# An evaluation of vacant office transformations to housing in the Netherlands, and the suitability of leasing facades as a way to increase the technical quality and user comfort of such projects.

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Render of La Luna transformation in Eindhoven (Diederendirrix)

# II. Introduction

As western economies continued to flourish in the years leading up to the turn of the century, and until the financial crisis 2008, the market for office space skyrocketed. A company with a name, needed to have its own office space, with the corresponding exterior, making their presence apparent. However this desire for an individualized space came at a cost. Not only did it mean that some companies chose to settle for sub-par solutions such as business parks, only reachable by car, or constructing/renting buildings which where built quickly rather than proficiently. Additionally this trend resulted in more and more office buildings dating back to the 60's - 80's becoming vacant. More recently also buildings built between the 80's and the turn of the century are becoming effected (Geraedts, van der Voordt, 2004; de Jonge, Koppels, & Remøy, 2009). Another compounding result of marginally constructed office space was the short functional life-span of these buildings. Shortly after construction, and long before the building components reached their end of life, many offices no longer adhered to environmental, social, health, or aesthetic standards of modern times (Geraedts, van der Voordt, 2004; Remøy & van der Voordt, 2006; den Heijer, 2013). The result of these developments is increasing vacancy of office buildings, and additionally the demolition of so called obsolete buildings. These are systematically replaced with new buildings, which in turn are often similarly destined to become obsolete in the near future.

While the office market experienced an unprecedented explosion of available real estate, the housing markets in the western world were crippled over the years. Not only is the match between supply and demand in dis-balance, however, the dedication to change the circumstances, is half hearted at best. A brief look at the current housing space available on the Dutch market reveals, a handful of middle to lower sector offers, while the offers for the high cost sector seem superfluous in relation to the demand. At an increasing rate only the financially stable are able to find housing space which suits their needs, and is affordable. Young families, students, or elderly not blessed by financial perpetuity are finding it difficult to find housing space which they can afford, and suits their needs (NVM, 2017; Gopel et al., 2016; UN, 2014).

The problem of surplus in one market and demand on another market, is generally a circumstance which the current market economy flourishes in. Turning what one user group may deem no longer useful into value for other users, has a history of being successful. The re-sale of second hand cars being one example, or simply offering more for less continues to work well in most fields. In the real estate market however, this seems to be more difficult than other industries.

These topics will be discussed in the first chapter of this thesis, in the second chapter of this thesis, the further chapters of this thesis will be introduced, and a road map of for the paper will be presented.

# 1. Literature Review

### 1.1.1 Motivation

Surely it is more difficult to move a vacant office to another location, or adding new housing space from another region. Although one solution to these problems is to transform the no longer valuable (vacant office) into value (new housing space), the lack of creativity in the real estate market. The lack of commitment to change the circumstances, be it from investors, legislators, owners, or users remains surprising, as so much potential value is lost. This trend on the office market is increasingly in discord with modern views on sustainability and efficient resource use. Businesses continues to prefer looking for a new office space once they deem their current environment unsuitable, rather than demanding an adaptation to make it suit their current needs. The responsibility for this can not be purely placed in the exploiters of the real estate but also on the architects, planners and legislators and owners who continue to foster such practices.

The problem lies within the rigidity of the building stock. There is often talk of apparent flexible buildings, however in practice very few flexible buildings exist, or the knowledge regarding their flexibility was lost after construction and initial exploitation for various reasons. Often the characteristic prompting the label of flexible doesn't reach farther than a large and open floor-plan. To make any lasting alteration to this trend, the way the existing supply of real estate is looked at, parallel to the demand on the market must change. This means looking for solutions within the building stock that already exists. Considering 87% of the building stock of 2050 is already completed the significance of the situation is undeniable (Remøy, Wilkinson, 2015).

### 1.1.2 Aim and scope

This review will look to suggest potential solutions to the named problems by first analyzing the different circumstances surrounding the main issue of a severe mismatch on the housing market. It will be shown why the building stock is so rigid, and why there are so few unconventional ways of dealing with this. As well as the circumstance that demolition is often still a popular and financially favorable solution for buildings which no longer fulfill the owners or users needs. These issues result in the main question which will be answered in the paper: where is the mismatch in the real estate market and what are potential solutions to resolve the rigidity of the building stock?

The scope of this paper is primarily focused on the existing building stock in the Netherlands, however examples from other regions in the world will be used, due to research being conducted in various locations around the world.

### 1.1.3 Method

To answer this question this paper is split into 4 sections of literature, each answering a corresponding subquestion. Section 2 will focus on the real estate market and investigate if there is a mismatch on the real estate market in the Netherlands resulting in a demand driven rather than supply driven market. The 3rd section will focus on flexibility on the real estate market. Flexible measures implemented in the office and housing stock will be discussed will lead to an investigation into how more flexibility of the properties available on the real estate market can be reached. The final, 4th section will be centered around a potential solution for both market shortcomings; office to housing transformation and why it is still to rarely done. Why transformation is still less popular than demolition and re-building in many cases and under which circumstances office to housing transformation is feasible will be analyzed. These sections will result in a brief discussion, and conclusions as to what solutions could lead to a more flexible building stock.

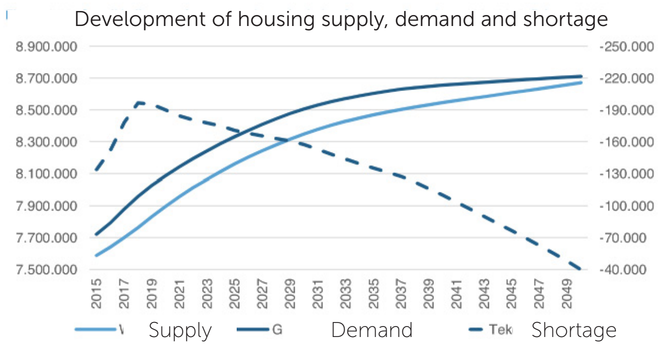
After the discussion a hypothesis regarding a potential solution will be presented, and discussed. To validly discuss this hypothesis, additional literature will be consulted and discussed. This paper will then lead into a research framework for a graduation in the field of Building Technology at the Technical University of Delft.

## 1.2 The mismatch of the real estate market

The financial crisis had a profound effect on real estate markets around the world. In particular the developed world was severely effected. To gather an understanding of the situation in the Netherlands, this section will explore if there is a mismatch on the real estate market resulting in a demand driven rather than supply driven market, by discussion potential reasons.

### 1.2.1 Development of the housing demand

Despite the financial crisis in of 2008 the world population continues to grow, and the resulting need for housing grows with it. Contributing to this increase in population is the growing desire to live in the urban environment. According to the UN urbanization prospect merely 30% of the world population resided in urban areas in 1950. By 2014 this amount rose to 54% and by 2050 it is projected to around 66% (UN, 2014). The increase from 2014 to 2050 in population equates to a urban influx of 2.5 billion people. Although most of the urban population growth is expected in Asia and Africa, the western world will also have to find solutions to the issues this growth will bring with it. Yet it can't be forgotten that in particular countries such as India, China and Nigeria, who are expected to account for 37% (925 million) of this growth, must find solutions for housing these amounts of humans (UN, 2014).



NVM, 2017

In the Netherlands this population growth can also be seen. Since 2008 the Dutch population has increased by 500.000 people, 54% of this increase is due to higher birthrates than mortality rates, and the remaining 46% consist of work-, study-, and asylum-migration (Gopel et al., 2016). The expectation is that this growth will continue until 2050, when the population is prognosticated to plateau at around 18.2 million citizens, another increase of 9.5% (Gopel et al., 2016).

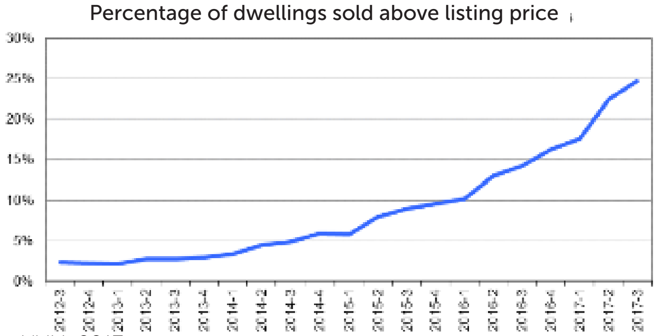
Other factors adding to the mere increase of population causing an increased need for housing is the composition of households. In the Netherlands the average household size in 2009 was 2.23 people, by 2025 it is expected to decrease to 2.10 (Gopel et al., 2016). A compounding factor is that as households become smaller, people increasingly desire larger dwellings (Remøy, p.199, 2007). These factors all contribute to a continued growth of the demand for housing.

### 1.2.2 Development of the housing supply

While housing demand has steadily increased, there are severe shortcomings of the housing supply in the Netherlands. The production of virgin real estate decreased by almost 50% from 2009 to 2014, from 80.000 dwellings yearly to 45.000 respectively (Gopel et al., 2016). Contrary to the belief that things got better after the crisis, production of new housing is still struggling to regain its former capabilities. The graph on the following pa shows the projection of the housing need, supply and shortage in the Netherlands. A worrying development is that even in 2016, the amount of new building permits has decreased in comparison to 2015 (Gopel et al., 2016). Although the amount of dwellings constructed per year is projected to increase to 65.000, the yearly demand of around 70.000 dwellings is still not reached (Gopel et al., 2016). This will only exacerbate the already precarious situation. Urban influx has also begun to make an impact on the Dutch market. While the amount of dwellings for sale has decreased nationally by 30-35%, especially larger cities such as Rotterdam are experiencing even larger decreases of around 53% (NVM, 2017).

A compounding factor which results in less dwellings being put up for sale is the decreasing amount of potential housing that people want to and can move into. Due to the overarching lack of new housing, people are not able to move on from their houses or apartments which no longer fulfill their needs (Remøy, p.199, 2007; NVM, 2017). This has particularly effected those members of society looking for apartments or city homes such as; row houses or stacked ground linked dwellings (NVM, 2017). These housing typologies are currently the most scarce on the market, and any potential buyer has the least selection (around 3) when searching for such a residence. Potential buyers looking for stand alone homes however, continue to have a much larger selection (around 10) to chose from (NVM, 2017). Again the factor which contributes, are the large regional differences. Rural areas have a lesser problem than urban areas. The scarcity on the housing market has also contributed to increasing prices. Although the average price for a newly built dwelling slightly decreased to € 308.000 in comparison to last year, this was caused by more dwellings smaller than 100m$^2$ and less larger than 130m$^2$ being sold. Once again the national average is deceiving, in the urban western regions of the country the

Percentage of dwellings sold above listing price




NVM, 2017

average price is significantly higher at around € 370.000 (NVM, 2017). The graph above also shows that the amount of dwellings, sold well above their actual value, is rising (NVM, 2017). Yet a new trend in the realization of housing space can been seen in recent years however. Gopel et al. also investigated the various ways in which housing is add or removed from the market. One interesting conclusion they have reached is that, a part of newly created housing space results from transformation projects (2016). The table below shows the projections how much added dwellings will be added to the housing stock in the next 35 years via transformation. Yet although transformation may only offer a small contribution of around 12% until 2024, it is apparent that new solutions are being discussed and realized. The housing market however is not the only sector which is out of balance, the market for office real estate, is equally in disarray.

| | New production | Transformation |
|---|---|---|
| 2015-2019 | 65.000 | 9.000 |
| 2020-2024 | 60.000 | 7.000 |
| 2025-2029 | 45.000 | 7.000 |
| 2030-2049 | 23.000 | 7.000 |
| 2015-2049 | 38.000 | 7.000 |

NVM, 2017

### 1.2.3 Mismatch of supply and demand of Office space

While the housing market is struggling to fulfill the global demand the office market is dealing with an ever increasing burden of being over-saturated. As of the second quarter of 2017 there are around 48.612.000 m$^2$ of office space available in the Netherlands. Of these, 6.359.000 m$^2$ are vacant, a considerable amount close to 13% of the whole stock (Cushman & Wakefield, 2017). For comparison 3 - 8% of vacancy is considered normal or even beneficial to allow for mutations in the market (Remøy, 2010). The amount of vacant office space by percentage is larger in more urbanized areas, despite the increasing amount of citizens living in these area, yet when looking at m$^2$ amounts urban areas also have a severe issue (Cushman & Wakefield, 2017). To improve these circumstances it is important to

Building and location characteristics ranked in the delphi study by Koppels et al

| BUILDING | | | | LOCATION | | | |
|---|---|---|---|---|---|---|---|
| Ranking | Round 1 | Round 2 | Chang | | Round 1 | Round 2 | Chang |
| Car Parking | 1 | 1 | = | Accessibility by car | 1 | 1 | = |
| Exterior Appearance | 2 | 2 | = | Status | 2 | 2 | = |
| Space efficiency | 3 | 3 | = | Accessibility by public transport | 3 | 3 | = |
| Layout flexibility | 4 | 4 | = | Facilities | 4 | 4 | = |
| Interior appearance | 6 | 5 | - | Safety | 6 | 5 | - |
| Comfort | 7 | 6 | - | Business cluster | 5 | 6 | - |
| User recognisability | 5 | 7 | - | | | | |
| Technical state | 8 | 8 | = | | | | |
| Building facilities | 9 | 9 | = | | | | |
| Security | 10 | 10 | = | | | | |
| Construction period | 11 | 11 | = | | | | |
| Energy performance | 12 | 12 | = | | | | |
| Routing | 13 | 13 | = | | | | |
| Bike parking | 14 | 14 | = | | | | |
| Commodity logistics | 15 | 15 | = | | | | |

Koppels et al., 2009

understand what the causes for vacancy are.

### 1.2.4 Causes for office vacancy

The causes for vacancy of office space are diverse, however some have a more intense effect than others. To make this section more clear three main factors will be highlighted: market, location, and the building.

#### Market

Since 2000 the market for office space has changed substantially. However due to the natural delay in the building industry, buildings initiated around this time now stand vacant (Remøy, 2006). This delay is caused by the fact completing the building process, often takes longer than the market demand changes. Additionally it is expected that the amount of office jobs in the Netherlands are due to decrease as a result of increasing labor transfer to less developed countries (Remøy & van der Voordt, 2006). The role of the market actors is also important. Most owners speculate that their vacant building will be rented out again in the future. This is caused by the value of the building being based significantly on the potential rental yield. Thus the sale of a vacant building before it has completed its financial exploitation cycle, results in a financial loss for the seller making it very unattractive, and vacancy a viable option (Remøy & Van der Voordt, 2014).

Another contributing factor is the fact that companies increasingly chose to rent office space rather than build it themselves. They operate under the motto: more investments for the company operations, less for the building, which is not a direct value creating asset. This trend was augmented by the fact that many companies wanted the flexibility of being able to re-locate and grow, independent of their building (Remøy, 2007). This trend however resulted in a mismatched market, where, when demand is high, it is not matched with high supply, and when the supply is high it is not matched with high demand, also known as the pig cycle (Geraedts, van der Voordt, 2004).

#### Location Characteristics

The location of an office building, contributes substantially to its potential to become vacant. In a study conducted by Hans de Jonge, Philip Koppels and Hilde Remøy in 2009, multiple location qualities which contribute to building vacancy, were distinguished through a Delphi study. The result of the study was that the three most important location characteristics which lead to building vacancy are; low area status, and poor accessibility by car and public transport (2009). The table below shows the other factors mentioned.

Additionally it was found that mono-functional locations are more likely to result in vacant offices (Koppels et al., 2009). Other factors such as other firms moving out of the area, or increasing amounts of vacant buildings in the area also increase the likelihood of vacancy (Remøy & Van der Voordt, 2014). Philip Koppels, Sabira el Messlaki and Hilde Remøy went even further and distinguished that buildings within a radius of 500m around a vacant building are more likely to become vacant ( 2010).

#### Building Characteristics

Location characteristics may be important when firms search for office space, however in the end the choice is largely influenced by the building characteristics

(Koppels et al., 2009). In their study the group of researchers also found that the exterior appearance was ranked as the second most important building characteristic, followed by layout flexibility, interior appearance, and comfort (2009). Alexandra den Heijer also states that façade appearance and poor location characteristics are the main causes for office vacancy (2013). This confirms the research Remøy and van der Voordt conducted in 2006 where they concluded that decay and poor maintenance, or signs of vandalism contribute substantially to potential vacancy. They conclude that the functional lifespan of a building is over when it no longer meets the requirements of new office space, due to inflexible spaces, or inefficient use of space. Furthermore poor condition of installations and low technical quality are also important to consider (Remøy & van der Voordt, 2006).

Particularly buildings constructed in the 60s and 80s are vacant due to the sombre appearance, as well as being technically and functionally outdated (Geraedts, van der Voordt, 2004). Regarding more recently built offices, Wilkerson and Remøy have also concluded that the trend continues and functional life spans of offices, often end before their technical life spans are reached (2015).

A lot can be said about the issues with the rigidity of existing office buildings and the need for housing, as illustrated in the previous section. More importantly though, it must be discussed how more flexibility can be introduced to these markets.

## 1.3 Flexibility of the real - estate market

The own four walls, is probably the longest existing item which has been known and called ones own in our society. Yet the more people experience different layouts of homes, or spend more time in their own home, they come to the conclusion that their wishes and needs change over time. However more often than not they live in homes which were built with one floor-plan, and exterior, meant to last the whole life cycle of the building (van Gassel & Rodders, 2004).

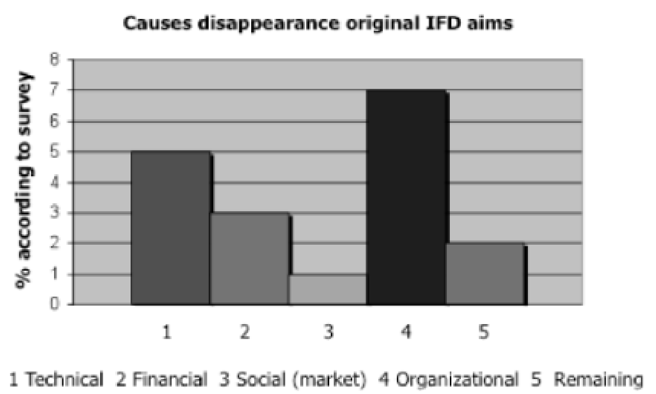
For offices the situation was comparable for a long time, however with increasing structural knowledge things began to change. It was no longer essential to building on structural walls but column and beams systems became more frequently used (Gann & Barlow, 1996). This allowed for internal walls to be constructed with less permanent material, additionally sound insulation plays a less significant role in office architecture than housing. However these factors didn't result in buildings that can grow with their users indefinitely. This is often caused by other building features such as the facade or technical services becoming outdated. In this section it will be investigated how more flexibility of the properties available on the real estate market can be reached.

### 1.3.1. The housing market

The housing market in recent history has been defined by mainly permanent structures. It was common for people to either take up a mortgage and build their home for the rest of their life, or before they do so, take what they can get on the open market, such as a rental space or a generic dwelling for sale. Beginning in Japan, dating back to around the 13th century, movable walls were a key element of traditional architecture. It allowed for the floor-plans to be adjusted depending on the activity being conducted in the room or for accommodating various amounts of inhabitants/visitors. As technical ingenuity increased, modern developers also began offering housing which could change with its users. Kazunobu Minami, a professor of architecture in Japan conducted a survey in 2007, focusing on flexible housing built in Tokyo in the early 80's. The complex central to his study was a multifamily building, which had integrated move-able wall partitions. He sought out to find out how many families made use of this system. Of all residents, 30% indicated that they had made changes to the room layout. Most of these changes were to increase the size of the living rooms, after their children had left their home. The survey also showed that some residents of the 2nd generation, changed the apartment layout when they moved in. They either also increased the common space, or subdivided it again to gain more separate rooms. Contrary to the expectation the residents which lived in the apartments with no movable walls lived in the residence the longest time (Minami, 2007).

At the end of the 20th century trends regarding flexible architecture in the Netherlands also began to pick up. The market was saturated, and becoming a housin driven market. Consumers were voicing their demands more loudly, and expected more (van Gassel & Rodders, 2004). In 1999 the theme Industrial Flexible Demountable (IFD) made its entrance, a government initiative which ran through 2006 initiated by the Committee for Experiments in Public Housing. This initiative was meant to increase the amount of integration during the process or design in close interaction with the construction phase. It particular involved actors were steered to take in account the potential for changes being made to the dwelling during its life time (van Gassel & Rodders, 2004).

The result were multiple project in which it was attempted to incorporate measures to increase the flexibility of the delivered dwellings. It is important to mention that IFD didn't only mean adaptable housing space, but also increased user involvement in the design process (Cuperus, Geraedts & Shing, 2011). One of the issues linked to IFD projects is that to achieve useful flexible potential, the initial amount of space which must be located, is more than customary (van Gassel & Rodders, 2004). In many cases what was called flexible housing, was to a large extent the involvement of the users in the design process. Giving them options such as staircase placement, or partly demountable elements, so when the volume is increased, the same façade can be re-installed after volume enlargement (Cupers et al., 2011). Often these simplified projects were a result of; lacking knowledge regarding technical solutions, poor coordination of the design and construction process, or technical and financial mis-planning (Geraedts, 2010). The table below shows the main reasons which



Geraedts, 2010

led to the deterioration of IFD aims based on a survey of various involved actors (Geraedts, 2010).

