 2008). The Dutch department of Infrastructure and Environment however has shown that the number of additional passengers due to congestion has been 1% in the 2000-2009 period whilst the congestion has increased travel times by 40% in the same period (KiM, 2010). These are national averages and thus regional variations occur, note Figure 4-17.

In 1999 CBS calculated the national average commuting time at 46 minutes, or 29 km. When looking at Figure 4-17 the assumption can be made this hasn't decreased since. In this research it is shown that people who commute by train travel, on average, 72 km when doing so. Inhabitants from the province of Flevoland travel, on average, 48 km to their place of employment (*Graph 4-9*).



Graph 4-9; Average commuting time per province (Source; CBS/VROM, WoningBehoefte Onderzoek, 1999)

Since average travelled distance by train is longer compared to that of automobiles the conclusion can be drawn that if the home work distance becomes larger the train becomes a more appealing alternative. And thus serve as an explanation for Almere's high capture rate.

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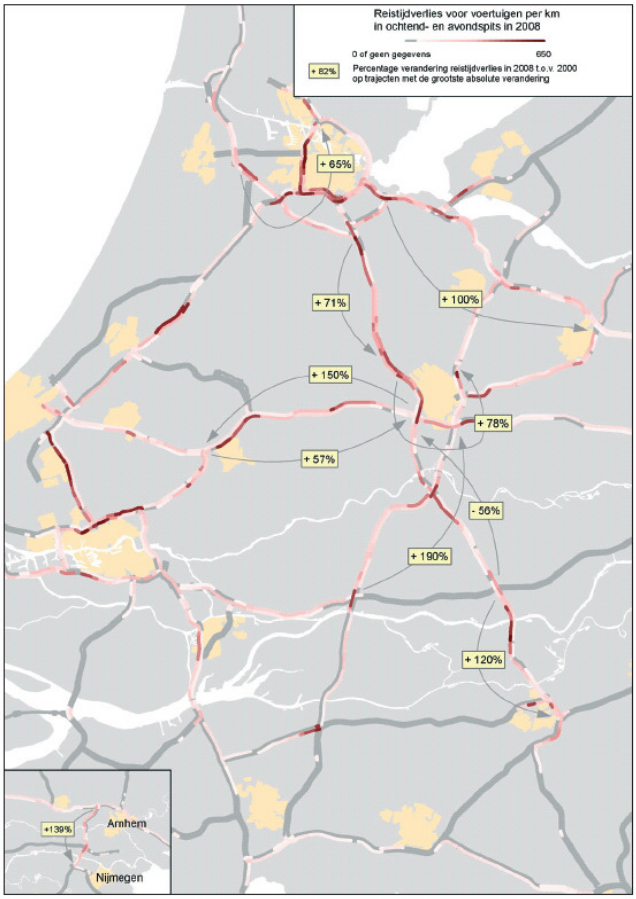


Figure 4-17; Change in travel time on highways 2000 – 2008 (Source; KiM, 2010)

In order to broaden this assumption it still has to be operationalized in a way that describes the train as an alternative to the automobile in such a way that it describes *centrality* as an added value. I will do so using de "Nationale Bereikbaarheidskaart", it shows number of jobs that can be accessed from a certain postal code within the Netherlands in both peak and normal road conditions and by using public transport. In order to determine the loss of accessibility caused by congestion, the number of jobs accessible in peak conditions will be shown as percentage of accessible jobs in normal conditions. The inverse of this percentage shows the loss of accessible jobs as shown in Table 4-14.

Accessible	Eindhoven	Almere Centrum
Jobs 30 min by car	638	984
Jobs 30 min by car (peak)	325	339
Accessibility loss	49%	66%
Jobs 60 min by car	2444	3830
Jobs 60 min by car (peak)	1203	1915
Accessibility loss	51%	50%

Table 4-14; Accessibility loss due to congestion (Source; Nationale Bereikbaarheidskaart, 2008)

Both points of origin show a considerable diminished accessibility of jobs in peak hours. Almere shows a little higher loss. When keeping in mind Figure 4-13 & Figure 4-17 which show the accessibility and congestion it becomes clear that Almere's accessible jobs form a circle around the city, in real life most passengers who live in Almere work in greater Amsterdam which is also the cause of the distorted attraction and production ratios. Amsterdam is accessible by car through the highly congested A6, A1 and A10 highways. It is thus probable that congestion loss on the route between Almere and Amsterdam is much higher than Table 4-14 shows.

Based on the two stations under consideration the relationship is still unable to pinpoint an exact cause and effect relationship. It seems reasonable however to replace population and jobs accessible from a station by the loss of accessibility to those jobs and population by car. This will express how appealing the train becomes as an alternative mode of transport as congestion increases.

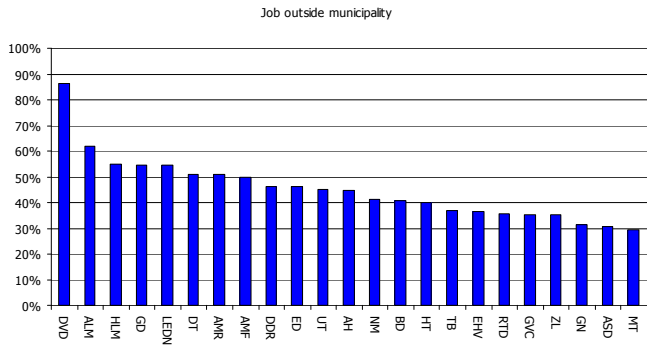
Travel motive

Congestion will only affect the outgoing commuter traffic if people actually work outside the municipality they reside in. In order to accommodate this conclusion the number of jobs available within the municipality, the municipal labour force and the percentage of the labour force working outside the municipality are taken into account.

	Eindhoven	Almere
Jobs in municipality	150810	80230
Labour force	96400	88400
% Job outside mun.	36%	62%

Table 4-15; Jobs and labour force in Eindhoven and Almere (Source; LISA 2009 & CBS, 2005)

Table 4-20 shows the number of jobs available in Eindhoven and Almere, it becomes clear that Eindhoven's labour force is unable to fill all local jobs, whilst Almere has a labour surplus. This is reflected in the percentage of the labour force working outside the municipality they live in, 36% in Eindhoven compared to 62% in Almere which is the largest share in any of the municipalities considered (Duivendrecht is an outlier; workforce of 5800 people). The stations completing the top 4 are all located on congested highways and all show above average capture rates.



Graph 4-10; Percentage of labour force working outside municipality (Source; CBS, 2005)

The number of inhabitants that work outside the municipality they reside in seem to be an explaining variable for a stations capture rate. Therefore it will be combined with the variables representing accessibility loss when describing the meta-value centrality.

4.2.4 **Transfer Quality**

When determining the influence of transfer quality on the capture rate of a station, transfer quality is described as the quality of the transfer from ones front door to the station and after arriving at the station, the transfer into the train that is able to take the commuter directly to his or her destination. In both Almere and Eindhoven a commuter has four options to travel to the station, on foot, by bike, by car or by bus. In order to facilitate these options, the station has to offer enough parking facilities for bikes and cars and sufficient bus-lines that connect the station to its service area.

Eindhoven shows a higher RSQI for both production and attraction, this is translated into a higher number of inter-train transfers and a higher number of BTM passengers using the station. Perceived transfer quality is equal as well as the number of available city bus lines although those in Almere provide faster transfers through dedicated bus lines.

Transfer Quality	Eindhoven	Almere Centrum
BTM/Day	21000	4000
Inter train transfers	10394	195
RSQI attraction	0,86	0,50
RSQI production	0,687	0,5
KTO grade	6,5	6,6
BTM lines	13	14
Inh. 15 min. (x1000)	11	81

Table 4-16; Variables that determine transfer quality (Sources; NS, 2009, De Graaff et. al. 2008 & CBS, 2008)

As Figure 4-18, shows, the fact that Almere Centrum is located on a line that has its terminus in Lelystad explains a low RSQI score, and with it a low number of inter train transfers. Transfer quality may increase but in the case of Almere it will not generate additional passengers. In 2012 the Hanzelijn will be opened, connecting Lelystad to Zwolle and in the process transforming Almere Centrum into a "gateway to the north". This is expected to drastically increase the number of inter train transfers and the number of daily passengers at Almere to 100.000 per day. (NPC 2010) Since BTM and inter train transfers are an effect of both RSQI and the number of BTM lines available these two variables will be omitted as well as the stations transfer KTO grade which also depends on the availability of transfer facilities.

After reviewing Table 4-16 the conclusion can be drawn that although Eindhoven's higher RSQI does indeed generate more inter train transfers and more BTM passengers, it does not cause an increased capture rate. Transfer quality on a local scale in the form of accessibility by local public and personal transport might provide the answer. Since easy access in the form of reduced travel time is an incentive to use the station as starting point (Peek, 2007).

RSQI

As stated in Table 3-3, an increase in transfer quality is expected to increase the number of passengers by 25-50% (De Graaff et. al. 2007). A well connected station thus, should show a higher capture rate compared to a station which is less well connected to others. De Graaff's conclusion is valid in this case as Eindhoven's higher RSQI does indeed reflect a higher number of passengers.

The question remains why a well connected station in terms of a higher RSQI such as Eindhoven does not manage to attract as many passengers from its service area as a less well connected station such as Almere. The answer lies in the RSQI of Almere Centrum and the way it is composed. Almere's lower RSQI can be explained by its location, on the Flevolijn. This line which was opened in 1987 connects Lelystad and Almere to Amsterdam and Utrecht. The line terminus is Lelystad limiting the possible RSQI scores for all stations located on it (see Figure 4-18).

Figure 4-18; Cut-out of the Dutch railway map showing Almere, Utrecht and Amsterdam (Source; ProRail 2010)

Since over 90% of the passengers that Almere Centrum produces travel away from Lelystad. On top of this 40% of the passengers travel to Amsterdam (22% Amsterdam CS, 7% Amsterdam Sloterdijk, 6% Amsterdam Zuid and 6% to Duivendrecht) Almere's RSQI does not reflect the actual quality of this connection as 90% of all passengers travel in one direction (see Figure 4-19).

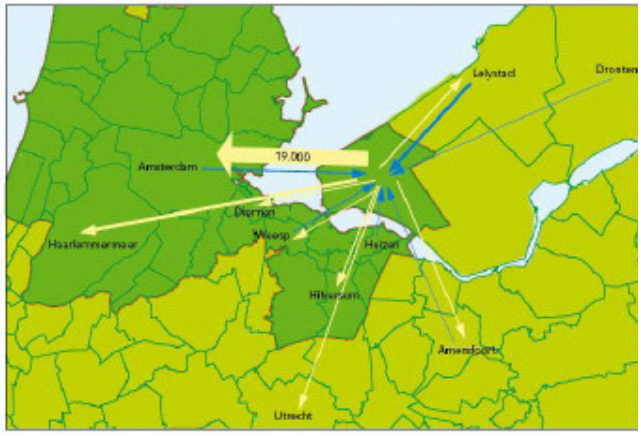


Figure 4-19; Outgoing commuter traffic from Almere (Source; O+S Amsterdam 2008)

Station Almere Centrum provides an acceptable pre-transport time to 81.000 people or 43% of the total Almere population compared to 11.000 in Eindhoven. This is achieved through the bus system serving Almere which makes use of dedicated bus lanes that enable a significant reduction in travel time to and from the Almere railway stations which are the hubs in the network.

In terms of absolute production, a significant relationship exists between the number of passengers and the number of inhabitants that are able to reach the station within 15 minutes. Translating absolute commuter production into the capture rate is done by dividing it by the stations potential customer base. In order to achieve the same relationship

the percentage of the population in the service area living within 15 minutes of the station has to be known. An attempt to do so will be done by overlaying the image from the "Bereikbaarheidskaart" with the postal code map of the Netherlands.

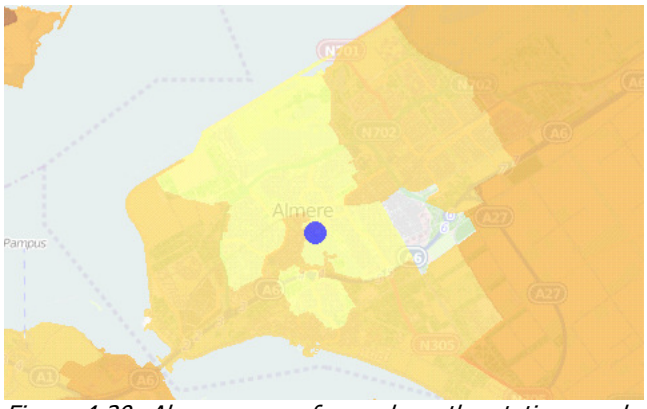


Figure 4-20; Almere, areas from where the station can be reached within 15 minutes by public transport (Source; Bereikbaarheidskaart 2008)

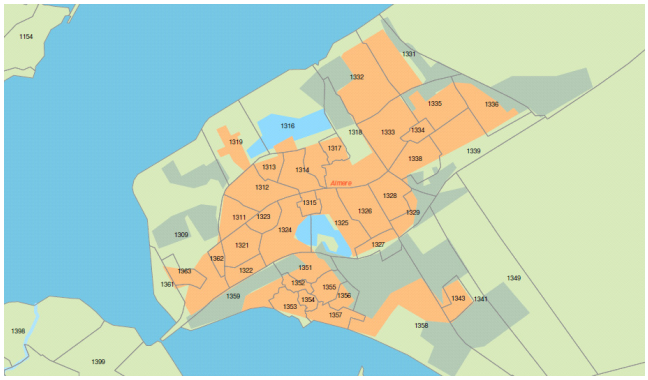


Figure 4-21; Almere in postal codes (Source; Postcode.nl 2010)

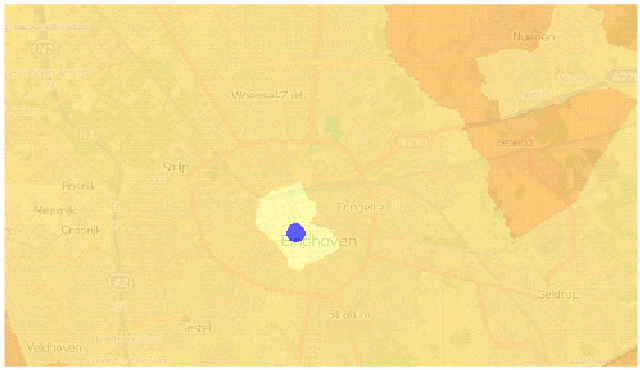


Figure 4-22; Eindhoven, areas from where the station can be reached within 15 minutes by public transport (Source; Bereikbaarheidskaart 2008)

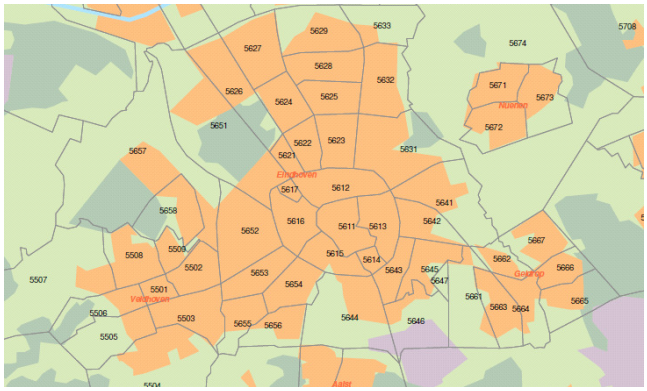


Figure 4-23; Eindhoven in postal codes (Source; Postcode.nl 2010)

The four maps above show results from the "Bereikbaarheidskaart" and the corresponding area form the postal code map. From the postal codes the potential passengers have been established. Since the number of potential passengers per postal code is known and whether it lies within 15 minutes from the station, the percentage of possible passengers living within 15 minutes can be established, resulting in Table 4-17.

Centrality	Eindhoven	Almere C.
Inhabitants 15 min.	9765	85565
Potential passengers	458407	75701
Potential passengers 15 min.	9543	45695
% within 15 min.	2%	60%

Table 4-17; percentage of possible passengers living within 15 min. of a station (Source; CBS 2008 & NS MOA 2008)

The table tells two things, first of all nearly all inhabitants living within the 15 minute radius can be considered as the stations potential customers. Second, only 2% of potential customers at Eindhoven are able to reach the station within 15 minutes compared to 60% in Almere. It thus seems reasonable use the potential passengers within the 15 minute radius in the next phase when relating between capture rate and transfer quality.

The final addition to the variables is that define transfer quality is the ability of the station to supply adequate facilities for bike storage. As Table 4-18 shows, Almere provides adequate facilities in comparison to demand whilst Eindhoven does not. The ease with which ones bike can be stored increases transfer quality, and reduces pre- and post transport time.

Bike storage	Almere Centrum	Eindhoven
Demand	1278	6240
Supply	2214	5351
Performance	173%	86%

Table 4-18; Bike storage facilities at Almere C. and Eindhoven (source; NS MOA, 2010)

4.2.5 **Spatial Quality**

Currently, no literature is available describing the level of spatial quality surrounding a station and the number of passengers it attracts. In this case where production is under investigation the question to which has to be answered is whether increased spatial quality leads to additional passengers using the station as place of departure.

First, an overview of variables that describe spatial quality is shown in Table 4-19. Overall spatial quality, based on the method used in "Fixing the Link" (Brouwer, 2010) is slightly higher at Almere. Liveliness of the connection from the station to the city centre is valued higher in Eindhoven whilst safety and comfort is higher in Almere. CBS' Leefbaarometer shows low grades for both Eindhoven and Almere (Scale is 1 – 7 in which 1 is highest possible). From these numbers the assumption can be made that spatial quality isn't outstanding in either of the two neighbourhoods.

Spatial Quality	Eindhoven	Almere Centrum
Spatial quality overall	41%	49%
Liveliness	10	7
Safety & comfort	4	9
Leefbaarometer	4	5

Table 4-19; Variables that determine spatial quality (Source; Brouwer 2010, CBS 2008)

In the case of these two particular stations spatial quality does not seem to reflect the assumption that increased spatial quality will induce an increase in capture rate as the train becomes more appealing through quality. When considering all stations in the next phase spatial quality will be represented by the "Leefbaarometer" as this the only nationwide spatial quality index available on the neighbourhood level.

4.2.6 **Intensity**

When considering the capture rate in terms of production, intensity is expressed as the number of inhabitants in the vicinity of a station. A higher number of inhabitants is expected to increase the stations capture rate, the reasoning behind this assumption is based on the fact that when one lives close to a station, the train becomes a more appealing *alternative* over the automobile since pre-transport is reduced in comparison to people living further from the same station.

The variables that may describe intensity are shown in Table 4-20. Data is collected on smallest geographical scale available from CBS, in this case a four digit postal code. The same four digit postal code serves as the point of origin from which the number of jobs that can be reached with public transport within 15 minutes are calculated. It also forms the destination that a number of inhabitants are able reach within 15 minutes by public transport.

Intensity	Eindhoven	Almere Centrum
Dwellings in PC	0	2150
Dwellings per km²	0	2129
Address km²	3063	2329
Jobs 15 min. (x1000)	28	41
Distance to Dept. Store	1	0,5
Dept. Stores within 1km	5	2,3
Cafe/Rest within 1km	5	15,9

Table 4-20; Variables that determine intensity (Source; CBS 2008, Nationale Bereikbaarheidskaart 2008)

The top four variables are related to production, the bottom four are related to attraction. Taking a closer look to the top three, it shows that the postal code in which Eindhoven station is situated does not contain any dwellings and thus no inhabitants. The neighbourhood, Fellenoord is an office district. The address density is higher in Eindhoven this, however, is not reflected in the built environment as these addresses are situated within large office blocks. The higher number of dwellings located near Almere are likely to cause an increased capture rate. This increase however will be small in comparison to the population that is able to reach the station within 15 minutes. A combination of all four activities at the smallest scale will be used to describe intensity in the next phase; Dwellings per km², Jobs within 15 minutes, Department stores within one kilometre and finally cafés and restaurants within one kilometre.

4.2.7 **Wrap Up**

The relationship between centrality and capture rate can be established through congestion. It will be expressed as a loss of accessibility by dividing accessible jobs in a 30 and 60 minute radius during peak hours by the number of jobs available during normal conditions. The inverse of this percentage describes the "accessibility loss". A loss of accessibility is only relevant if activities take place to which access is lost. Therefore the percentage of the population working outside the municipality is taken into account. In the case of Eindhoven and Almere Centrum accessibility loss in combination with stronger demand for commuting does explain the difference in capture rates, confirmation will follow in the next phase when generalization takes place.

Transfer Quality variables as shown in Table 4-15, are explanatory in terms of absolute commuter numbers. Since the assumption is made that absolute numbers are dependant on the facilities provided passenger numbers are omitted and transfer quality is described by the number of available BTM lines and the RSQI score. In addition population within a 15 minute radius will be taken into account since the number of bus lines alone is not able to describe the ease of access to the station that a well organized feeding system provides.

Spatial Quality does not seem to influence the capture rate of Eindhoven nor that of Almere Centrum. Nevertheless the "leefbaarometer" will describe spatial quality in the next phase if only to see if a relationship can be established when looking at a larger group of stations

Intensity, especially that of dwellings does influence the number of a station produces however its share in the total numbers is very small and therefore it is difficult to establish a cause and effect relationship. In the generalization phase intensity will be described by the number of dwellings per km², jobs within 15 minutes, department stores within one kilometre and cafés and restaurants within one kilometre. Separately the relationship between dwellings per km² and the capture rate will be determined since this relates solely to production. An overview of all variables that describe the four concepts when relating to a stations capture rate are shown in Table 4-21

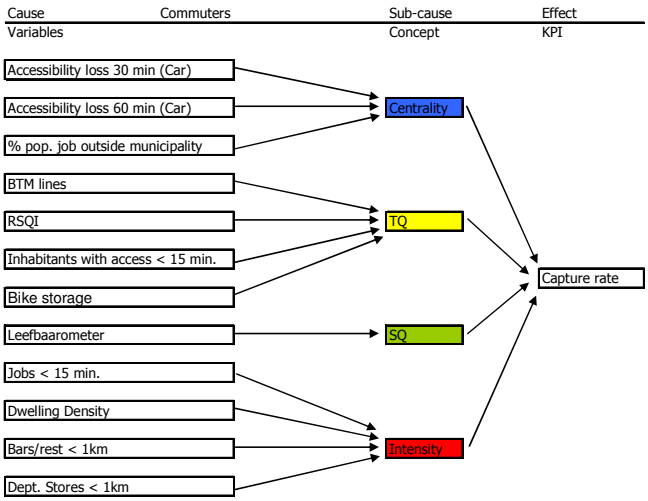
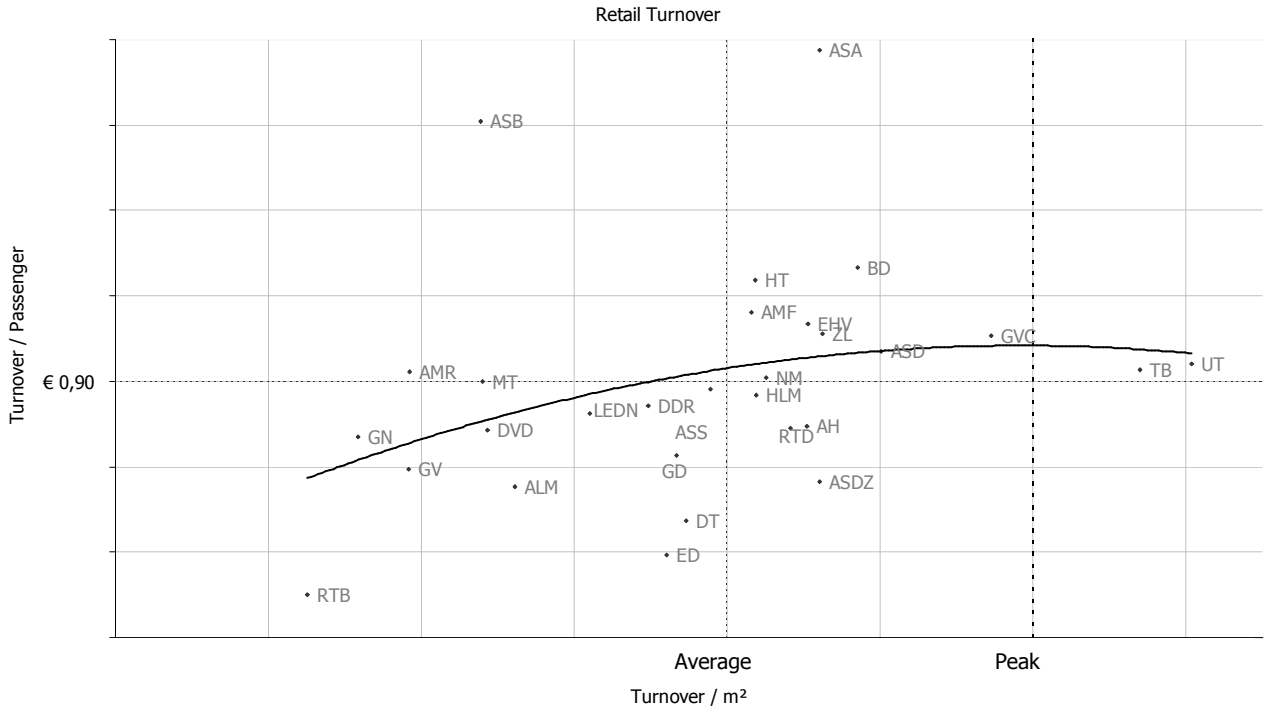


Table 4-21; Variables that determine the four meta-values in relationship to the capture rate



Graph 4-11; Turnover/Commuter vs. Turnover/m², axis are masked due to confidentiality of data. (adapted from ROP, NS Poort, 2010.)

4.3 **Testcase 3; Retail Turnover**

4.3.1 **Station selection**

If one wants to compare turnover at retail outlets at stations caused by differences in the station area, the retail outlets at these two stations have to be comparable.

Graph 4-11 shows the relationship between retail turnover per commuter and retail turnover per square meter. By using this method of comparison the size in m² of the station and the number of passengers at a station becomes less important. An interesting fact of the graph is that it shows a declining trend at around €14.000/m² meaning that Utrecht Centraal and Tilburg are in fact too crowded resulting in a lower spending per commuter.

The graph shows three outliers, two very positive and one negative. Both Amsterdam Bijlmer ArenA and Amsterdam Amstel show a high turnover per commuter. This is caused by the fact that both of these stations accommodate 40.000 metro passengers daily on top of those generated by NS trains. Rotterdam Blaak is a negative outlier the reason behind this can be found in the small number of retail outlets, one. The fact that this one outlet is a "Restauratie" containing tables and chairs negatively influences the turnover per square meter.

A comparison between explainable outliers isn't useful therefore two different stations will have to be selected. I will do this by there relative distance to the top performing station and least performing station. The distance in the graph is computed by multiplying the distance in €/passenger and €/m² and taking the square root of the resulting value. The station "nearest" to Rotterdam Blaak is Den Haag HS and the one "nearest" to Amsterdam Amstel is Breda.

A test case thus will be conducted to establish the differences in centrality, transfer quality, intensity and spatial quality in an effort to link these four meta-values to the retail performance at Breda and Den Haag HS. The second objective is to test whether the variables that will be used in the next phase of the research are relevant and/or useful.

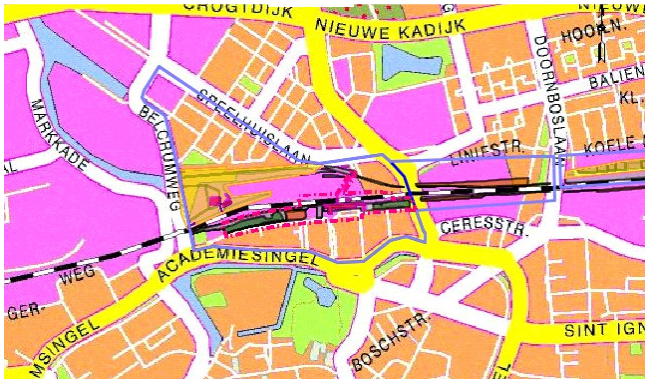


Figure 4-24; Breda station area (Source: Geopoort)

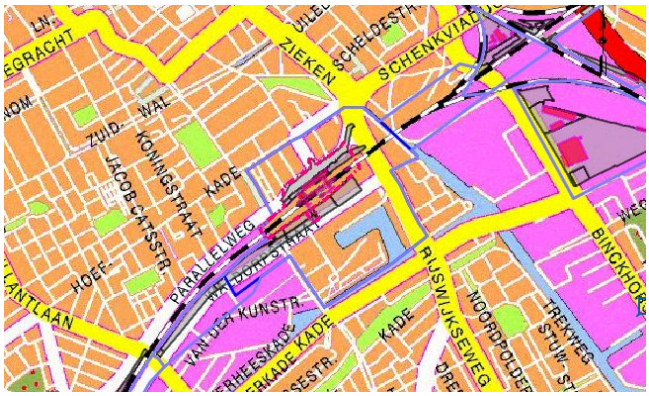


Figure 4-25; Den Haag HS station area (Source; Geopoort)

4.3.2 Breda vs. Den Haag HS

The objective of this test case is to find out if Peek's four meta-values are able explain why people spend more on goods at Breda station compared to Den Haag HS. First we start by presenting a number of key performance indicators from both stations.

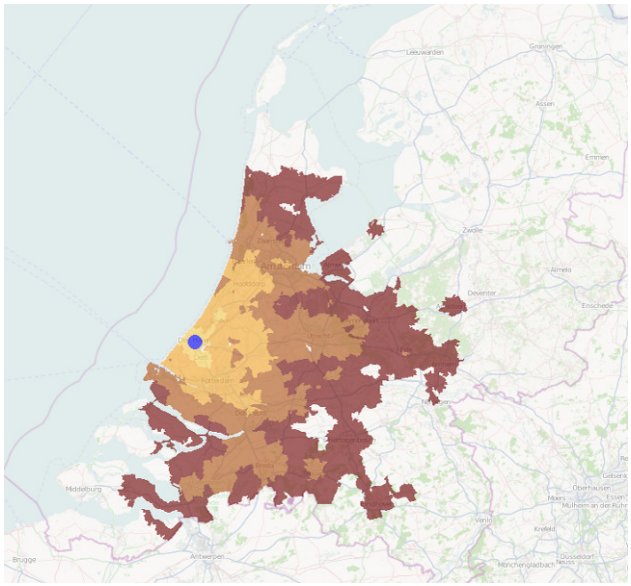
KPI	Breda	Den Haag HS
RE Value	-3%	-25%
Passengers/Day ('08)	25427	36029
Turnover / Commuter[5]	146	67
Turnover / m² [6]	121	60
KTO	6,8	7,1

Table 4-22; Key Performance Indicators of stations Breda and Den Haag HS (Source; DTZ, NS Poort)

4.3.3 Centrality

Centrality is believed to be the main generator of passengers (NS, 2010), and through those passengers it is a driver of absolute retail turnover. However as shown in Graph 4-11, the number of passengers does not directly influence how much someone spends at the station. In this way centrality does not seem to influence retail turnover, it might however be interesting to take a look anyway and try to answer the question whether the centrality in the form of access to jobs and population of a station causes passengers to spend more money at the station.

- How many people live within 30 and 60 min from the station?
- How many jobs are located within 30 and 60 min. from the station?
- What is the attraction/production ratio of the station?



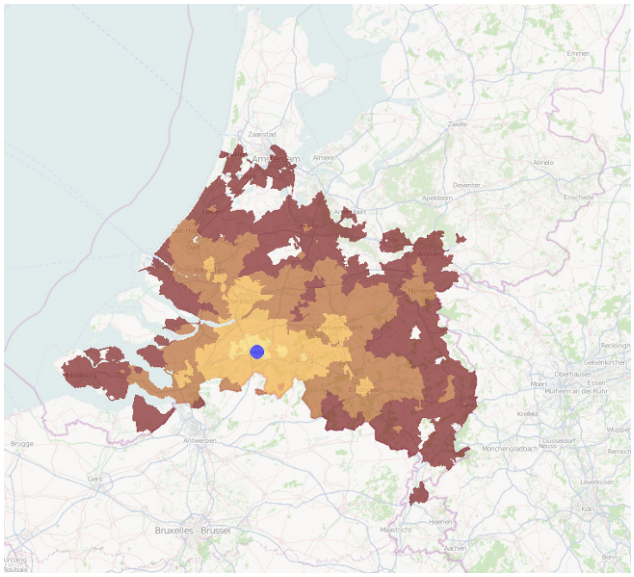
< 15
15 - 30
30 - 60
60 - 90
90 - 120

Accessible within	Inhabitants x1000	Jobs x1000
15 minutes	12	8
30 minutes	845	402
60 minutes	3.237	1.437
90 minutes	6.376	3.026
120 minutes	9.486	4.408

Figure 4-26; Number of inhabitants and jobs that have access to Den Haag HS (Source; Nationale Bereikbaarheidskaart, 2008)

[5] *Confidential data, expressed as index, average equals 100.*

[6] *Confidential data, expressed as index, average equals 100.*



Accessible Within		Inhabitants x1000	Jobs x1000
< 15	15 minutes	15	18
15 - 30	30 minutes	316	165
30 - 60	60 minutes	1.975	980
60 - 90	90 minutes	5.333	2.483
90 - 120	120 minutes	9.131	4.292

Figure 4-27; Number of inhabitants and jobs that have access to Breda station. (Source; Nationale Bereikbaarheidskaart, 2008)

Centrality	Breda	Den Haag HS
Inh. 30 min. (x1000)	316	845
Inh. 60 min. (x1000)	1975	3237
Jobs 30 min. (x1000)	165	402
Jobs 30 min. (x1000)	980	1437
Attraction	48%	46%
Production	52%	54%

Table 4-23; Variables that determine centrality (Source; Bereikbaarheidskaart, 2010 & NSR, 2009)

Table 4-23 shows that the number of people that can reach Den Haag HS within 30 and 60 minutes is almost double that of Breda. The same observation goes for the number of jobs within 30 and 60 minutes that can be reached from Den Haag HS compared to those from Breda. This is not translated to a large passenger numbers at HS, since it has "competition" from The Hague's four other stations, most notably Den Haag Central Station, with which it essentially serves the same part of the city. Both stations show similar production and attraction ratios, indicating that their use is similar. Attraction and production will return in the analysis of the station intensities.

Centrality, as expected, doesn't seem to provide a clear explanation for the difference in retail turnover at Breda and Den Haag HS. Since production and attraction are a macro effect of centrality, these to variables will be omitted in the next phase and treated separately when discussing the creation of added value on a macro scale

4.3.4 **Transfer Quality**

As shown in Table 3-3 an increase in transfer quality is expected to increase absolute retail turnover, through a increased number of passengers. In this case the objective is to find out whether higher transfer quality causes people to spend more at a station. The first step is to compare the transfer quality of the two stations under investigation, Breda and Den Haag HS.

Transfer Quality	Breda	Den Haag HS
BTM/Day	18000	23000
Inter train transfers	2274	4753
RSQI attraction	0,64	1,501
RSQI production	0,5	1,118
KTO grade	6,4	7,3
BTM Lines	10	15
Bike storage	3,88	1,11

Table 4-24; Variables that determine transfer quality (Sources; NS, 2009, De Graaff et. al. 2008 & CBS, 2008)

The transfer quality table depicted above shows that Den Haag boasts a higher number of transfer compared to Breda which is also reflected in the stations RSQI, KTO grade and the fact that a higher number of inner city BTM lines are available. However commuter spending is lower, as we've seen previously, this contradicts the hypothesis as stated in Table 3-3. The next step thus is to find out why this is the case. I will do so by looking at the plans of both stations and determine where shops are located in relation to the routing of transferring passengers.

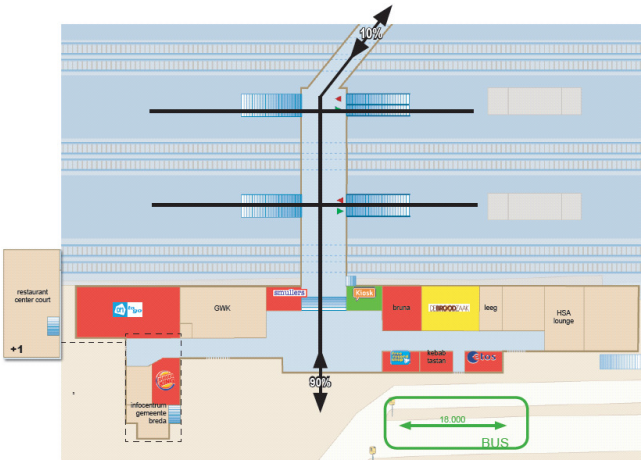


Figure 4-28; Plan of station Breda (Source; ROP, NS Poort 2010)

The plan of Breda station shows that there are no retail outlets on the platforms nor are any located in the hallway connecting the platforms. This means that inter train transferring passengers have to take a detour when transferring in order to purchase goods. leaving the station in order to transfer onto the busses in front of the station or travel on foot to the city centre pass through the main hall,

thus walking by the stations retail outlets. In Breda 90% of the passenger use this entrance/exit.

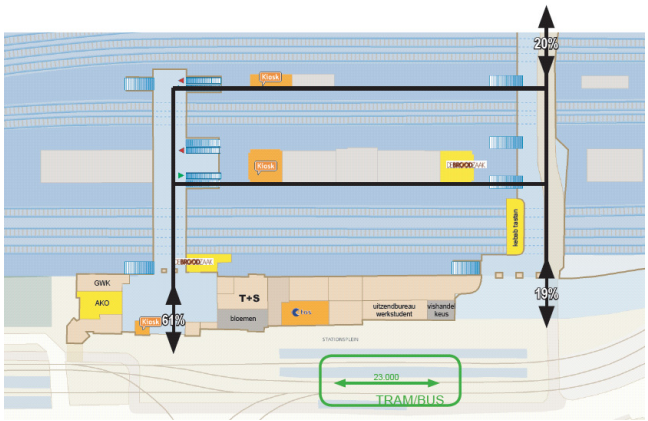


Figure 4-29; Plan of station Den Haag HS (Source; ROP, NS Poort 2010)

Den Haag HS does have retail outlets on the platforms, making it easy for transferring passengers to purchase goods whilst waiting for the connecting train. The hall connecting the platforms doesn't have any retail outlets either. Passengers leaving the station in order to transfer on a bus or tram mainly do so via the main hall, however the percentage is considerably lower compared to Breda. Furthermore the supply of retail outlets is smaller and more dispersed compared to Breda, and Den Haag HS does not contain an AH to go, which in all other stations boasts the highest turnover per commuter (NS Poort ROP, 2010).

Considering a large group of stations in the next phase when these findings are generalized it seems logical to compare the number and types of retail outlets located on the main transfer route through the station area when connecting transfer quality to retail turnover. As well as the number of BTM lines and RSQI since the assumption is made that these are drivers for transferring.

4.3.5 **Spatial Quality**

Spatial Quality	Breda	Den Haag HS
Spatial quality overall	32%	37%
Liveliness	8,25	10,33
Safety & comfort	10,25	7
Leefbaarometer	3	5

Table 4-25; Variables describing spatial quality (Sources; Brouwer, 2010 & CBS, 2008)

Table 4-27 shows four variables that describe the spatial quality of the station area. The top three are taken from "Fixing the Link" (Brouwer, 2010) the fourth, Leefbaarometer is taken from CBS. Overall spatial quality seems to be higher in Breda. The difference in quality is confirmed by the incomes of both neighbourhoods shown in Table 4-27. Lower income tends to reflect an area with less quality compared to higher income neighbourhoods especially in larger cities (Bransington & Hite, 2005).

The relationship between spatial quality and retail turnover is expected to be dependant on the number of passengers. However as explained the amount of money an average commuter spends at a station might be influenced by its spatial quality. The next few paragraphs are dedicated to answering the question; can spatial quality explain the difference in spending between Breda and Den Haag HS?

Spatial quality, more specific safety and liveliness are conditions to let the station area become a "place to stay", and thus retaining passengers, and their wallets. Through this logic it seems likely that higher quality will induce more spending as people spend more time. So the question can also be reformulated; Are the surroundings of Breda and Den Haag HS attractive places to stay?

An average home to work commuter uses the station because he or she must through the need for transportation. They want to get to their destination as fast as possible and are not likely to dwell at the station. People who visit the station on a "leisure" trip are in less of a hurry, but then, they are not likely to spend their time inside the station complex, thus spatial quality will not be reflected in retail turnover but rather in the turnover of cafés and restaurants in the station area

The answer to this question thus cannot be derived from NS' current retail turnover; NS retail outlets are located within the station complex and do not benefit from this longer stay. Finding the correlation between spatial quality and retail turnover will not make sense because it is influenced by the number of passengers. The relationship between the number of passengers and spatial quality may provide further insight into this problem.

4.3.6 **Intensity**

Intensity	Breda	Den Haag HS
Dwellings in PC	740	3220
Attraction	48%	46%
Address km²	2560	6638
Jobs 15 min. (x1000)	18	8
Non res. Addresses	165	203
Distance to Dept. Store	1,2	0,8
Dept. Stores within 1km	3,1	11,4
Cafe/Rest within 1km	38,6	43,3

Table 4-26; Variables that determine intensity (Sources: CBS, 2009 & Goudappel Coffeng, 2008)

Table 4-26 shows the variables that determine the meta-value intensity, for Breda and Den Haag HS. Density of dwellings, businesses and leisure is considerably higher in the area that HS serves compared to that of Breda, this as we've seen before does not generate a considerable difference in and doesn't generate a higher turnover, on the contrary as we've seen its lower in Den Haag. The hypothesis is that higher intensity should generate higher

turnover, the next few paragraphs are dedicated to finding out why isn't so.

Dwellings

As expected a higher number of dwellings, shops etc. produces more passengers, however the subject here is retail turnover so why don't these passengers spend as much? It seems a logical step to investigate their income.

Average	Netherlands in 2007 (x1000)			13,3
City	The Hague	13,4	Breda	13,8
Neigh.	Huygenspark	10,5	Station	13,2

Table 4-27; Average income per inhabitant (CBS, 2007)

Table 4-27 shows the average incomes of inhabitants of the Netherlands as a whole, Breda, The Hague and the neighbourhood in which the stations under investigation are situated. Both Breda and The Hague show an income that is above the national income, what I striking is difference between the two station neighbourhoods; income at Den Haag HS is 78% percent of the city's (and national) average. This might serve as an explanation for the difference in retail turnover and thus it will be included in group of variables describing intensity when comparing it to retail turnover since it is an indication of the *intensity* of purchasing power.

Jobs

The Hague is the governmental seat of the Netherlands thus it has a lot of job is the public sector; most of these are located near Den Haag Centraal. A large commercial area surrounding the Beatrixlaan is served by Den Haag laan van NOI. Most of the jobs in the city are thus served by other stations. Table 4-26 shows that the number of jobs accessible from Breda and Den Haag HS within 15 minutes by public transport are 18000 and 8000 respectively. Since both stations have similar attraction ratios and HS attracts 5000 passengers more than Breda with 10000 less jobs, where do they go? It seems educational facilities provide an answer.

Educational Facilities

As mentioned in paragraph 1.8, Functions such as schools tend to attract high volume of passengers. The Haagse Hogeschool (The Hague University of applied sciences) and ROC Mondriaan are located on the south entrance of Den Haag HS and house around 18.000 (THU, 2009) students, because most HBO/MBO students live with their parents as opposed to university students (CBS, 2010), these students are a considerable contribution to the number of passengers that travel via Den Haag HS.

Breda doesn't directly serve an educational institution, except from the KMA (Royal Military Academy) which hosts around 1200 students who also live on the KMA campus and thus do not provide the station with a substantial number of daily passengers.

Retail & leisure

Haaglanden Megastores, a large shopping centre is situated to the southwest of Den Haag HS. This centre however contains "large" formulae such as home decorations etc. These formulae usually attract transport by car, and since the complex has excellent parking facilities the number of passengers that it generates is very limited.

The Hague's city centre is directly served by Den Haag Centraal, indicating that shoppers travel to this station when visiting the city centre, this is an important factor in retail turnover since shoppers tend to spend more compared to home-work passengers €3 and €1 respectively (BCI, 2010). This thus seems to cancel the fact that number the of retail outlets and their nearness to the station is higher at HS compared to Breda since the shopping area isn't served by HS but by Den Haag Centraal this is also reflected in its attraction ratio of 68% (compared to HS' 46%).

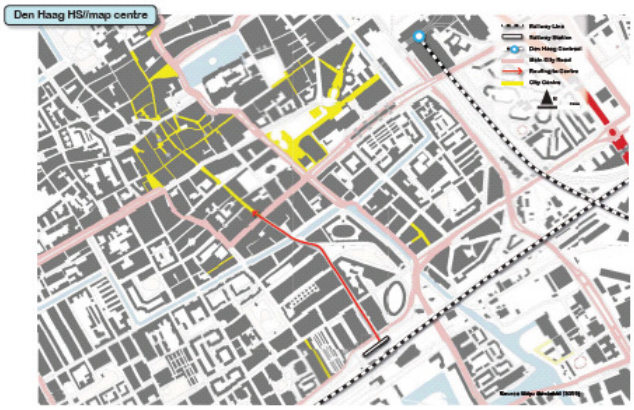


Figure 4-30; Nearness of HS and Central stations to The Hague city centre (Source; Brouwer, 2010)

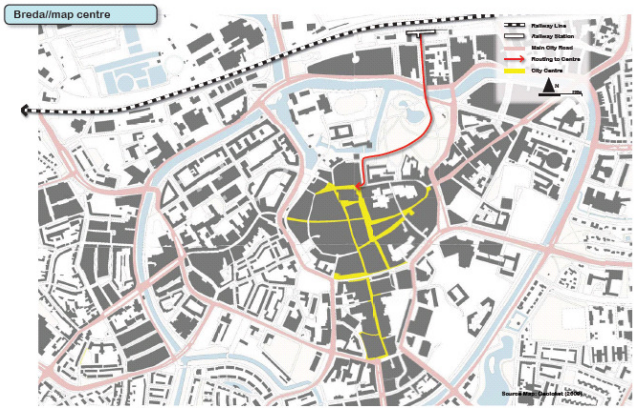


Figure 4-31 Nearness of Breda station to the city centre (Source Brouwer, 2010)

The way in which stations are or mostly aren't connected to the city centre and ways to fix this is the subject of Inoek Brouwer's master thesis "Fixing the Link". Figure 4-32 shows how the connection between Den Haag Centraal and the city centre was improved by a large scale inner city redevelopment adding, shopping, leisure, cultural- and public functions. The impact of these redevelopments on the KPIs of Den Haag Centraal is, sadly, unknown due to the unavailability of data. The distance from the station complex to the shopping area seems to be a credible variable to describe intensity it might however, as we've seen be compromised by inter station competition.

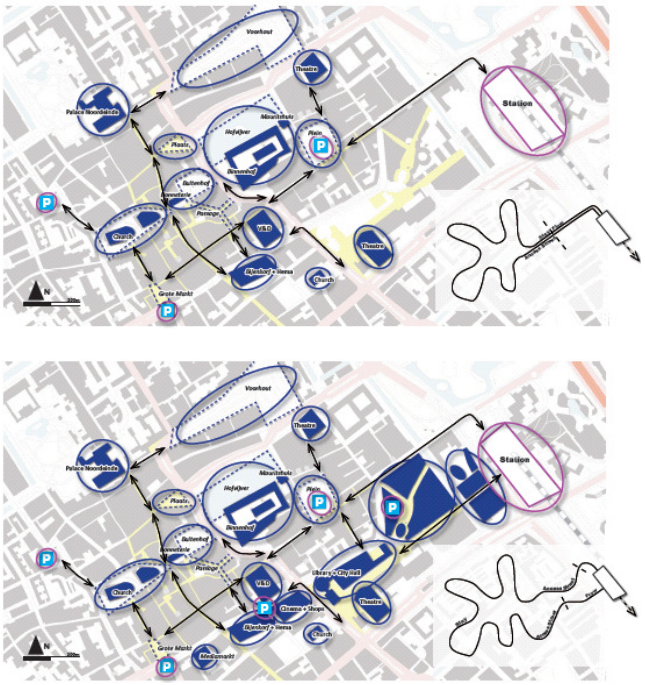


Figure 4-32; Connecting the station to the city centre (Source; Brouwer, 2010)

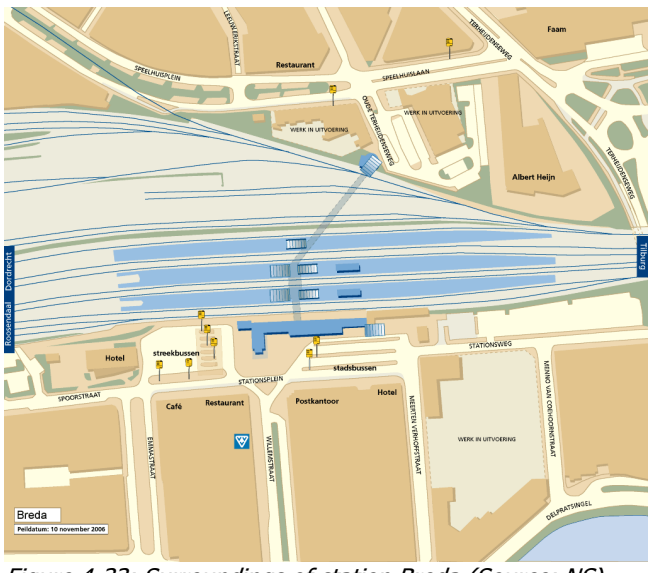


Figure 4-33; Surroundings of station Breda (Source; NS)

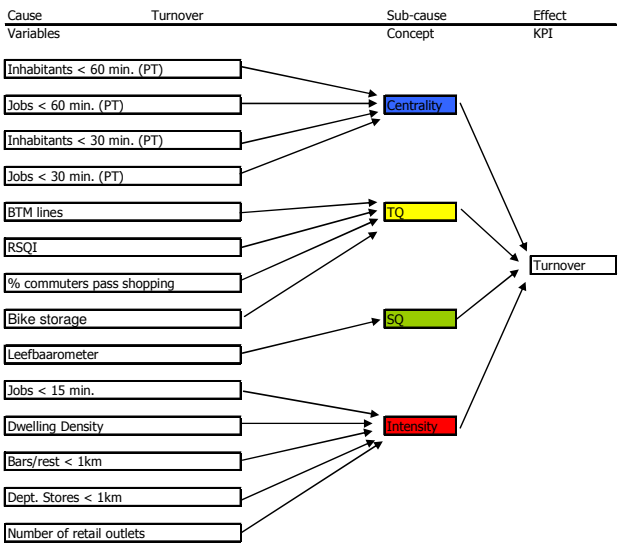
4.3.7 **Wrap Up**

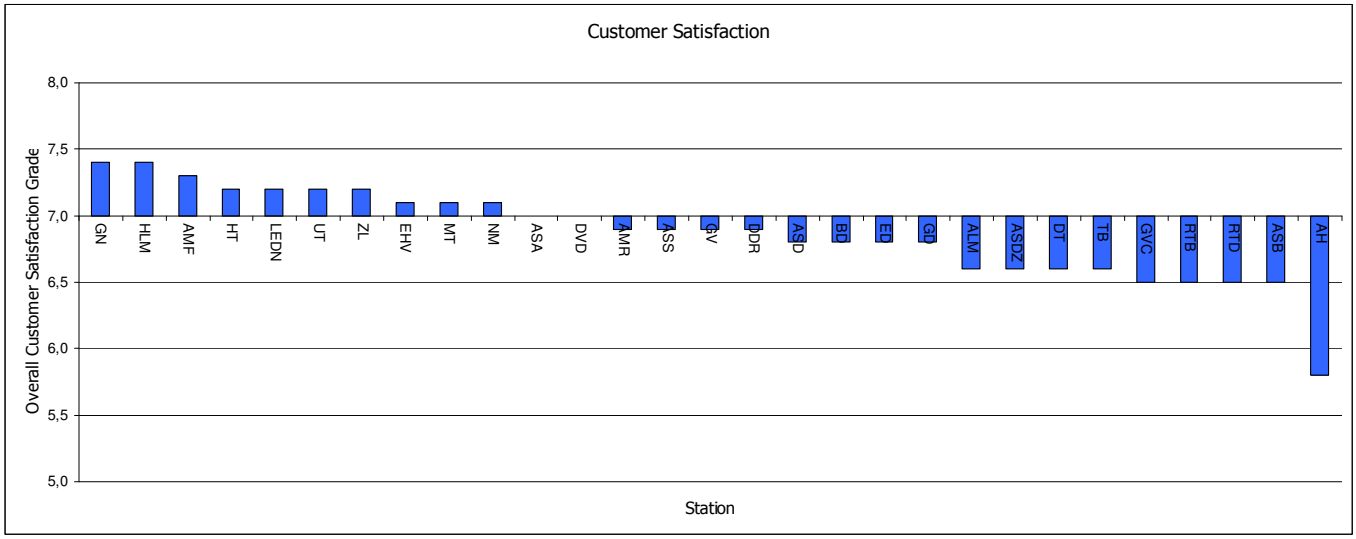
Centrality does not seem to affect the amount of money an average commuter spends at a station. It, however does affect the number of passengers and thus absolute retail turnover. It will therefore be represented by the population that have access to the station within 30 and 60 minutes as well as the number of jobs that can be reached from the station within 30 and 60 minutes by public transport.

Transfer quality can serve as an explanation, in which the stations transfer routes should pass by retail outlets in order to seduce passengers to make a purchase. As we've seen at station Breda 90% of its passengers pass through the main retail area, compared to 61% at Den Haag HS. Furthermore the types of retail seems to be an influence, hereby AH to go has a large stake in total turnover. In the next phase the *percentage of passengers passing through the main retail area* will be taken into account and the *number of types of retail*; AH to go, fast-food, "luxury" food, media and "other" containing scarce and non Servex formulae such as AKO, flower shops etc.

Spatial quality is expected to increase the number of passengers and thus total retail turnover. However no apparent relationship between consumer spending can be established, since NS turnover reflects purchases in the station complex only. A higher quality will benefit functions surrounding the station, NS can benefit indirectly through higher rent of real estate objects. Spatial quality should thus be reflected in relation to real estate value.

Intensity of retail and leisure functions seems to be a positive influence on retail turnover but only if the station serves this retail cluster. It is thus expected that cities with a regional retail function should benefit, since passengers come from the surrounding municipalities with the objective to purchase goods or a good time, this group is likely to spend more at the station (BCI, 2010). In order to let the station cater to the retail cluster it should be connected to it (Brouwer, 2010), keeping in mind that stations might be competing for the same group of passengers in this case additional investments in the station area will draw passengers away from another station and thus not create extra revenue for NS. In the statistical phase, the *distance to and number of retail and leisure functions* will be included, as well as the *number of stations* that cater to the same retail area for which an inverse relationship is to be expected. Additionally some stations do not serve a shopping area at all.





Graph 4-12; Stations ranked by customer satisfaction overall score, score of 7 is assumed to be the target (Source; NSR KIS 5 2008)

4.4 Test Case 4; Customer satisfaction

NS Poort regularly surveys at their stations in order to determine customer satisfaction. The goal of these surveys is to find out whether the services NS provides meet the customers demand and if not where improvements are to be made. NS Poort uses customer satisfaction as key performance indicator for its stations, the *assumption* is made that similar to the train services (NS Annual Report, 2010) the objective is to let each station obtain a score of at least 7. The questions asked cover the whole spectrum of the station complex from shelter against the weather to the price of goods sold at the station.

Since this research focuses on the stations surroundings only those grades related to this are used. Only a handful of these grades are related to the station area, and are focussed on the ability of the station to provide adequate pre- and post transport. Besides the stations overall score, the customer satisfaction on the availability of the station to provide bike storage, car parking and BTM transfer is taken into account.

4.4.1 Station Selection

In order to select a "best" and "worst" performing station the overall scores of the stations are used. Graph 4-12 shows the 30 largest stations ranked according to their score relative to the desired 7. It becomes clear that Groningen and Haarlem are tied for "best" with an overall score of 7.4. These two stations, both type 2, are more or less equal in size in terms of per day and location in relation to the city centre. Since Groningen has a special status of sorts due to its geographical location, for instance shown by the average distance its travel, anomalies are expected to arise in a direct comparison. Therefore Haarlem is selected for this case.