One of the main points of criticism of the flexible housing projects, was the lack of information about the implemented measures. Often not even the first time users were aware of their ability to change the building layout, not to mention 2nd or 3rd generation users (van Gassel & Rodders, 2004). Another criticism was that the technology used in some projects was not up for the task, or users didn't trust their functionality (Geraedts, 2010). As with the examples from the Netherlands, one of the main criticisms of the apartments in Japan was that after an extended period of time, the mechanisms were no longer functional. Also the fear of poor sound insulation was a deterring factor for many resident (Minami, 2007).

Unfortunately, although the ideas were well intentioned, many people living in flexible buildings, were unhappy with the current layout, and were not aware that they could change the layout, rather easily (Cuper et al., 2007). This shows, that merely installing Elements which foster flexible lay-outing, doesn't necessarily result in a flexible dwelling.

### 1.3.2 Mega Projects: modular structures

Flexible housing however can also be interpreted on an even larger scale. Especially in Asia, with ever increasing urban sprawl, quick and adaptable housing solutions are needed. Prefabricated modular architecture is attempting taking on the role of fulfilling the demand of 35 million apartments needed globally to satisfy the urban housing need (Generalova, Generalov & Kuznetsova, 2016). A company responsible for some of the most remarkable modular projects is BROAD, a China based construction firm. They were responsible for erecting the T30 Hotel in 2012, it stands 99.9m tall and was completed in 15 days (Generalova et al., 2016). The image below shows images throughout the building process; day 1, day 4. day 8, and the completion. The building is composed of prefabricated

https://arch3150.wordpress.com/2012/12/14/prefabricated-skyscrapers/t30-hotel/

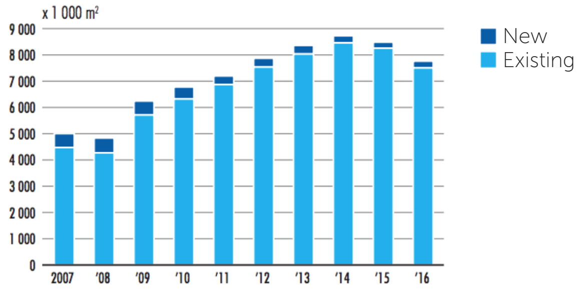
floor modules spanning 12.5m by 4.1 and internal walls made of steel and concrete. The exterior is clad with curtain wall elements. All services are pre-installed in a factory environment, resulting in the unbelievable construction time. Their current, even more ambitious project is Sky City, a high-rise standing 838 meters tall, scheduled to be completed in 220 days, and designed to house 17.000 inhabitants (Generalova et al., 2016). If proven successful, this may be the way to rapidly fulfill the global urban housing demand. One often mentioned draw back of modular architecture is that it hard to customize it. Thus adapting to various user needs, is considered difficult, due to high costs. Yet the housing project, 461 Dean Street in Brooklyn, New York, shows that custom modular architecture doesn't have to result in high costs. It was purposed to be rented to families with low and medium incomes, and is part of a program aiming to provide families with affordable housing. The 33 story building was erected with 930 modular building block, however it is made up of 225 unique module blocks. Due to the modular design, 1 floor was completed per week (Generalova et al., 2016).

### 1.3.3 The office market

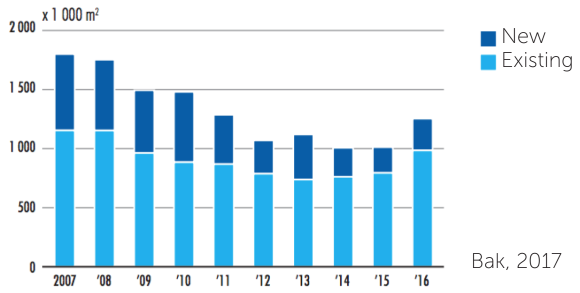
In comparison to the housing market, the office market, became increasingly flexible sooner and at a faster rate. To respond to changing organization structures of the 80's, firms wanted a competitive advantage over other firms. This resulted in large continuous and adaptable floor-plans replacing the rigid cellular office layouts of the 60's and 70's (Gann & Barlow, 1996). These buildings are marginally flexible at best, and don't allow for life time exploitation, quickly making them obsolete. The development and increased understanding of reinforced concrete, as well as pre-stressed concrete made it possible for architects and engineers to build with larger spans between structural members, and no longer having to rely on load bearing walls (Remøy, p. 217, 2007). Also the increased demand for technical appliances, be it ventilation, cooling/heating or personal electronics, changed the demands of the buildings, both for users and owners. This resulted in the increased desire to integrate building technologies in the floor or ceilings of office structures (Remøy, p.215, 2007). Current office architecture has continued along this trend, however the trend of companies moving on to the next best building continues, and the age of vacant buildings continues to decrease (De Jonge et al., 2009). The two graphs on the right show; 1. the demand for office space, and 2. the supply of office space. It is evident that the demand for new offices remains relatively constant, and is no where close to being fulfilled (Bak, 2017). The adaptability of these buildings which have stood vacant for extended periods, to current standards, decreases as their vacancy continues (Remøy, p.195-197, 2007).

As it will be difficult to rehabilitate these offices, and make them competitive on the office rental market again, new solutions for these aged buildings must be discussed. One such solution which has been gaining traction since the late 20th century is, transforming vacant office space into housing space. By increasing the amount of transformation projects, both the need for housing and the oversupply of office space could be countered.

Supply of Office space by building type




Demand of Office space by building type




Bak, 2017

## 1.4 Transformation as a potential solution

If flexibility is already being discussed on the housing side, then finding unorthodox solutions for unused offices should be the focus of the future. As the trend of always searching for he next best space continues, a solution must be found with remaining the building stock which has become obsolete. Transformation and its risks and benefits will be discussed belowt. As a result this section will answer the question, why transformation is still less popular than demolition and re-building in many cases and under which circumstances office to housing transformation is feasible?

### 1.4.1 Transformation of housing to office

The solution, of transforming vacant office space to housing, seems apparent, however the process is more challenging than the circumstances may suggest. David M. Gann and James Barlow investigated the issue with multiple studies in the UK throughout the 90's (1996). Quite quickly they came to the conclusion that there was some untapped potential in transformation. The Open Building Group in the Netherlands has been discussing the topic since the 50's Gann & Barlow, 1996). As the office market and housing market continue to fail in fulfilling the demands of users, transforming vacant office space to housing continues to be mentioned in literature into the 21st century (Bullen & Love, 2010; van der Voordt & Remøy , 2006). The main cause is, frustrated building owners who no longer are turning a profit on their offices due to vacancy (Remøy & van der Voordt, 2006). The longer a building is vacant, the higher the likelihood of the current owner to look at the potential for conversion (Geraedts & van der Voort, 2004). However one of the main issues with transformation is the lack of knowledge on both the investor/owner side as well as the designing/building side (Remøy & van der Voordt, 2014). Rob Geraedts and Theo J.M van der Voordt also note that for transformation projects to be successful it is key that an enthusiastic backer is involved (2007). For this to happen more consistently, the potentials of transformation must be made more apparent, and knowledge of the topic must be more widely spread.

Differing circumstances surrounding a vacant office make it difficult to generalize which buildings are most suitable and which less so. As mentioned the length of vacancy is a factor which will increase the likelihood for transformation. However if the location is the cause for vacancy, either due to poor characteristics or mono-functionality, transformation also becomes unfavorable. Building factors also play a significant role. Buildings characteristics which provide favorable circumstances for transformation are: open floor-plans, large spans >5.4m, ceiling heights of more than 3m, façade grid = 1.8m (Remøy, 2007; Gann & Barlow, 1996). Most buildings that fulfill these criteria where mostly built after 1960, and are still structurally intact, however technically outdated (Remøy & Wilkerson, 2015). One issue in the Netherlands is the large amount of mono-functional office locations. Around 70% of vacant office space is in such locations (Remøy & van der Voordt, 2014). This brings with it an even larger task as building transformation is not sufficient, location transformation may be needed (Remøy & van der Voordt, 2006). This was also quantified by a study which concluded that buildings in mono-functional areas which are renovated only experience positive effects for 5 years (Koppels et al., 2010.

As the selection of the most suitable buildings is a difficult process, a method developed in the Netherlands at the TU Delft will be briefly introduced next.

### 1.4.2 *Transformation Potential Meter*

To aid in the selection of suitable vacant offices for transformation, Rob Geraedts, and various other researchers developed the transformation potential meter. This tool provides criteria as well as a framework for the assessment of the transform-ability of a building (Geraedts, 2002). In 2004 the tool was further developed together with Theo van der Voordt, and is made up of the following steps:

1. Quick-scan; key criteria regarding location, building, are selected by a given organization, if any are not all fulfilled, the building is not suitable. Another element of the quick scan is guaging if an enthusiastic developer can be found, again this is a go/no go criteria. A

second checklist is provided to verify if the building is suitable for transformation, and multiple factors are checked, building and location characteristics as well as investors/ developer interest.

2. Feasibility model: Based on the results of the quick-scan it must be deduced which target groups are most suitable for the project. The target groups also influence the projected rental income, and the demands which must be met. The most suitable target groups named are; students, young creatives, and seniors (Remøy, 2010; Geraedts & van der Voordt, 2004). Furthermore the financial feasibility of the project is assessed in more detail, and the effect this has on the amount of residences to be developed should be examined.

3. Checklist: The checklist is the final step which outlines potential risks in the development process, relating to factors such as, city zoning laws, sources of pollution or the market situation (Geraedts & van der Voordt, 2004).

This method can assist in quickly generating a general overview of transformation feasibility. Furthermore it highlights the potential risks that must be taken care of during the process.

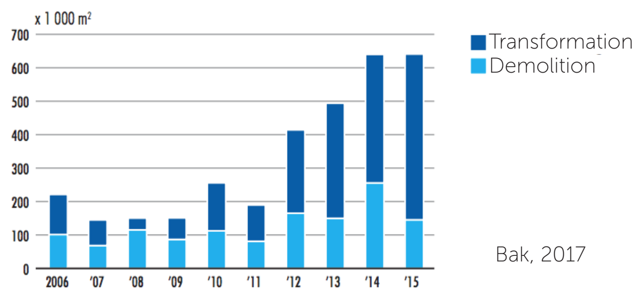
### 1.4.3 Risks and benefits of transformation

Despite that each project is unique, there are some general risks that go hand in hand with transformation projects. One of the more prominent risks of transformation is the escalation of costs. This can have multiple reasons, ranging from building drawings not matching what was actually built, or lack of building depth causing lighting issues to a once present market demand subsiding by the time the transformation is completed (Gann & Barlow, 1996; Remøy & van der Voordt, 2006; Bullen & Love, 2010). One of the most prominent building elements which contribute to high transformation costs is the façade amount about 27% of the total costs on average (Wilkerson & Remøy, 2015; Remøy & van der Voordt, 2014; Geraedts & van der Voordt, 2004). At the same time the façade contributes largely to the level of acceptance of the buildings, be it aesthetic value, or the technical potential it offers (den Heijer & de Jonge, 2013; Geraedts & van der Voordt, 2004). The ability for facades to take over some buildings service functions, such as ventilation or energy production, also speaks for developing more suitable facades. As such, the façade, although it is a potential financial risk, is an important factor which dictates if transformation will be successful long term or not, and is worth investing in. The façade should be a building element where further research is conducted; to investigate how they can increase the flexibility of a building, or at least satisfy various user and owner needs at a lower cost.

Potential risks which are hard to avoid are the differing demands that the housing function has on buildings in compared to office functions. For example the need for operable windows, or dwelling linked outside space is more relevant for housing than offices. Making these demands even more difficult to fulfill, is that without substantial transformation, they can not be met (Gann & Barlow, 1996).

Beyond the building characteristics it has been shown that building owners tend to make more profit with their building after transformation than before, while it was still functional (Remøy, p. 200, 2007). However due to their lack of knowledge of their options regarding transformation they are unaware of the potential benefits for their enterprise. This goes to show that making owners and users aware of the possibilities and potential benefits of transforming, remains an important task of other market actors, such as architects, realtors, or engineers (Remøy & van der Voordt, 2014). Unfortunately this lack of knowledge has contributed to the common answer for a building showing signs of declining performance; demolition and redevelopment (Pearce, 2004). However according to Peter Bullen and Peter Love, transformation is potentially cheaper than demolition, when structural components are in tact (2010). Although the performance of a transformed building will never reach the same levels as a new building, these drawbacks must be weighed against the environmental and social impacts of transformation (Bullen, 2007). Based on their research Bullen and Love come to the conclusion that the opportunities created by transformation weight heavier than those created by demolition and rebuilding. In the recent market research by NVM in the Netherlands, it can be seen, that transformation is becoming increasingly popular (Bak, 2017).

Way of removal of offices from the market




Bak, 2017

Although many benefits can be named for transformation, the real and associated risks of transformation, which often stem from lack of information and financial fear are still a deterring factor. To make transformation more popular and a financially attractive alternative to demolition, new tools must be investigated. These should lead to; improving the flexibility of the project, but in particular the financial viability. Another vital aspect is increasing the awareness of market actors that transformation is a financially as well as social beneficial in many cases.

## 1.5. Municipal regulation

One of the most effective measures taken is the creation of the task force Expert Team Transformatie: a team of experts working together with the Ministry of Internal Affairs, and Ministry of Infrastructure and Climate. Together they support municipalities in gauging the transformability of vacant offices, and presenting these buildings to potential investors (ExpertTeam, 2015). However, there are also exemptions from building regulations which are geared to making the transformation process more feasible.

Unfortunately, amongst the useful exemptions, there are also some regulations which provide investors with loopholes which sacrifice building quality. Some positive examples are the decreased minimal ceiling height, rather than 2.6m, only 2.1m are required in transformations (Toolbox, 2012). As the ceiling height required at the moment of construction of most buildings was only 2.1m this is a logical exception. Some questionable exemptions are the permitted re-use of building installations, only if these are replaced must they adhere to the current standards. Another change leading to decreased building quality is the minimal required insulation value (Rc) of 1.3 m2K/W, compared to the current requirement of at least 4.5 m2K/W. This shows that legislation can have a positive effect, but can also cause issues. However other factors such as location characteristics also have a profound effect on the transformability of a vacant office.

## 1.6 Discussion

The issues facing most societies around the globe related to the real estate market, are pressing, however also multifaceted and difficult to manage with generic solutions, as shown by the preceding three sections. At the same time it is also clear that there are many views regarding potential solutions for the lack of adequate housing opportunities, and the ever increasing amount of vacant office space.

The mismatch on the on the Dutch real estate market is apparent. The demand for office space is far below the supply with around 13% of offices vacant (Cushman & Wakefield, 2017). Vacant office buildings are becoming younger and younger, due to the strong replacement market, dictating the market supply (Wilkerson & Remøy, 2015). The main reasons for office vacancy are: poor location characteristics, poor building exteriors, and expired technical lifespans (Remøy & Wilkerson, 2015; de Jonge et al., 2009). An exacerbating consequence of office vacancy is the effect on the surrounding area. Buildings within 500m of a vacant one, are subsequently more likely to also become vacant (Koppels et al., 2010) This only makes it more important for solid solution for widespread vacancy.

Additionally the most needing citizens searching for adequate dwellings on the housing market are those which have the smallest selection to chose from (Gopel et al., 2016; NVM, 2017). Furthermore the price levels on the urban housing markets continues to escalate at a much quicker rate than in rural areas, adding to the scarcity of affordable housing in cities (NVM, 2017). These factors contribute to a severe mismatch on the Dutch real estate market, and the current trend is suggests that the gravity of circumstances does not bother many market actors enough to merit immediate change.

To counteract the mismatch which has developed on the real estate market dating back to the early 90's, flexible housing and office solutions have been developed, to allow for changing user demands to be met in the long term (Gann & Barlow, 1996). Some of these trends are the larger role consumers play in the development of housing solutions (Cuperus et al., 2011). As users began voicing their demands more vehemently the industry remains slow in reacting. The building industry has attempted to offer more flexible solution to designers, owners and users. Movable partitioning walls, or volume extensions have been integrated in some housing projects in the early 21st century (van Gassel & Rodders, 2004). Yet these projects never reached their full potential due to various issues hindering the process. Additionally the lack of knowledge of the users regarding the potential their dwelling holds is important to remember (Cuperus et al., 2007; Minami, 2007; Geraedts, 2010; van Gassel & Rodders, 2007).In many cases technological solutions were not yet up to the task, or users did not believe in their functionality and their technical quality (Minami, 2007; van Gassel & Rodders, 2007; Geraedts, 2010).

A factor further adding to the failure of many flexible solutions is the increased demand for transparent and direct communication among the actors involved. Some extreme solutions have been developed in the realm of modular architecture. Although ambitious, various projects have shown that modular solutions can fulfill differing user demand without resulting in increased costs (Generalova et al., 2016). One prominent example is 461 Dean Street in Brooklyn, New York, constructed with 930 modules, of which 225 were unique, and the target group were financially weak families (Generalova et al., 2016).

Similar developments can be seen on the office market. Structural advancement in the 60's and 70's allowed for the rigid cellular office layouts, typical of post WWII offices began being replaced by large continuous and adaptable floor-plans (Gann & Barlow, 1996). Beam and column structures became more common, and with them came integrated building services, ushering in a new era of office building (Remøy, p.217, 2007). However although these developments lead to more technologically advanced buildings, the speed of advancement in this field, didn't stop the trend of companies moving to new more aesthetically and technically advanced offices (de Jonge et al., 2009).

The main issue with these developments however is that they are mainly targeting the building interior, while in particular the building exterior contributes greatly to office vacancy (Wilkerson & Remøy, 2015; den Heijer, 2013; Remøy & van der Voordt, 2006). As these buildings continue to stand vacant, their adaptability to modern standards becomes increasingly unlikely (Remøy, p.195-197, 2007).

Although there have been attempts on both the housing and the office market to make the building stock more flexible, and provide future proof solutions, most projects have failed. Nonetheless the ideas which have been developed are not as such unsuitable, however they the way they are applied, and developed must be re-evaluated. Additionally it is of the utmost importance that new financially feasible solutions are discussed, which are also able to adapt to various, and changing user, owners and market requirements.

Due to the lack, of suitable solutions for a building stock which no longer fulfills the current demand, and the absence of wide spread knowledge of the potential some buildings hold, demolition and redevelopment continues to be a common practice (Pearce, 2004). Although a change in the mindset can be observed, it continues to hold true even though transformation is the potentially cheaper and socially/environmentally more sustainable solution (Bullen & Love, 2010; Bak, 2017; O'Donnell, 2004). One of the largest contributing factor to this trend is the fear of high redevelopment costs (Gann & Barlow, 1996; Remøy & van der Voordt, 2006; Bullen & Love, 2010). One of the deciding elements which can contribute to high costs is façade replacement (Wilkerson & Remøy, 2015; Remøy & van der Voordt, 2014; Geraedts & van der Voordt, 2004). At the same time poor exterior and lacking technical standard are two of the main building features resulting in vacancy (den Heijer, 2013; Geraedts & van der Voordt, 2004). A well designed façade is able to fulfill both of these demands. An issue which must also be taken seriously is the absence of knowledge by the various actors on the building market, regarding the potential for transformation. Although it has been discussed since the early 70's, few projects have been successfully realized to date (Gann & Barlow, 1996; Remøy & van der Voordt, 2014). A tool developed by Rob Geraedts could prove to be of importance in increasing in the awareness of the a buildings transformation potential. The Transformation Potential Meter can be used to judge the feasibility of a office to housing transformation (Geraedts & van der Voordt, 2004).

Although the trend continues that buildings no longer profiting their owners are being demolished and redeveloped, there are strategies which can lead to more re-use of these currently obsolete buildings. However the construction world must also take on a role in this process, and begin offering solutions which can be implemented in the transformation process. The main aim should be at providing maximal flexibility for a price which reflects the value provided. Although it may not be as easy as going along with the status quo, it becomes clear that the potential of a flexible facade can not be ignored in the quest for improving the longevity of the building stock. The question however remains, how significant changes to the way of doing can be made to decrease investment costs, and at the same time create incentives for higher quality facades.

Some options that may lead to lower costs are decreasing quality, lowering the standards required or changing the market economy. However these options are either counter inducive of the goal envisioned or are not likely to occur. However a solution which has gained traction in other product fields, is offering certain products as a service. Such product service systems will be discussed in the following section.

### 1.6 Further research

In the previous sections the reasons for office vacancy, the mismatch on the real estate market, and a potential solutions; transformation, have been discussed. It can be concluded that the building stock must be made more flexible. To achieve more flexibility, transformation of vacant office buildings seems to be an intriguing solution. However, useful transformation often comes at a price. Two of the main contributing factors to high transformation costs are the façade, and building services. At the same time, an aesthetically pleasing, technically sound as well as representative façade and building, effect the long term exploit-ability of a given building substantially. Via the façade, aesthetic shortcomings, as well as technical flaws could be tackled at the same time. The main issues is, offering such façades at competitive prices, and still providing individual solutions for diverse customers.