The "worst" performing station is Arnhem, this does not come as a surprise since it has been under construction since 2007 as a part of the NSP program and is currently housed in a temporary structure adjacent to the old station complex. When looking from right to left in the graph,
Tilburg is the second suitable candidate for comparison to Haarlem as it matches both in type, location in relation to the city, number of and the fact that it is the city's main station.

4.4.2 Haarlem vs. Tilburg

The goal in this last of the four cases is to find out what Haarlem's station area is able to offer in terms of commuter experience that Tilburg doesn't. In order to do so the two stations will be compared according to Peek's four meta-values this will show if, for instance, spatial quality leads to increased customer satisfaction.

KPI	Haarlem	Tilburg
RE Value	4%	-3%
Passengers/Day ('08)	37841	28364
Turnover / Commuter[7]	96	105
Turnover / m²[8]	107	159
KTO	7,4	6,6

Table 4-28; Key performance indicators of Haarlem and Tilburg (Source; DTZ 2010, NSR 2008 & NSP ROP 2010)

First, an overview of both stations key performance indicators is presented in Table 4-28. Real estate values are close to the city average in both station areas which both

[7] *Confidential data, expressed as index, average equals 100.*
[8] *Confidential data, expressed as index, average equals 100.*

do not contain a substantial volume of office space. Haarlem accommodates 33% more in comparison to Tilburg which in turn is an above average type 2 stations (24039 passengers/day). Retail turnover per passenger does not vary much with the €0,90 average. Turnover per square meter at Tilburg is substantially higher, in fact it is above optimal level shown in Graph 4-11, indicating overcrowded retail outlets at the station. Finally customer satisfaction scores an overall 7,4 at Haarlem and 6,6 at Tilburg which was the reason for selection in the first place.

4.4.3 **Centrality**

A relationship between centrality and customer satisfaction does exist. Station that provide better access are usually larger, and since larger stations by enlarge provide more services customer satisfaction tends to be greater with these stations. Graph 4-12 does reflect this statement when looking at the grades of the type 1 stations. Of the type 1 stations only Eindhoven and Utrecht manage to achieve a grade that is higher than 7. The other three are however currently either being renovated (ASD & GVC) or under construction (RTD). Generally speaking the conclusion can be drawn that; Since greater accessibility leads to larger stations, larger stations lead to an increase of services and an increase of services leads to an increase in customer satisfaction, larger stations provide more customer satisfaction.

Centrality	Haarlem	Tilburg
Inh. 30 min. (x1000)	414	312
Inh. 60 min. (x1000)	2795	1874
Jobs 30 min. (x1000)	215	190
Jobs 60 min. (x1000)	1430	935
Attraction	42%	49%
Production	58%	51%

Table 4-29; Variables describing centrality (Source; Bereikbaarheidskaart 2008, NSR 2008, De Graaff et. al. 2007)

Since customer satisfaction is *indirectly* influenced by the meta-value centrality, through the size of the station and its subsequent level of services, no one to one relationship between the variables shown in Table 4-29 and both stations customer satisfaction grade is to be expected. The variables describing centrality show that Haarlem provides access to a larger group of inhabitants and jobs this is reflected in the higher number of the station accommodates on daily basis. Although Haarlem accommodates more this increase over Tilburg is not large enough to explain the difference in customer satisfaction, since both stations are type 2 and provide more or less the same level of services.

4.4.4 **Transfer Quality**

When relating transfer quality to customer satisfaction, it is necessary to look at the way the station surroundings are able to accommodate a transfer from pre-transport onto the train or the transfer from the train to post-transfer facilities. Inadequate parking and bike storage facilities hamper pre-transport and with it the attractiveness of the train as an alternative mode of transport. This makes NS dependent on the provision of BTM facilities by locally active transportation companies such as GVB, Connexxion, Veolia etc.

Transfer Quality	Haarlem	Tilburg
BTM/Day	15000	13500
Inter train transfers	2694	4320
RSQI attraction	1,39	0,85
RSQI production	0,948	0,657
KTO grade	7,4	6,6
BTM Lines	9	13
Distance to highway	3,0	3,75

Larger stations by enlarge provide more services within the station complex compared to smaller ones. Large stations, types 1 and 2 however tend to provide less services in the station area in comparison to smaller ones (types 3-6) especially those related to pre- and post transport. The reason is scarcity and thus value of land surrounding the large inner city stations. Amsterdam Central for instance does not provide any car parking facilities and inadequate bike storage facilities. An inventive solution has been constructed, but still capacity does not meet demand.

Figure 4-34; "Fietsenflat" Amsterdam Centraal (Source; Architectenweb.nl 2010)

In terms of attraction of passengers the lack of parking facilities in inner cities is of course a reason for to use the

train in the first place. Most that travel to those stations are dependent on local BTM services in order to reach their destination since few have a car or bike permanently parked at the station they get off the train.

Adequate transfer facilities thus, are essential to the attractiveness of the train as an alternative mode of transport in providing comfortable post- and pre- transport facilities. Bike storage is only 43% of demand in Haarlem whilst it is able to supply 88% of demand in Tilburg. This is not translated into higher appreciation for the service.
At both Harlem and Tilburg are unsatisfied on parking facilities a common sight among large inner city stations as they tend to provide little or no car parking at all. Finally BTM services receive a higher appreciation in Haarlem, whilst it provides less facilities it term of lines.

KTO	Haarlem	Tilburg
Bike (s)	6,9	7,0
Bike	5,5	5,6
Parking	4,9	4,5
BTM	6,7	5,8

Table 4-30; Customer satisfaction grades concerning transfer facilities (Source; NS MOA 2008)

Bike storage	Haarlem	Tilburg
Demand	6301	4056
Supply	2734	3589
Performance	43%	88%

Table 4-31; Demand and supply of bike storage facilities (Source; NS MOA 2008)

As it is more difficult and expensive at larger inner city stations to supply adequate transfer facilities, in terms of car parking and bike storage a possible negative relationship will emerge in the next phase, nevertheless bike storage will be included in the generalization phase as it reflects actual shortages and with it added travel time taken up by searching for a spot to park a car or bike.

4.4.5 **Spatial Quality**

Again the variables that describe the concept of spatial quality are composed of results from Brouwer's "Fixing the Link" and the "Leefbaarometer". Table 4-32 discrepancies between both methods of measuring. Whilst the link to the city in Haarlem receives a low score, the spatial quality of the neighbourhood is the highest scoring one in the spatial quality index.

Spatial Quality	Haarlem	Tilburg
Spatial quality overall	20%	30%
Liveliness	8,33	10,67
Safety & comfort	7,33	7,67
Leefbaarheidsindex	2	3

Table 4-32; Variables describing spatial quality (Sources; Brouwer, 2010 & CBS, 2008)

In the spatial quality index Haarlem outperforms Tilburg suggesting a positive relationship between spatial quality and customer satisfaction. When considering the ink to the city it is the other way around. Since the spatial quality of the station area itself is under consideration the spatial quality index score will be used in the generalization phase.

4.4.6 **Intensity**

Does the intensity of the station area have positive influence on the satisfaction with hat station? This is the question that will be answered. The neighbourhood, in which Tilburg NS lies, is far denser in comparison to Haarlem especially in terms of population, available jobs and dwellings. The availability of leisure facilities does not seem to differentiate as much this indicates that the same level of leisure activities take place within a less dense and crowded environment. Spaciousness of the surroundings is appreciated by people, as seen in the spatial quality index. This suggests that larger stations with more intense surroundings will tend to score lower in comparison to those situated in more spacious settings. A negative relationship is thus to be expected in the generalization phase in which the concept of intensity will be described by the same activity based method used in the previous three test-cases; dwellings per km² Jobs within 15 minutes and department stores and café/restaurants within a one kilometre radius.

Intensity	Haarlem	Tilburg
Dwell./km²	1942	3414
Pop./km²	3385	7301
Address km²	2281	3738
Jobs 15 min. (x1000)	14	34
Inh. 15 min. (x1000)	22	73
Dist. to Dept. Store	0,6	0,5
Dept. Stores < 1km	7	2,4
Cafe/Rest < 1km	50,9	63,1

Table 4-33; Variables that determine intensity (Sources: CBS, 2009 & Goudappel Coffeng, 2008)

4.4.7 **Wrap Up**

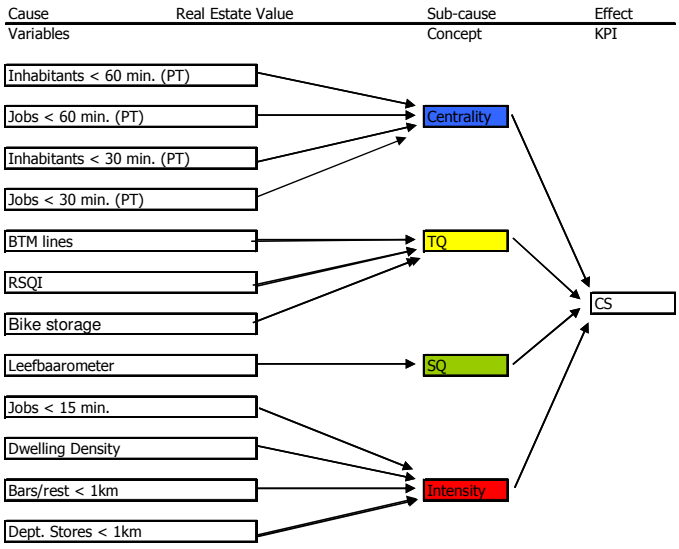
The effect centrality has on customer satisfaction can not be determined by examining two single stations as this is a combination of aspects on two different levels. Accessibility on the macro level and the satisfaction with the station area

itself on a micro level. In the next phase the centrality concept will be described by the population that has access to the station within 30 and 60 minutes an the number of jobs that can be reached from the station within 30 an 60 minutes, both by use of public transport.

Transfer quality shows a distorted cause an effect relationship. Larger, better connected stations tend to provide more services within the station complex leading to a higher appreciation for the station overall. At those same large stations is more difficult and expensive to provide enough transfer facilities within the station area, leading to a lower overall score. In the next phase transfer quality will be described by the RSQI, number of available BTM lines and the ability to provide bike storage.

The two elements from which the variables describing spatial quality are derived show opposite results, since the quality of the station area itself is under consideration, scores from the PBL spatial quality index will be used when generalizing the relationship between spatial quality and customer satisfaction.

Similar to transfer quality the relationship between intensity and customer satisfaction seems to be a double one. Larger stations tend to be situated in more dense environments; therefore less space is available to accommodate transfer facilities leading to a lower satisfaction grade when intensity increases. A more intense surrounding on the other hand is able to supply more activities which, in theory, should lead to a higher satisfaction grade. Those activities, living working shopping and leisure will describe intensity in the next phase.



5 GENERALIZATION

"Production" at Haarlem
(Source; FLickr)

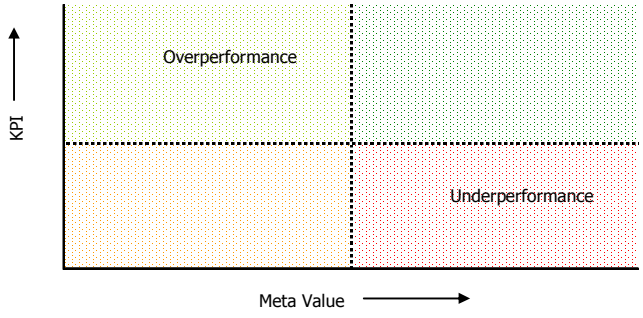
5 Generalization

In this chapter the variables that are suitable to describe the relationship between each of the four concepts and each KPI are combined. Since the performance of a station is compared to all the others each variable is indexed whereby the average equals 100. The factors that describe customer satisfaction and spatial quality are measured in an ordinal scale hence for these two the mode equals 100. A complete composition matrix of the variables that describe each mate-value is presented in the appendix.

The goal is to identify the influence of each meta-value on each KPI separately and by doing so identify elements that enhance performance of a station. Those elements then, are to be included in future design briefs in order to safeguard the creation of added value through redevelopment of the station area.
The next step is to combine the different factors that describe one concept. Each concept is built up from a number of factors or variables. Since the influence of an individual factor on the total concept is unknown it is impossible to establish a theoretically acceptable weighing factor. Therefore the assumption is made that each factor has an equal share in describing one concept.

Finally the relationship between one concept and one KPI is presented in a scatter plot accompanied by a linear trend line, a correlation coefficient (r), regression coefficient R^2 and significance p. Statistical significance represents the probability that a similar outcome would be obtained if the entire population were tested. Thus, everything that would be found after testing the entire population would be, by definition, significant at the highest possible level. The stations in this research can considered to be the entire population and thus probability becomes arbitrary its inclusion is for the sake of completeness.

Each graph is divided onto four quadrants by two dotted lines that represent the average of a concept and the average KPI performance. This will help in determining which stations are not able to convert above average properties into above average performance those are located in the bottom right quadrant. On the other hand the top left quadrant will host those stations that show above average performance despite below average meta-value properties.



5.1 Real Estate Value

Influences of meta-values on real estate value

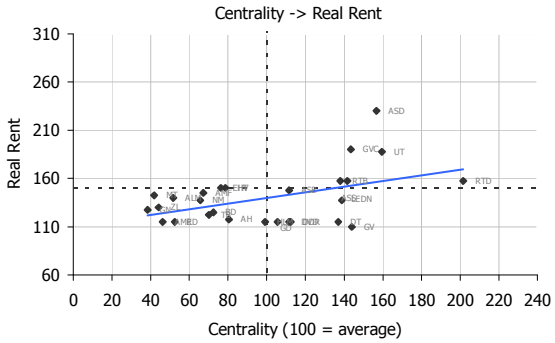
In this section the goal is to translate the findings from the comparison between Leiden and 's-Hertogenbosch to all 29 stations and derive conclusions on the way the meta-values are a cause for the differences in real estate value. Or, what actions are expected to increase real estate value and what circumstances cause diminishing real estate value. Each meta-value consists of the variables that were tested in the previous section; they are transformed into an index whereby the 29 station average is 100.

The effects of the centrality, and transfer quality on the performance of real estate will be explored at two different levels micro and macro. Micro relates to the effects of the four meta-values on the performance of real estate value within a single station area, real estate value is represented by real rent levels. Macro relates to the effects of the four meta-values on the performance of a station areas real estate within the NS network. In order to smooth out market differences, real estate value is presented as rent relative to the city average.

Intensity and spatial quality are local (micro) properties that influence the performance of a local real estate object therefore these two relationships will be measured only at the micro scale. After all it would not make sense to measure the effect of spatial quality at station X on the value of real estate at station Y.

The effect of centrality on real estate value

In order to determine the effects of centrality on real estate value in all station areas real rents and the centrality index are plotted in a scatter graph.

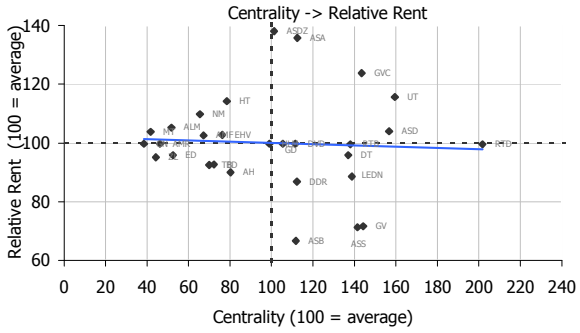


Graph 5-1; Centrality vs. Real Rent
r = 0,46 R^2 = 0,21 p = 0,01

Real rent levels show a correlated relationship with centrality. Amsterdam Zuid and Amsterdam Amstel show exceptionally high rent levels and might be considered outliers since they provide an additional property; status. Therefore these two locations are omitted from the scatter plots. At the micro level the assumption thus can be made that centrality has a positive influence on the value of office space. In other words; office space near stations within the NS network that provide access to more possible customers and labour is able to command a higher rent.

In order to determine the performance of office space on a macro level, performance compared to other stations, office space rents relative to the city average are plotted against the centrality index.

Graph 5-1 shows the relationship between the meta-value centrality and real estate value of the 29 stations under consideration. The data points in Graph 5-1 show a large spread indicating a very weak or non causal relationship between centrality and *relative* real estate value of office space. From this the conclusion can be drawn that centrality does not automatically cause increased rent levels at every station over those locations which are not near a station but within the same city. In other words, proximity to the station alone is not enough to ensure to maximize creation of added value. In the case of those stations areas that are under the dotted line, higher rents are commanded elsewhere in the city.



Graph 5-2; Centrality vs. Relative Rent

r = -0,06 R² = 0,00 p = 0,63

The hypothesis is that increased accessibility will provide better access to customers and skilled labour and thus increases willingness to pay. In other words, an increase in centrality should increase rent levels. Graph 5-1 does not reflect this hypothesis as an upward sloping trend line would be the result. This is the case at the macro scale however at the micro level the trend line is flat, and as centrality increases so does volatility in rent levels. The question thus arises; Why does increased centrality not lead to higher rent levels at the micro level? When taking a closer look at the underperforming stations in the bottom right quadrant of both graphs it becomes apparent that these stations are closely linked with those in the top right quadrant. All but a few are located within either the greater Amsterdam area or the south wing of the Randstad implying the existence of a single market between those related stations where high centrality alternatives are available to future tenants. Below average rent levels are then caused by competition between the "smaller" stations in the bottom right trying to compete with the large (NSP) stations in the top right which they match in terms of centrality but perform less in terms of the other meta-values.

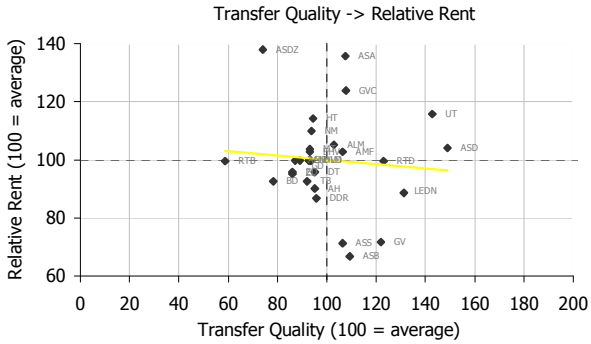
The effect of transfer quality on real estate value

In order to determine the effects of transfer quality on real estate value all station areas individually (micro) real rents and the transfer quality index are plotted in a scatter graph.

Graph 5-3; Transfer quality vs. Real Rent

r = 0,55 R² = 0,30 p = 0,00

Real rent levels show a positive relationship with transfer quality although rent volatility again seems to increase when transfer quality increases. The assumption thus can be made that stations which are better connected to others are able to command a higher rent and with it increased value of office space.

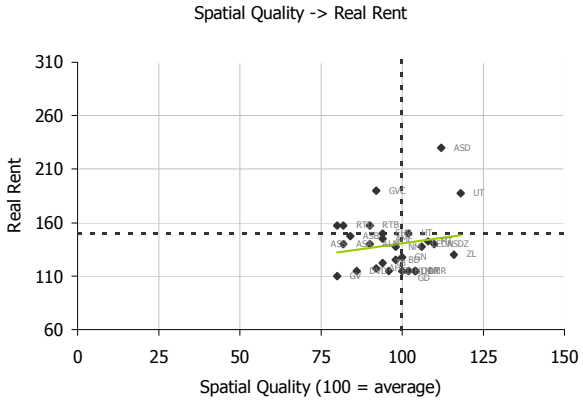


Graph 5-4; Transfer quality vs. Relative Rent

r = -0,09 R² = 0,01 p = 0,63

As larger, more central, central stations tend to provide better transfer facilities willingness to pay should increase, which is the case at the macro level. However at the macro level this is not the case. Graph 5-4 shows a similar image when compared with Graph 5-1. Again the data points show a wide spread indicating weak or non existent causal relationship and rent volatility tends to increase when transfer quality increases. The stations located in the bottom and top right quadrants are the same ones shown in Graph 5-1. It was expected that ease of access, represented by transfer quality would increase willingness to pay. Once again the question arises; Why is higher transfer quality not translated into higher *relative* rent levels? If a combination of high centrality and high transfer quality still is not able to generate higher rent levels a presumably "better" alternative must be available to future tenants. "Better" thus has to be defined by qualities that the top right stations posses whilst those located in the bottom right quadrant do not in order for them to provide a unique selling point.

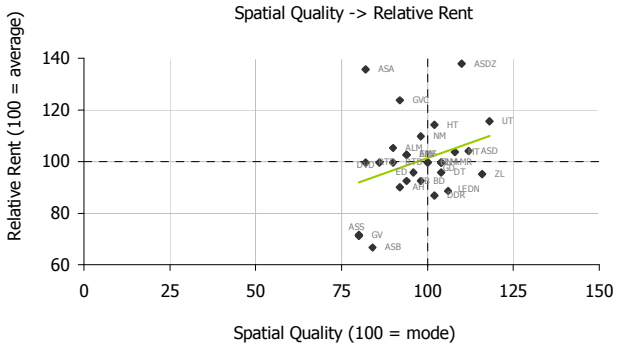
The effect of spatial quality on real estate value



Graph 5-5; Spatial quality vs. Real Rent

r = 0,17 R^2 = 0,03 p = 0,39

Surprisingly spatial quality and real estate value show a negative relationship on the micro scale, indicating that areas that have more spatial quality command lower rent. However it is seems very unlikely that higher quality is a cause for lower rent since this would imply; paying more for less.



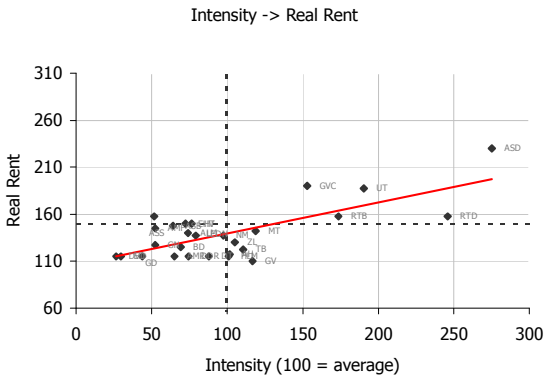
Graph 5-6; Spatial Quality vs. Relative Rent

r = 0,31 R^2 = 0,10 p = 0,05

Graph 5-6 shows the relationship between spatial quality and real estate value of office space. Real estate value is represented by indexed relative rents whilst spatial quality is represented by a transformed "leefbaarometer" score in which the mode (3) has been set as 100, correspondingly the ratings 7 to 1 have been transformed from 0 to 150 respectively.

Stations are clustered around the respective scores implying a correlated effect in the graph. This effect however is partly caused by the fact that each station can only obtain a single score. When looking at the four quadrants of the graph it becomes clear that the stations located in the bottom right quadrant of the two previous graphs are either located in the bottom left quadrant (ASB, ASS, GV) or on the mode (LEDN, DT, DDR, GD). Both groups not substantially outperforming their network related "high rent" stations and thus fail to provide a unique selling point to prospective tenants.

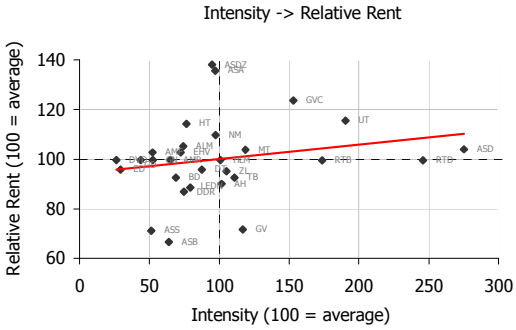
The effect of intensity on real estate value



Graph 5-7; Intensity vs. Real Rent

r = 0,71 R^2 = 0,51 p = 0,00

A positive relationship seems to exist between intensity and real estate value. At the micro level this would imply that office spaces near stations that have more dwellings, retail, jobs and leisure in their vicinity are able to command higher rent levels. Once again ASDZ and ASA are outliers as without them correlation will increase.



Graph 5-8; Intensity vs. Relative Rent

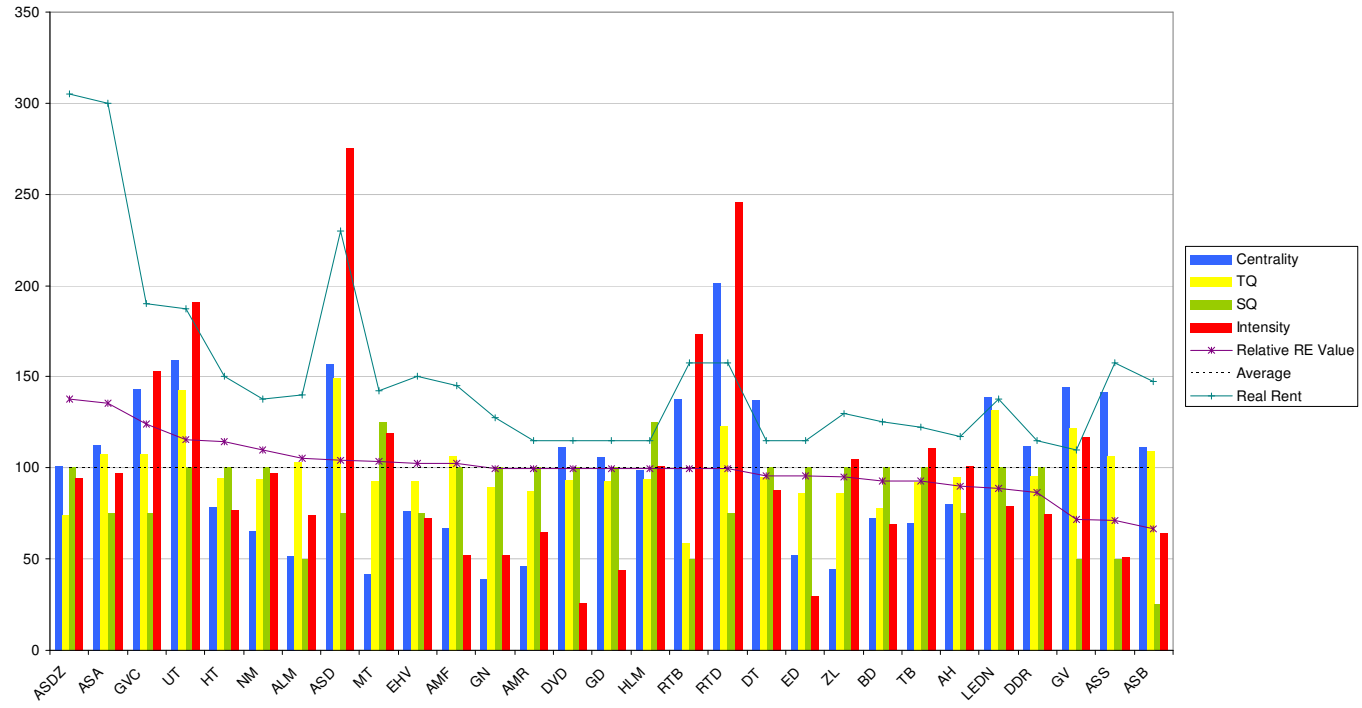
r = 0,21 R^2 = 0,04 p = 0,27

The relationship between intensity surrounding each station and relative real estate value is shown in Graph 5-8. Real estate value is represented by indexed relative rent in which 100 represents the city average. Intensity is represented by the presence of dwellings, jobs and leisure facilities. The graph shows a cloud of stations surrounding both averages combined with a group of outliers suggesting weak correlation.

The large NSP stations (GVC, UT, ASD & RTD) tend to provide far more intensity compared to the smaller ones. The Randstad stations located in the bottom right quadrant of the previous graphs have moved to the left bottom quadrant which indicates below average rent combined with below average intensity, Den Haag HS being the notable exception. This indicates that these particular stations are unable to provide the level of intensity that the "high rent" stations do making those more appealing to tenants of office space and with it increase willingness to pay.

Graph 5-9 is a combination of the four separate meta-values versus relative real estate value graphs. All 29 stations under consideration are ranked according to their relative real estate value combined with the four indexed meta-value scores the final addition is the blue line which depicts actual rent levels at each station. As Peek's theory suggests, added value will grow if synergy at the stations grows, does the graph reflect this? In part it does, by enlarge the stations that shows high scores on all four meta-values also show high real rent levels. The relative rent level line shows a smoothed pattern which is a result of comparison to city average. The stations at which the relative rent line dips below the city average, are those which are closely related to larger regional stations this implies that rent levels suffer from inter station competition. They can be clustered into four separate groups based on their geographical location;

1. Greater Amsterdam in which Amsterdam Sloterdijk and Amsterdam Bijlmer ArenA compete with Amsterdam Centraal and Amsterdam Zuid.
2. The southern wing of the Randstad where Delft, Leiden, Dordrecht, Gouda and Den Haag HS compete with Den Haag CS, Rotterdam CS & Rotterdam Blaak.
3. Brabantstad consisting of Breda and Tilburg competing with Eindhoven and 's-Hertogenbosch.
4. The combination Arnhem – Nijmegen



Graph 5-9; Four meta values vs. real and relative rent

5.1.1 **Wrap Up**

When plotting centrality and real rent levels it shows that an increase in centrality will also lead to an increase in rent. However when comparing *relative* rent to centrality this relationship fails to hold up. This shows that not all station areas are able to convert accessibility into higher rent levels. Those that are unable to do so are those which are closely linked to larger stations in the region. This leads to the conclusion that access to larger numbers of customers and labour not always leads to higher value, since it also leads to competition between stations in which larger ones have a competitive advantage.

The relationship between transfer quality and real estate value shows a similar pattern whereby stations do show a positive relationship at the micro level, but at the macro level some fail to do so. In fact the same "high centrality" stations that underperform to the city rent average also underperform in relation to transfer quality.

Spatial quality seems to positively influence real estate value at the macro level indicating that more quality is an incentive to future tenants when locating to a station as such it is competitive advantage.

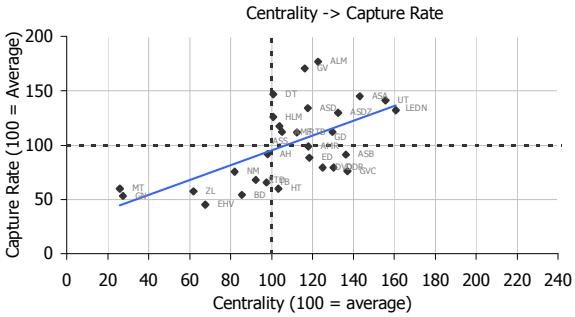
Intensity positively influences real estate value both on the micro as on the macro level. This implies that rents are higher when located near a station that show more intensity (micro), it also implies that stations that show higher levels of intensity have a competitive advantage in attracting new tenants (macro).

Improvements in centrality, transfer quality, spatial quality and intensity all show a positive relationship on real estate value at the micro level. Highest real rents are commanded where all four meta-values show (above) average levels. This indicates that as Vaessens (2002) already pointed out, synergy within the station area indeed leads to added value. At the macro level not all stations are able to capitalize on positive attributes the station area provides the conclusion therefore may be drawn that creation of added value is threatened by competition between stations. Accessibility and transfer quality provide choice between stations and with it they tend to form one clustered market which makes synergy between stations imperative to the creation of added value at closely related stations.

5.2 **Passengers**

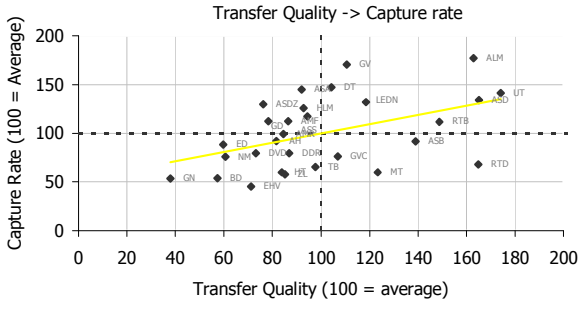
In this section the relationship between passenger production and the four meta-values will be generalized based on the variables describing each concept that were obtained from comparing Eindhoven and Almere Centrum. The key performance indicator in this case is transformed into an indexed "capture rate" whereby 100 is the average of all stations considered. The goal is to generalize influence of the four meta-values on the ability of the station area to attract passengers on a micro level. The chapter will be concluded with a reflection of the implication this has on a macro level.

Effects of centrality on the capture rate



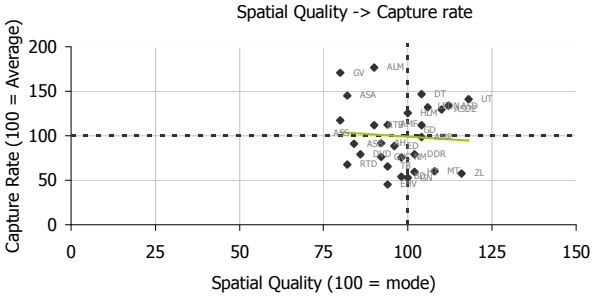
Graph 5-10; Centrality vs. Capture Rate
r = 0,59 R^2 = 0,35 p = 0,00

Graph 5-10 shows the relationship between the concept centrality and the KPI capture rate. Centrality seems to have a positive influence on the ability of the station to capture possible passengers. The stations located in the bottom right quadrant of the graph are those that are unable to convert a high level of centrality into a higher capture rate. The smaller stations (DVD, DDR & ED) in this quadrant are those that obtain a high centrality score due to their proximity to large network hubs. A remarkable difference in capture rate is shown in The Hague where Den Haag Centraal (GVC) shows a substantial lower capture when compared to Den Haag HS (GV).



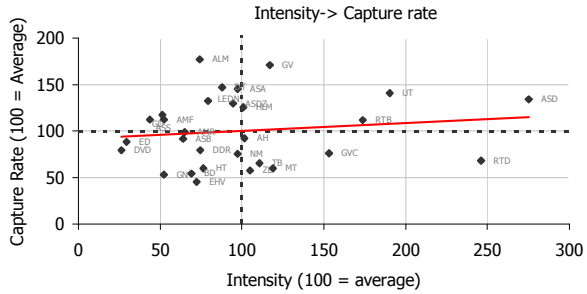
Graph 5-11; Transfer Quality vs. Capture Rate
r = 0,46 R^2 = 0,21 p = 0,01

The relationship between transfer quality and capture rate is depicted in Graph 5-11. A positive relationship seems to exist, indicating that increasing transfer quality has a positive effect on the capture rate of an individual station. Again those stations located in the bottom right quadrant are those that are unable to convert a high transfer quality rate into a high capture rate.



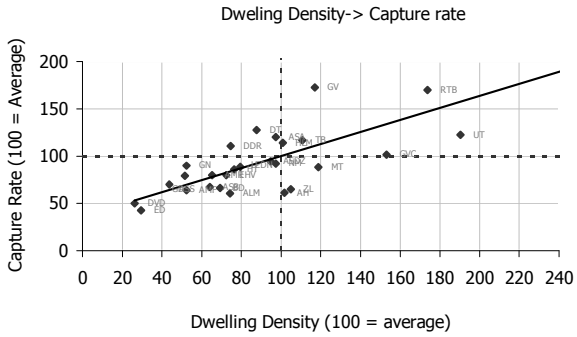
Graph 5-12; Spatial Quality vs. Capture Rate
r = -0,07 R^2 = 0,01 p = 0,70

As with the relationship between real estate value and spatial quality a negative relationship seems to exist between the spatial quality of a station area and its ability to capture possible passengers (Graph 5-12). The cause and effect relationship has become distorted as it is unlikely that less quality will attract more passengers. It is far more plausible that a station is able to capture passengers despite the quality of its surroundings but because it offers an attractive transportation alternative in terms of travel time and comfort.



Graph 5-13; Intensity vs. Capture Rate
r = 0,14 R^2 = 0,02 p = 0,48

The effect intensity has on the ability of a station to capture passengers shows a wide spread; this indicates that no clear cause and effect relationship can be established. Since this section deals with production of passengers i.e. passengers that use the station as a point of origin this result is not an unexpected. Passengers are captured because they travel to an activity elsewhere it thus makes sense that leisure and work related activities at the point of origin do not influence the capture rate. A higher intensity of dwellings alone (Graph 5-14) shows more a positive influence on a stations capture rate however when related to the inhabitants that live within the acceptable 15 minute radius (transfer quality) this share is marginal.



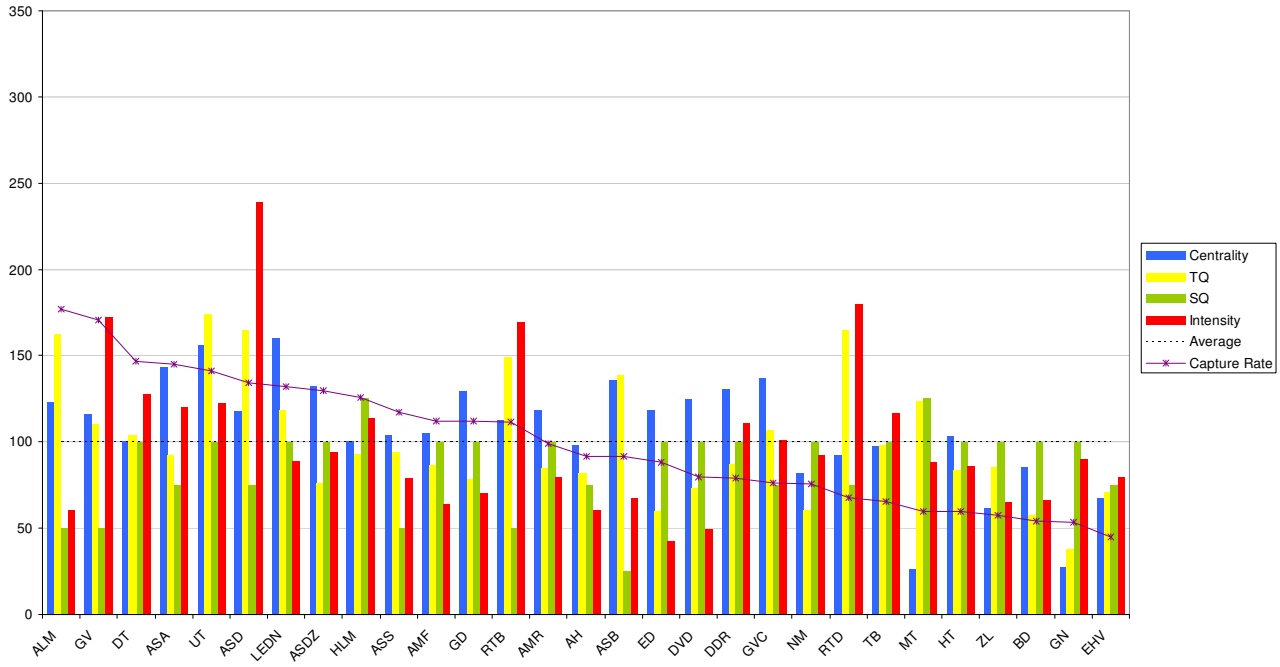
Graph 5-14; Dwelling Density vs. Capture Rate

r = 0,31 R^2 = 0,10 p = 0,10

5.2.1 **Wrap Up**

A stations capture rate describes how many passengers a station is able to persuade to use train to travel to an activity. Peek's four meta-values describe the way it is able to do so. Centrality and transfer quality show a fairly strong relationship with a stations capture rate, this indicates that the main reason for a commuter to use the train is the ability to get there as fast and efficient as possible. The influence of congestion has shown that the train is an *alternative* to the car, since the stations that show low capture rates by enlarge suffer less from congestion compared to those that show high capture rates. A high percentage of the population that has a job outside the municipality automatically cause a higher demand for transport, which increases capture rates. It also tends to unbalance production and attraction, a macro effect that will be discussed in the next paragraph.

If the train is seen as an *alternative* mode of transport over the car, it is not surprising that centrality and transfer quality show fairly strong relationships compared spatial quality and intensity. A negative relationship between spatial quality and capture rates seems highly unlikely however. Intensity shows a weak relationship as the capture rate is related to production, travelling to an activity. When only dwellings are considered the relationship seems to become stronger. If a higher concentration of dwellings near a station produces more passengers, which seems to be the case. The relationship between attraction and activities surrounding the station



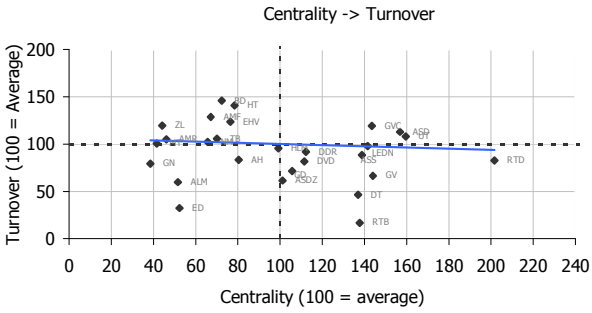
Attraction vs. Production

At the micro level, a single station, it seems desirable to attract as much as possible since they on average will spend €4,40 on a ticket and €0,90 in retail outlets thus; more is more. At the macro level however attracting as much passengers as possible will prove not be beneficial for NS. More does not automatically mean more, it may just as well be less.

Capture rates on a macro scale relate to attraction and production. When a large share of the inhabitants work outside the municipality they reside in demand for transport will increase and with it a stations capture rate. If the municipality is unable to provide enough jobs for its citizens outgoing commuter traffic is generated. When confronted with congestion, an the train becoming a more appealing alternative capture rates increase and outgoing commuter traffic tends to increase even further is seen in Almere. This leads to unbalance in the production attraction ratios since the station produces more passengers than it is able to attract. Vice versa, the same must be true; when a municipality provides more jobs that its inhabitants are able to occupy the stations in that city will automatically attract more than it is able to produce.

When a station produces more than it attracts this implies full trains leaving in the morning and empty trains returning on the round trip. In the evening the opposite movement takes place when passengers go home from work. Unbalance thus leads to increased capacity which is paid for only one way (origin -> destination) however the costs for NS are for a round trip. Added value of increasing capture rates on a macro level thus lies in balance between attraction and production. As with real estate value synergy within the station area will only add value if there also synergy between station areas.

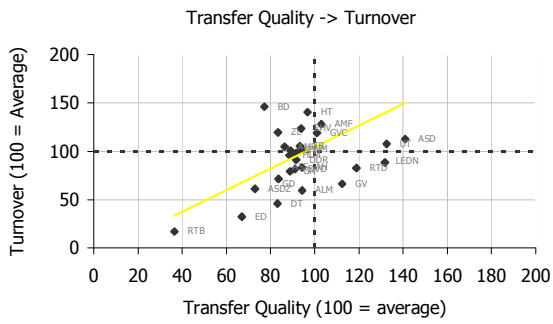
5.3 **Turnover**



Graph 5-15; Centrality vs. Retail turnover

r = -0,06 R^2 = 0,00 p = 0,76

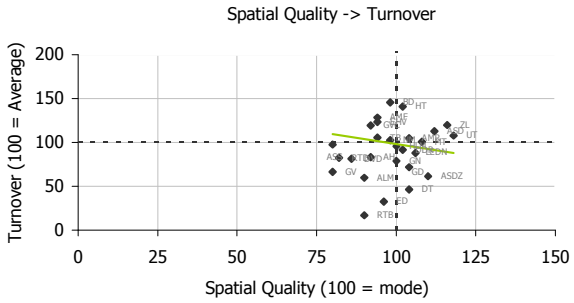
The relationship between the centrality of a station and retail turnover at those station is depicted in Graph 5-15. As expected no clear relationship seems to exist since customer spending is generated at a micro level its position within the network therefore is of less importance. Stations that provide access to larger numbers of inhabitants and jobs thus do not automatically increase customer spending. Absolute retail turnover of course is greater at stations that provide more access since more will automatically increase total turnover.



Graph 5-16; Transfer Quality vs. Turnover

r = 0,55 R^2 = 0,30 p = 0,00

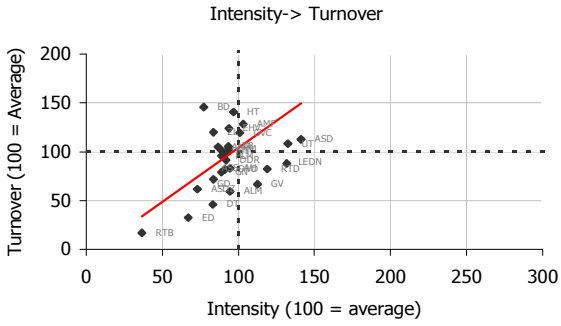
Transfer quality shows a positive relationship with turnover, this is mainly caused by a stations internal routing and less by its place within the network, again as with centrality a higher TQ will induce higher absolute turnover as these tend to attract a larger number of. The Hague HS has shown that although it provides adequate retail, it simply not used because do not pass by it because the station has "too many" exits. The stations that perform well are all "barrier" stations that concentrate all in a single space. Concentrating retail in a single corridor that breaches the rail barrier will not only increase passenger spending, since they all pass through the same area it will also allow for capturing passers-by that use the station to cross the barrier.



Graph 5-17; Spatial quality vs. retail turnover

r = -0,14 R^2 = 0,02 p = 0,48

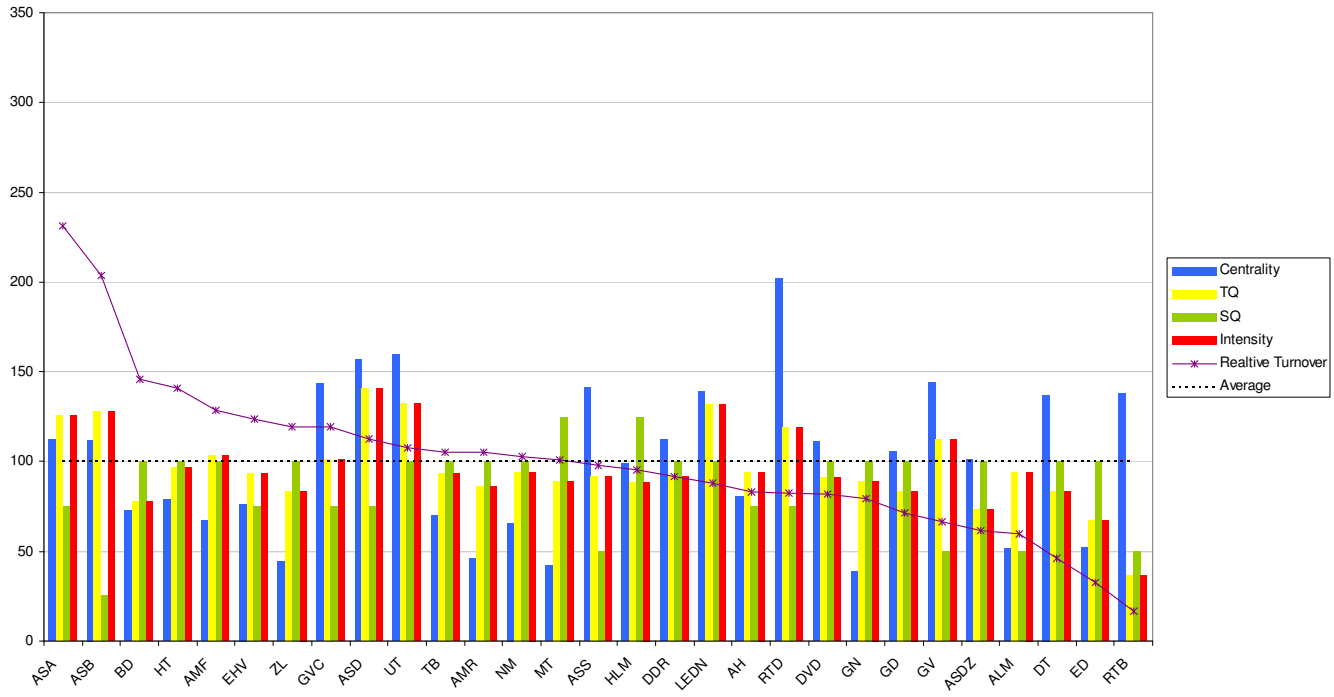
Spatial quality of the station environment and retail turnover do not seem to have a direct relationship. It seems reasonable to assume that the quality of station itself does influence the buying behaviour of.



Graph 5-18; Intensity vs. retail turnover

r = 0,55 R^2 = 0,30 p = 0,00

Intensity of a stations surroundings and mainly intensity of retail outlets at a certain station shows a positive relationship with retail turnover. Indicating that more choice between outlets and types of goods available leads to increased spending in other words, supply creates demand. It also shows that stations that provide access to regional shopping centres tend to show increased spending. This can be explained by a relatively higher number of "leisure" passengers that tend to spend more to begin with (BCI, 2010). Since proximity to regional shopping in city centres provides increased retail revenues it may be assumed that a "fixed link" (Brouwer, 2010) not only increases customer satisfaction but also generates added value.



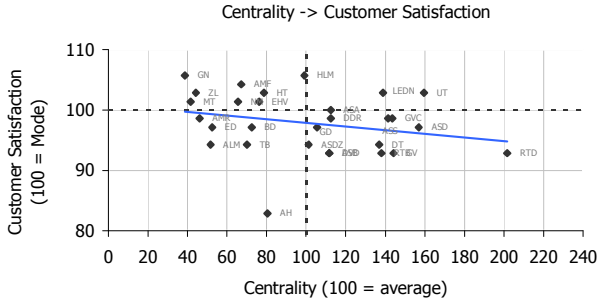
5.3.1 **Wrap Up**

Turnover per passenger tends vary heavily among stations; this is caused by elements at the micro level i.e. the station itself. Macro influences are all but non existent except for Amsterdam Amstel and Amsterdam Bijlmer ArenA where the local metro provides a large share of whom also tend to purchase goods at NS retail outlets. The location of the shops within a station are crucial for capturing potential customers, those stations that concentrate most of its passenger flow in a single space show higher revenues. Especially those stations that form a barrier in the urban fabric have potential for increased revenues if they are able to; 1. Concentrate passengers in a single corridor no matter which side of the station they exit. 2. If that corridor is also the preferred route for traversing the rail barrier for passers-by.

Supply creates demand since more outlets offering different types of goods induce more spending. More types of retail outlets thus are expected to increase revenues especially at those stations that provide limited or no (Rotterdam Blaak) choice. Stations that serve a regional shopping centre show higher retail revenues, a fixed link to the inner therefore is financially beneficial to NS, as well as convincing out-of-town shoppers to use the train when planning a trip, providing goods and services at the station that specifically targets this group may aid in doing so.

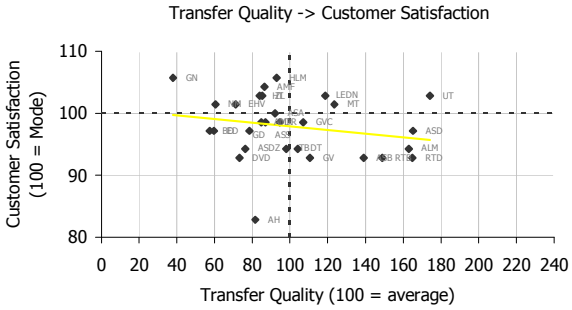
5.4 **Customer Satisfaction**

In this section the results from the 4th test case are generalized. Each concept is plotted against the customer satisfaction accompanied by its correlation coefficient which indicates whether a relationship exists and if so, how strong this relationship is.



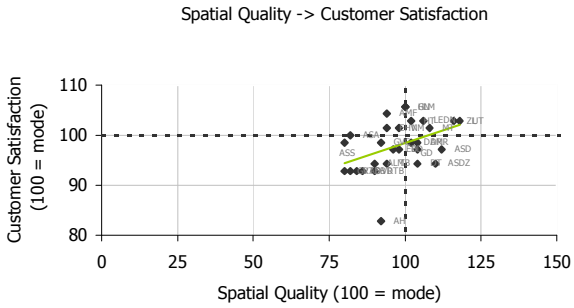
Graph 5-19; Centrality vs. customer satisfaction
r = -0,26 R² = 0,07 p = 0,18

As centrality increases customer satisfaction related to transfer facilities tends to decline although the relationship is not very strong. As centrality increases, by enlarge so does the size and type of station. In case of the large inner city stations where space is scarce within the station area it is difficult and hence costly to supply bike storage let alone car parks. This will result in a lower appreciation of the transfer facilities.



Graph 5-20; Transfer quality vs. customer satisfaction
r = -0,21 R² = 0,04 p = 0,28

The relationship between transfer quality and customer follows a similar pattern. Transfer quality is composed of a number of factors, both macro and micro. The macro aspects of transfer quality such as it connection to other stations within the network thus has a negative relationship with micro aspects such as bike storage. The reason is the same as the negative relationship between centrality and customer satisfaction.

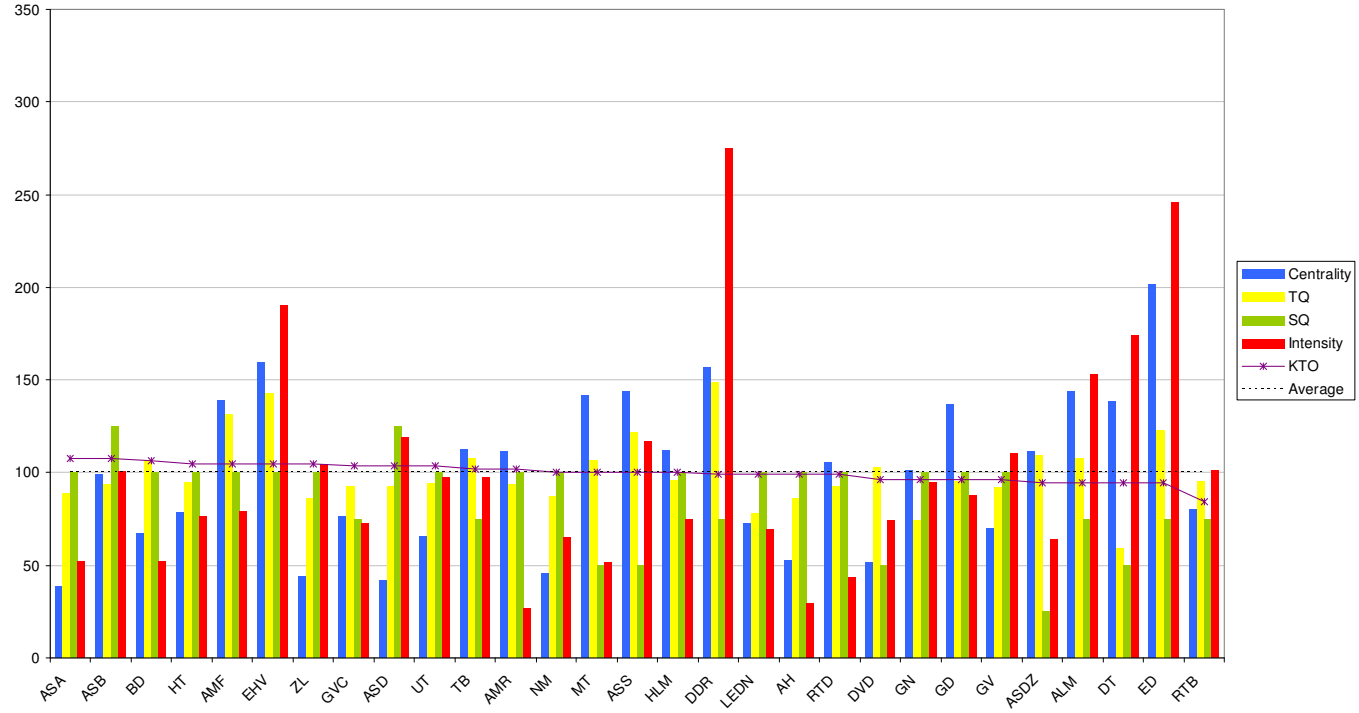


Graph 5-21 Spatial quality vs. customer satisfaction
r = 0,42 R² = 0,18 p = 0,02

Spatial quality seems to have a positive influence on customer satisfaction. The "smaller" stations show higher scores on the SQI. A less crowded environment and spaciousness are appreciated and leads to higher spatial quality index scores. Spaciousness also allows for the provision of transfer with relative ease in comparison to the large inner city stations this leads to a positive relationship between spatial quality and customer satisfaction regarding transfer facilities.

Graph 5-22; Intensity vs. customer satisfaction
r = -0,13 R² = 0,02 p = 0,51

As intensity increases customer satisfaction declines. A more intense environment tends to go hand in hand with a dense environment, limiting the ability to provide transfer facilities. However, a more intense environment should also lead to a decrease in demand for transfer facilities as activities are within walking distance of the station. This is not reflected in the relationship. Apparently if a station accommodates more passengers, the share of those passengers that travel to those activities becomes smaller, this assumption seems reasonable since it is the large stations in the bottom right quadrant that cause the relationship to be negative.