A new strategy of dealing with diverse/changing user demands, and increasing long time user satisfaction with products, has been; offering products as a service. Product service systems (PSS) have been around for around 30 years and might be able to contribute to the resolution of the rigid nature of the real estate market. The main question guiding this section is; what the characteristics of a PSS are, and how a facade could be provided as a PSS?

This section will also discuss the potential for façades to simultaneously fulfill building services, while also serving as an attractive envelope. A link will then be made between façades, and PSS, and how this link could be a valuable asset to making transformation more financial feasible and successful. The section will serve as the basis for the framework for the remaining graduation project, presented in section 7.

#### 1.6.1. A review of PSS's

Since the mid 1990's, PSS's became a topic fostering increased interest from various industries, as well as researchers world wide. This increased interest may stem from the fact that services are hard to grasp. Services in their conventional form are:

1. Intangible: actions are performed rather than objects being offered

2. Heterogeneous: Service product quality is subject to variability due to humans being part of providing it

3. Perishable: Services are consumed as they are provided, and can't be stored, returned or used at a later date.

(Aurich, Mannweiler & Schweitzer. 2010). However when a product is offered as a service, some of these drawbacks can be mitigated. Arnold Tukker, defines PSS as "a mix of tangible products and intangible services designed and combined so that they are jointly capable of fulfilling final customer needs" (2013). The differentiation Tukker makes - by noting that combing products and services is substantially different to conventional services is key to understanding PSS. A factor also contributing to increased interest on the topic, is that services are seldom associated with a product (Kim, Rhee & Yoon, 2012). Selling a service means that the incentive for a company to generate profit changes. Rather than more sales resulting in higher turnovers, as product centered companies, a PSS requires the user to pay for the service provided, and the materials needed to provide this service are a cost factor for the provider (Tukker, 2013). However providing a service instead of a product is not always as easy as it would appear. One of the main difficulties when providing a product as a service is translating the services a product delivers, into concrete performance demands, needed to provide the same result as a service (Tukker, 2013). Furthermore it is often difficult to view a product as a service, due to the conventional product definition: you get what you see (Bastl et al., 2009). Arnold Tukker adds, that the intangible value of ownership is often forgotten. The status and self esteem owning a product causes is culturally attached to most product (2013).

### 1.6.2 Advantages of a PSS

Despite the potential difficulties, PSS's have the ability of being able to fulfill client needs in a custom and personalized way, while also reducing the environmental impact of products (Aurich, 2010; Tukker, 2004). What sets PSS's apart is the fact that products are relatively easy to replicate, while extraordinary service provision is not (Tukker, 2004). To achieve such extraordinary services however, companies must begin to re-think how they design, market and distribute the products they develop.

As it is hard to translate the abstract demand for something into concrete performance indicators for a service, producers and users must start working together more closely to reap the benefits that a PSS can offer (Kim et al., 2012; Aurich et al., 2010; Bastl et al., 2009; Tukker, 2013). This improved collaboration benefits the users, as they are able to focus their concentration on the core activities of their business, rather than optimizing performance of profit unrelated assets such as; building, services, catering , etc. (Tukker, 2004). While at the same time the service provider is able to focus on providing the best possible service for the specific user. This close relationship, and the custom service provided, often leads to higher client loyalty, resulting in stable finances for providers and stable demand fulfillment for the users (Tukker, 2013).

PSS's are also said to reduce the environmental impact of economic activity (Bastl et al., 2009). In a study conducted which analyzed 3 small scale PSS providers, it was shown that significant environmental savings can be achieved (Lindahl, Sakao & Sundin, 2013). Due to the provider remaining responsible of the products they use to offer a service, the likelihood that they use products which last longer, and thus require less virgin material to make, also increases (Kim et al., 2012; Tukker 2015; Lindahl et al., 2013). In Arnold Tukkers summary of PSS research conducted in the last 20 years, he summarizes that PSS's work particularly well, when focused on expensive and technologically advanced products, which require maintenance for optimal performance, and are not subject to fashion trends. He adds, that especially products with slow development cycles are proving to be suitable for PSS's (Tukker, 2013). Another important point made is that modularity can be beneficial, as it allows for future mutations to be made, allowing for continued satisfaction of user needs (Tukker, 2013).

One point which must also be mentioned is, that successful PSS provision is largely dependent not only the close relationship between user and provider, but also the providers relationship with his suppliers (if they have any). As a team, they should together form the service provider (Bastl et al., 2009). The point is also echoed by Tukker stating that successful PSS providers often are split into a product development branch, and service providing branch. The collaboration between these two branches must be close, but they should not form one entity (2013).

A highly technological element in the construction industry is the façade. Based on some literature discussed above regarding PSS; the technical nature, its profound effect on user comfort, and building owner satisfaction, of a façade, make it well suited to be developed as a PSS.

### 1.6.3. Façades as PSS

In recent years, increasingly façades have been investigated as a PSS. In particular at the TU Delft multiple graduation papers have discussed the potential benefits of such systems. The financial feasibility, the increased user satisfaction, as well as lessened environmental aspect have been touched upon. Two papers of particular relevance to this literature study will be highlighted. Juan Azcarate investigated façade as a PSS in general, looking at financial feasibility, with University buildings as the main case. Jeroen van Winden, investigated integrated façades as PSS's.

To fulfill the changing functional and aesthetic demands of a user, it will be of importance that the facade can be changed over time (van Winden, 2016; Azcarate, 2014). Van Winden maintains that the provider being able to make these changes continuously will allow the performance and the value of a facade to remain high throughout its life time ( 2016). Simultaneously it is also in the interest of the provider, to evaluate potential upgrades which could reduce the costs for delivering the agreed service (Azcarate, 2014). The topic of product ownership is also of significance. By maintaining ownership, the provider benefits if when producing/using goods that last long, but also he can count on the residual, material and financial value of his product (Azcarate, 2014; van Winden, 2016). This should result in the flexibility of being able to transform obsolete components, rather than deposing of them (Azcarate, 2014; van Winden, 2016). Azcarate adds, that beyond recycling components, complete façades could be down-cycled to other buildings. This is feasible if the initial building upgrades to another system, or reaches its end of life, due to facade unrelated reasons. He suggests a cascading model, as shown in the illustration on the next page. He claims that such models could in particular assist in the diverse financial sectors on the housing market; social housing, and high end penthouses have differing demands which can realistically be met. However such a cascading system could provide high end options, even for projects with small budgets, by providing the down-cycled façade from flagship projects.

Yet it is not only the demands of the user which would benefit from facade PSS models, building owners also profit. The added flexibility that a PSS facade can offer, improves the chances of their building remaining occupied, and so, their investment too is better protected (Azcarate, 2014). These improvements can range from aesthetics, to energy performance (Azcarate, 2014; van Winden, 2016). One of the main issues van Winden encountered during his research, which involved client interaction was; that there was interest in new business models, but they require investments, and product redesign. Companies were reluctant to take on this challenge due to the risk of failure (2016).

In his paper, Juan Azcarate provides some financial models, showing that a PSS model can result in significant savings. In comparison to an investor choosing for a PSS solution rather than not renovating his building, Azcarate claims that after 3 years the PSS model will already be cheaper. Over a course of 30 years, it will have accumulated savings of up to 50% (Azcarate, 2014). Furthermore he shows that the initial investment costs are substantially lower, compared to the conventional cost of purchasing a facade. As building owners first decide if they should renovate rather than how, a PSS facade offers a risk free solution. It will fulfill various user and owners needs, without substantial additional spending.

An issue van Winden encountered, one of the main prohibiting characteristics of PSS's, is the organizational re-alignment which must precede profitable activity. This reflects what Tukker mentioned as one of the main issues surrounding the availability of PSS solutions. One of the solutions for this is a more direct relationship between providers and users, however as van Winden makes clear, the knowledge gap between the various actors must be filled. He suggests more design studies, and research towards the field being done.

To build on the work that Azcarate and van Winden have done, it will be the main goal of this graduation, to explore a new case for PSS façade; office to housing transformation. As the conducted literature review has shown, façades seem to be suitable as PSS's. Additionally the case of office transformation, actors are searching for low cost, high impact solutions, to make the real estate more flexible in the long term. How this can be achieved, what types of products and services are needed and how the knowledge regarding façade as a PSS will be augmented during this graduation, will be shown in a research framework in the following chapter.


De Groene Toren after transformation, 2018 (Diederendirrix)

# 2. Methodolgy

The literature presented and discussed shows that there are various issues which make this transformation of vacant office to high quality residential spaces difficult. To develop a vision regarding potential solutions this thesis will focus on answering the following question.

## 2.1. Main question

Based on these conclusions the following question was formed:

*Can offering façades as a PSS in the case of transforming offices to housing, contribute to the building, more reliably being adaptable to various user needs and thus extending its life time and increasing user comfort and* façade *quality?*

## 2.2 Scope

This graduation will focus primarily on the design of a facade, and how the various needs of the actors involved can best be met in the long term. I will not look extensively at the interaction between actors, or financial models, as this has already been discussed in previous graduations, however it will be mentioned, as it can not be ignored in the process central to this graduation.

## 2.3 Method

To conclude if this question asked is true or not, the following steps needed will be briefly presented.

The next step will be finding out which features and demands a facade being offered as a PSS must meet. The main question asked will be: What are the features a PSS facade should poses to adequately fulfill various user and building owner needs?

One of the main conclusions drawn from literature concerning PSS is that the collaboration between various actors from real estate, building sector, and technology is crucial. From this background a graduation on the topic of PSS can not be conducted without various market actors being interviewed. The views of these actors is important to chart and take seriously, as users, owners and suppliers will all have differing opinions regarding the demands a PSS facade should fulfill.

Parallel to this, by conduction a case study, the user demands, and how they were met in previous transformation projects will be deduced. Various target groups are suitable for transformation based on literature: elderly, students and starters. Their unique demands must be take into account for the final design.

The interviews and case study results will contribute directly to the program of requirements for the final design. Based on the literature review, and also the graduation of Juan Azcarate, the most suited solution is likely not one modular facade, however a portfolio of facades, which can be fine tuned for specific user/owner needs. This portfolio will form the final design product of this graduation.

### 2.3.1 Roadmap

To answer these questions and cater to the demands set, the remaining paper is divided into five further chapters. The 3rd chapter will present and discuss the case study conducted.

In chapter 4, the interviews conducted will be summarized. The fifth chapter will discussed both the case study and interviews. In chapter 6 the design recommendations, requirements and final design are presented and briefly analyzed. The 7th and final chapter will conclude.

GAK building seen from A 10 (Rufus de Vries, 2015)

# 3.Case study

## 3.1 Introduction

The topic of transformation off vacant offices has been discussed in the previous section. However the literature and studies referred to were published, to a varying degree, multi years ago. Since then the real estate market has changed from a supply driven market to a demand driven market, and the requirements for both housing and office have become more challenging to reach adequately. Although the building sector generally changes its ways slowly, and remains largely traditional, changes do occur, which effect the way all involved parties approach their projects. Theses changes are not limited to new building materials, but also include a change in mindset towards sustainable design, increasing of decreasing liquidity of stakeholders, and increasingly the lack of inner city space to develop new housing space.

## 3.2 Method

Due to these mutations, before commencing with suggesting changes to the transformation process, it is seen as important to verify the validity of the research regarding transformations conducted in the past. In particular it is of interest to understand if any changes can be observed in the way buildings are selected to for transformation, and how these transformations are approached. Based on the literature studied, the buildings transformed should have certain qualities, finding deviations from these expectations are one of the reasons a case study of transformation projects was conducted. These deviations or similarities should be analyzed, to develop an understand why these difference can be seen.

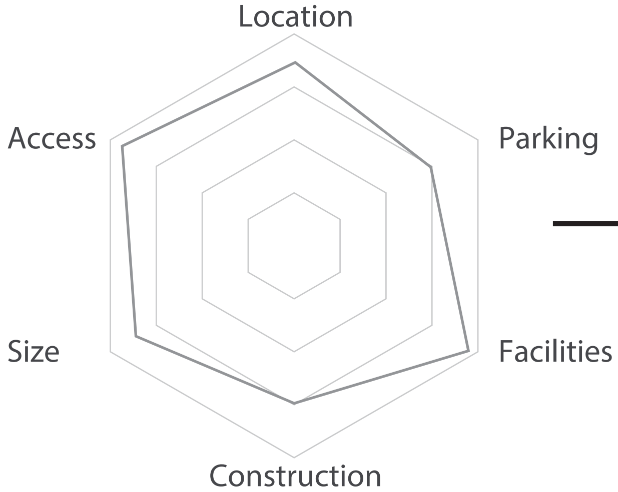
Moreover it is not only of interest to compare to the past, however comparing various projects with each other will give insight into the process and results of such projects. Which types of buildings were transformed, why, and how are the main question this case study should answer. With the goal of this graduation being a suggestion of requirements and design for a PSS façade, to be implemented in transformation projects, any similarities provide valuable insights. Especially in relation to the facade, the requirements and the final result are valuable to chart. Another reason for conducting case studies was to find out which parties were involved in the transformation projects, so a list of potential interview partners could be collected, which had relevant information regarding the process.

To ensure that the projects studied are relevant to the topic of this graduation, a set of requirements were set for the projects to be studied. As discussed in the previous chapter, the scope of this graduation is limited to the Dutch market, as such only transformation projects completed within the Netherlands were considered. Furthermore the buildings chosen should have a fully replaced façade, and also be completed in the 5 years previous to this graduation (2012-2018). In addition to these points it was decided to only study projects which resulted in at least 100 residential units, to ensure that the facade transformation formed a significant financial part of the project.

The result of the data of the building studied was collected in an excel sheet seen in Appendix A. To make this date more accessible and to facilitate the caparison of these projects,

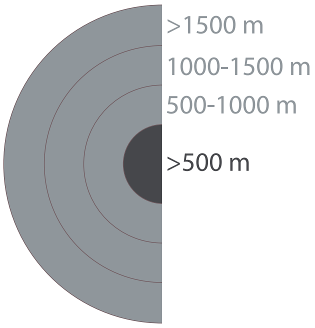
# 3.1 Cases

| | |
|---|---|
| Architect | Investor |
| Constructor | Developer |
| Facade assembly | Owner/User |



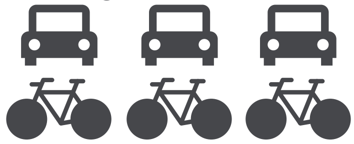

## Location

Distance to center



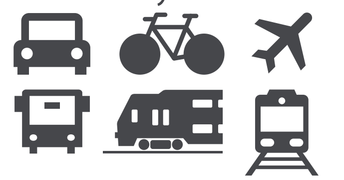

Location type

Parking



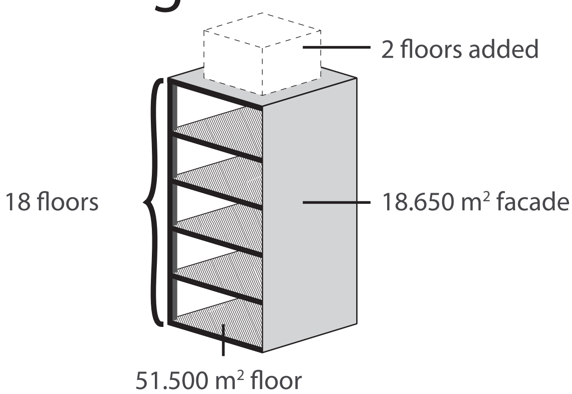
Vacancy


Reachability

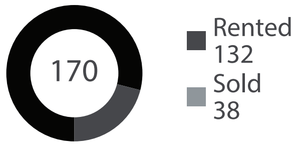


Services

## Building



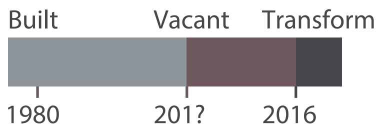

Units



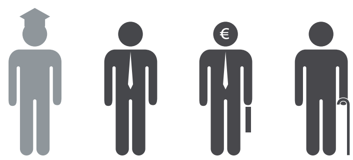

Services

Mechanical ventilation, solar panels on roof. Connected to central heating/warmwater network.

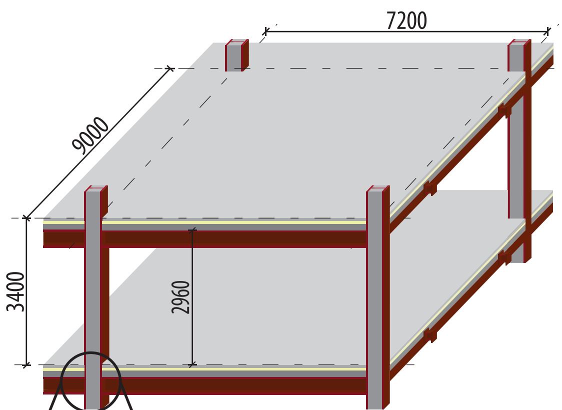
Building lifespan

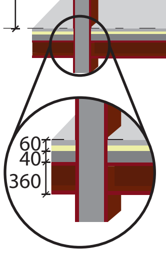



Target groups

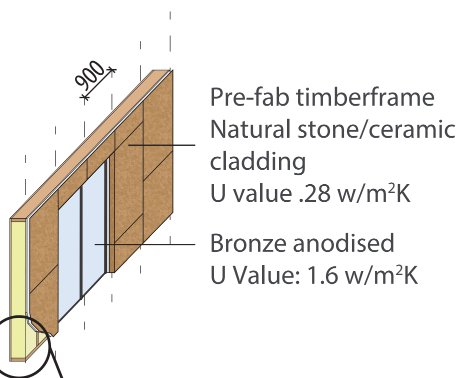


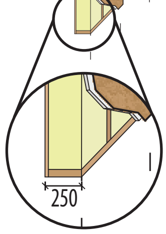
## Construction



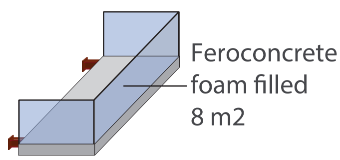




Steel columns, concrete cast around, concrete beams. TT floors spanning parallel to long facades of building.



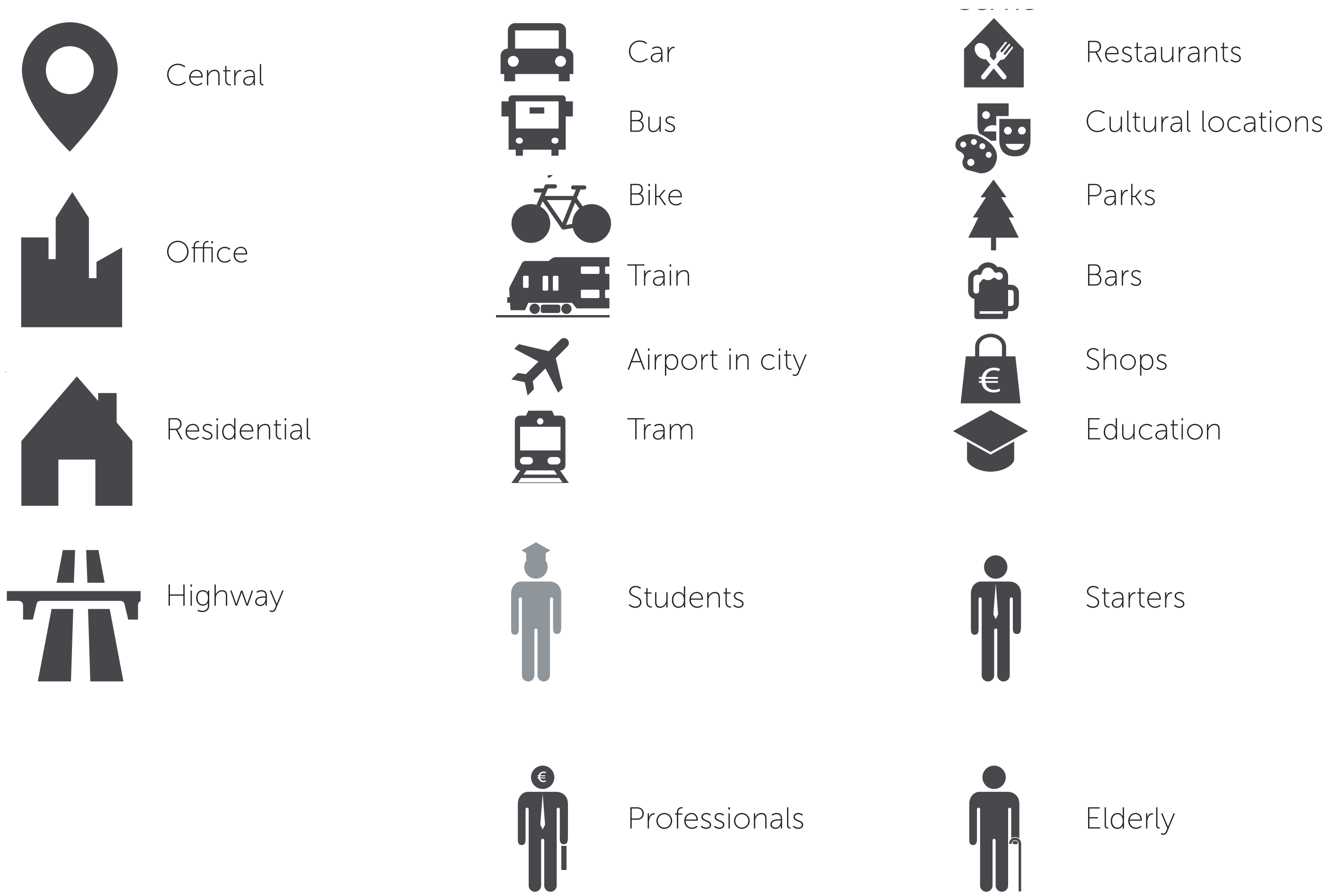

Prefab timber frame facade, with aluminum window frame, cladding fixtures pre installed, cladding fixed on site




Balconies were mounted via steel consoles added to existing floor. Beams cast into the balconies could then be fixed

# Legend

The rating hexagon has the function of summarizing the building, and making it quickly comparable to other buildings, based on the characteristics of the location and building which are either favorable for transformation towards housing or not.

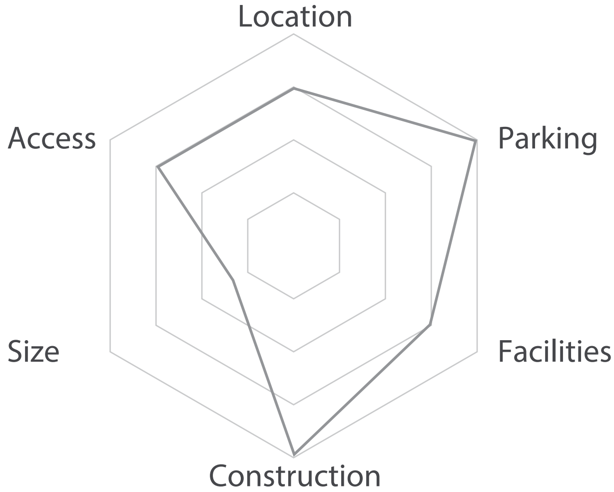



The difference in light gray and dark gray indicates if a characteristic applies to the location or the building. In the example shown, the main target groups are starters, professionals and elderly as seen by the student icon being light gray filled.

# Bellavista, Rijswijk

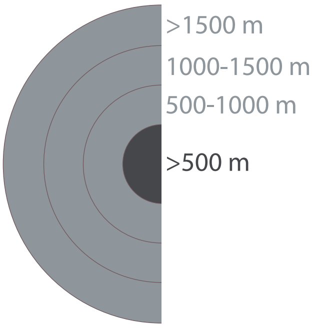
**Architect**
Rijnboutt Architecten
**Constructor**
AKOR/Vastbouw
**Facade assembly**
Decomo/ABB

**Investor**
Urban Interest
**Developer**
Urban Interest
**Owner/User**
Urban Interest



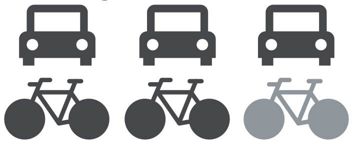

## Location

### Distance to center



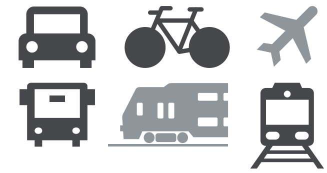

### Location type

### Parking



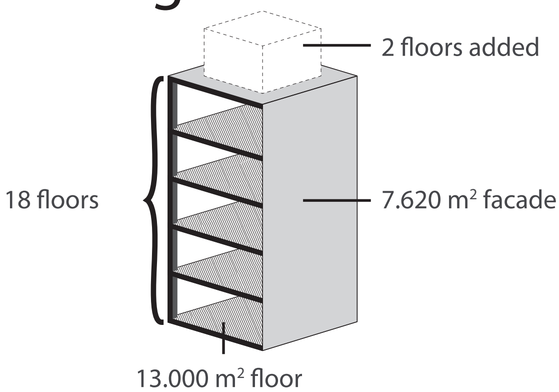
### Vacancy


### Reachability



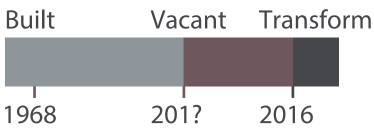
### Services

## Building




### Units

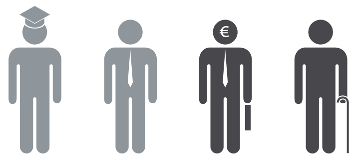

### Building lifespan



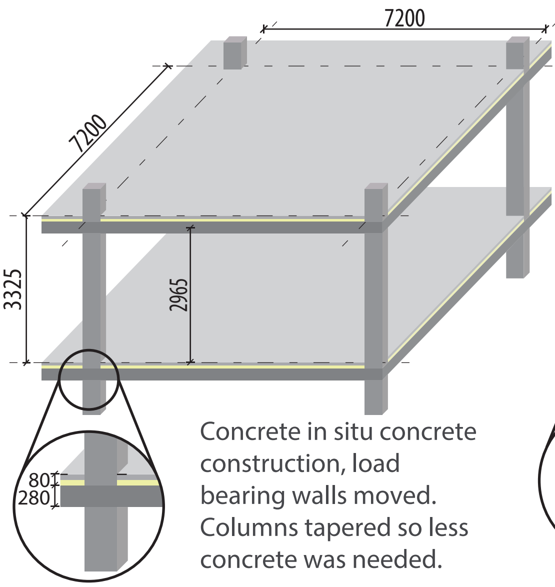

### Services

Mechanical ventilation, solar panels on roof. Connected to central heating/warmwater network.

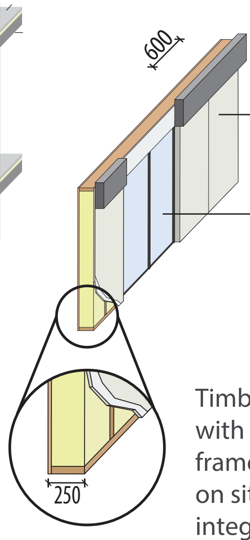
### Target groups



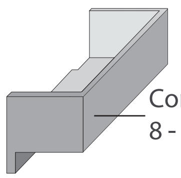
## Construction




Concrete in situ concrete construction, load bearing walls moved. Columns tapered so less concrete was needed.




Timber frame facade, with aluminum window frame, cladding installed on site, No services integrated in facade.



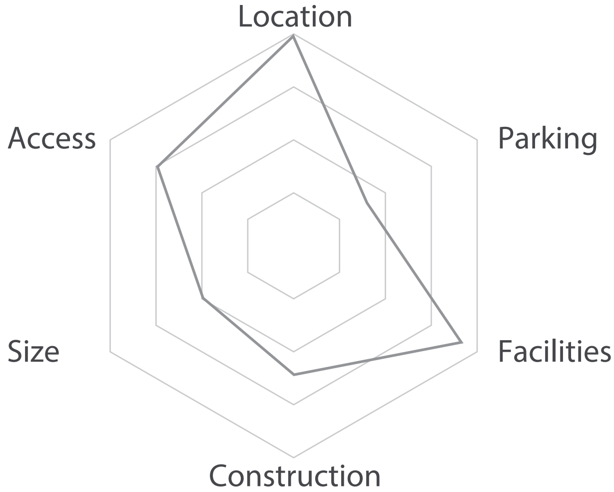

The balconies are part of facade cladding, made from z shaped concrete elements, large balconies could thus be realised.




The *Bellavista* transformation is a redevelopment of the Piet Zanstra designed office tower, completed in 1968 (Starink, 2014). Originally the building served as office space for health services in Rijswijk (Elbers, 2016). The project is geared in particular at the higher rental sector, and has resulted in various apartments ranging in size from 77 - 130 $m^2$ (Rijnboutt, 2018). The rental price for these apartments came in at € 840 to € 1380, which includes a parking spot on the adjacent parking deck (Bellavista, 2015). The transformation was initiated 10 years prior to the its completion and was subject to an extensive development period, which resulted in various design proposals (Rode, 2018). The final design was a result of an increased focus on increasing the cohesion of the area, which was always more a housing are than an office location. The project is state of the art based on various structural and technical aspects. The construction was adapted by tapering all columns added to replace the structural core towards the top of the building. Furthermore the building was transformed with the clear ambition of reaching the current technical standard required for newly built housing (Rode, 2018; Van Spanje 2018). The result mirrors these ambitions, as the complex received an energy label of B-A (Rode, 2018).

All sources used for the case study spreads and text are listed in the list of references under Case studies

# De Kortenaer, Den Haag




**Architect**
ZZPD architecten

**Constructor**
De Vries en Verbrug

**Facade assembly**
unknown

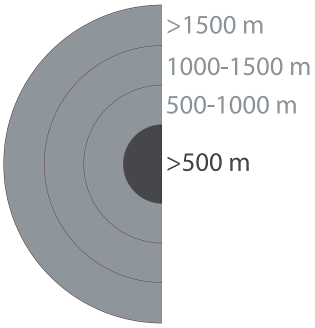
**Investor**
Provast + Syntrus Achmea

**Developer**
Provast + Syntrus Achmea

**Owner/User**
Provast + Syntrus Achmea, private

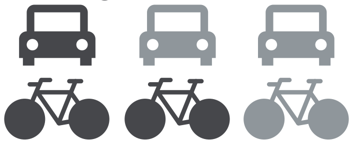
# Location

Distance to center



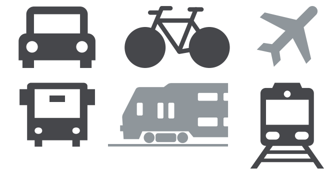

Location type

Parking



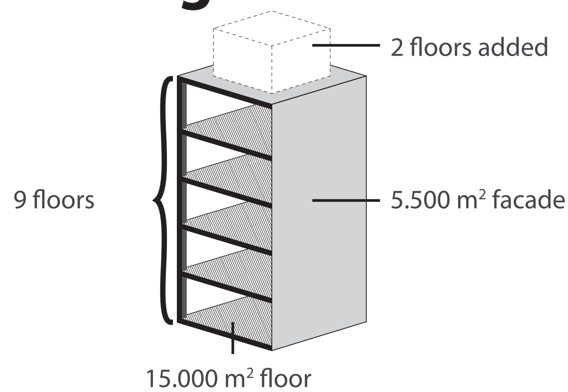
Vacancy


Reachability

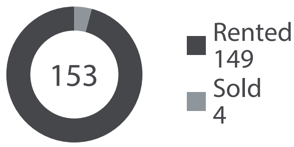


Services

# Building



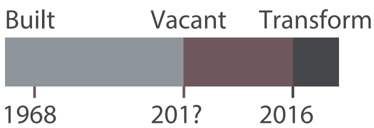

Units




Services

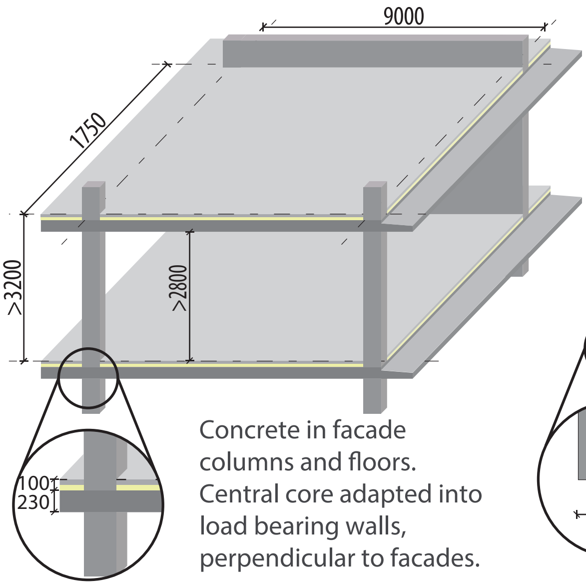
Natural ventilation vents in facade.

Building lifespan

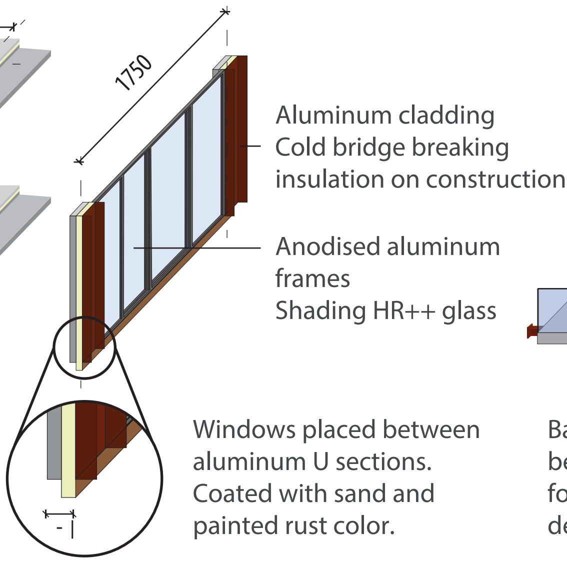



Target groups

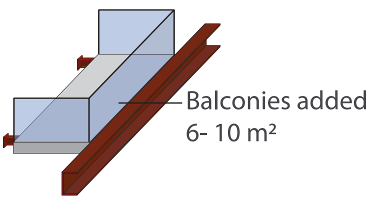
# Construction




Concrete in facade columns and floors. Central core adapted into load bearing walls, perpendicular to facades.

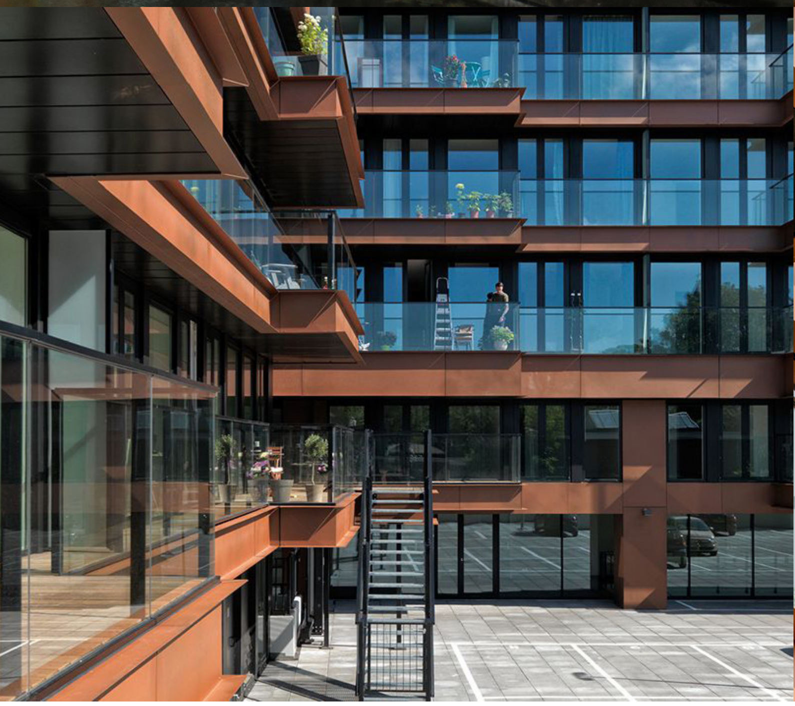



Windows placed between aluminum U sections. Coated with sand and painted rust color.




Balconies attached to facade beams and floors with steel fork construction. Thermally detached from construction.

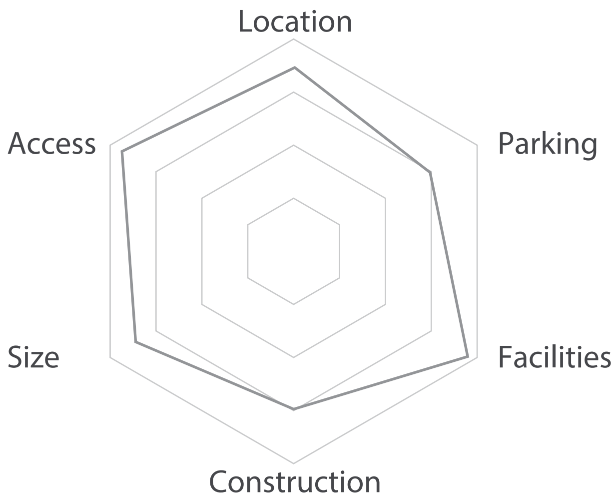





The *Kortenaer Kade*, similar to the *Bellavista* project was a building originally designed by Piet Zanstra (Schuin, 2018). The building was originally built for OLHEV insurances, and was later used by the *Rijksgebouwendienst* (Schuin, 2018). Achmea Syntrus developments purchased the building after a vacancy period of 8 years together with Provasat (Theunissen, 2016; Schuin, 2018). The building in its previous designed relied on a multiple large structural core as well as facade columns. As this construction made the design of apartment divisions difficult it was decided to re-organize the construction. Several load bearing walls were added to replace the central core ( Theunissen, 2016). The decision to transform the building rather than demolish and rebuild was largely a result of the time saved in this process. As such a high quality housing complex was built in less than 16 months (Theunissen, 2016). For the exterior appearance of the facade various concepts were explored, however the final decision was to keep the original vertical rhythm with cortensteel elements (van Gils, 2017). However due to the vicinity of the project to the north sea, the corrosive qualities of this material were insufficient, and thus aluminum sheeting was bent into the final shape seen above, and coatede with a sand layer and painted in a rust color (van Gils, 2017).

All sources used for the case study spreads and text are listed in the list of references under Case studies

# Wijnhaven Kwartier, Den Haag

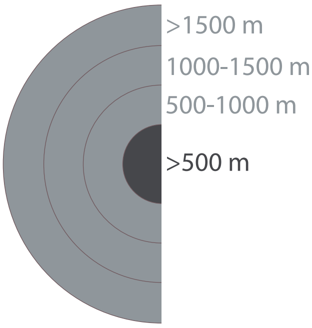



**Architect**
Geurst & Schulze Architecten
**Constructor**
Heijmans
**Facade assembly**
Rollecate/WVH projecten

**Investor**
Rabobank, BPL, Syntrus Achmea
**Developer**
Heijmans Vastgoed, Proper Stok
**Owner/User**
Leiden University, private

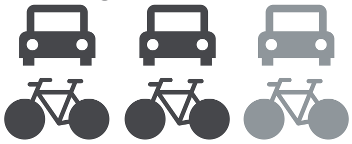
## Location

### Distance to center




### Location type

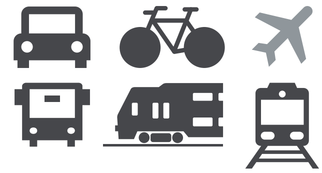
### Parking



### Vacancy

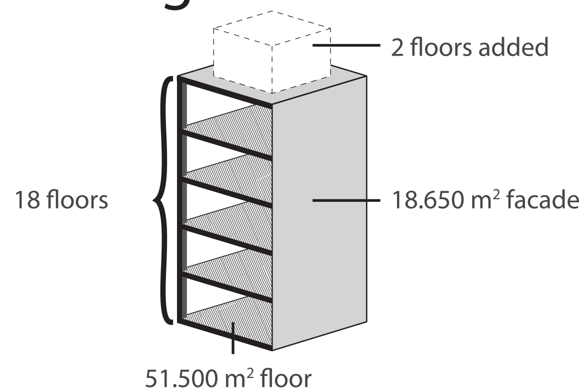
13%

### Reachability

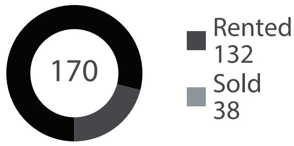


### Services

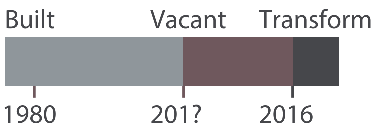
## Building




### Units



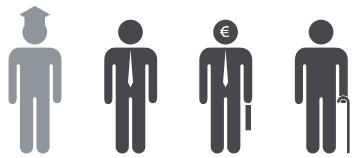

### Building lifespan



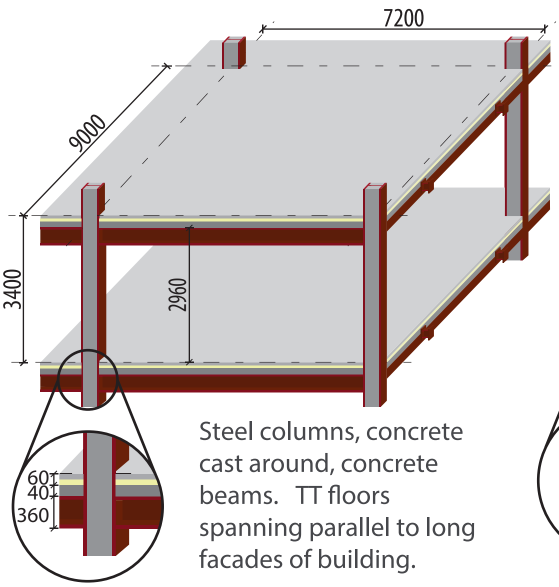

### Services

Mechanical ventilation, solar panels on roof. Connected to central heating/warmwater network.