5.4.1 **Wrap Up**

Customer satisfaction with the ability of the station area to provide transfer facilities appears to decline when transfer quality and centrality increase. This caused by the inability of large stations to meet demand of those transfer facilities. Since space is scarce at large inner city stations development of bike storage solutions and car parks is both difficult and capital intensive these stations show a lower grade of satisfaction grade compared to those that are located in more spacious setting. Adding capacity will not automatically lead to an increased satisfaction grade because the relationship between the supply and demand of bike storage and car parks is not clear; if more facilities are created, and convenience is improved, more passengers will choose for the corresponding modality in pre-transport. This in turn will increase demand and with it capacity needed to meet demand.

Spatial quality positively influences the customer satisfaction. Those stations that obtain a high spatial quality index score are those which are situated in medium dense surroundings thus allowing for transfer facilities to meet demand. Additionally the stations with high spatial quality scores also tend to show less crime and vandalism which reduces the risk of stolen or damaged property when parked at station.

Intensity and customer satisfaction shows a slightly negative relationship. This is unexpected as the assumption is that intensity reduces the need for transfer facilities since activities are within walking distance of the station. The large stations do not follow this pattern because in a larger group of passengers a smaller percentage will actually travel to those activities.

6 Conclusions

In the last four paragraphs the relationships between each of the four concepts and key performance indicators have been presented in sixteen scatter graphs accompanied by the correlation coefficient R^2. It is now possible to answer the research question and connect the key performance indicators to the strategies that enable the creation of added value. The first step is to revisit the research question;

"To what extent does real estate development in station areas generate added value for Nederlandse Spoorwegen?"

I will answer the question by describing which aspects of the station area have a positive influence on each of the four key performance indicators and what strategy is needed to actually create added value. First I will provide a short description of the four meta-values (aspects) of the station followed by a short description of the four key performance indicators.

Centrality describes the stations ability to provide access to and from activities within the city (micro) and access to activities elsewhere in the network (macro).

Transfer Quality described the ability of the station to provide an inter-modal transfer (network <-> city) and inter train transfers (network <-> network).

Spatial Quality describes the ability of the station to provide a comfortable, safe and pleasant public space in the station area, location and complex.

Intensity describes the ability to provide a diverse range of activities and functions in the vicinity of the station.

Real estate value relates to the value of office space in the vicinity of the station. It is described in two ways, real rent and rent *relative* to the city average.

Number of passengers is described as the capture rate; actual passenger production as a percentage of possible NS passengers

Retail turnover is described as turnover per passenger.

Customer satisfaction describes the overall satisfaction of the station complex in combination with satisfaction of transfer facilities.

6.1 Real Estate Value

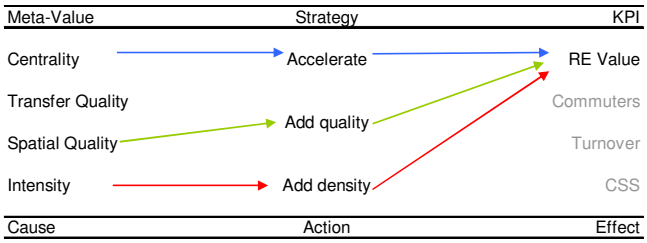


Figure 6-1 Confirmed relationships that improve real estate value in station area

Real estate value of office space within the station area at the micro level is positively influenced by three of the four meta-values; centrality, spatial quality and intensity.

Increased centrality has a positive influence on the value of office space in the vicinity of a station. Accelerating inter station connections by reducing travel times leads to increased centrality of a certain station since it is then able to provide access to more clients and skilled labour which in turn leads to increased willingness to pay and a higher real estate value of office space. Speeding up trains by, for instance, a higher maximum speed or less stops will reduce travel time and hence increase centrality and with it real estate value. NS Poort is not responsible for train services and thus its influence in doing so is limited furthermore if all connections become faster the advantage that one station provides over others (macro) will disappear.

Spatial quality has a positive effect on the real estate value *relative* to the city average. At those stations where office space rents underperform in comparison to the city and other stations (macro), adding quality and will thus generate a competitive advantage of the station area over other city locations and decrease the competitive disadvantage with other large stations nearby. A clear organised "city link", attractive surroundings and activities for office employees will aid in doing so.

Intensity of activities has a positive influence on the value of real estate. Adding density thus, will generate added value. Additional square metres in the vicinity however will only generate added value to office space if it contains a diversity of functions. Especially those function that cater towards the employees in existing office buildings will enable the creation of added value as the area becomes a more attractive place to work (Bak, 2009). Additional office space is not likely to add value to existing space except when the activities in the additional office are similar to that in existing space. In this case synergy between different organizations will provide an improved business-case of the tenants and with it a higher willingness to pay. This form of economies of scale in part explains the difference in office space rents at station Leiden and the adjacent Bio Science Park. Note that adding activities and functions is a *cause* of an increased willingness to pay (effect).

Link to theory of land value

In this section I will relate the effects of improving centrality, transfer quality and intensity to the value of land by using existing location theory and in the process show that these interventions are indeed a cause for increased value.

In a closed system rent depends on access to a magnet site in this case the railway station. The value of the land depends on the trade of between displacement costs and rent. In other words they both come from the same budget. If this is the case, a location further from the magnet site will be less valuable since part of this budget has to be spent on transport. Theoretically a site next to the magnet has maximum value since nothing is spent on transport. On the other hand a site on the fringe of the service area is worth nothing as the entire budget is spent on transport.

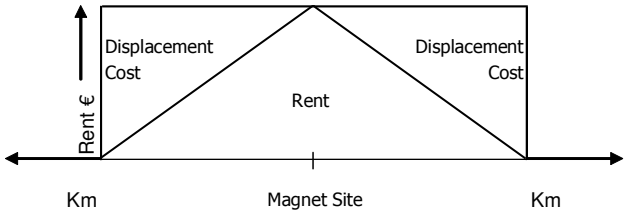


Figure 6-2; Land rents around a magnet site (Source; O'Flaherty 2005)

Increasing centrality will expand the service area of the station, thereby enlarging the base of the pyramid, and thus increasing the value of the land in the entire existing service area.

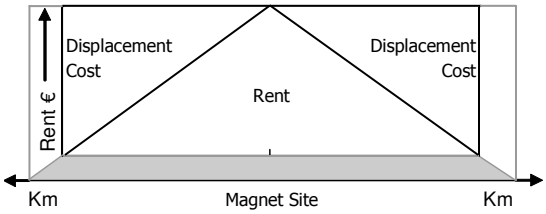


Figure 6-3; Influence of centrality and transfer quality on land rent.

Improving transfer quality will show the same effect, access to and from the station is improved thereby increasing its range in the urban fabric. This will enlarge the base and thus total value at the magnet site and at all other locations in the original pyramid.

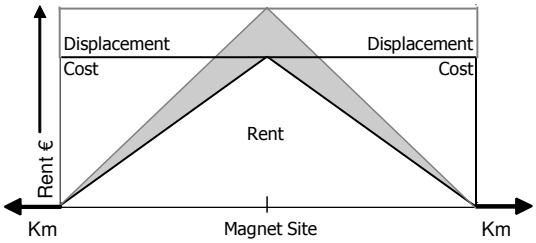


Figure 6-4; Influence of intensity on land rent

Adding intensity of activities and functions at the magnet site will increase it attractiveness for a larger number of inhabitants and with it willingness to pay thus it will enlarge the total budget comprised of rent and displacement costs.

6.2 Passengers

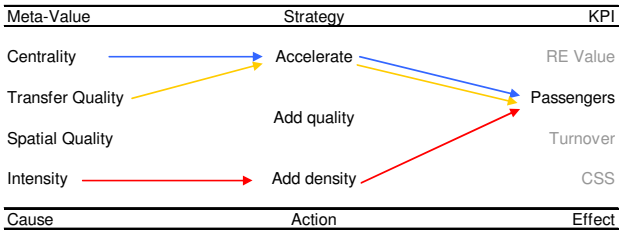


Figure 6-5; Confirmed relationships that improve number of passengers

Centrality has positive influence on the number of passengers a station is able capture. The underlying factors that determine centrality in this case contain the accessibility loss due to congestion. If transportation by train is sped up the difference in accessibility between car and train will further increase in favour of the train, inversely the same will happen if congestion increases. Both congestion and the train service itself are outside the influence of NS Poort hence, no action can be taken to further benefit from these underlying causes.

Accelerating post- and pre-transport i.e. physically expanding the 15 min. radius leads to an increase in transfer quality which in turn leads to an increase in passenger numbers. Fast BTM connections greatly increase the stations fifteen minute radius. NS therefore benefits greatly from dedicated BTM lanes that service the station and should encourage cities to implement them in urban restructuring plans as a way to improve public transport efficiency. Since the local component of the transport sequence is provided by local public transport operators, a study into the benefits of operating those concessions should be undertaken in order to gain insight into the costs and benefits of tendering for such a concession.

Accelerating in post- and pre-transport is also achieved by supplying adequate bike storage since the quest for a parking spot increases travel time. In order to decrease travel time and hence enlarge the 15 minute radius, passengers have to be able to easily find a parking place as well as getting there fast and safely. In order to accomplish this, the provision of additional bike storage has to become a more important element in the re-development of station areas than currently is the case. Since the supply of bike storage drives demand, some form of regulation has to be in place, the existing public transport chip-card provides a cheap and efficient way to do so. Dedicated bike lanes should service the station and the crossing of the stations adjacent roads should preferably be bike and pedestrian priority or unequal crossings. Within the station area a clear bike lane should lead to the bike storage facilities.

Intensity has a positive influence on the number of passengers a station is able to produce. Dwellings in particular generate additional passengers. Leisure, retail and office space tend to attract passengers. More dwellings

thus will generate additional passengers however the effect on production is only a fraction of that generated by expanding a station 15 minute accessibility radius.

6.3 **Retail Turnover**

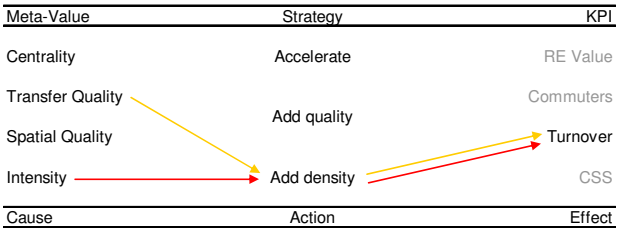


Figure 6-6; Confirmed relationships that improve retail turnover

The fact that increased transfer quality shows a positive relationship with retail turnover implies that the "transfer machine'" and "shopping centre" are not mutually exclusive properties of the station complex. In fact they tend to amplify each other. Transfer quality is in part defined by the number of passengers that pass by the main retail area within the station complex. An increase in passenger density in single space leads to additional retail turnover, if and only if the retail outlets are situated within that same space. Concentrating passengers and retail outlets in a single space offers those passengers freedom of choice between goods and services and convenience in purchasing. Apparently passengers are unaware of the presence of retail outlets when not passing by them or are unwilling to make a detour within the station complex. In redeveloping new station complexes the goal therefore should be to concentrate passengers and retail in a single space. Stations that form a barrier in the urban fabric provide the opportunity to also capture pedestrians using the station as an attractive route traversing the barrier.

Intensity has a positive relationship with turnover. Intensity in combination with diversity of retail outlets in the station complex in particular induces spending as supply creates demand. Offering choice between different types of goods should therefore be stimulated at more stations. This in part explains the performance of AH to go compared to other station retail outlets as it offers choice between various foods and drinks in one space and thus; convenience.

Intensity of shopping and leisure in the vicinity of the station positively influences the retail turnover. "Leisure" passengers tend to spend more at the station compared to everyday passengers. The share of "leisure" passengers tends to increase when more attractive activities are located within the vicinity of the station. Regional shopping centres serviced by a station thus are the locations where the supply of retail should be focussed even more on "leisure" passengers. The quality of link to the city centre hereby is crucial as it makes the train a more appealing alternative to travel to those regional shopping centres.

6.4 **Customer Satisfaction**

Centrality, transfer quality and intensity have al shown negative relationships with customer satisfaction. This indicates that at larger stations, which by enlarge score high on all three meta-values; passengers are less satisfied in comparison to smaller stations. The large stations thus, become (over)crowded resulting in an unclear situation from the viewpoint of the passenger to navigate through the station area and complex and utilize the transfer facilities provided.

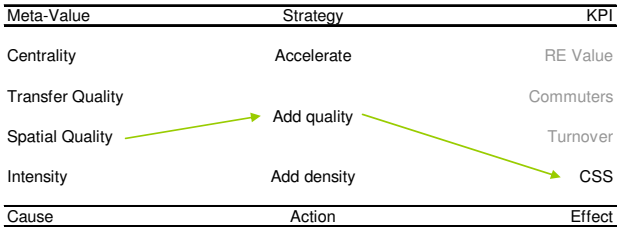
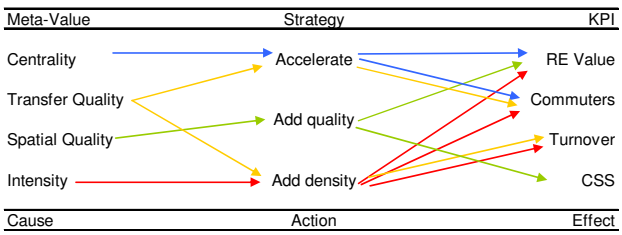


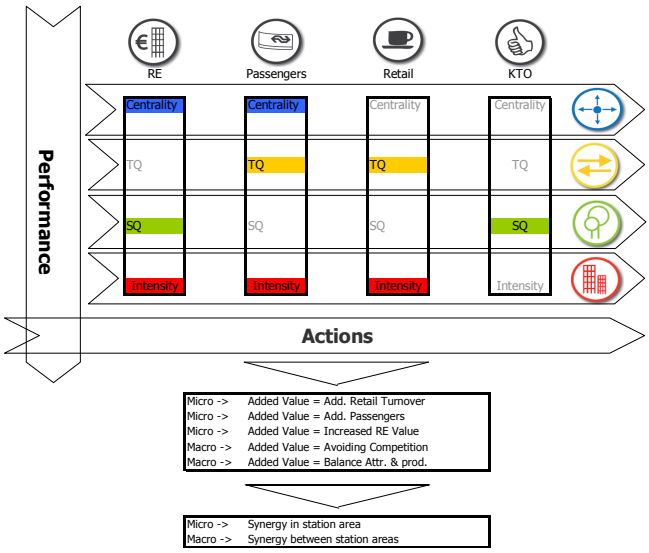
Figure 6-7 Confirmed relationship that improves customer satisfaction

Spatial quality positively influences the customer satisfaction with the transfer facilities at station area. Adding quality to the stations immediate surroundings thus, will improve customer satisfaction as it will make it a more pleasant place to stay. Currently the station location which provides the post- and pre-transport functions at many stations is especially equipped to do just that; supply post- and pre-transport. Large scale BTM stops and the surrounding roads form a barrier between the station and the urban fabric. Unequal crossings between slow and fast traffic, condensed BTM facilities and amenities that facilitate a comfortable "place to stay" (Gehl et. al. 2006) are ways to connect the station to the city (Brouwer, 2010) as for example is the case at Leiden. In redeveloping the public space of station areas emphasis has to be on the division of fast and slow traffic surrounding the station whereby slow traffic (bikes, pedestrians) have priority and follow a "natural" route to and from the station complex. Car traffic should be minimized to a kiss and ride facility.

Finally, an overview of the relationships of the cause and effect relationships which clarifies where and how added value is generated and which strategy is to be followed in order to enhance current performance of a station.



7 Recommendations



In this section I will present my recommendations that are geared towards ensuring the creation of added value in the station area when spatial interventions take place. An introduction into the effects on the network level is presented in section 7.5.

In the past NS Poort has focussed too much on the development and exploitation of retail at its railway stations and in the process focussing too little on the other elements that enable the passenger to experience a safe, comfortable and efficient journey. Today the focus is shifting towards both the quality of the services provided in and around the station complex and the amenities that are able to facilitate the entire transport sequence.

7.1 A focus on quality

Increased spatial quality leads to increased value of commercial real estate and increased customer satisfaction. NS Poort thus should not only improve the quality of the station complex but also focus on the quality of its surroundings and thereby preventing the creation of an "oasis in the desert". This has an important implication since investments in the public space benefits three parties; the municipality, real estate owners and NS. The municipality will receive a higher price for land and increased real estate tax, the real estate owners will an increase in rent and NS will see an increase in customer satisfaction. As three parties benefit it does not seem unreasonable that all benefactors share the costs of improving the quality of the public space that surrounds NS' stations. Station specific information that includes the actors in the station area, costs of improving quality and division of benefits therefore should be included in the analysis, strategy and business-case for each station

7.2 A focus on transfer

An increase in transfer quality not only increases the number of people that use the station but also the amount they spend at the station. Speeding up the trip to and from the station will generate additional passengers for NS. Speeding up this post- and pre-transport can be accomplished through the provision of adequate bike storage facilities, dedicated bike lanes and efficient BTM services. In the station area thus more focus has to be on providing these transfer facilities. This does not necessarily have to mean that transfer facilities and real estate development are mutually exclusive since they occupy the same valuable space, it does imply that in order to facilitate both innovative architectural are needed.

Improving transfer quality will also yield additional retail turnover. On one hand by providing time to NS passengers on the other hand by an internal efficient routing within the station complex whereby the bulk of the passengers pass by the retail outlets. This will aid in the convenience to acquire goods and services. In future redevelopments thus, the goal should be to concentrate passengers and retail in the same central space. Those stations that form a barrier in the urban fabric have additional potential of increased retail turnover if the station is able to provide an attractive route in traversing it.

Improvements in transfer quality will require additional investments in the station area. Due to the generic nature of this thesis it is at this time impossible to determine whether the additional revenues are able to cover the costs. This however can be determined in a station specific business-case. I therefore feel valuable knowledge will be developed when a specific cost and benefit analysis of transfer quality and transport sequence improvements is conducted.

7.3 Implementation

This section deals with recommendation on how the findings of this research can be incorporated into the Aset Development research program. A detailed workflow is available in Appendix II.

The proposed key performance indicators should be implemented as input in the station analysis phase of the Asset Development research program. This will identify the indicators that underperform in comparison to the average, *why* this is the case, and *where* improvements can or should be made. Implementation of the four meta-values as input into the spatial analysis in order to measure the stations' surroundings and in this way connect it to the performance of that particular station and identify *in what way* improvements can be made through spatial interventions in the station area and complex. In the next phase of the research program dealing with the station and spatial strategy the relationship between key performance indicators and meta-values can then be used a basis for those strategies and specifically aim spatial interventions to improve underperforming key performance indicators.

The effect the stations' surroundings has on its performance should be both graphically and numerically presented in the

current KISS format, although it will require a third scale for each station; the city itself. In this way it will complement the two existing scale levels; station complex and station area. KISS is then able not to only present an oversight of performance and surroundings of a station but also its over- and underperformance and why it is performing the way it does and thus link all three scale levels to performance.

7.4 **Further research**

Geographical influences on and within the station area cause every station to be unique. The results from this master thesis are therefore to be considered as generic. The performance graphs and relationships provide insight into the direction in which solutions to enhance performance should be sought. A prolonged measurement over several years of meta-values and KPIs will provide a more detailed insight into the creation of added value. I therefore recommend to set up an ongoing measurement of at least six stations; two of each type. The stations which are currently being redeveloped, the NSPs provide an opportunity to conduct a "before and after" analysis of performance that will provide a more in depth analysis of the influence a stations environment has on its performance.

Due to lack of reliable data this thesis only deals with a stations production in the form of its capture rate. It would be valuable to know not only where produced passengers come from but also where they are going, since this is where the motive to travel lies in the first place. Further improvements on post-transport can then be made. Identifying the needs of arriving and departing will enable NS Poort to target those groups specifically, not only in terms of pre- and post-transport but also on the supply of goods and services at each station and thus increase revenue as more services and goods are provided that match the specific demands of both groups.

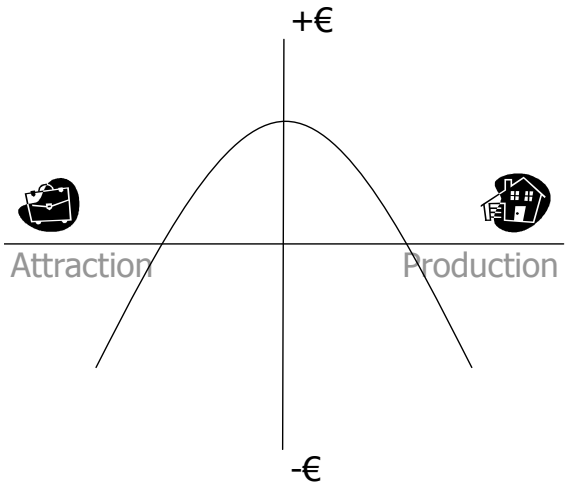
7.5 **Encore; Effects on the network**

In this section I will present the effects that spatial interventions at a single station have on the rest of the network and in what way production and attraction can be balanced and competition between stations might be prevented in the future. Although this is technically not a part of my thesis I feel it that these effects can not be omitted as they can have severe consequences for NS' profitability. This section thus may serve as introduction into follow up research on the network effects of spatial interventions surrounding railway stations.

NS' core business product, transportation, is an economically unique product which is characterized by two properties that distinguish it from other free market products; First of all production and consumption take place at the *same time*, therefore much like energy producers, its production capacity is determined by peak demand. Secondly it operates at a more or less fixed maximum price due to government regulations, implying that supply and demand is not balanced by price as is the case in "normal" free market circumstances. Whilst prices are reduced in off peak hours, again much like energy producers, as an incentive to travel in those periods, capacity is still determined by peak demand occurring in morning and evening rush hour.

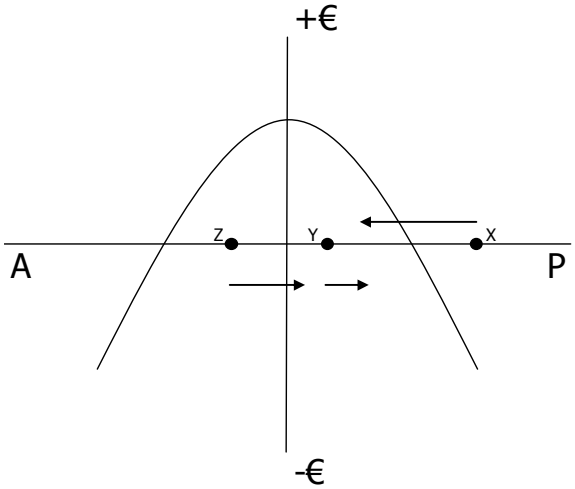
The comparison between energy and transportation stops at the geographical location of supply and demand. For an energy company it doesn't really matter where demand is located, it doesn't physically deliver a few kilowatts to your doorstep. In the case of transportation this geographical difference between supply and demand causes a further increase in peak capacity when production and attraction become more unbalanced. Almere Centrum for instance shows far more production than attraction, this means that packed trains leave the station in the morning travelling to Amsterdam where the disembark and the train returns virtually empty or has to parked in a rail yard (which also consumes valuable land) until needed in evening rush hour when the opposite movement takes place.

It is here that added value of real estate development in station areas becomes apparent as it can be used as an instrument to balance supply and demand or, in other words, production and attraction.



Graph 7-1; relationship between production/attraction and added value

When looking at a single station area, development of real estate in its surroundings can, in part, be used to as a tool to balance production and attraction. In general additional dwellings will generate production, development of offices, schools and leisure will generate attraction, this of course is dependant on local market conditions. When additional real estate is developed and as an effect attraction and production becomes more balanced this has to cause an opposite effect at a number of other stations. This is illustrated by Graph 7-2; Offices are developed at station X thus generating additional attraction, as a result this has to cause additional production at stations Y and Z.



Graph 7-2; relationship between attraction and production on a macro (network) level.

Real estate development at one station thus does not only influence the performance of that particular station (micro) but also that of the stations with which it shares its most intensive relationships (macro). The effects of an intervention might provide a win-win situation but only if its effects cause all influenced stations towards more balance between attraction and production this will however not always be the case. These interconnected stations therefore should not be considered separately but as a single market that supplies activities. Since attraction at one station causes production at another synergy between stations is

just as important in the creation of added value as synergy within the station area.

Effects on the value of Real Estate

What should this synergy between different stations look like? The first step is to establish a theoretical framework on which further steps can be based. I will start with presenting the land-use transportation feedback cycle (Wegener & Fust, 1999) as it incorporates the terms that have been mentioned abundantly in the last few chapters; Transport, accessibility, land use and activity.

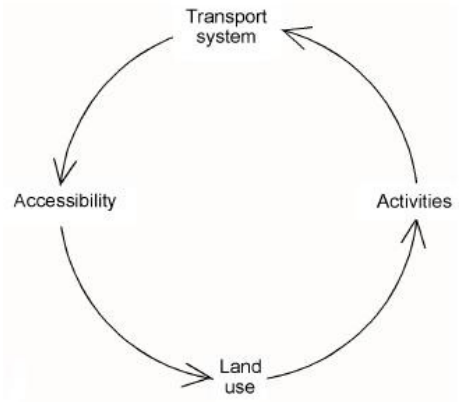


Figure 7-1; Land-use transportation feedback cycle (Source; Wegener & Fürst, 1999)

Distribution of land use; dwellings, offices & retail determines the activities; reside, work, shopping. In order to perform these activities, people make use of transportation to cross the distance between these activities. Transportation system determines the accessibility of a place. Different types of land use need different levels of accessibility; change in accessibility leads to different land use.

Synergy between station areas lies in separation of activities since this is the cause for transportation demand. Activities need to supplement in each other in order to create synergy. If activities overlap, this will have two unwanted consequences; (1) a diminishing demand for transport (between A & B), and one directional transport from C (2) competition in the real estate market between the two stations (A & B).

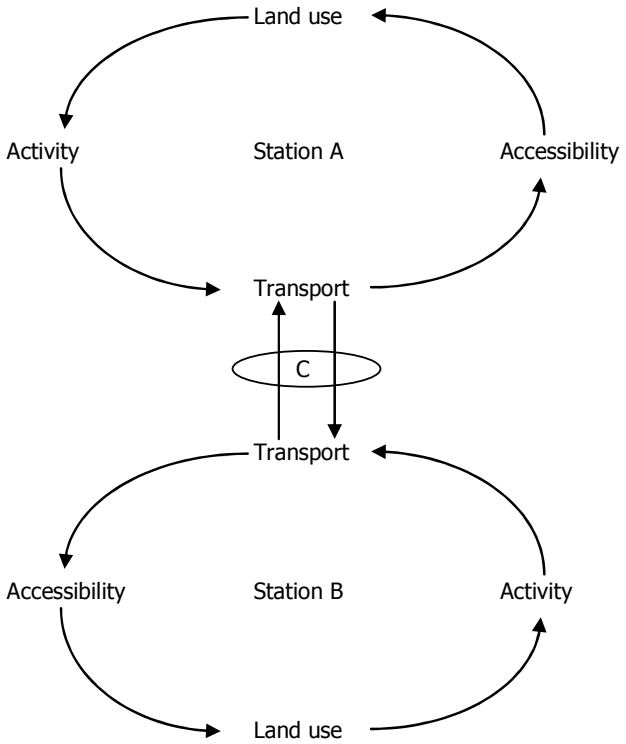
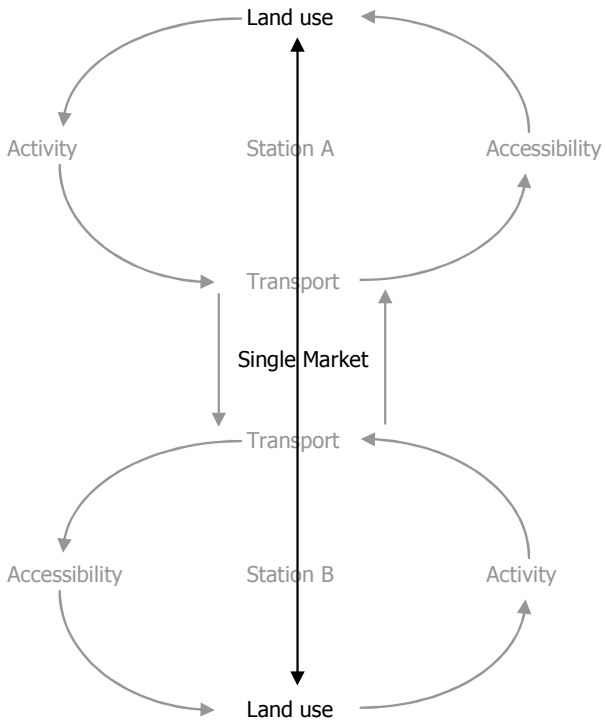


Figure 7-2; Land use transport cycle of three interconnected stations

A diminishing demand for transport is caused by the diminishing need to travel to an activity if it is supplied at multiple places; If the same activity is provided at A & B there is no need to travel from A to B, this will decrease production of both A & B and distort balance between production and attraction of A & B since both still attract passengers from C.