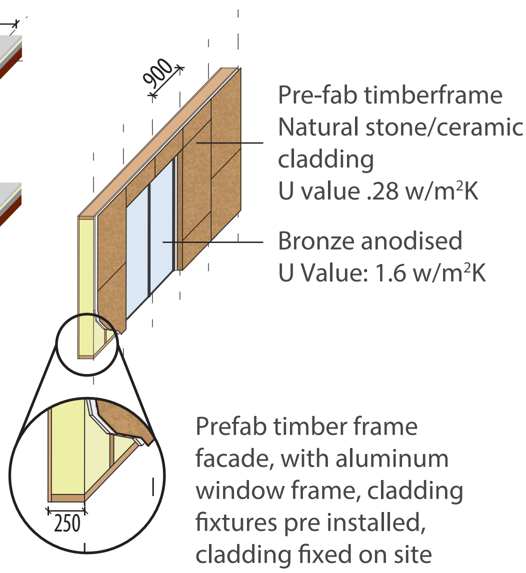
### Target groups



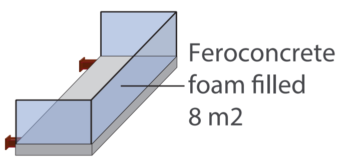
## Construction




Steel columns, concrete cast around, concrete beams. TT floors spanning parallel to long facades of building.




Prefab timber frame facade, with aluminum window frame, cladding fixtures pre installed, cladding fixed on site




Balconies were mounted via steel consoles added to existing floor. Beams cast into the balconies could then be fixed

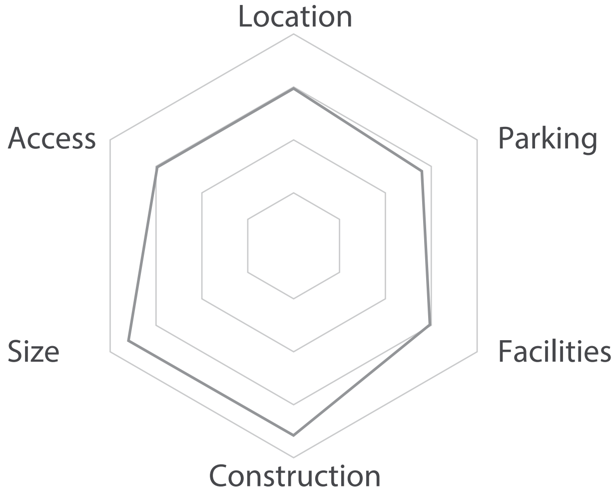
The *Wijnhaven Kwartier* is one of the largest transformation projects studied in the course of this thesis encompassing 51.500 m² of floor area (Heijmans, 2016). The program of the transformed building is also the most diverse of all projects, including not only housing and commercial functions, but also spaces for the University Leiden and restaurants (Fleers). The project was completed in merely two years, and made space for 162 rental apartments and eight penthouses, which were sold after completion (Heijmans, 2016). The main issues encountered in the transformation had much to do with the existing construction (Crone, 2017). The issues encountered had to do with very thin floors: causing issues with acoustic insulation, low ceiling height of 2.96m: resulting in problems in the university areas, and the dimensioning of the construction, which made the addition of balconies difficult (Crone, 2017). The solution for the balconies was rather ingenious, as their construction is based on a foam core, cast into ferro concrete, which results in a very light balcony construction (Crone, 2017; Geurst & Schulze, 2018). Concerning the dimensioning the construction, the municipality had approved the addition of 10 additional layers of construction to the building, however due to its under dimensioning, this was finally not possible (Crone, 2017).

All sources used for the case study spreads and text are listed in the list of references under Case studies

# De Nieuwe Admiraliteit, Rotterdam

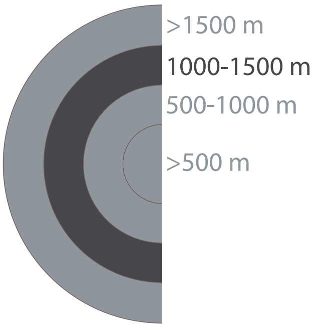
**Architect**
Klunder Architecten
**Constructor**
ABB Bouwgroep
**Facade assembly**
Decomo/ABB

**Investor**
Bouwfonds IM
**Developer**
ABB, B.V. en U, Citypads
**Owner/User**
CityPads



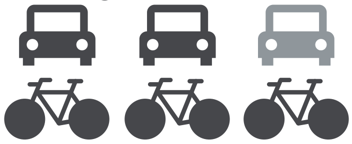

## Location

Distance to center



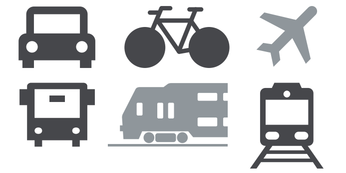

Location type

Parking



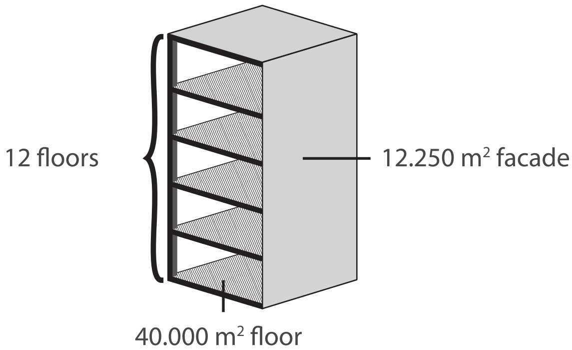
Vacancy


Reachability



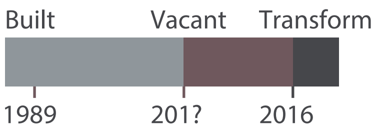
Services

## Building




Units

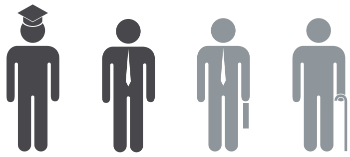

Building lifespan



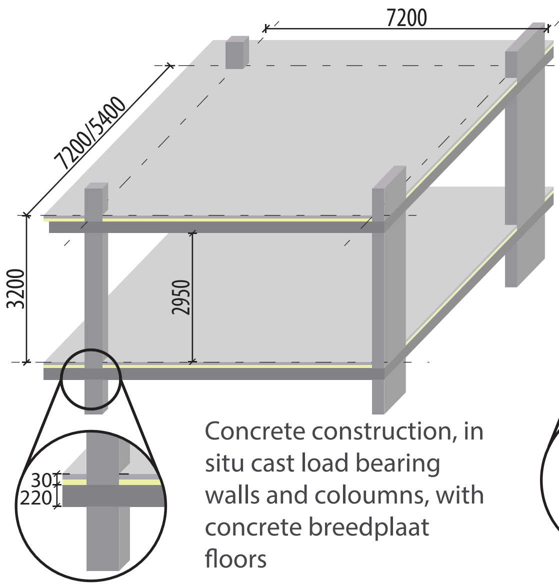

Services

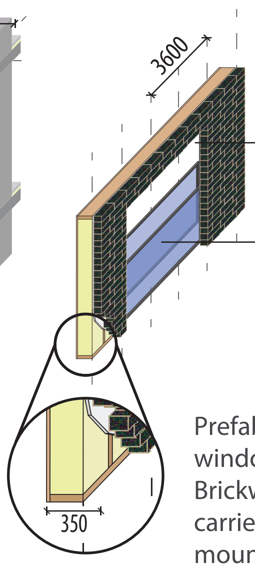
Mechanical ventilation.
Connected to central heating/warmwater network.

Target groups



## Construction




Prefab Timberframe
light and dark brick
U value: .28 W/m²K

Anodized aluminum
vertical opening windows
HR++ glazing

Concrete construction, in situ cast load bearing walls and coloumns, with concrete breedplaat floors

Prefab timberframe with windows installed. Brickwork layed onsite, carried by angle mounted to floors/wall

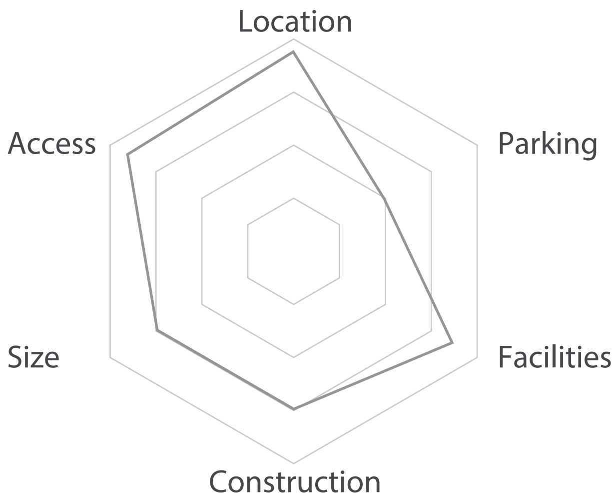
No balconies added, however large vertical sliding windows allow the facade to open facade half way.


The transformation of *De Admiraliteit* was at the time of its development one of the largest transformation of the Netherlands (Renovatie, 2016). To account for the need of any type of outside space, large vertical sliding windows, as seen above were installed. To make space for these windows, the load bearing facade walls had to be modified and largely cut out (Wind, 2016). The floors of the building did not have to be adapted as the fulfilled the building codes the building was subject to at original construction. However to increase the acoustic performance between floors, suspended ceilings were added (Wind, 2016). The project was also built in an impressive tempo, as around 30 apartments were completed per construction week. This also had much to do with the construction of the wet cells added. The addition of wet cells was revolutionary in transformation projects, as all of these units were per-fabricated and electrical heaters only had to plugged into the sockets on location after placement (Renovatie, 2016). What further sped up the process was that all installations were added before further construction. These had to made with a high degree of precision as they were eventually fitted in the thin internal metal stud walls . The use of digital location devices made this possible (Wind, 2016).

# Van Vollenhovenkwartier, Rotterdam

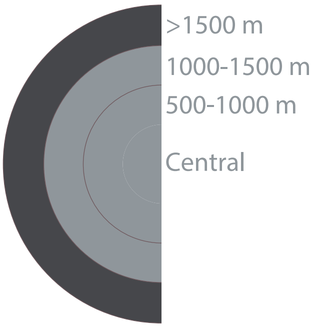
**Architect**
RoosRos
**Constructor**
ABB Bouwgroep
**Facade assembly**
ABB

**Investor**
Triverstor
**Developer**
ABB + DBOG + Trivestor
**Owner/User**



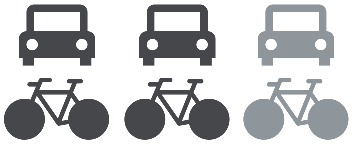

## Location

Distance to center

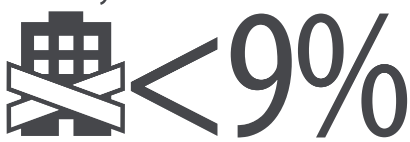



Location type

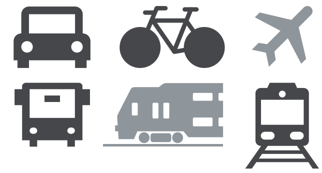
Parking



Vacancy

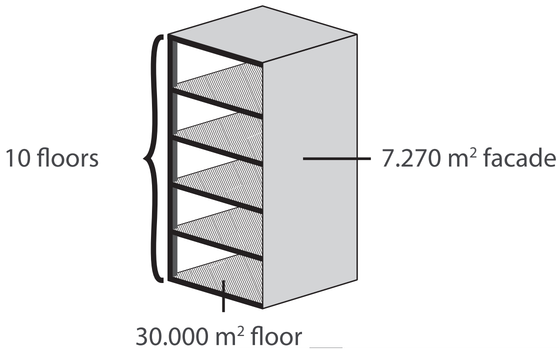



Reachability



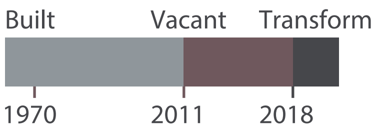
Services

## Building



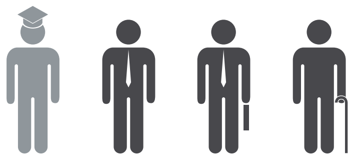

Units


Building lifespan

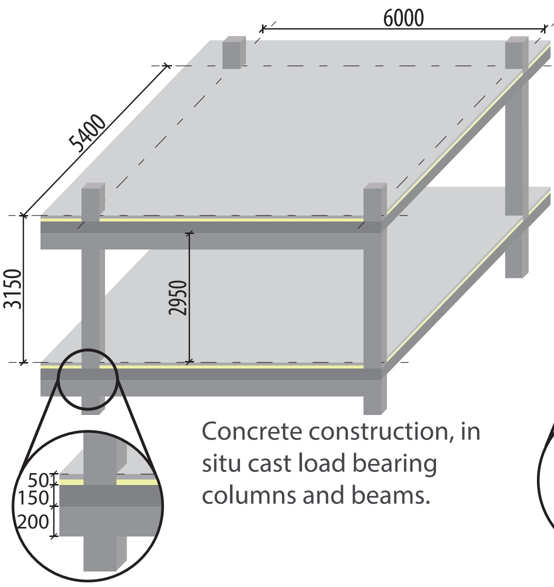



Services
Connected to central heating grid, floorheating, mechanical exhaust ventilation, PV cells on roof

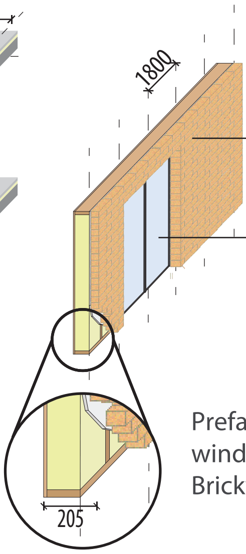
Target groups



## Construction



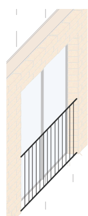

Concrete construction, in situ cast load bearing columns and beams.




Prefab Timberframe
Creme and gray brick
U value: .22 W/m²K

Bronze anodized aluminum
HR++ glazing

Prefab timberframe with windows installed. Brickwork layed on site.

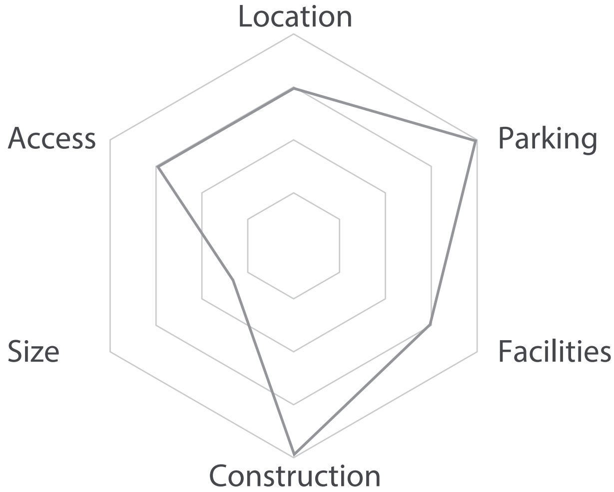


French balconies added to appartements. Roof top terraces also added in somce cases.

The *Van Vollenhoven Kwartier* is a formed office building located in the vibrant *Scheepvaart Kwartier* in Rotterdam. The project was initiated in 2016 when a trio of developers/investors, ABB DBOG and Trivestor purchased the building, and began developing a plan for transformation. One of the main difficulties encountered in the project was the extreme depth of the building, which was not necessarily practical for the creation of housing (Tabbers, 2018). The architects Roosros made an effort in convincing the developers of adding light-wells in the center of the buliding to increase the amount of natural light, however due to concerns regarding cost, and the top up on the roof, this decision was structurally and financially denied (Tabbers, 2018). The residential units constructed range from city lofts of around 40 $m^2$ to larger apartments of 115 $m^2$ (Roosros, 2018). These apartments were all put up for sale rather than being rented (Top010, 2017). An interesting point is that no balconies were added to the building. This however did not stem from issues relating to the construction, however had to do with the building perimeter being on the zoning border, and thus added balconies would have protruded over this line. An exemption could have been been requested, however the investors were not willing to wait (Tabbers, 2018).

All sources used for the case study spreads and text are listed in the list of references under Case studies

# Hermes City Plaza, Rotterdam

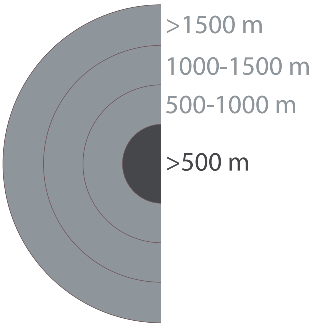



**Architect**
Van Wilsum van Loon
**Constructor**
Du Prie bouw & ontwikkeling
**Facade assembly**
Blitta

**Investor**
Egeria + Erasmus Universiteit
**Developer**
Hermes City Plaza B.V.
**Owner/User**
Wolf Huisvestingsgroep

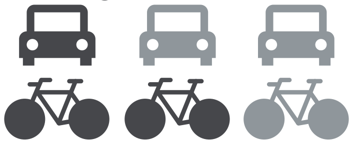
# Location

Distance to center



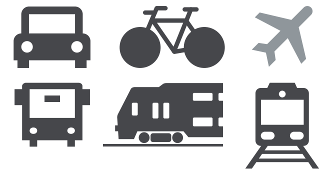

Location type

Parking



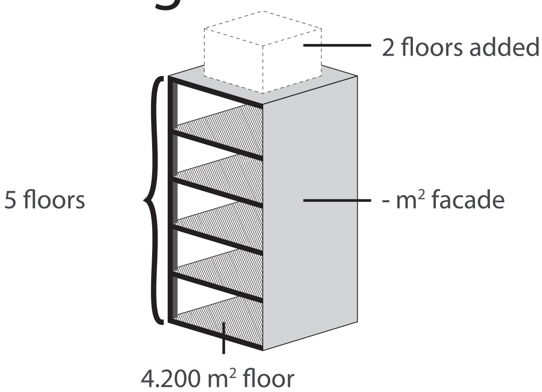
Vacancy


Reachability

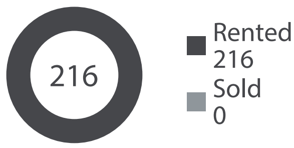


Services


# Building

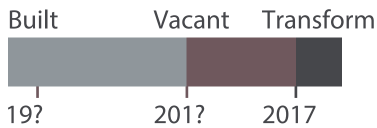



Units

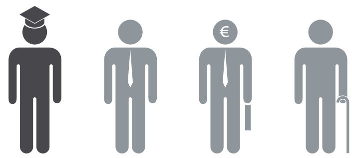



Services

Building lifespan




Target groups




# Construction

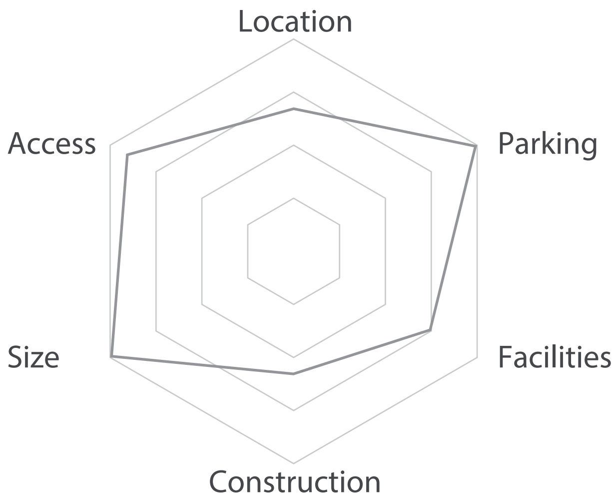

The *Hermes City Plaza* is a former office building located in the center of Rotterdam at the stadhuiplein (Top010, 2017b). The project was initiated by the Erasmus University, and aimed towards creating student housing for their students (Top010, 2017b). The ground floor is being developed to also house various commercial functions. The building is being topped up with two layers, and will receive roof terraces, accessible to the students (Top010).

More detailed information is unfortunately available currently. More data could be gathered from the interview with the developer EGERIA, as well as insight of building drawings in the Rotterdam Archive.