Competition comes into being when an equally satisfying alternative is offered. In the case of railway stations equality in accessibility leads to equally satisfying alternatives at multiple locations. If those locations are in the vicinity of one another a single market is formed and thus competition will be created resulting in rent inflation and with it lower land prices.



If travel time diminishes between station A and B, they will tend to form one real estate market whereby the larger of the two gains competitiveness over the smaller station since they both provide equally satisfying alternatives. In order to prevent supply of equally satisfying alternatives at both stations, a new unique property will have to be introduced. This unique property has to become a stations "unique selling point" which sets it apart from all others that provide equal accessibility.

Figure 7-3 shows groups of stations that in the case of office space in the station area tend to form a single market. The larger circles denote anchors of each group, the smaller circles depict subordinate stations. The goal is to create synergy between the anchors and it subordinates through diversification of activities. In the case of office space this diversification can be achieved through clustering of area specific activities.

Each anchor and node city in a single market group has specific attributes or predominant activities that distinguish it from the others. The station area has to magnify these local attributes and thus serve as a "unique selling point" that benefits a tenants business-case and its corporate profile. In turn these corporate profiles help the municipality in expressing its city brand especially when located at the entrance to the city; the railway station.

As seen when examining Leiden where RE values are below the city average, the station does not have a unique selling point, and thus The Hague becomes an equally, if not better, satisfying alternative. The top office district in Leiden is the bio-science park, which does offer a unique selling point; clustering. The bio-science park is grouped around LUMC and enables life science companies to share resources, which is an advantage for companies in this sector due to high development and start-up costs. The area specifically targets life science companies, which is in line with the desired city image. This form of activity based clustering can be employed to differentiate the activities taking place at competing stations and thus create synergy between stations.

For example the Randstad south wing cluster (green) can be ordered into the following activity based clusters;

- Leiden – Life Science cluster (UL/LUMC)
- The Hague – Government/International affairs cluster
- Delft – Technology cluster (TUD)
- Rotterdam – Logistics & south Randstad general services cluster (Erasmus, Port and Financial Services)

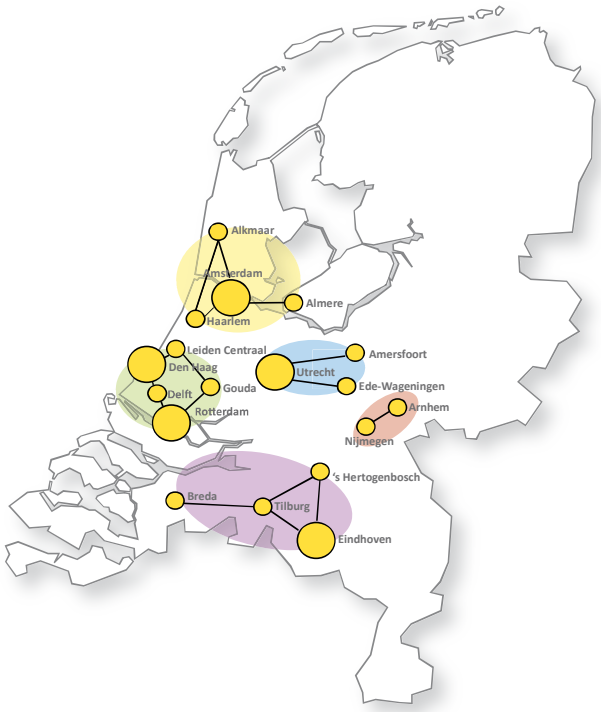


Figure 7-3; Clusters of single office space markets comprised of anchors and nodes

In terms of capacity utilization, diversification through clustering will provide two benefits; Area specific activities will aid in equalizing attraction and production at the anchors and nodes (A & B in Figure 7-2). Secondly it will aid in equalizing the production between the two directions that passengers from the stations in between travel to (Figure 7-4).

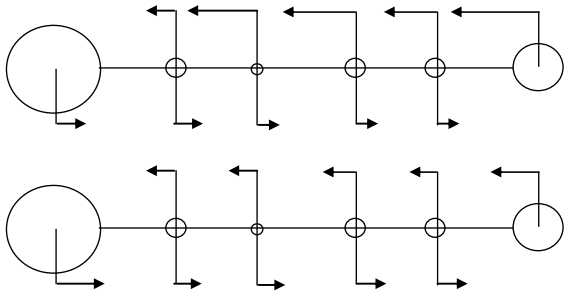


Figure 7-4; Equalizing the direction of production between two anchor stations

Effects of synergy on RE value

Within the station area a functional mix comprised of housing, offices leisure and retail is considered to add value not only for NS but for all stakeholders involved as it provides a unique "place of buzz" (Peek, 2007). When at related stations areas other "places of buzz" arise this will create competition between the real estate markets surrounding those stations, which is the exact opposite of the objective of synergy between stations. Especially in the case of offices these related stations should be considered as a single market. The office market at station Leiden has shown effects of this single market principle, since it is in direct competition with Den Haag putting downward pressure on rent performance.

A unique station area provides a competitive advantage over others, when more station areas become "unique places" this competitive advantage dissolves rapidly. Synergy requires the combination of unique attributes in order to create added value, it is thus essential that station areas remain unique places to settle and do not become copies of others causing a decrease in willingness to pay for a particular location.

Municipal policy has an important role to play in maintaining uniqueness, if two neighbouring municipalities decide to allow development of office space within the station area, competition for future tenants is born. This competition leads to lower rent levels and inflation of land values and thus decreasing revenues for the municipalities. If future office developments in these two municipalities would target specific tenants based on their activity the door is opened to added value generated from accessibility in combination with added value generated from clustering. In order to avoid competition between stations and instead create synergy between stations these areas should be diverse through clustering in such a way that the combination of accessibility and clustering serves as a unique selling point of that particular location. This creates a win-win-win-win situation for the tenants, owners, municipality and NS.

15 Mei.... een nieuwe Dienstregeling met véél goed nieuws!

1. Eindhoven-Maastricht, Sittard-Heerlen en Maastricht-Heerlen geëlectrificeerd!
2. Rijtijden op de hoofdlijnen verkort.
3. Bovendien: Expres-treinen met Restauratiewagen (in etenstijden) Amsterdam-Maastricht in 2 uur 54 min.
4. Diesel-electrische Expres-treinen:
   Rotterdam, Den Haag-Groningen in 3 uur 12 min.
   Rotterdam, Den Haag-Leeuwarden in 3 uur 15 min.
   Amsterdam-Enschede in 2 uur 13 min.
   Rotterdam-Vlissingen in 1 uur 44 min.
5. *En dan nog een nieuw* Spoorboekje *met alle aanduidingen. In handig formaat.*

Veilig - Vlug - Voordelig!

26 Februari 1949

Voor spoedige indiensttreding bij het Seinwezen worden gevraagd

ENIGE JONGE INGENIEURS

met diploma T.H.S. Delft (electrotechniek of werktuigbouwkunde).

Sollicitaties met uitvoerige inlichtingen te zenden aan de 2e Afdeling van de Algemene Dienst der N.V. Nederlandsche Spoorwegen te Utrecht.

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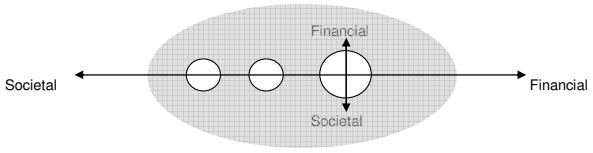
Appendix I; Personal Reflection

In this final section of my thesis report I will look back on the last months and reflect on both the research process and final product and identify what I might have done better or mere efficiently. It has been an interesting undertaking at a real estate company which deals with complex problems combining transport and spatial development whilst balancing between financial gain and societal issues that impact a city as well as the entire NS network.



Process

In my own opinion real estate development serves a single goal; adding value to land. This added value either financial or societal is influenced by many factors one of the most important however is accessibility. Inaccessible land, no matter how beautiful, sustainable or fertile is virtually worthless. The positive effects of infrastructure on the value of land have been the subject of research and debate for decades and it has been proven many times over that the presence of a railway station positively influences the value of land. The urban fabric of Dutch cities have adapted to the presence of railway stations and the resulting increased land value and they will continue to do so in the future by large scale urban interventions such as the NSPs or "naturally".

In the search for a suitable company to write my master thesis NS Poort stood out as it deals with both transportation and real estate development. What sets NS Poort apart from other real estate developers is that it does not develop real estate near railway stations to capitalize on the added value the infrastructure induces it does so in order to make the train a more appealing mode of transport. The goal of the organization thus led me to writing a master thesis on the influence of the urban fabric on the performance of a station.

The first step in the research was to determine the "characteristics" of the station and "performance" the main obstacle in doing so is demarcation of the terms. Gert Joost Peek's dissertation provided the four meta-values that are able to describe a stations characteristics and NS Poort provided me with four KPIs that are able to describe performance. This enabled a focussed literature review of articles that describe a specific relationship between one meta-value and one KPI furthermore it helped in narrowing down relevant search entries in the different scientific databases and repositories. This has helped me limit the time spent in searching for relevant literature by keeping a narrow focus and "stay on topic" which is something I usually find hard to do.

A systematic review of retrieved articles and common sense led to the elements or variables that I use to describe each of the meta-values. Actually retrieving and organizing the data was very time consuming caused by the fact that I failed to provide adequate demarcation beforehand and thus collected heaps of data that is not incorporated in the final product. A clear description of each meta-value from the perspective of the relevant user would have been able to prevent this.

The four test cases between a KPI and four meta-values of a "best" and "worst" performing station has proven to be extremely time consuming whereby results are outweighed by effort. The reason again is insufficient demarcation this has led to a trial and error process in trying to answer the question why A is better than B acquiring even more data along the way. Although it has lead to insights which in turn have lead to elements that are able to describe the difference in performance these have been gained at the cost of to much time spent in wandering off topic. These insights would probably also have been generated by speaking to the experts who work at NS Poort, and then retrieve the data needed to test those assumptions.

The amount of data generated in the previous phases of the research forced me to reassess which elements were actually useful to describe the relationships between the urban fabric and a stations performance. A re-focus on the elements retrieved from literature review combined with adaptations gained from the test cases proved to be sufficient in order to describe the relationship underlining the importance of solid demarcation in the early phases of the research. The conclusions, finally, were relatively easy to draw as the scatter graphs provide an overall snapshot of each individual relationship which then in turn had to be interpreted and presented in the report. A clear distinction between effects on micro and macro level made it easier to focus on the micro level and instead of completely discarding the macro level provide a small insight into the (future) effects on the network as a separate section.

All in all I can conclude that a solid demarcation aided in defining the problem and retrieving and reviewing the relevant literature. A second demarcation step in which the relationship is described from the viewpoint of the relevant user would have been helpful in increasing efficiency of retrieving data and performing the test cases.
I can also conclude that I have depended too much on available data within NS Poort and NS MOA and far too little on the available expertise within those same organizations most notably that within Asset Development. This would have lead to a more efficient approach and probably to a more in depth description of the relationships. Within Asset Development the existence of most of these relationships was expected although never proven. A dialogue beforehand on those presumptions would have produced a more in depth analysis.

Product

The objective of this thesis is to provide insight into the effects the urban fabric has on the performance of a station. The goal in doing so is to aid in answering a basic question that arises when new developments take place; what do I want? And at the same time provide insights into the way this goal can be reached. In this section I will describe they way in which the final product meets these objectives.

The four operationalized meta-values are able to describe the properties of the station area at a basic level. The large group of stations the research covers forced me to generalize these properties this has led to the loss of area specific elements which have a large stake in the attractiveness of a location. Describing a single area with variables would have enabled the inclusion of the nuances that describe the situation more accurately although a description of the real world through a series of numbers will never reflect all the processes that influence a certain location. When developing a business case for the development of new functions at those stations these nuances can be included in order to determine future effects.

The key performance indicators that NS has developed for its stations needed to be altered in order to compare the stations with each other. Turnover and customer satisfaction did not need any modifications because they depict actual situations and are relevant no matter the size of the station. The transformation of the number of passengers into the capture rate enables both comparison and at the same time shows the success with which a station is able to persuade passengers to use the train. The capture rate however lacks in an important element, the station as a destination. It is only based on a stations production and thus is not related to the motive to travel which is always located at a different location. The value of real estate is described by office space rent this is of course only one element of the real estate market and differs in volume at every station. A more accurate description would have been obtained when the price of dwellings and rent of retail would have been included along with the volume of each type. This however may be considered as a thesis in its own right and would have become too time consuming. The KPIs do provide an answer to the question; what do I want? In that respect they serve their goal and identify what KPI underperforms and has to improve when new developments take place.

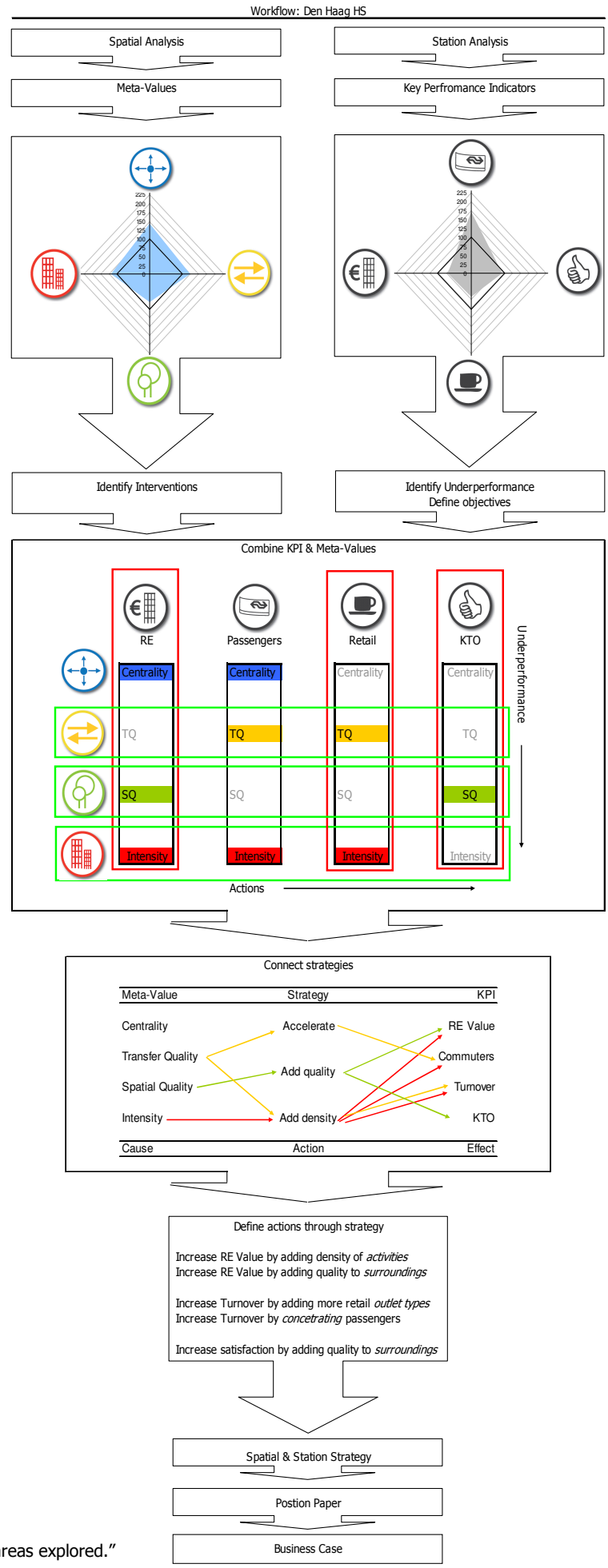
The test cases have proven to be useful in understanding the relationships and adding new elements in describing them although it has become a too large part of the thesis that does not offer enough clear information and thus it would have been better to include it in a different more result based manner. A problem that is resolved through the wrap ups but this does not solve the fact that the report has become somewhat bulky in the middle.

The generalization phase of the report provides the insight the test cases are unable to. It becomes clear that positive relations exist in which meta-value influences what KPI. In combination with the key performance indicators it is able to provide insight in the way performance can be enhanced by spatial interventions. As such it serves the goal I set out to achieve one year ago.

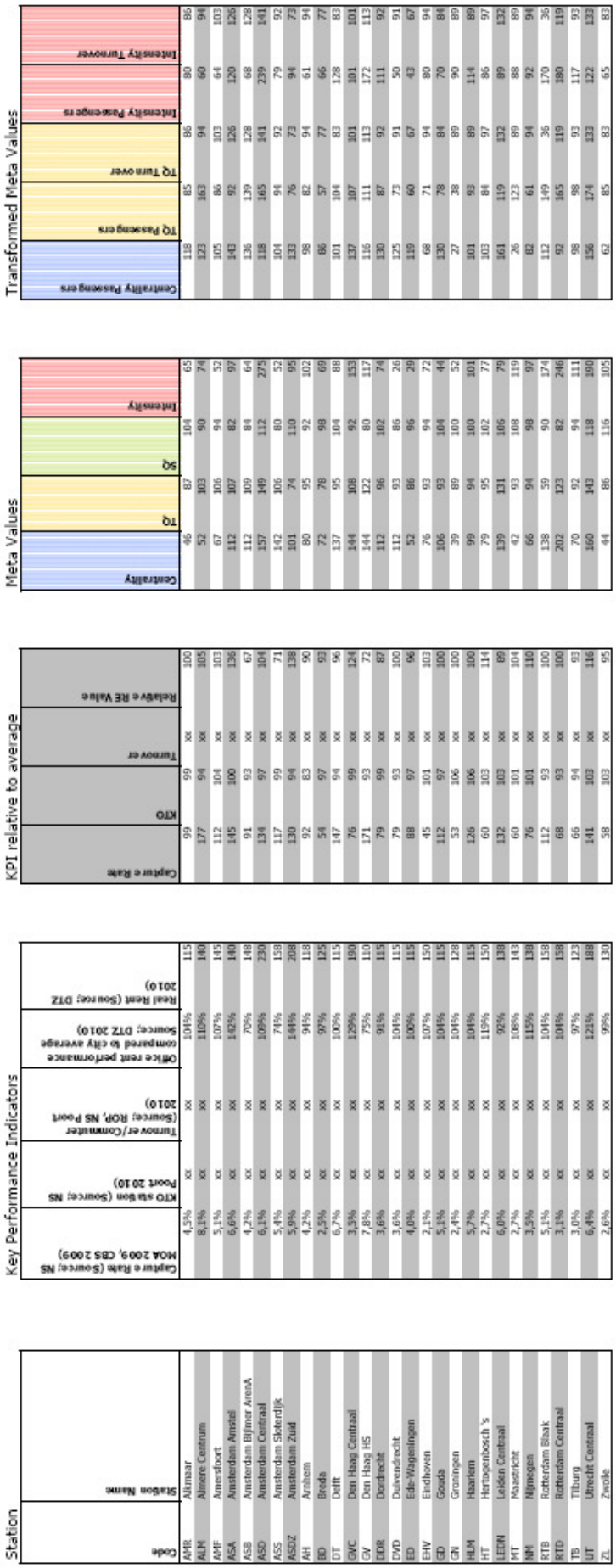
Final remarks

All in all I've spent nine months at NS Poort working both on my thesis and a research project for NS' land issuing company. The combination of academic research on one hand and practical experience on the other has made this a valuable experience for me personally. Not in the least because of the support that NS Poort provided. This nine moth insight into NS Poort has shown me that it is a real estate company unlike any other in the country or Europe for that matter. This is in part because development and exploitation of real estate is not a goal in itself it serves as a means to make using the train as attractive as possible. Asset development especially views the development of stations and the services that should be provided at those stations through this strategy and its extensive research program is geared towards achieving this goal. Projects such a ROP and KISS are examples of the unique way Asset Development "does business" by developing new knowledge that is a basis for future strategies. It therefore feel has been a great experience and an addition to my education at RE&H and can only regret that most of the knowledge that is developed at NS Poort will remain confidential for the foreseeable future. It is quite unique for any company to share so much of its expertise and often confidential information or the benefit of a student's master thesis and personal development. I therefore sincerely hope that my efforts are able help NS Poort in achieving its goal; providing a safe, pleasant and dynamic station area.

Appendix II; Workflow



Appendix III; KPI and Meta-Values



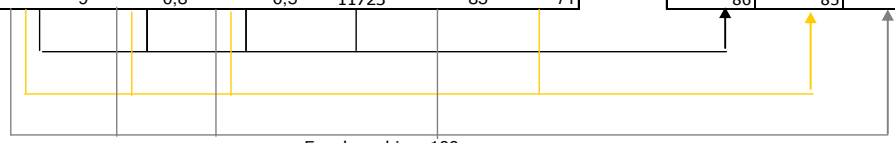
Station			Key Performance Indicators					KPI relative to average				Meta Values				Transformed Meta Values			
Code	Station Name		Capture Rate (Source: NS MOA 2009, CBS 2009)	KTO sub goal (Source: NS Point 2010)	Turnover/Commuter (Source: ROP, NS Point 2010)	Office rent performance compared to city average Source: DTZ 2010)	Real Rent (Source: DTZ 2010)	Capture Rate	KTO	Turnover	Relative RE Value	Centrality	TQ	SQ	Intensity	Centrality Passengers	TQ Passengers	TQ Turnover	Intensity Passengers	Intensity Turnover
AMR	Almsar		4,5%	xx	xx	104%	115	99	99	xx	100	46	87	104	65	118	85	86	80	86
ALM	Almere Centrum		8,1%	xx	xx	110%	140	177	94	xx	105	52	103	90	74	123	163	94	60	94
AMF	Amersfoort		5,1%	xx	xx	107%	145	112	104	xx	103	67	106	94	52	105	86	103	64	103
ASA	Amsterdam Amstel		6,6%	xx	xx	143%	140	145	100	xx	136	112	107	82	97	143	92	126	120	126
ASB	Amsterdam Bijlmer ArenA		4,2%	xx	xx	70%	148	91	93	xx	67	112	109	84	64	136	139	128	68	128
ASD	Amsterdam Centraal		6,1%	xx	xx	109%	230	134	97	xx	104	157	149	112	275	118	165	141	239	141
ASS	Amsterdam Sloterdijk		5,4%	xx	xx	74%	158	117	99	xx	71	142	106	80	52	104	94	92	79	92
ASDZ	Amsterdam Zuid		5,9%	xx	xx	144%	208	130	94	xx	138	101	74	110	95	133	76	73	94	73
AH	Arnhem		4,2%	xx	xx	94%	118	92	83	xx	90	80	95	92	102	98	82	94	61	94
BD	Breda		2,5%	xx	xx	97%	125	54	97	xx	93	72	78	98	69	86	57	77	66	77
DT	Delft		6,7%	xx	xx	100%	115	147	94	xx	96	137	95	104	88	101	104	83	128	83
GVC	Den Haag Centraal		3,5%	xx	xx	129%	190	76	99	xx	124	144	108	92	153	137	107	101	101	101
GV	Den Haag HS		7,8%	xx	xx	75%	110	171	93	xx	72	144	122	80	117	116	111	113	172	113
DDR	Dordrecht		3,6%	xx	xx	91%	115	79	99	xx	87	112	96	102	74	130	87	92	111	92
DVD	Duivendrecht		3,6%	xx	xx	104%	115	79	93	xx	100	112	93	86	26	125	73	91	50	91
ED	Ede-Wageningen		4,0%	xx	xx	100%	115	88	97	xx	96	52	86	96	29	119	60	67	43	67
EHV	Eindhoven		2,1%	xx	xx	107%	150	45	101	xx	103	76	93	94	72	68	71	94	80	94
GD	Gouda		5,1%	xx	xx	104%	115	112	97	xx	100	106	93	104	44	130	78	84	70	84
GN	Groningen		2,4%	xx	xx	104%	128	53	106	xx	100	39	89	100	52	27	38	89	90	89
HLM	Haarlem		5,7%	xx	xx	104%	115	126	106	xx	100	99	94	100	101	101	93	89	114	89
HT	Hertogenbosch 's		2,7%	xx	xx	119%	150	60	103	xx	114	79	95	102	77	103	84	97	86	97
LEDN	Leiden Centraal		6,0%	xx	xx	92%	138	132	103	xx	89	139	131	106	79	161	119	132	89	132
MT	Maastricht		2,7%	xx	xx	108%	143	60	101	xx	104	42	93	108	119	26	123	89	88	89
NM	Nijmegen		3,5%	xx	xx	115%	138	76	101	xx	110	66	94	98	97	82	61	94	92	94
RTB	Rotterdam Blaak		5,1%	xx	xx	104%	138	112	93	xx	100	138	59	90	174	112	149	36	170	36
RTD	Rotterdam Centraal		3,1%	xx	xx	104%	158	68	93	xx	100	202	123	82	246	92	165	119	180	119
TB	Tilburg		3,0%	xx	xx	97%	123	66	94	xx	93	70	92	94	111	98	98	93	117	93
UT	Utrecht Centraal		6,4%	xx	xx	121%	188	141	102	xx	116	160	143	118	190	156	174	133	122	133
ZL	Zwolle		2,6%	xx	xx	99%	130	58	103	xx	95	44	86	116	105	62	85	83	65	83

Appendix IV; Data conversion

Station		Centrality Raw Data							Meta-Values	
Code	Station Name	Number of inhabitants 30 min x 1000 (Source; Goudappel Coffeng)	Number of inhabitants 60 min x 1000 (Source; Goudappel Coffeng)	Number of jobs 30 min x 1000 (Source; Goudappel Coffeng)	Number of jobs 60 min x 1000 (Source; Goudappel Coffeng)	Accessibility loss due to congestion 30	Accessibility loss due to congestion 60	Jobs outside municipality (CBS, 2005)	Centrality	Centrality Passengers
AMR	Alkmaar	247	1238	94	577	690	1646	51%	46	118
ALM	Almere Centrum	194	1564	79	880	645	1915	62%	52	123
AMF	Amersfoort	194	2114	114	1195	407	2547	50%	67	105
ASA	Amsterdam Amstel	470	2708	320	1462	963	2000	31%	112	143
ASB	Amsterdam Bijlmer ArenA	447	2726	316	1490	919	1852	31%	112	136
ASD	Amsterdam Centraal	800	3398	469	1770	735	1838	31%	157	118
ASS	Amsterdam Sloterdijk	745	3073	420	1555	628	1658	31%	142	104
ASDZ	Amsterdam Zuid	313	2604	301	1443	879	1876	31%	101	133
AH	Arnhem	459	1742	230	835	433	2103	45%	80	98
BD	Breda	316	1975	165	980	359	1902	41%	72	86
DT	Delft	832	2952	403	1261	512	1679	51%	137	101
GVC	Den Haag Centraal	840	3211	384	1518	902	1894	35%	144	137
GV	Den Haag HS	845	3237	402	1437	714	1765	35%	144	116
DDR	Dordrecht	596	2892	266	1305	755	2079	46%	112	130
DVD	Duivendrecht	457	2680	321	1460	584	1825	86%	112	125
ED	Ede-Wageningen	191	1543	104	817	564	2502	46%	52	119
EHV	Eindhoven	412	1658	218	850	313	1241	36%	76	68
GD	Gouda	385	3518	163	1659	799	1598	55%	106	130
GN	Groningen	223	728	137	323	105	233	32%	39	27
HLM	Haarlem	414	2795	226	1344	494	1683	55%	99	101
HT	Hertogenbosch 's	263	2390	155	1247	485	2228	40%	79	103
LEDN	Leiden Centraal	654	3751	304	1842	1154	1369	54%	139	161
MT	Maastricht	290	733	136	314	79	356	29%	42	26
NM	Nijmegen	374	1466	184	679	343	1788	41%	66	82
RTB	Rotterdam Blaak	877	2801	412	1230	658	1867	35%	138	112
RTD	Rotterdam Centraal	1382	3750	612	1684	494	1642	35%	202	92
TB	Tilburg	312	1874	168	916	513	1805	37%	70	98
UT	Utrecht Centraal	616	4258	381	2328	985	2260	45%	160	156
ZL	Zwolle	222	1086	114	525	207	1546	35%	44	62

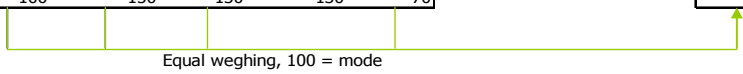
Equal weghing, 100 = average

Station		Transfer Quality Raw data						Meta-Values		
Code	Station Name	BTM Lines	RSQI attraction (2000) (Source De graaff et. al. 2009)	RSQI production (2000) (Source De graaff et. al. 2009)	Inter train transfers (Source KIS 2009)	Percentage of commuters passing main shopping area	Number of inhabitants 15 min x 1000 (Source; Goudappel Coffeng)	TQ	TQ Passengers	TQ Turnover
AMR	Alkmaar	12	0,80	0,5	129	87	7	87	85	86
ALM	Almere Centrum	14	0,50	0,5	195	55	81	103	163	94
AMF	Amersfoort	9	1,377	0,915	25772	80	12	106	86	103
ASA	Amsterdam Amstel	8	1,13	0,901	671	200	13	107	92	126
ASB	Amsterdam Bijlmer ArenA	11	0,815	0,575	2275	200	20	109	139	128
ASD	Amsterdam Centraal	35	1,38	1,058	17926	70	122	149	165	141
ASS	Amsterdam Sloterdijk	15	1,286	1,058	8792	30	0	106	94	92
ASDZ	Amsterdam Zuid	10	0,95	0,742	754	100	10	74	76	73
AH	Arnhem	13	0,957	0,807	16942	85	13	95	82	94
BD	Breda	10	0,64	0,5	2274	90	15	78	57	77
DT	Delft	9	1,227	0,867	1	36	36	95	104	83
GVC	Den Haag Centraal	15	1,14	0,946	4434	75	73	108	107	101
GV	Den Haag HS	15	1,501	1,118	4753	61	12	122	111	113
DDR	Dordrecht	5	1,22	0,959	5707	75	33	96	87	92
DVD	Duivendrecht	6	1,158	0,845	2763	97	5	93	73	91
ED	Ede-Wageningen	7	0,86	0,602	2048	0	8	86	60	67
EHV	Eindhoven	13	0,858	0,687	10394	100	11	93	71	94
GD	Gouda	4	1,46	0,884	9544	46	10	93	78	84
GN	Groningen	7	0,275	0,5	3921	100	4	89	38	89
HLM	Haarlem	9	1,39	0,948	2694	73	22	94	93	89
HT	Hertogenbosch 's	9	1,332	0,953	15065	100	13	95	84	97
LEDN	Leiden Centraal	13	1,82	1,285	16351	100	26	131	119	132
MT	Maastricht	10	0,8	0,5	1506	80	99	93	123	89
NM	Nijmegen	10	0,80	0,5	7654	97	14	94	61	94
RTB	Rotterdam Blaak	4	0,8	0,5	23	0	101	59	149	36
RTD	Rotterdam Centraal	25	1,26	1,038	18829	83	308	123	165	119
TB	Tilburg	13	0,847	0,657	4320	100	73	92	98	93
UT	Utrecht Centraal	22	2,00	1,464	51346	54	170	143	174	133
ZL	Zwolle	9	0,8	0,5	11723	85	71	86	85	83



Equal weghing, 100 = average

Station		Spatial Quality Raw Data						Meta-Value
Code	Station Name	Dwelling Stock (Leefbarometer 2010)	Public pace (Leefbarometer 2010)	Amenities (Leefbarometer 2010)	Population Mix (Leefbarometer 2010)	Social Cohesion (Leefbarometer 2010)	Safety (Leefbarometer 2010)	SQ
AMR	Alkmaar	90	110	140	110	90	70	104
ALM	Almere Centrum	70	110	140	50	100	50	90
AMF	Amersfoort	70	100	100	110	80	80	94
ASA	Amsterdam Amstel	60	110	130	60	60	50	82
ASB	Amsterdam Bijlmer ArenA	50	120	130	50	70	50	84
ASD	Amsterdam Centraal	70	140	140	120	90	70	112
ASS	Amsterdam Sloterdijk	50	100	100	50	90	60	80
ASDZ	Amsterdam Zuid	70	140	140	120	90	60	110
AH	Arnhem	100	70	100	110	90	90	92
BD	Breda	100	80	130	110	90	80	98
DT	Delft	80	100	130	110	90	90	104
GVC	Den Haag Centraal	70	100	140	70	90	60	92
GV	Den Haag HS	70	80	140	50	80	50	80
DDR	Dordrecht	90	90	130	110	100	80	102
DVD	Duivendrecht	60	130	120	50	70	60	86
ED	Ede-Wageningen	80	90	110	100	80	100	96
EHV	Eindhoven	80	80	120	110	90	70	94
GD	Gouda	120	110	120	120	100	70	104
GN	Groningen	80	100	130	110	90	70	100
HLM	Haarlem	110	100	150	110	80	60	100
HT	Hertogenbosch 's	80	100	120	120	90	80	102
LEDN	Leiden Centraal	90	140	140	110	80	60	106
MT	Maastricht	80	120	140	110	100	70	108
NM	Nijmegen	90	100	130	110	80	70	98
RTB	Rotterdam Blaak	60	100	140	90	70	50	90
RTD	Rotterdam Centraal	70	90	150	50	70	50	82
TB	Tilburg	80	90	130	110	80	60	94
UT	Utrecht Centraal	60	100	150	130	140	70	118
ZL	Zwolle	60	100	150	130	130	70	116

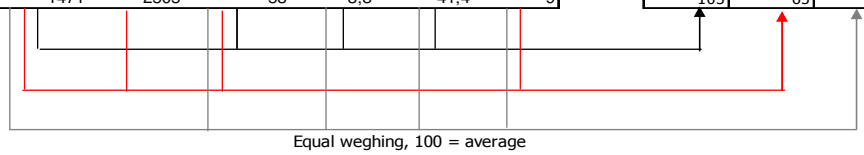


Station

Intensity Raw Data

Meta-Values

Code	Station Name	Dwellings/km² in PC (Source: CBSinuwbuurt.nl)	Adress/km² (Source: CBS 2010)	Number of jobs 15 min x 1000 (Source: Goudappel Coffeng)	No. Department stores within 1km (Source: CBS 2010)	Cafe/ Restaurant within 1km (Source: CBS 2010)	Types of retail outlets	Intensity	Intensity Passengers	Intensity Turnover
AMR	Alkmaar	3808	3065	5	5	32,8	8	65	80	86
ALM	Almere Centrum	2129	2329	41	2,3	15,9	5	74	60	94
AMF	Amersfoort	63	2465	12	5	5	9	52	64	103
ASA	Amsterdam Amstel	2985	4629	10	13	5,7	13	97	120	126
ASB	Amsterdam Bijlmer ArenA	3125	2604	40	1,1	1,1	8	64	68	128
ASD	Amsterdam Centraal	3453	9205	107	13,2	100	16	275	239	141
ASS	Amsterdam Sloterdijk	88	3053	18	2,4	0,1	8	52	79	92
ASDZ	Amsterdam Zuid	552	3629	45	4	15	5	95	94	73
AH	Arnhem	882	2351	30	5	71,3	10	102	61	94
BD	Breda	2552	2560	18	3,1	38,6	9	69	66	77
DT	Delft	1250	4922	15	3,2	39,8	4	88	128	83
GVC	Den Haag Centraal	2437	3907	84	11,4	3,4	13	153	101	101
GV	Den Haag HS	9200	6638	8	8,7	43,3	7	117	172	113
DDR	Dordrecht	1429	4269	15	3,6	22,1	5	74	111	92
DVD	Duivendrecht	1660	1917	2	2	2	3	26	50	91
ED	Ede-Wageningen	913	1651	6	2	5,3	1	29	43	67
EHV	Eindhoven	0	3063	28	5	5	16	72	80	94
GD	Gouda	2608	2709	11	2	6,3	5	44	70	84
GN	Groningen	3159	3471	6	4,2	4,4	9	52	90	89
HLM	Haarlem	1942	4387	14	7	50,9	9	101	114	89
HT	Hertogenbosch 's	2108	3318	18	4	34,2	13	77	86	97
LEDN	Leiden Centraal	3029	3414	12	5	42,3	13	79	89	132
MT	Maastricht	4305	3397	61	4	37,6	7	119	88	89
NM	Nijmegen	2995	3558	14	2	92,5	11	97	92	94
RTB	Rotterdam Blaak	4395	6539	83	4,1	51,1	1	174	170	36
RTD	Rotterdam Centraal	1359	6934	150	4	65	13	246	180	119
TB	Tilburg	4229	4504	34	2,4	63,1	6	111	117	93
UT	Utrecht Centraal	306	4713	101	7	62,5	19	190	122	133
ZL	Zwolle	1471	2505	53	3,8	41,4	9	105	65	83