# Europoint II + III, Schiedam

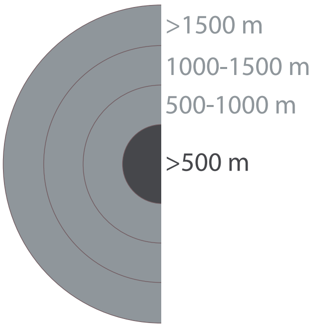
**Architect**
DiederenDirrix
**Constructor**
TBD
**Facade assembly**
TBD

**Investor**
Citypads, tB|BHW Projects
**Developer**
Citypads, tB|BHW projects
**Owner/User**
TBD



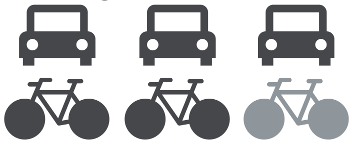

## Location

Distance to center

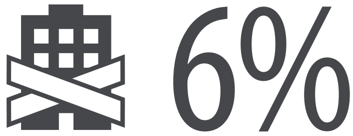



Location type

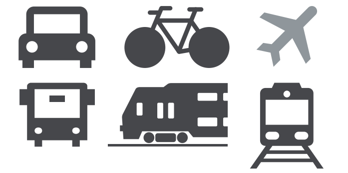
Parking



Vacancy

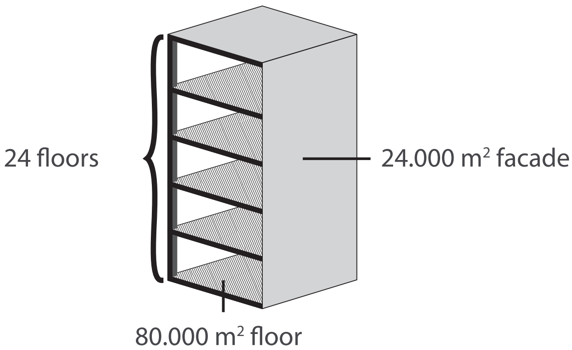



Reachability

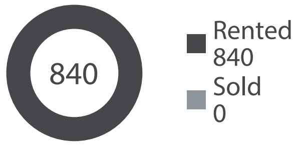


Services

## Building

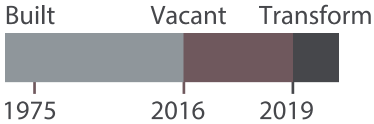



Units

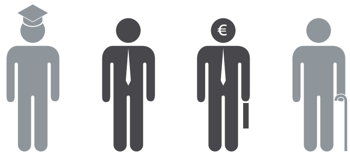



Services

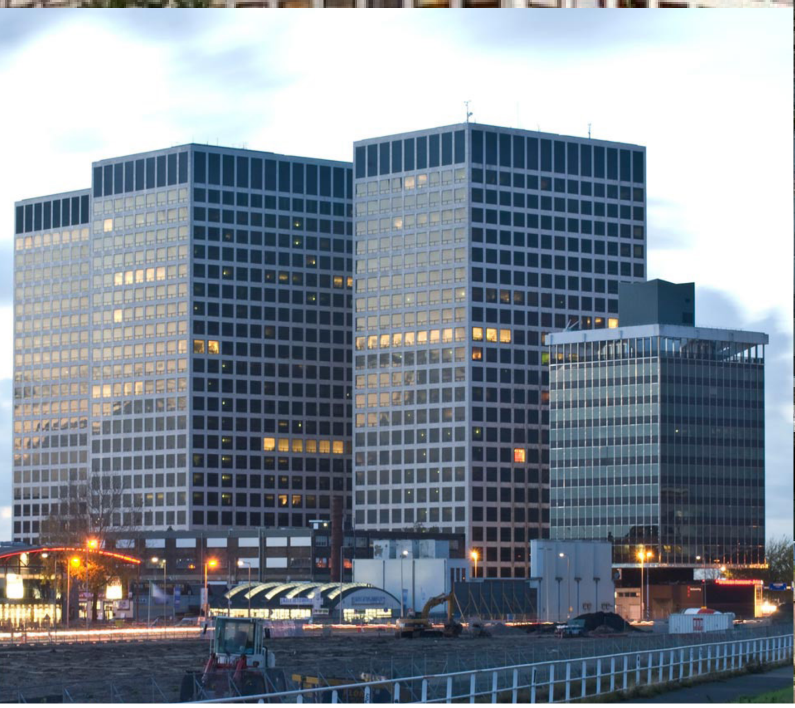
Building lifespan




Target groups

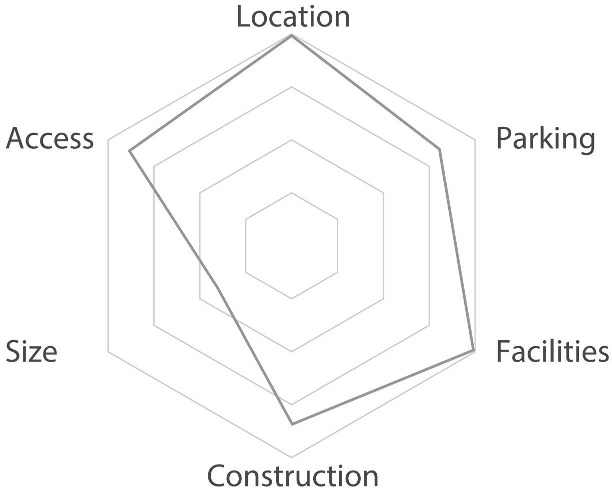


## Construction



The Europoint II and III are the only projects studied in this case study which are not complete at this point in time yet should be completed by the end of 2018 (Top010). However due to their size they could not be omitted. The three towers designed by SOM in 1975 used to house the municipality of Rotterdam, which moved to their new office *De Rotterdam* and left upwards of 80.000 $m^2$ vacant (diederendirrix, Lee Towers; top010). One of the towers was eventually taken over by the *Hogeschool Rotterdam* in 2004, and is still being used. As such only two of the three towers are currently being redeveloped. The two towers will be developed into single studios of up to 40 $m^2$ and two room apartments of around 70$m^2$ (dieredendirrix, Lee Towers). In addition to the residential function being planned, the top two levels of the towers will be used for a restaurant, providing a view over the whole city of Rotterdam and the harbor (diederendirrix, Lee Towers).

# De Groene Toren, Eindhoven

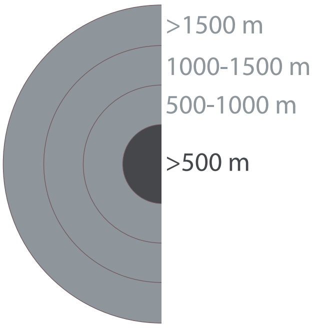



**Architect**
DiederenDirrix
**Constructor**
Stam & de Koning
**Facade assembly**
Van Hoesel

**Investor**
Strabane Holding Investments
**Developer**
Fooln & Reijs BV
**Owner/User**
NH Collection, Eindhoven2Stay

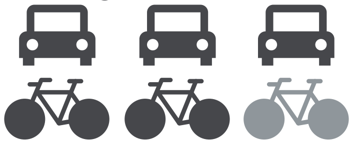
## Location

Distance to center



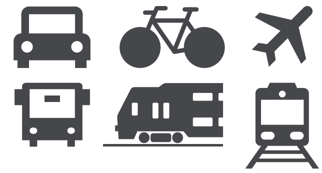

Location type

Parking



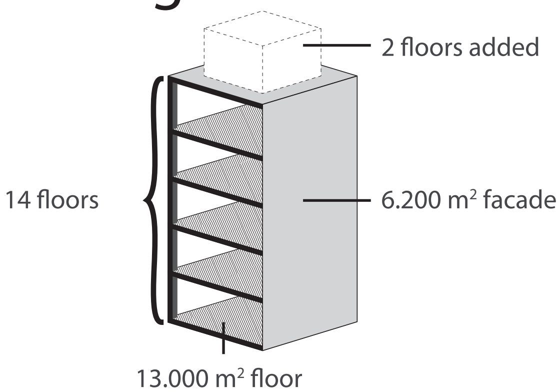
Vacancy


Reachability

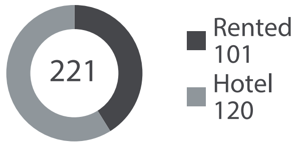


Services

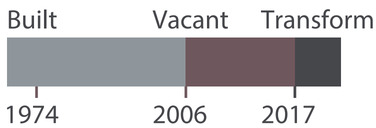

## Building




Units



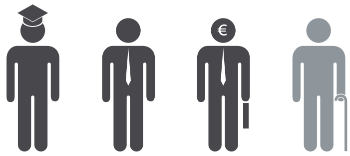

Building lifespan



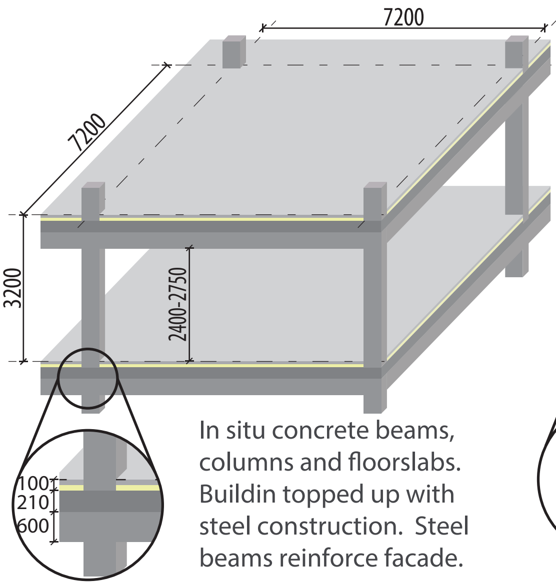

Services

Mechanical fancoil unit ventilation (heating/cooling), heat re-capture by balanced ventilation system from exhaust

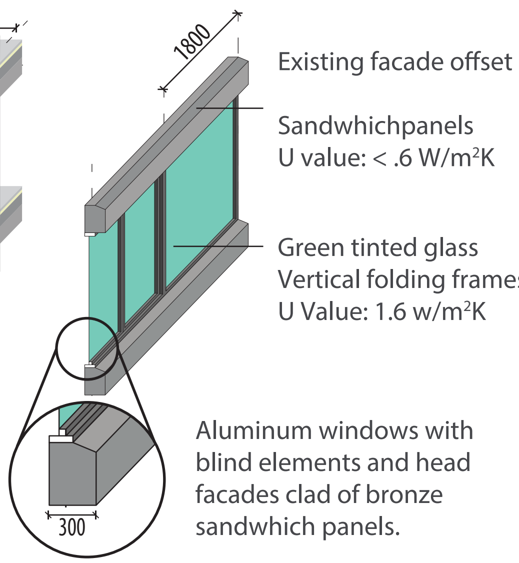
Target groups



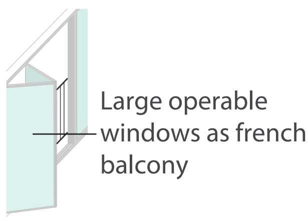
## Construction



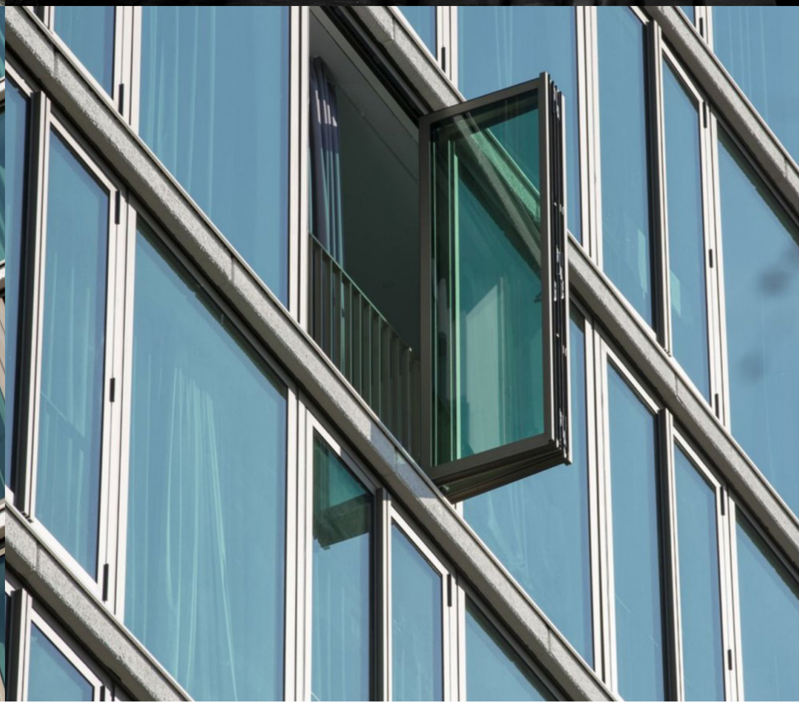

In situ concrete beams, columns and floorslabs. Buildin topped up with steel construction. Steel beams reinforce facade.




Aluminum windows with blind elements and head facades clad of bronze sandwhich panels.




French balconies installed, infront of large vertical facade height windows.

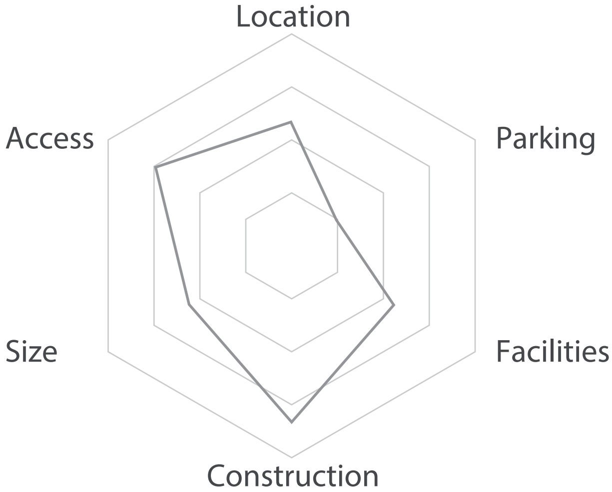
The former office building used by American Express, and Arcadis was sold in 2014 to the investors of the project (Louter, 2018). A special feature of this transformation is that although the upper levels had to be cleared for the transformation of the building into short stay apartments and hotel rooms, the commercial units on the ground floor remained in use (Louter, 2018). The redevelopment resutled in 82 studios and 30 apartments for short stay function, as well as a 101 room large hotel (Holland2Stay). Furthermore a restaurant was added on the top floor of the building (Holland2Stay). The buildings facade was constructed with ceiling high facade elements. The existing concrete facade bands seen above, were thermally disconnected from the rest of the construction to increase the thermal performance of the building (Louter, 2018; BureauEau, 2017). Furthermore there was no motivation to add balconies to the spaces created however the facade is fully open-able outwards, as such inverse French balconies could be created. The installations of the building were fully exchanged, and make use of modern technology, including fan coil ventilators, mechanical balance ventilation, and a heat recovery unit running on exhaust air. (Louter, 2018; BureauEau, 2017).

All sources used for the case study spreads and text are listed in the list of references under Case studies

# La Luna/Potentiaal, Eindhoven

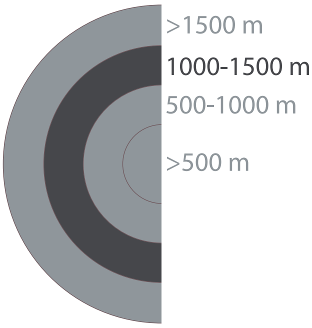
Architect
DiederenDirrix
Constructor
Dura Vermeer
Facade assembly
Rollecate

Investor
Dura Vermeer, DBM
Developer
Camelot Realestate + TU/e
Owner/User
Camelot Realestate + TU/e



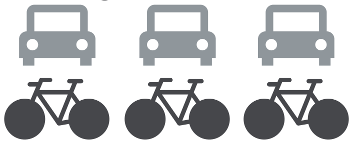

## Location

Distance to center



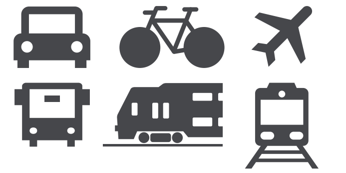

Location type

Parking



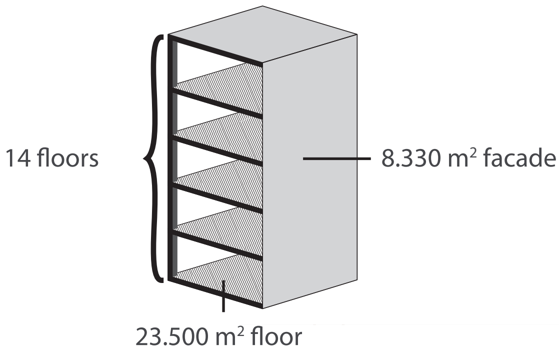
Vacancy


Reachability



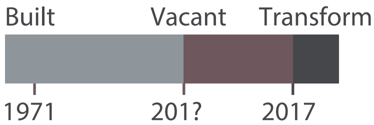
Services

## Building




Units

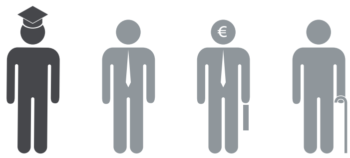

Building lifespan



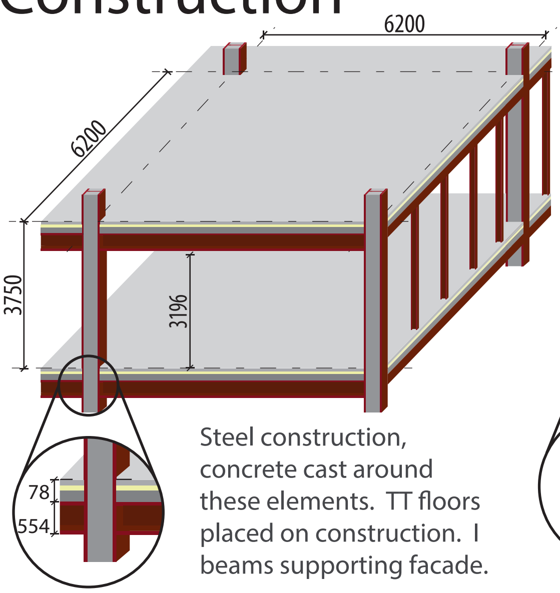

Services

Mechanical ventilation, solar panels on roof. Connected to central heating/warmwater network.

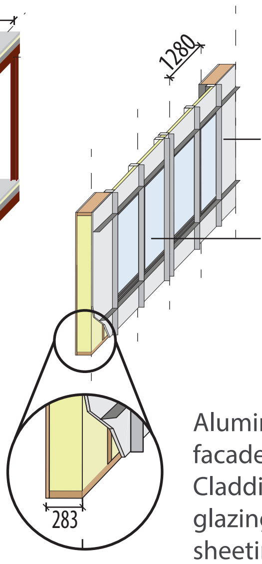
Target groups



## Construction




Steel construction, concrete cast around these elements. TT floors placed on construction. I beams supporting facade.




Aluminum cladding
U value < 3.5 W/m²K

Aluminum elements
HR++/Insulight glass
U Value: 1.1 w/m²K

Aluminum element facade on HSB basis. Cladding between glazing aluminum sheeting or shadowbox.

No balconies added, large sliding windows installed.

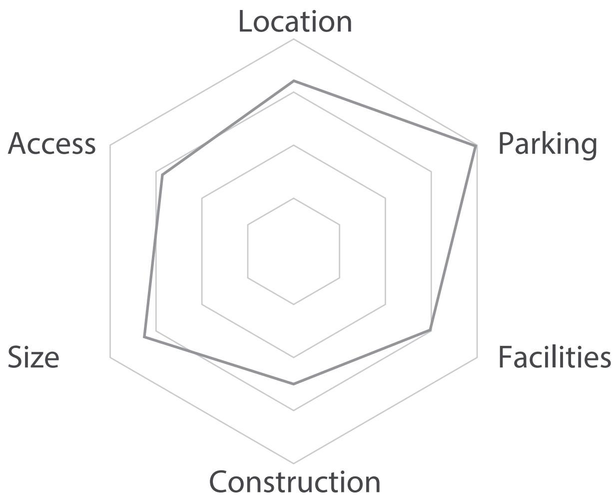


The transformation of the La Luna buding on the TU Eindhoven campus is one of the three projects studied, developed by the architects *Diederendirrix*. The project was developed by the TU Eindhoven together with Camelot Europe (Camelot). The 441 studios built were designed and furnished so students merely had to carry their bags into their rooms (Camelot). According to *Diederendirrix* architects, the collaboration between the three developers and the architects had a profound effect on the result of the building, as various experts sat around the same table from the beginning of the project (Diederendirrix, 2018). One the main points of focus was speed of completion, however redesigning in keeping with the original facade was also important (Dieredendirrix, 2018). To speed up the building process the wet cells were pre-fabricated, as already seen in the DNA transformation (Diederendirrix, 2018). Furthermore the facade was built with sustainability in mind, resulting in a well insulated facade, as well as user comfort, due to large sliding windows which function as balcony replacements (Rollecate, potentiaal).

# GAK “de Studio”, Amsterdam

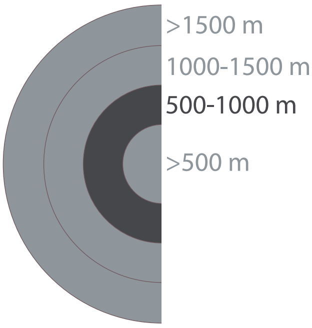
Architect
Wessel de Jonge, ZECC
Constructor
HSB Bouw
Facade assembly
Blitta

Investor
AM, Stadgenoot, Steenvastgoed
Developer
AM + Stadgenoot
Owner/User
Stadgenoot, Steenvastgoed/Private



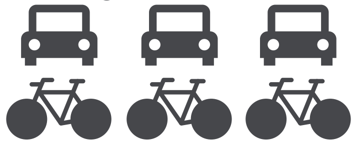

# Location

Distance to center



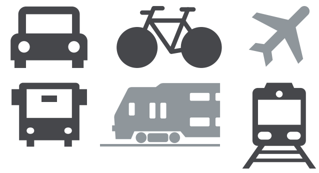

Location type

Parking



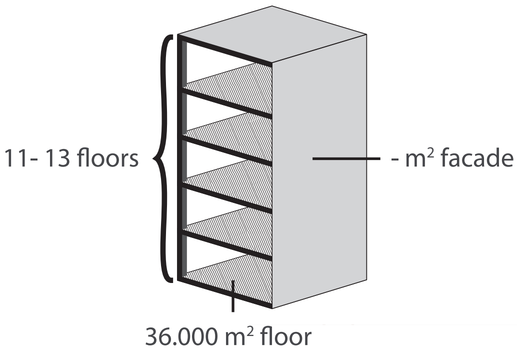
Vacancy


Reachability

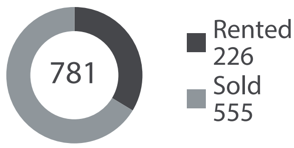


Services

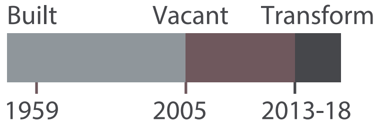
# Building




Units

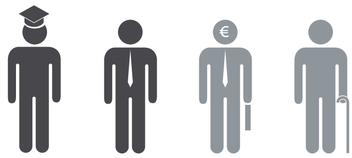



Building lifespan

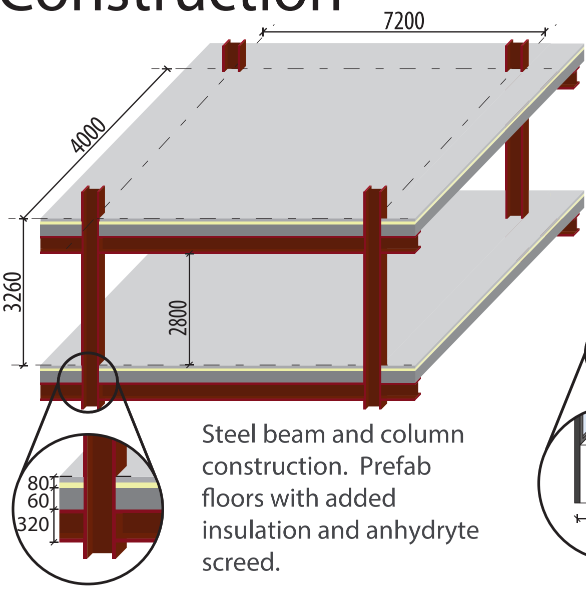



Services
Mechanical ventilation in facade, floor heating/cooling, heat pump integrated system.

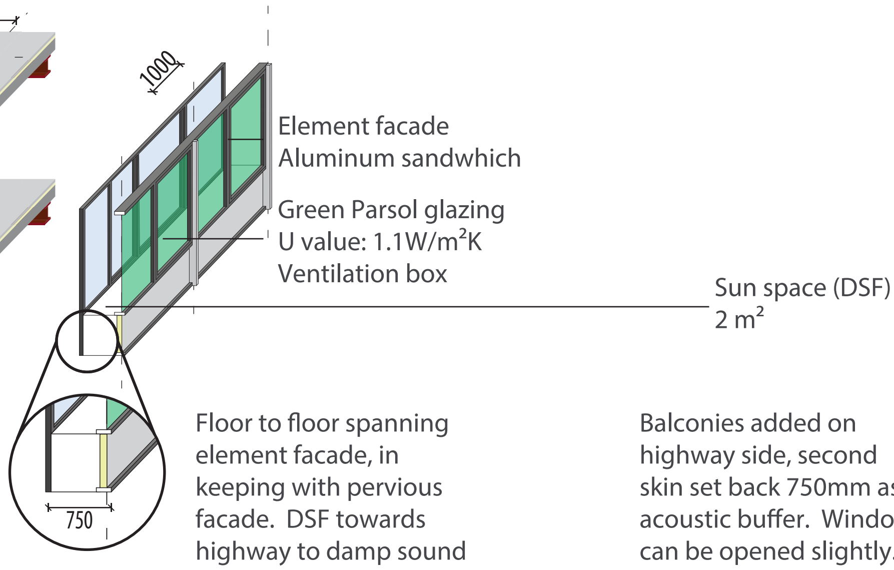
Target groups



# Construction



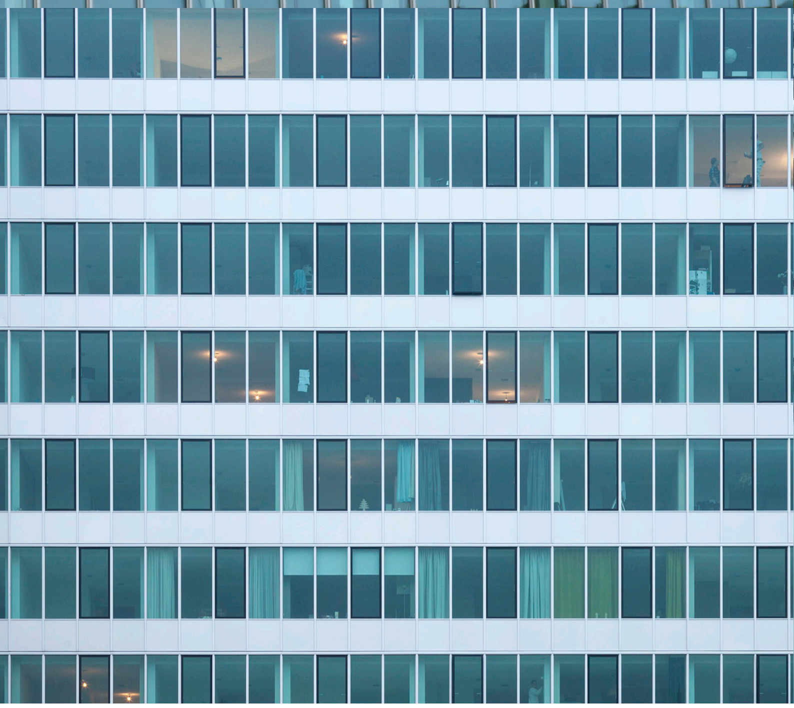

Steel beam and column construction. Prefab floors with added insulation and anhydryte screed.




Floor to floor spanning element facade, in keeping with pervious facade. DSF towards highway to damp sound

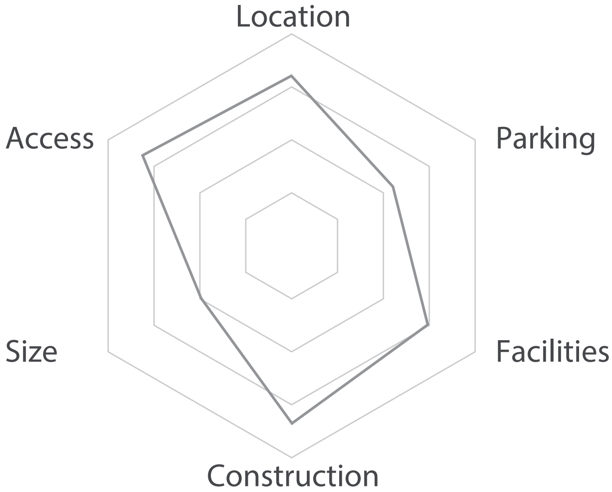
Balconies added on highway side, second skin set back 750mm as acoustic buffer. Window can be opened slightly.






When the Gemeente Administratie Gebouw (GAK) became vacant in 2005, the once most sustainable building of the Netherlands was subject to potential decay (ARCAM). The building was transformed in three development cycles, over the course of 6 years (Amsterdam.nl). Two of the main points that dictated most design decisions were the outstanding naming of the building as a municipal monument, and the acute need for student and small scale housing (Schüco). Due to this the residential units created, are mainly below 47 m2 large in both the North and South section. The middle section however was purchased by AM, who sold their apartements, and as such also realized large units, ranging from 40 - 100 m2 (ARCAM; Schüco). The level of sustainability reached in this transformation is largely related to the fact that the facade had to 1. follow the original design and 2. the building code exemptions were not in effect at the initial date of planning in 2011 (Schüco). Due to these regulations the existing double skin facade was kept and upgraded to current standards, the heat pump system was kept, solar glazing was installed, and mechanical ventilation boxes were integrated in the highway facing facade (Beemster).

# Elsevier, Amsterdam




**Architect**
Knevel Architecten

**Constructor**
Nijs en Zonen

**Facade assembly**
Nijs en Zonen

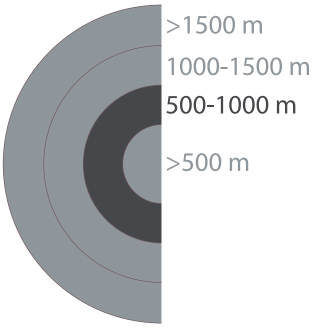
**Investor**
DUWO

**Developer**
DUWO, Woonstichting Rochdale

**Owner/User**
DUWO, Woonstichting Rochdale

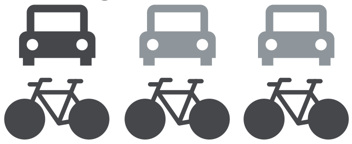
## Location

### Distance to center



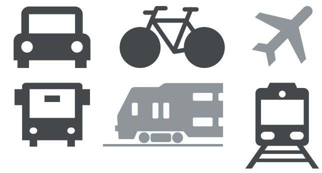

### Location type

### Parking



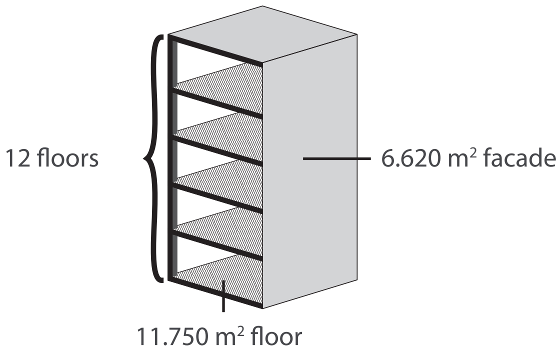
### Vacancy


### Reachability

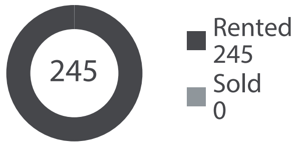


### Services

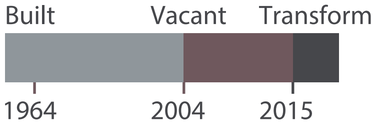
## Building




### Units



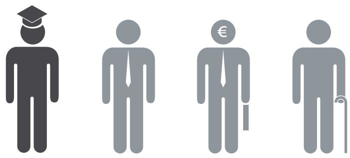

### Building lifespan



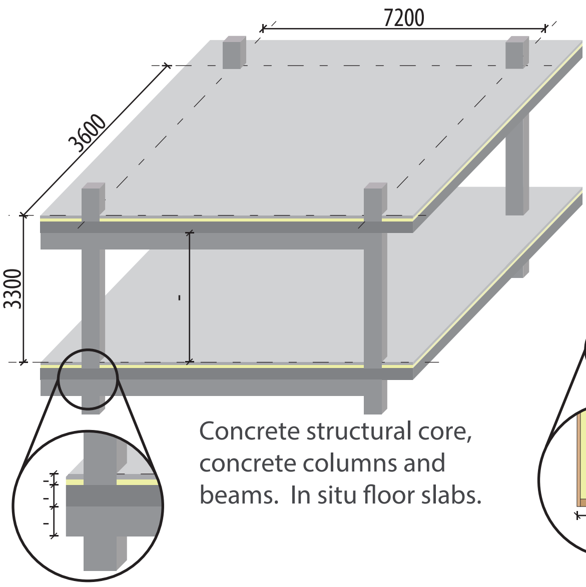

### Services

Mechanical ventilation, connection to central heat grid, heating + warmwater via central piping (heat exchange)

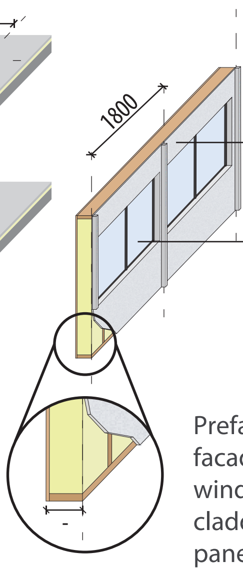
### Target groups



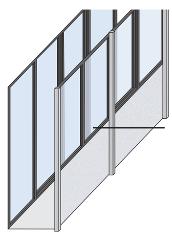
## Construction




Concrete structural core, concrete columns and beams. In situ floor slabs.




Prefab timber frame facade, with aluminum window frame. Facade cladding stone/concrete paneling




No balconies were added, however through loggias on the west facade, acoustic damping was added

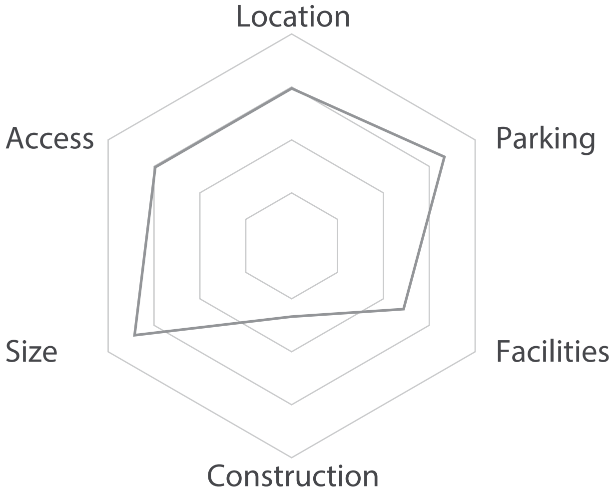



The former office building of the printing company *Elsevier* became vacant in 2015, and was subsequently only used on the ground floor, by various neighborhood groups (Knevel Architecten). As with the GAK building, demolition was not an option, due to the pending monument status of the building (Blom, Dieters, 2014). One the main concerns during the transformation into housing was the close vicinity of the A10 on along the West facade of the building (Robichon, 2015). This resulted in the final design making use of a double skin facade along the highway, which serves as an acoustic barrier, however also provides half of the units with an outside space (Robichon, 2015). At the same time a lot of design time was invested in making these changes, while still respecting the initial design of the building by Dudok (Knevel Architecten). In addition to the high quality of the building its self, the transformation of this vacant office also had a profound effect on the neighborhood. The area being mainly dominated by housing in its direct surrounding, suffered from the dilapidated building, and due to the new users, frequenting the area, and making use of the commercial infrastructure, have returned much needed life to the area (Knevel Architecten).

# Rembrandtpark Hotel, Amsterdam

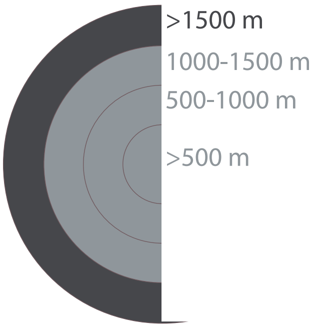

**Architect**
ZZDP
**Constructor**
BAM, De Nijs
**Facade assembly**
AKS

**Investor**
ProNam Aurora
**Developer**
Peak Development
**Owner/User**
ProNam/Ramada Hotel, Hotel School



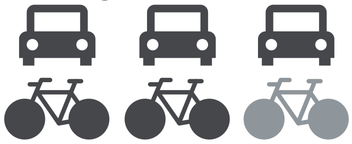

## Location

### Distance to center



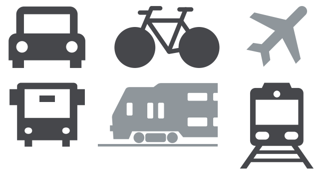

### Location type

### Parking



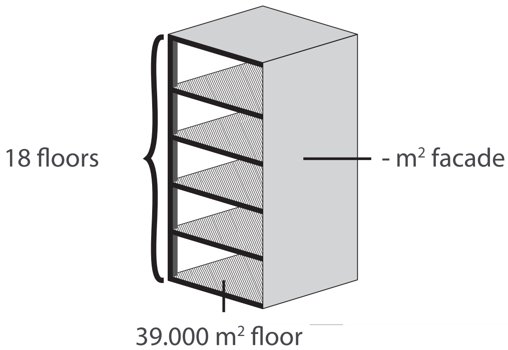
### Vacancy


### Reachability

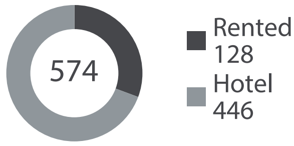


### Services

## Building



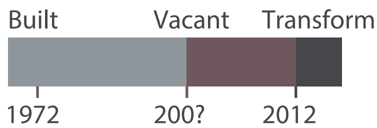

### Units



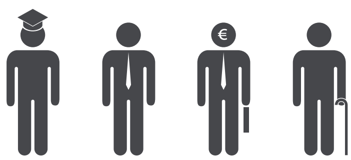

### Services

? still unknown....

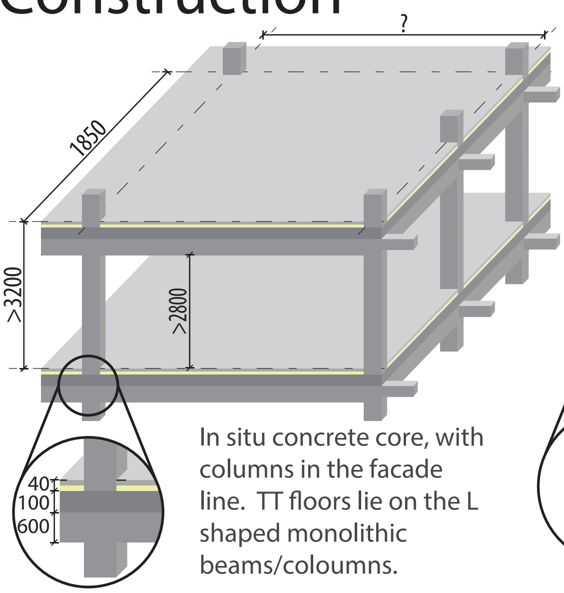
### Building lifespan



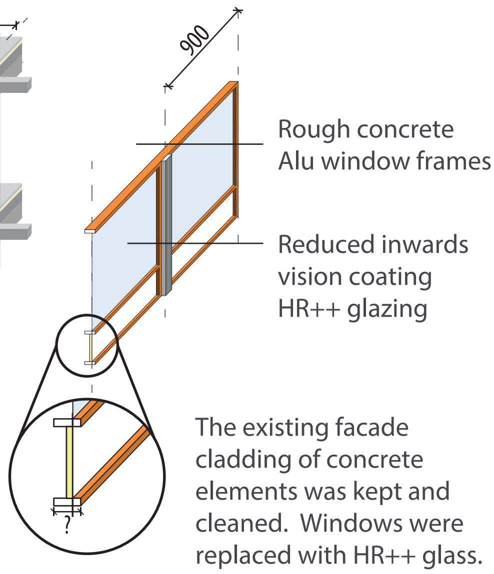

### Target groups



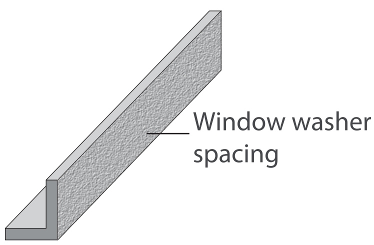
## Construction




In situ concrete core, with columns in the facade line. TT floors lie on the L shaped monolithic beams/coloumns.




The existing facade cladding of concrete elements was kept and cleaned. Windows were replaced with HR++ glass.




No balconies added for users. However there is window washer space behind the cladding, carried by consoles.

In 1972 ZZDP architects completed the building complex along the A10 for the former users, ABN AMRO (Bouwwereld, 2012). The building remained vacant for several years before its location was too good to pass up for investors ProNam Aurora (ARCAM). The combination of accessibility via the A10, the large amount of parking spaces, and the ideal grid of 1.85m made the building perfectly suitable for redevelopment into hotel rooms. In addition to Hotel rooms though, a partnership with the Hotel School the Hague was made, which resulted in several student rooms being added to the initial design (Bouwwereld, 2012). Again the aspect of speed was a relevant driver behind the project, and resulted in the wet cells being pre-fabricated, both for the hotel as well as the student rooms (Herbestemming). Similarly to the *Elsevier* transformation, the removal of a vacant building lead to an increased livability in the area, and the social control in the surrounding park was restored (Herbestemming). The construction of the building s peculiar, the beams and columns are cast toegher in L shapes. These concrete elements however are linked to consoles which carry the window washer balconies, and could have been used for added balconies for users (Bouwwereld, 2012). These were not implemented, for unknown reasons.

All sources used for the case study spreads and text are listed in the list of references under Case studies

# 3.3 Discussion of case study

The case study conducted comprised 12 projects, selected based on the previously discussed requirements. The results of the case study will be summarized, and these findings are simultaneously discussed where relevant with respect to the results of the literature review in the previous section. This section is divided into five main parts concerning different characteristics of these transformations. The five main fields of discussion are the age and vacancy, location characteristics, structure, façade, and service integration.