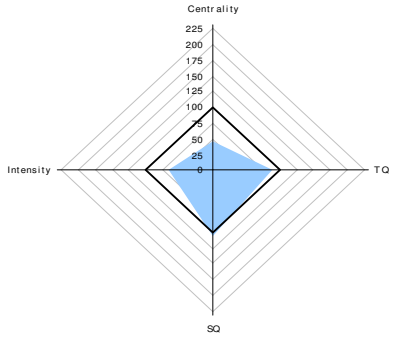


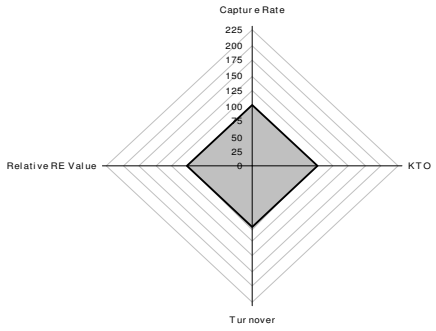
Equal weghing, 100 = average

Appendix V; KPI scores per station

Synergy | Alkmaar | KPI

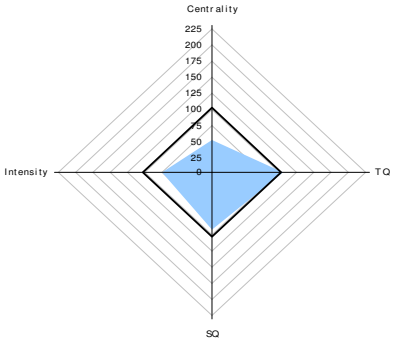
AMR

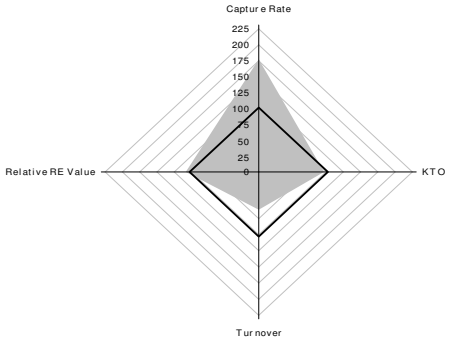




Synergy | Almere Centrum | KPI

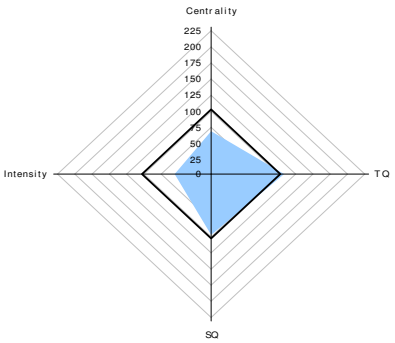
ALM

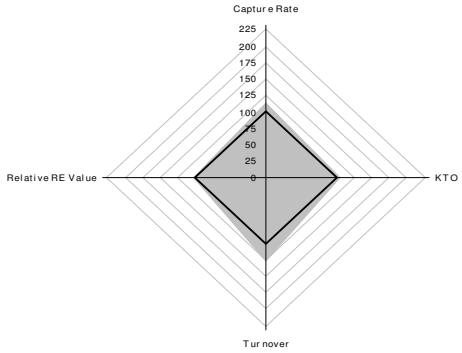




Synergy | Amersfoort | KPI

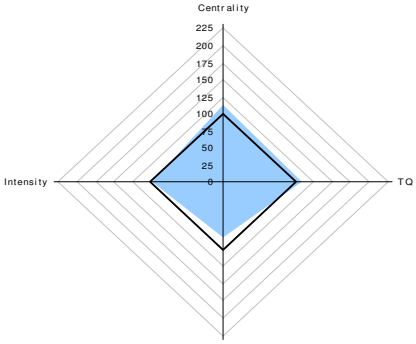
AMF

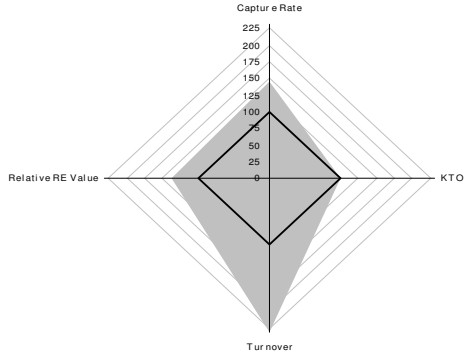




Synergy | Amsterdam Amstel | KPI

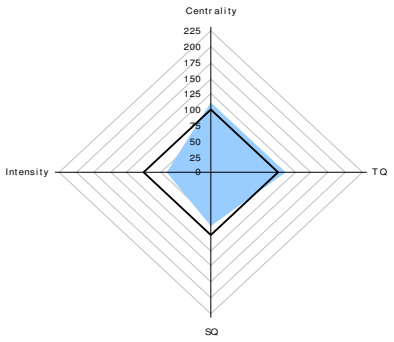
ASA

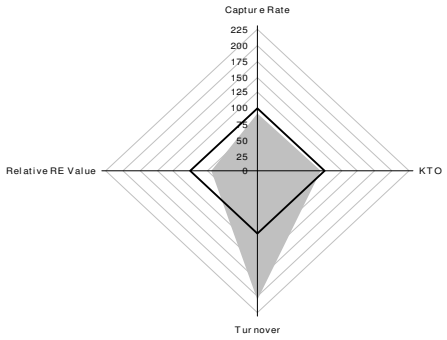




Synergy | Amsterdam Bijlmer ArenA | KPI

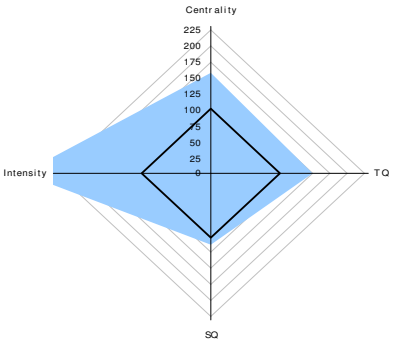
ASB

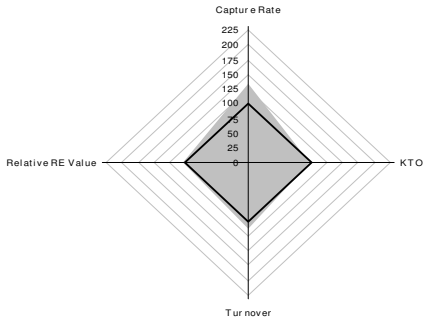




Synergy | Amsterdam Centraal | KPI

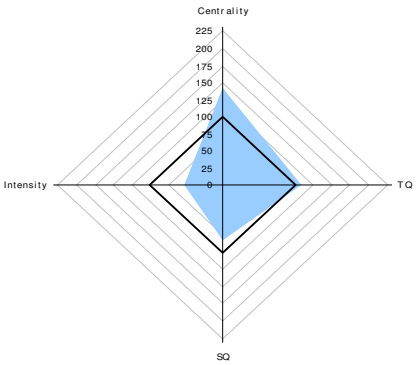
ASD

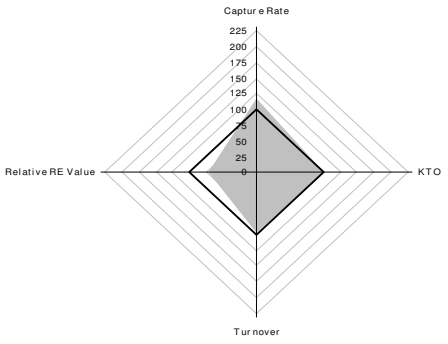




Synergy | Amsterdam Sloterdijk | KPI

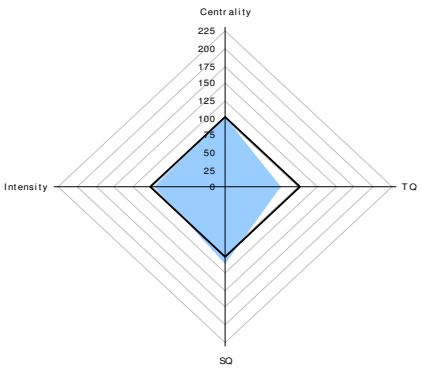
ASS

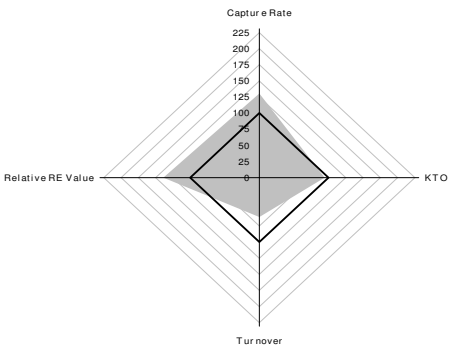




Synergy | Amsterdam Zuid | KPI

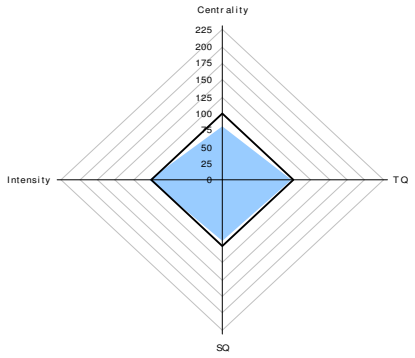
ASDZ

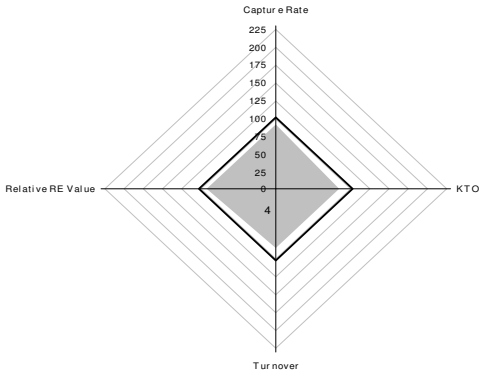




Synergy | Arnhem | KPI

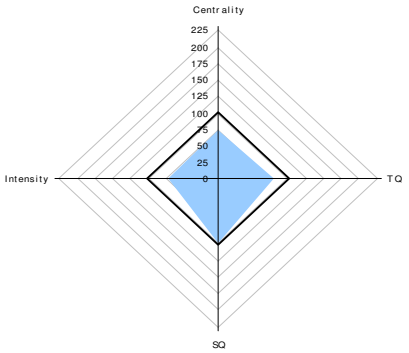
AH

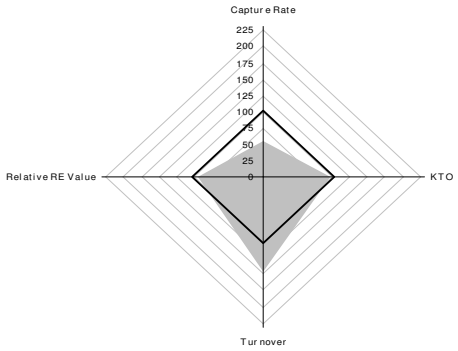




Synergy | Breda | KPI

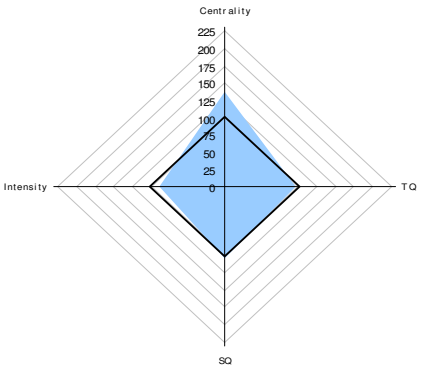
BD

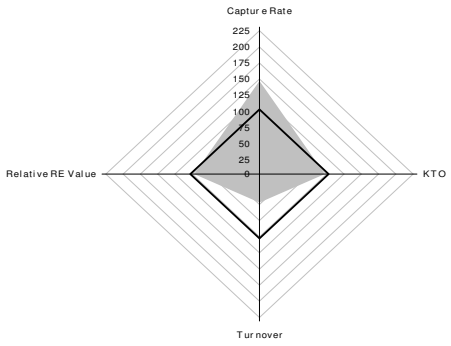




Synergy | Delft | KPI

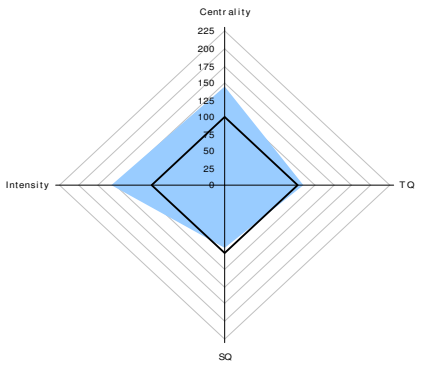
DT

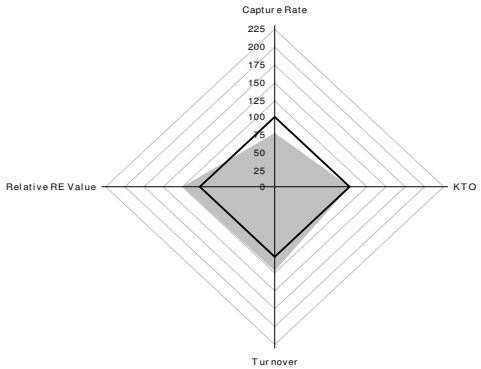




Synergy | Den Haag Centraal | KPI

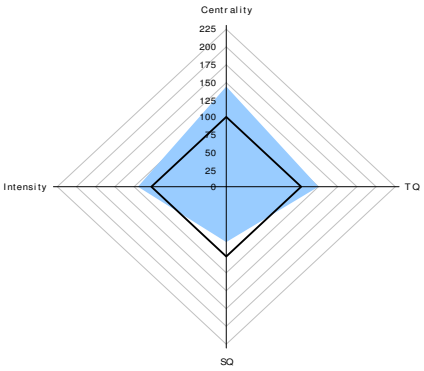
GVC

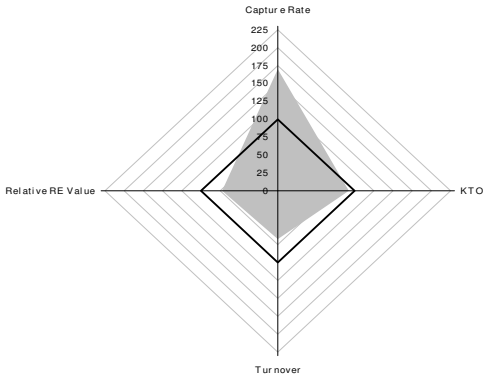




Synergy | Den Haag HS | KPI

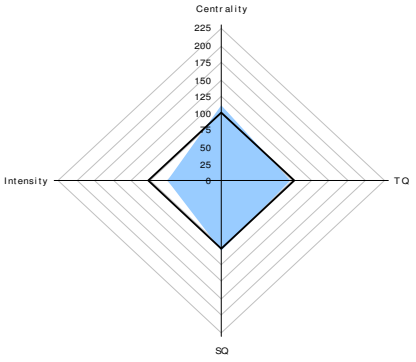
GV

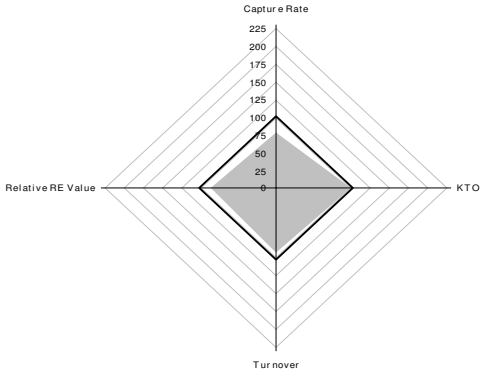




Synergy | Dordrecht | KPI

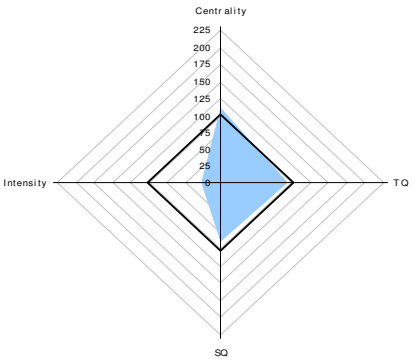
DDR

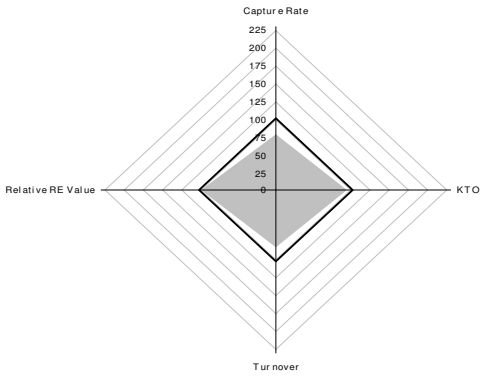




Synergy | Duivendrecht | KPI

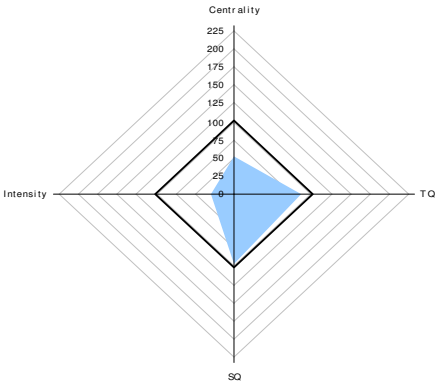
DVD

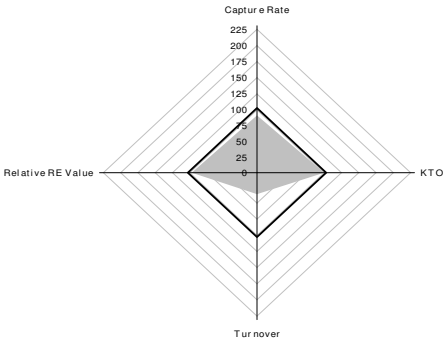




Synergy | Ede-Wageningen | KPI

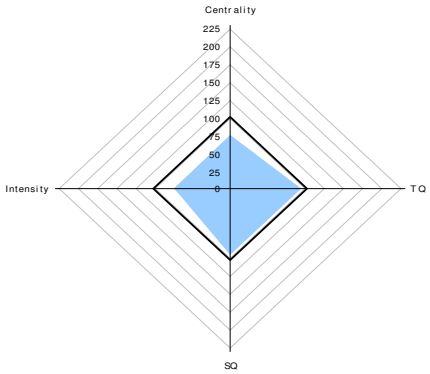
ED

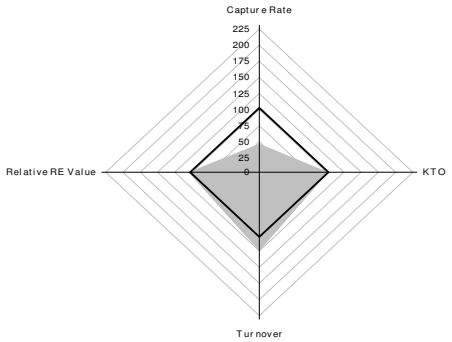




Synergy | Eindhoven | KPI

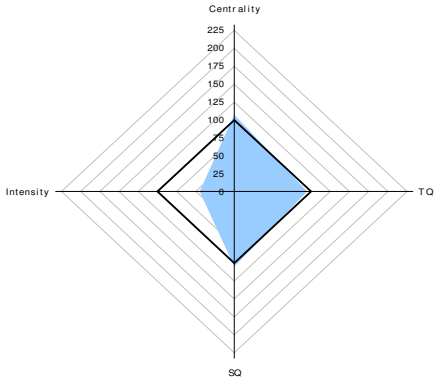
EHV

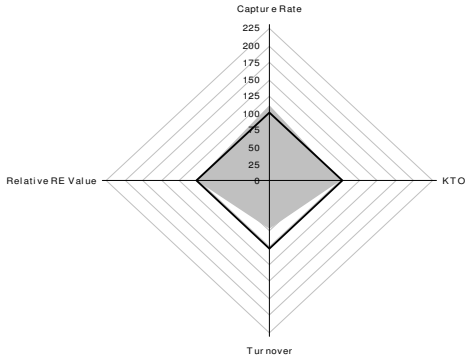




Synergy | Gouda | KPI

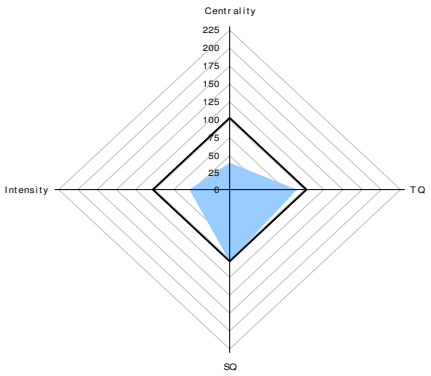
GD

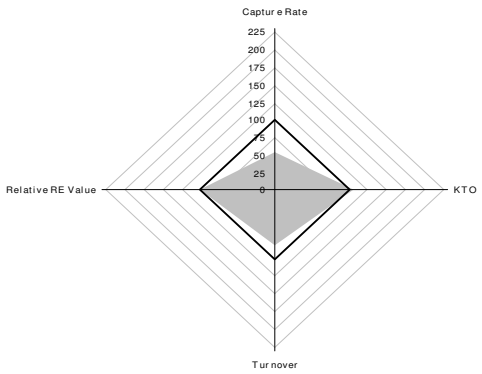




Synergy | Groningen | KPI

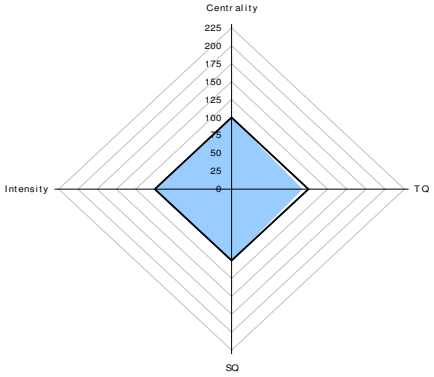
GN

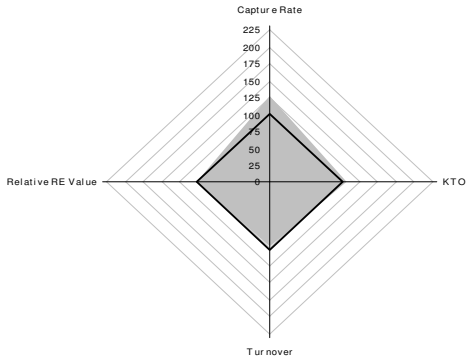




Synergy | Haarlem | KPI

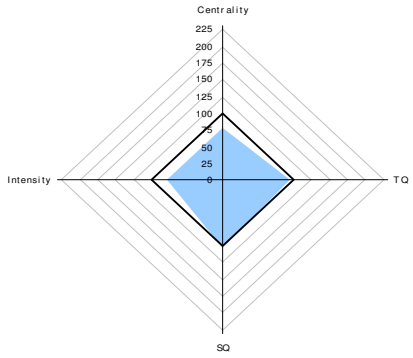
HLM

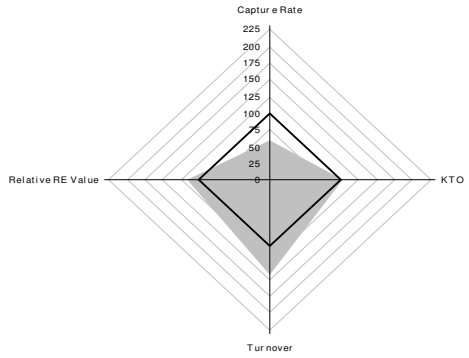




Synergy | Hertogenbosch 's | KPI

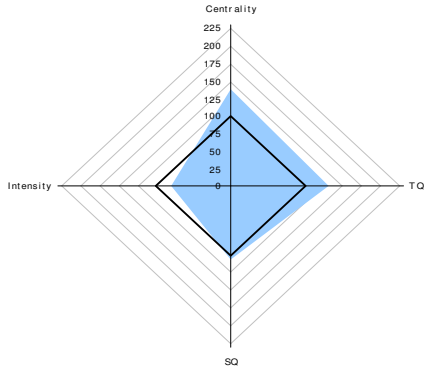
HT

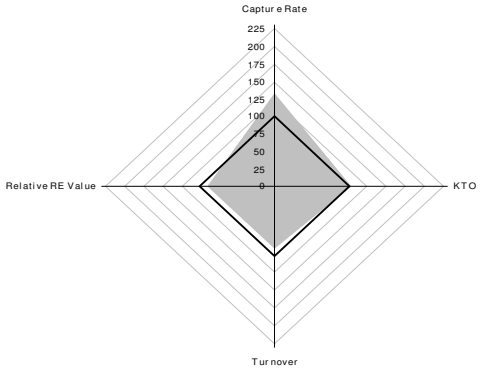




Synergy | Leiden Centraal | KPI

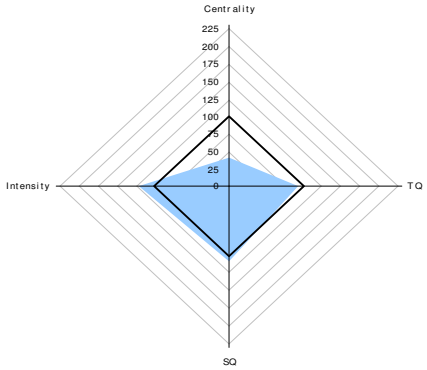
LEDN

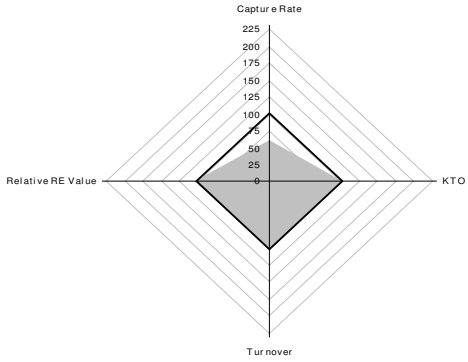




Synergy | Maastricht | KPI

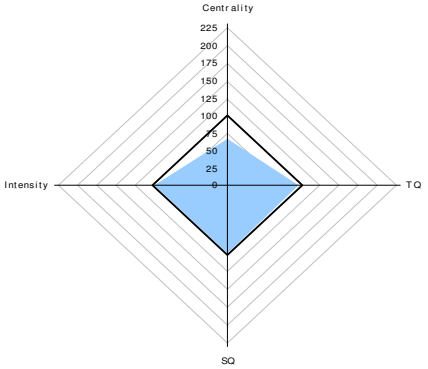
MT

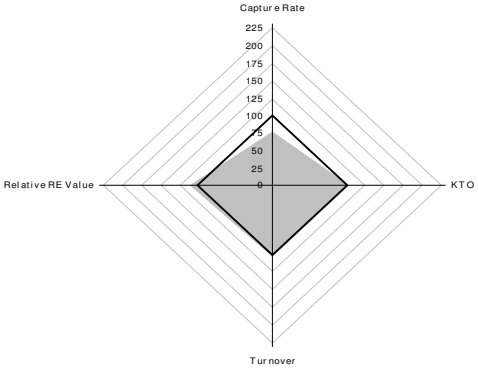




Synergy | Nijmegen | KPI

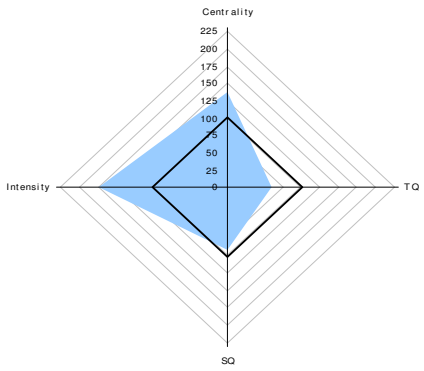
NM

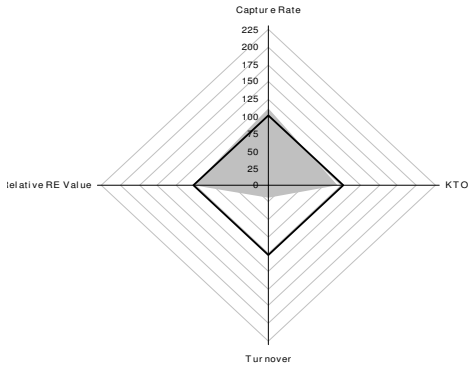




Synergy | Rotterdam Blaak | KPI

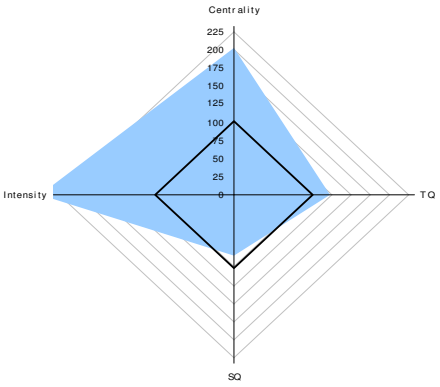
RTB

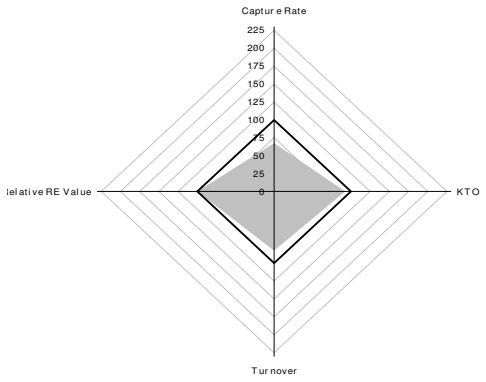




Synergy | Rotterdam Centraal | KPI

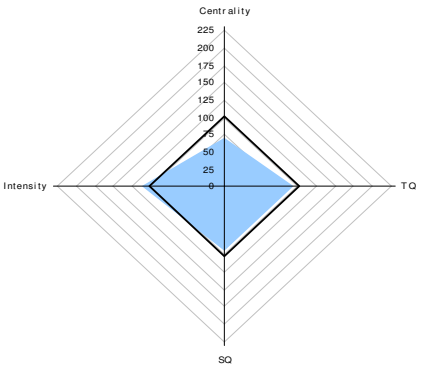
RTD

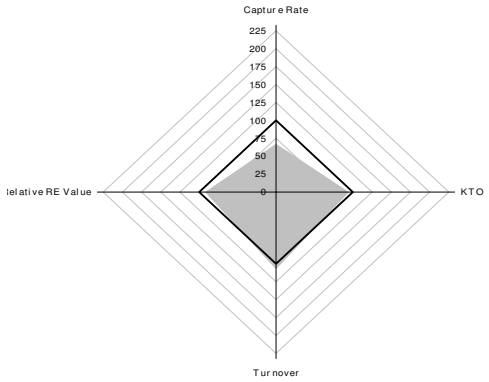




Synergy | Tilburg | KPI

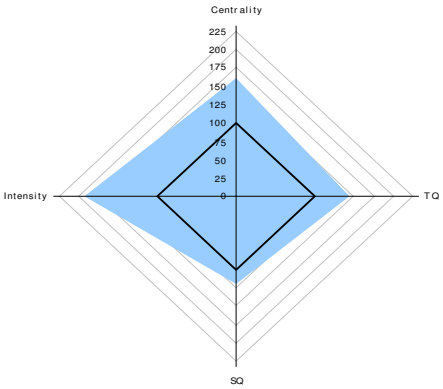
TB

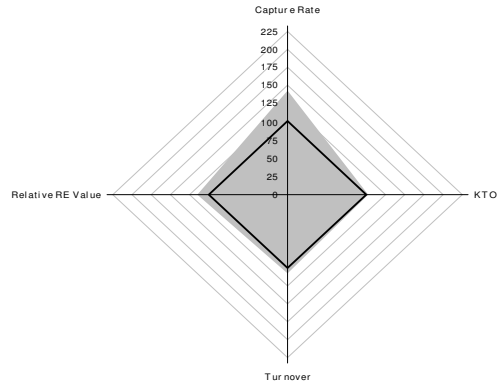




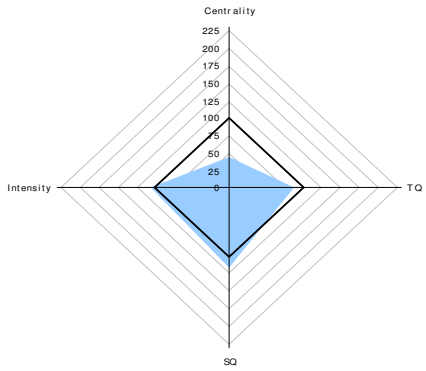
Synergy | Utrecht Centraal | KPI

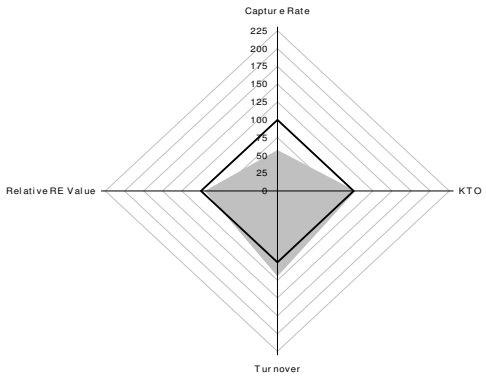
UT





ZL


Centrality
225
200
175
150
125
100
75
50
25
0
Intensity
TQ
SQ


Capture Rate
225
200
175
150
125
100
75
50
25
0
Relative RE Value
KTO
Turnover

Appendix VI; Statistical tests

Statistical tests Meta-values vs. Real rent

Centrality -> Real Rent

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,460069934
R-kwadraat	0,211664344
Aangepaste kleinste kwadraat	0,182466728
Standaardfout	24,54772879
Waarnemingen	29

Variantie-analyse

	Vrijheidsgraden	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	4368,405379	4368,405379	7,249370571	0,012032975
Storing	27	16269,95669	602,5909885		
Totaal	28	20638,36207			

	Coëfficiënten	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	110,226216	11,81302293	9,330906803	6,14E-10	85,98789535	134,4645367	85,98789535	134,4645367
Centrality	0,293427495	0,108980967	2,692465519	0,012032975	0,069817024	0,517037966	0,069817024	0,517037966

TQ -> Real Rent

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,551543889
R-kwadraat	0,304200662
Aangepaste kleinste kwadraat	0,278430316
Standaardfout	23,06204086
Waarnemingen	29

Variantie-analyse

	Vrijheidsgraden	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	6278,203395	6278,203395	11,80429099	0,0019262
Storing	27	14360,15867	531,8577287		
Totaal	28	20638,36207			

	Coëfficiënten	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	62,1619852	22,93334774	2,710549977	0,011531147	15,106643	109,2173274	15,106643	109,2173274
TQ	0,774069803	0,225299471	3,435737329	0,0019262	0,311793478	1,236346128	0,311793478	1,236346128

SQ -> Real Rent

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,166640791
R-kwadraat	0,027769153
Aangepaste kleinste kwadraat	-0,008239397
Standaardfout	27,26091506
Waarnemingen	29

Variantie-analyse

	Vrijheidsgraden	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	573,109839	573,109839	0,771182215	0,38759968
Storing	27	20065,25223	743,15749		
Totaal	28	20638,36207			

	Coëfficiënten	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	97,84248247	47,78417947	2,047591558	0,050442435	-0,20255405	195,887519	-0,20255405	195,887519
SQ	0,429406674	0,48897909	0,87816981	0,38759968	-0,573895533	1,432708882	-0,573895533	1,432708882

Intensity -> Real Rent

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,714922794
R-kwadraat	0,511114601
Aangepaste kleinste kwadraat	0,493007734
Standaardfout	19,33122007
Waarnemingen	29

Variantie-analyse

	Vrijheidsgraden	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	10548,56819	10548,56819	28,22766695	1,31495E-05
Storing	27	10089,79388	373,6960696		
Totaal	28	20638,36207			

	Coëfficiënten	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	106,482942	7,187950969	14,81408853	1,73984E-14	91,73448504	121,231399	91,73448504	121,231399
Intensity	0,330860235	0,062274046	5,312971574	1,31495E-05	0,203084449	0,458636021	0,203084449	0,458636021

Statistical tests Meta-values vs. Relative rent
Centrality -> Relative Rent

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,057957
R-kwadraat	0,003359
Aangepaste kleinste kwadraat	-0,03355
Standaardfout	16,31199
Waarnemingen	29

Variantie-analyse

	Vrijheidsgrad	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	24,21313816	24,21313816	0,090999	0,765222042
Storing	27	7184,18525	266,0809352		
Totaal	28	7208,398388			

	Coëfficiënte	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	102,1846	7,849764174	13,01753305	3,77E-13	86,07817905	118,29095	86,07817905	118,29095
Centrality	-0,02185	0,072417949	-0,301660649	0,765222	-0,170435001	0,12674371	-0,170435001	0,12674371

TQ -> Relative Rent

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,092382
R-kwadraat	0,008535
Aangepaste kleinste kwadraat	-0,02819
Standaardfout	16,26958
Waarnemingen	29

Variantie-analyse

	Vrijheidsgrad	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	61,5201742	61,5201742	0,232415	0,633623719
Storing	27	7146,878214	264,6991931		
Totaal	28	7208,398388			

	Coëfficiënte	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	107,6625	16,17878962	6,654546805	3,85E-07	74,46637891	140,8586467	74,46637891	140,8586467
TQ	-0,07663	0,158942026	-0,482094825	0,633624	-0,402747223	0,249496967	-0,402747223	0,249496967

SQ -> Relative Rent

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,314139
R-kwadraat	0,098683
Aangepaste kleinste kwadraat	0,065301
Standaardfout	15,5123
Waarnemingen	29

Variantie-analyse

	Vrijheidsgrad	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	711,3463855	711,3463855	2,956164	0,048521
Storing	27	6497,052003	240,6315557		
Totaal	28	7208,398388			

	Coëfficiënte	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	53,5128	27,19067523	1,968056948	0,05941	-2,277859241	109,3034539	-2,277859241	109,3034539
SQ	0,478399	0,278244218	1,71934993	0,048521	-0,092510794	1,049309146	-0,092510794	1,049309146

Intensity -> Relative Rent

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,211367
R-kwadraat	0,044676
Aangepaste kleinste kwadraat	0,009294
Standaardfout	15,97029
Waarnemingen	29

Variantie-analyse

	Vrijheidsgrad	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	322,0430194	322,0430194	1,262665	0,271039196
Storing	27	6886,355369	255,0501988		
Totaal	28	7208,398388			

	Coëfficiënte	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	94,21898	5,93825269	15,86644777	3,28E-15	82,0346882	106,4032641	82,0346882	106,4032641
Intensity	0,05781	0,05144707	1,123683779	0,271039	-0,047750429	0,163370906	-0,047750429	0,163370906

Statistical tests Meta-values vs. Capture Rate
Centrality -> Capture

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,594943973
R-kwadraat	0,353958331
Aangepaste kleinste kwadraat	0,330030862
Standaardfout	30,21918917
Waarnemingen	29

Variantie-analyse

	Vrijheidsgraden	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	13508,9311	13508,9311	14,79296984	0,000663928
Storing	27	24656,38364	913,1993941		
Totaal	28	38165,31474			

	Coëfficiënten	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	27,01062093	19,7894796	1,36489799	0,183552094	-13,59403676	67,61527861	-13,59403676	67,61527861
Centrality Commuters	0,680742517	0,176992633	3,846163003	0,000663928	0,317583635	1,043901398	0,317583635	1,043901398

TQ -> Capture

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,463062107
R-kwadraat	0,214426515
Aangepaste kleinste kwadraat	0,185331201
Standaardfout	33,3231425
Waarnemingen	29

Variantie-analyse

	Vrijheidsgraden	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	8183,655431	8183,655431	7,369795459	0,011417796
Storing	27	29981,65931	1110,431826		
Totaal	28	38165,31474			

	Coëfficiënten	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	51,91366525	18,76282958	2,766835622	0,010091942	13,41551939	90,41181111	13,41551939	90,41181111
TQ Commuters	0,477666575	0,175953186	2,71473672	0,011417796	0,116640463	0,838692687	0,116640463	0,838692687

SQ -> Capture

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,073459149
R-kwadraat	0,005396247
Aangepaste kleinste kwadraat	-0,03144093
Standaardfout	37,49536529
Waarnemingen	29

Variantie-analyse

	Vrijheidsgraden	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	205,9494476	205,9494476	0,146489148	0,704909877
Storing	27	37959,36529	1405,902418		
Totaal	28	38165,31474			

	Coëfficiënten	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	125,0134252	65,7235922	1,902108831	0,067875118	-9,840245422	259,8670957	-9,840245422	259,8670957
SQ	-0,257412821	0,672554445	-0,382739008	0,704909877	-1,637380539	1,122554897	-1,637380539	1,122554897

Intensity -> Capture

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,135715687
R-kwadraat	0,018418748
Aangepaste kleinste kwadraat	-0,017936113
Standaardfout	37,24909019
Waarnemingen	29

Variantie-analyse

	Vrijheidsgraden	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	702,957303	702,957303	0,506637822	0,482703212
Storing	27	37462,35744	1387,49472		
Totaal	28	38165,31474			

	Coëfficiënten	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	91,45892983	13,85037431	6,603354377	4,38759E-07	63,04030948	119,8775502	63,04030948	119,8775502
Intensity	0,085410702	0,119995093	0,711784955	0,482703212	-0,160798889	0,331620292	-0,160798889	0,331620292

Dwellings -> Capture

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,310508274
R-kwadraat	0,096415388
Aangepaste kleinste kwadraat	0,062949291
Standaardfout	35,73855222
Waarnemingen	29

Variantie-analyse

	Vrijheidsgraden	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	3679,723634	3679,723634	2,880986955	0,101130626
Storing	27	34485,59111	1277,244115		
Totaal	28	38165,31474			

	Coëfficiënten	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	74,00419254	16,69158608	4,433622555	0,000139408	39,75588724	108,2524978	39,75588724	108,2524978
Intensity commuters	0,259958075	0,153155524	1,697347034	0,101130626	-0,0542911	0,574207249	-0,0542911	0,574207249

Statistical tests Meta-values vs. Retail turnover
Centrality -> Turnover

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,058352148
R-kwadraat	0,003404973
Aangepaste kleinste kwadraat	-0,033505954
Standaardfout	45,10814078
Waarnemingen	29

Variantie-analyse

	Vrijheidsgraden	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	187,701871	187,701871	0,09224838	0,763666313
Storing	27	54938,09784	2034,744364		
Totaal	28	55125,79971			

	Coëfficiënten	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	106,0823813	21,70724249	4,886957952	4,12686E-05	61,54279923	150,6219633	61,54279923	150,6219633
Centrality	-0,060823813	0,200260025	-0,303724184	0,763666313	-0,471723439	0,350075814	-0,471723439	0,350075814

TQ -> Turnover

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,550604066
R-kwadraat	0,303164838
Aangepaste kleinste kwadraat	0,277356128
Standaardfout	37,71903714
Waarnemingen	29

Variantie-analyse

	Vrijheidsgraden	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	16712,20412	16712,20412	11,74660961	0,001968054
Storing	27	38413,59559	1422,725763		
Totaal	28	55125,79971			

	Coëfficiënten	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	-7,278066396	32,07485188	-0,226908808	0,82220392	-73,09022554	58,53409275	-73,09022554	58,53409275
TQ Turnover	1,114357735	0,325138475	3,427332726	0,001968054	0,447228698	1,781486773	0,447228698	1,781486773

SQ -> Turnover

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,13522729
R-kwadraat	0,01828642
Aangepaste kleinste kwadraat	-0,018073342
Standaardfout	44,77009012
Waarnemingen	29

Variantie-analyse

	Vrijheidsgraden	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	1008,053528	1008,053528	0,502930132	0,484294756
Storing	27	54117,74618	2004,36097		
Totaal	28	55125,79971			

	Coëfficiënten	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	155,3394255	78,4750628	1,979475007	0,058041817	-5,678101305	316,3569523	-5,678101305	316,3569523
SQ	-0,569497281	0,803041199	-0,709175671	0,484294756	-2,217201701	1,078207138	-2,217201701	1,078207138

Intensity -> Turnover

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,550604066
R-kwadraat	0,303164838
Aangepaste kleinste kwadraat	0,277356128
Standaardfout	37,71903714
Waarnemingen	29

Variantie-analyse

	Vrijheidsgraden	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	16712,20412	16712,20412	11,74660961	0,001968054
Storing	27	38413,59559	1422,725763		
Totaal	28	55125,79971			

	Coëfficiënten	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	-7,278066396	32,07485188	-0,226908808	0,82220392	-73,09022554	58,53409275	-73,09022554	58,53409275
Intensity Turnover	1,114357735	0,325138475	3,427332726	0,001968054	0,447228698	1,781486773	0,447228698	1,781486773

Statistical tests Meta-values vs. Customer satisfaction
Centrality -> KTO

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,256336733
R-kwadraat	0,065708521
Aangepaste kleinste kwadraat	0,031105132
Standaardfout	4,966199014
Waarnemingen	29

Variantie-analyse

	Vrijheidsgraden	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	46,83292724	46,83292724	1,898904	0,179515173
Storing	27	665,9045816	24,66313265		
Totaal	28	712,7375088			

	Coëfficiënten	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	100,9199638	2,389867646	42,22826481	3,38E-26	96,01636052	105,8235671	96,01636052	105,8235671
Centrality	-0,030381904	0,022047709	-1,378007345	0,179515	-0,075620065	0,014856256	-0,075620065	0,014856256

TQ -> KTO

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,206492234
R-kwadraat	0,042639043
Aangepaste kleinste kwadraat	0,007181229
Standaardfout	5,027137702
Waarnemingen	29

Variantie-analyse

	Vrijheidsgraden	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	30,39044509	30,39044509	1,202529	0,282501544
Storing	27	682,3470637	25,27211347		
Totaal	28	712,7375088			

	Coëfficiënten	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	100,8121034	2,830565213	35,61553819	3,11E-24	95,00426343	106,6199435	95,00426343	106,6199435
TQ Commuters	-0,029108493	0,026544342	-1,096598756	0,282502	-0,083572983	0,025355998	-0,083572983	0,025355998

SQ -> KTO

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,422715257
R-kwadraat	0,178688188
Aangepaste kleinste kwadraat	0,148269232
Standaardfout	4,656257178
Waarnemingen	29

Variantie-analyse

	Vrijheidsgraden	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	127,3577742	127,3577742	5,874238	0,022339724
Storing	27	585,3797346	21,68073091		
Totaal	28	712,7375088			

	Coëfficiënten	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	78,21171817	8,161700668	9,582772188	3,51E-10	61,46529186	94,95814447	61,46529186	94,95814447
SQ	0,202424273	0,083519295	2,423682743	0,02234	0,031056838	0,373791709	0,031056838	0,373791709

Intensity -> KTO

Gegevens voor de regressie	
Meervoudige correlatiecoëfficiënt R	0,1274907
R-kwadraat	0,016253879
Aangepaste kleinste kwadraat	-0,020181163
Standaardfout	5,095941595
Waarnemingen	29

Variantie-analyse

	Vrijheidsgraden	*Kwadratensom*	*Gemiddelde kwadraten*	*F*	*Significantie F*
Regressie	1	11,58474895	11,58474895	0,446106	0,509859668
Storing	27	701,1527598	25,96862073		
Totaal	28	712,7375088			

	Coëfficiënten	*Standaardfout*	*T- statistische gegevens*	*P-waarde*	*Laagste 95%*	*Hoogste 95%*	*Laagste 95,0%*	*Hoogste 95,0%*
Snijpunt	98,9782292	1,894830134	52,2359379	1,16E-28	95,09035895	102,8660994	95,09035895	102,8660994
Intensity	-0,010964558	0,016416186	-0,667911424	0,50986	-0,044647789	0,022718673	-0,044647789	0,022718673