### 3.3.1 Age and vacancy

The buildings studied are all offices constructed before the 21st century. More specifically a trend can be seen, that a majority of buildings transformed were built before the 80's. Only one building transformed was built later: the *DNA* project built in 1989. This trend can be explained by conclusions of the literature studied. The dilapidated exterior appearance of many of these buildings, as seen below, is one of the main reasons for transformations. Furthermore, the lacking energetic performance of these buildings forms the second reason which explains why these buildings stood vacant and were thus transformed. The trend of companies searching for offices and continuing to move into newer offices has also resulted in increasingly large buildings becoming vacant. For example, the *Wijnhaven Kwartier*, with 51.500 $m^2$ of floor space, used to house the Ministry of Justice, and Internal Affairs, which moved down the road into a newly constructed office. Similarly the *GAK* building in Amsterdam used to house the Municipal Administration, which moved buildings leaving the 36.000 $m^2$ standing empty. Another example are the *Marconi Towers II + III*, which until recent also housed municipal administration, which moved locations and left upwards of 80.000m² of real estate behind. These are thus no isolated incidents, as also discussed in the literature review. Due to these extremely large amounts of vacant floors space, these buildings stood vacant for multiple years before transformation. Yet this is not merely linked to the building size, as close to all buildings studied, were vacant for at least 1 year. Some exceptions are the *Bellavista* which

Thoerbecketoren (Flickr, Ploeger, 2014)

Elsevier Building (Beelen.nl, 2014)

was never fully vacant or the *Van Vollenhoven Kwartier*, also never completely vacant. One factor which, in addition to companies moving to more modern offices, has affected the frequency of transformation projects are changes in legislation, and a concise effort by policy makers to support the process of removing vacant offices from the market.

### 3.3.2 Location characteristics

From the case studies conducted some clear patterns can be seen regarding the locations in which certain types of transformations were conducted. Many of these patterns are correctly described in the literature studied, however there are also some new developments which can be observed. The buildings studied are for a large part located in central locations: 50% are within 500m of the city center and another 20% are within 1000m, the rest is a slightly outside this radius, with only one, the Rembrandt Park Hotel 4 km away from Amsterdam central. However, this measurement does not consider that all project, except for *La Luna* are situated in alternative city centers such as Rijswijk in Den Haag, Slotermeer in Amsterdam or even the *Rembrandt Park Hotel* which is close to the Van Galenbuurt, and vibrant alternative center of Amsterdam West. As such all transformations are in multi-functional areas, with the exception of the *La Luna* which is on a university campus. This coincides with the literature which suggests that the most suitable vacant offices for transformations are in non-monofunctional areas (Koppels et al., 2009). Yet one trend can be seen, although in central locations, these areas often suffer of increased vacancy, 80% of the transformed buildings are surrounded by up to 15% vacancy, only 20% are in areas with less than 5% vacancy. This contradicts the literature which suggests that most successful transformations are in areas with lower vacancy (El Messlaki, et al., 2010; Koppels et al., 2009). Nonetheless most buildings are well accessible by at least four of the six modes of transport analyzed due to their locations, again supported by a study conducted by Hans de Jonge, Philip Koppel and Hilde Remøy (2009). These locations also benefit from the addition of parking spaces to transformations when such projects are not geared towards non-student target groups. Conveniently the transformed projects already had integrated parking possibilities which were re-used or are surrounded by municipal parking areas.

In addition to the reachability and parking infrastructure of these projects, the transformed offices are in locations that provide future inhabitants with a slew of infrastructure favorable for housing functions. As such, the areas these buildings are situated in areas that provide access to commercial shopping areas, social localities; such as restaurants and bars, public parks, but also cultural institutions; such as museums or theaters. This supports the claims made by de Jonge et al. relating to location characteristics conducive for transformations (2009). Furthermore, there are multiple locations which are close to educational institutions such as schools or universities. This can be observed in Amsterdam and Rotterdam in particular. The location characteristics though are equally as important as the building characteristics which will be summarized in the next section.

### 3.3.3 General building characteristics

As already briefly touched upon in the first section of this chapter, all buildings studied suffered of extremely dilapidated exteriors. This, according to the literature likely had a profound effect on their subsequent vacancy. As result of the exterior, the façades of all but one building were completely replaced. One project only had window frames and glazing replaced while the façade was merely cleaned. This conclusion however is not absolute, as a selection criterium for the case study was complete facade transformation. The size of the transformed building ranges from at least 10.000m2 to upwards of 50.000m2 floor space. Again, the minimum; results from the selection criteria, the large size of some projects however explains the large amounts of units transformed in most cases. Of these cases 80% realized more than 200 units, with some projects such as the *DNA*, *GAK*, and *Rembrandt Park Hotel* resulting in upwards of 500 units. An interesting relationship is that these projects resulted in student housing, small studios or hotel rooms respectively.

When comparing total floor space and unit size it can be seen that the higher the target group the larger the apartments realized become. For example, the *Bellavista, De Groene Toren,* and *Kortenaer Kade* are all around 13.000m2 large, however based on their target groups, high sector rent, short stay and high sector rent respectively, result in largely differing amounts of units. The *Bellavista* comprises 116 units, the *Groene Toren* 221 and the *Kortenaer Kade* 153 units. Although this is to be expected, it also shows that some target groups are more suitable for transformed projects, as the higher number of units realized has a larger effect on the fulfillment of housing need. Creating 221 student housing units can alleviate the housing market to a larger degree than 116 high sector apartments being realized, which don't necessarily fulfill the technical and comfort standard of current buildings, that such a target group desires.

Another aspect which can be related to the target groups chosen for these projects, is whether balconies were added to the existing buildings or not. All transformations geared towards students did not have balconies added, although there was a possibility to do so. One exception is the *Elsevier* building, which has sun spaces resulting from a double skin façade. The projects geared towards starters, young professionals or the wealthy, were designed with added balconies. One outlier is the *Van Vollenhoven Kwartier*, in which only French balconies were installed. This resulted from municipal building codes prohibiting and further extension of the buildings perimeter (Tabbers, 2018). This coincides with the literature which suggests that balconies should be a focus point when developing housing. Such additions are also resulting from the structural capacity of a building, these characteristics will be discussed next.

### 3.3.4 Structural building characteristics

The majority of the buildings studied were constructed with in situ concrete. Yet there are some exceptions, the *Wijnhaven Kwartier, GAK,* and *La Luna*. Surpassingly this has nothing to do with advancements in structural knowledge as the literature may suggest; these buildings were constructed in 1980, 1959 and 1971. Why this is the case for these projects is not completely clear. One relevant feature is except for the *GAK* and *Wijnhaven Kwartier,* the steel constructions are additionally cast around with concrete. This is likely due to the increased fire safety requirements implemented after the construction of the *GAK*. There is some variance in the buildings constructed with concrete structural members, some are beam column systems with pre-fabricated floors, while others make use of in situ columns and floors, or load bearing walls.

Although such similarities exist in relation to the construction material, when looking into the construction of these buildings in detail, it becomes clear that there are various differences in relation to building grid, and ceiling height. In particular when looking at the structural grids of these buildings the outliers are apparent. Seven of the buildings studied are on a grid based on 900mm resulting in grids of 3600mm, 5400mm, 7200mm or 9000mm. The large floor spans is in agreement with the literature which suggests that the larger the floor span of an office the more suitable it is for transformation (Remøy & van der Voordt, 2006; Remøy 2007; Gann & Barlow, 1996). Nonetheless there are two projects which are constructed on a grid of 4000mm and 6200mm which are difficult to explain. Particularly as these buildings were not built at significantly earlier dates than other projects. When looking at the ceiling height of the studied cases the only conclusion that can be made is that all buildings have a higher ceiling height than 2600mm, after subtracting beam heights. Again, this is supported by the literature which suggests that an important criterium for a transformable building is sufficient ceiling height greater than 2.6m (Remøy & van der Voordt, 2006; Remøy 2007; Gann & Barlow, 1996). These structural characteristics though have profound effects on the façades, which are the focus of the following section.

### 3.3.5 Façade characteristics

The cases studied were selected based on the complete transformation of the façades. Of the selected cases, merely one only had window frames and glazing replaced, while the façade was only cleaned. Based on the requirements transformations projects had to fulfill to be part of the case study, the resulting façade area in all cases is above 5.500 $m^2$. Most projects though have larger façade areas, mainly around between 7.500 $m^2$, the largest façade area known for sure is that of the *Wijnhaven Kwartier* at 18.500$m^2$ Because of the high financial cost of the façade transformation due to the large area, the target groups of these projects are the higher rental sector, and in the case of the *GAK* result in many, small, high quality studios, which can subsequently be rented at a higher price.

One of the most surprising conclusions from the case studies is the façade typology of the transformed projects. Seven of the 12 studied projects were completed with timber frame façades, two projects remain unknown. This is likely a result of the ease of assembly due to the pre-fabricability of such façades, and the resulting construction speed. Another reason for this choice is the significantly reduced façade weight in comparison to element façades or curtain walls, while also making higher insulating performance possible. The three projects which were not transformed with timber frame façades were constructed with element façades and in one case a curtain wall. Interestingly two of the three students housing projects are element façades. Although the *Elsevier* student home has a timber frame façade, the addition double skin façade added on the west façade is an element façade. The third project which did not make use of a timber frame façade was the *GAK*. This is a result of the requirements concerning its nomination for monument status. As such, its previous façade which was also a curtain wall façade, was to be reconstructed.

Other elements of the façades which are largely similar across all analyzed projects is the choice of aluminum window frames, and the use of HR++ glazing. In some projects such as the

*GAK, Groene Toren* or *Rembrandt Park Hotel,* special sun shading glazing was used, either tinted green, or with a special coating reducing glare. One aspect of the façade which was surprising was the lack of integrated services in most façades. These shortcomings will be presented in the final section of this chapter.

### 3.3.6. Building services

The most surprising conclusion from the case study conducted was the complete lack of modern buildings services added to buildings. One of the features which was omitted in all, but 3 projects was sun shading fixtures. Of these project only one: the *GAK* had pre-installed exterior sun shading, the other two projects includes fixtures for interior sun shading and all other projects left it up to the future users to find a personal solution. Furthermore, the integration of façade services is also minimal regarding ventilation. Most projects are designed for natural ventilation, either via small ventilation openings (two projects) while the rest, with exception of the *GAK* which has façade integrated ventilation units) only have operable windows. Seven of the studied projects have mechanical ventilation of which the two projects with ventilation slits make use of mechanical exhaust ventilation, so fresh air intake is a result of under pressure in the apartments. Other than the features mentioned some projects are connected to the heat grid, and a few projects have photo photovoltaic panels installed on the roof. The *GAK* project is the most technically advanced project, also making use of a heat pump installation which was present from the initial construction in 1959 when it was the most sustainable building in the Netherlands.

This discussion of the cases studied shows that certain aspects of the literature still hold true, while others are less relevant then they may have been in the past. For a deeper insight of some projects and creating a bridge to façade leasing concepts, interviews were conducted with relevant actors, involved in these cases. These interviews will be presented and discussed in the subsequent section.


Wijnhaven kwartier Transformation (Mosa.com)

Kortenaer Kade Transformation (architectenweb.nl)

# 4. Interviews

## 4.1 Introduction

From the cases studied, it is clear that some valuable insights are not possible to retrieve to non human information sources. As such, and as discussed in the methodology of this thesis, several interviews were planned to gain more insight into the process behind several transformations. The second main reasons for conducting interviews with actors in the field of office transformations, is the literature concerning PSS products suggesting that the main deterring factor for such products is the lack of knowledge communication amongst actors. Due to this it is seen as a valuable measure to discuss this topic with actors.

## 4.2 Method

The actors for the interviews were selected based on their contribution to transformation projects in one of three main fields: developers/investors, constructors, and architects. This division was made as these are the three main parties involved in the building process, and together should be able to give insights regarding the total process.

The focus was placed on conducting interviews with all 3 parties involved in a particular project. This however is subject to the response received from actors. To gauge the interest and willingness of actors, e-mails were sent to various actors. After a positive response interviews were scheduled at a location, which best suited these people.

The focus of the interviews was various, depending on the actor interviewed:

- Questions for Developers/Investors: (to understand why the transformed building was chosen, if there was a long term vision, what the requirements and goal was, how PSS façade may influence future decision making)

- Questions for Architects: (to understand what effected the façade choice, in particular the design of the façade, how these choices effected the final result, and could this result have been improved.

- Questions for Constructors: (to understand what effected the façade choice, who made the final decisions, which difficulties were encountered during construction, and the qualities a PSS façade should possess to be implemented consistently)

The interviews were split into three main sections:

1. The boundary conditions of the project transformed.
2. The facade decision making process/ building selection
3. Outlook concerning the implementation of PSS products in transformations.

The questions asked to each of the parties can be studied in detail in Appendix B. On the following pages, the interviews conducted are summarized and briefly commented on.

# 4.1 Interview summaries

**Mattijs Tabbers (Roosros)**


Matthijs Tabbers  (Roosros)

The interview with Matthijs Tabbers, Project architect and manager was conducted in person on April 25, 2018 in Oud Beijerland in the Roosros office.

***Project Van Vollenhoven Kwartier***

- No focus on sustainability from developer

- Budget was large however calculated based on maximal returns
  - Comfort was a focus as the target group was higher sector
  -Students were not wanted in the neighborhood by the municipality (posh neighborhood)

- One main difficulty is staying within municipal regulations
  - Repetition in the façade, was linked to apartments, however there were also designed so they could be joined together.
  - Also made possible by the construction (in situ concrete beam column)

- Project successful because target group matches location

**Façade design**

- Improvements could have been better insulation (limited based on building limits) and floor heating could have been added)
  -Both not desired by developed ABB

- Main difference compared to conventional project are the large amounts of limitations by an existing building
  -Was experienced as a positive, as the process was clearer and simpler

- Existing old buildings always good for an unexpected surprise (even with point cloud)

- Façade optimized for maximal daylight, as such large windows, ABB proposed timber-frames due to lower weight, cheaper, and could be prefabricated

Façade material chosen due to sustainable aspect (brick long lifespan)
  -As such the aesthetic quality is guaranteed for a long time
  -Window cleaning however an issue of the users....

- One issue was the large depth of the building, however due to wanting to keep as much of building as possible this was accepted. Making a vertical light well was not desired as the top up would have had to have been removed... would have been more expensive and sales area would have

been sacrificed.
    -ABB did not want this

- Façade was the main design element of the buildings, all costs were acceptable, more expensive solutions explored, however only thrown out due to undesired appearance
    -Expensive façade material, stones with very low tolerances and expensive quality
    -Fully operable windows and French balcony doors

- Service integration in the façade were botched by the developer
    -Minimal budget for service consultant, as such minimal actions take
    -Ventilation investigated = too expensive
    -Clima-rad investigated = too expensive and window area would have had to be sacrificed

- Improvements could definitely have been made on sustainable level, both hard as well as soft
    -Increased community within building
    -Adding balconies
    -Climate services

PSS

- Higher performance of materials, in particular the pressure must be put on the production companies
    -The question of responsibility must be discussed
    -Better glazing, and the implementation of future technologies would definitely be a benefit

- New products can be pushed this way
    -Also supported by literature

- How the façade is built up should be considered, detachable layers!
    -Repetition of façades should be avoided, there should be away for architects to express their "creativity"
    -Various "modules" interconnected should suffice

The interview with Matthijs Tabbers was very insightful concerning the building development process and the collaboration with developers. Most issues and shortcomings of the project are directly related to ABB not willing to pay for adequate technical consultancy, or the simple rejection of non standard ideas. Furthermore it became apparent that issues can arise when the developing party and the construction company are the same, as the question of fair and valid cost projection can become an issue. In this case the cheapest and best known methods were applied to a large degree, although an effort was made to install a high quality facade. This quality however does not really reach beyond a well thought out materialization of the facade, which results in a future proof cladding.

Furthermore Matthijs Tabbers, was a valuable source of information regarding the potential of PSS facades. His main suggestions ranged from careful implementation of standardization, which could be beneficial as long as it doesn't lad to monotony of the built environment. Furthermore the impression was gained that the office itself had the desire and vision to add more sustainable and technically sound measure to the project, however were continuously hindered by the developers. This goes to show that certain developers are not interesting in developing high quality dwellings, but rather are looking for an easy profit.

Sylvia Rode (Rijnboutt )


The interview with Sylvia Rode, Project architect and manager was conducted in person on April 24, 2018 in Amsterdam in the Rijnboutt office.

### Project Bellavista

- Main focus was on realizing a renovation as close to the current energetic standard as possible.
  -Subsequently the main focus was also for user comfort

- Thus large balconies added and large windows were installed to maximize daylight in apartments

- Process took 10 years
  -various complications due to building code regulations and issues with final design caused this long development process

- The longterm vision was mainly focused on the fact that the neighborhood was to be improved.
  - In relation to livability, as such the success of the building is guaranteed within itself

- Due to diverse target groups and various apartment sizes various user can and will live in the buildings
  - Future proof in that sense

### Façade design

- Timber frame was chose due to weight concerns, and is most often used in housing
  - Furthermore the focus being comfort, the cold feeling curtain walls give was not desired
  - This final façade choice was made by the construction company

  Another main reason was the acoustic separation of housing, as well as the easy prefabrication of timber frames

- Another deterring factor regarding an element façade was the difficulty of making the building water and air tight

- Architects design for the façade was resulting from the apartment divisions
  -Furthermore no costs were shied away from regarding façade costs Although no services were integrated
  -Sun shading was proposed by the architects, however scrapped
  -This was repeatedly suggested, however the decision by the developer was against it (arch limited in power)

- Floor heating and mechanical exhaust ventilation was installed

### PSS envisioned issues

- Are developers willing to look towards the future? Or are they merely looking to make a quick turn around

-Often buy, redevelop and sell with profit

- Not every building is suitable to be transformed
  - Large tolerances must be accounted for as these old buildings are never as drawn, and are no longer in good condition (sagging, etc)

PSS envisioned benefits

- Largest effect on increased comfort
  - Balconies, ventilation (not in façade) due to decreased life span, sun shading

- Timber frame façade easily produced, can be easily adapted on inside, as all inside walls can be attached as needed in various locations

The interview with Sylvia Rode, provided valuable insight into the design process of the *Bellavista* tower transformation, on various levels, ranging from the design, to the power of architects in influencing final design decisions. Not only did it become apparent that although various concerns were voiced regarding technical decisions, for example heating devices or the addition of sun shading, the decision is based on the willingness of investor to go the extra distance financially. This conclusion makes it clear that even if the interaction between architects and investing party is relatively good, merely providing these parties with a good argumentation is not sufficient to convince them of thus measures. This supports the general opinion of this thesis, that the financial burden encountered by investors must be decreased, however at the same time, an awareness must be fostered and forced by municipal regulations to strive for maximal building quality and resulting user comfort.

## John van Spanje (AKOR)

John van Spanje (Linkedin.com)

### Project *Bellavista*

- The main focus for the constructors of the project was completion speed, as well as staying below the budget suggested
  -However not hindered by a very low financial budget

- The project was developed in such a way that the floorplans could be adapted in the future due to light internal walls.

- There was also a focus placed on maintenance, resulting in roof top cleaning appliances, as well as low maintenance cladding

- The design of the architects was largely unchanged by the constructors.
  -the only change made was the structural solutions, which lead to the structural core being removed for structural columns which are tapered towards the top of the building

- One aspect also adapted by the constructor was the company responsible for the construction of the balconies
  -The solution was rather ingenious, integrating the balconies in the cladding, by shaping them in a Z form

- The facade design of the architects was also not amended
  -the suggested timber frames were kept, also as this was previously discussed, and was necessary due to weight concerns

- The main reasons no services were implemented in the facade were increased costs, as well as the fear of not being able to properly close the building

### Façade construction process

The process was incredibly streamlined, all facade elements were prefab, except for windows

- due to the construction from inside out, no scaffolding was needed (1st project in Netherlands)
-As such assembly was rapid, and after mounting the facade, all windows were installed from the inside

- The main reason for this was lack of space on the construction site, and higher building speed to cause shorter inconvenience on street

- The main difficulties encountered were the differences between building drawings and actual situation.
  -as such large margins were integrated in the design of the facade (in width)

### PSS

- Potential benefits of PSS could be the increased implementation of sustainable measures

-envisioned risks are which party takes final responsibility of facade, the company taking care of the mounting or assembly?
-Ideally this company would be the same so responsibility question is clear

- The implementation of more standard projects is a positive development
  -Increasingly pre-fabricated elements are taking over on the building site, van Spanje indicated that he no longer works with traditional site assembly

- Main issues with increased modularity seen are architects limited in their creativity
  -Furthermore the idea of disassembly and re-use on another location brings the issue that most products do not survive the disassembly process, and break

However technically likely possible, the main issues that would prohibit the success of PSS facades is the question of financing
-If developers are no longer taking the financial risk, it would be constructing companies, which do not have the same financial measures, due to their decreased size and financial power
- Another concern was the question of storing various types of standard elements, and where this space would come from

The insights gained from the interview with John van Spanje, are particularly valuable in the realm of the building process. Although the technical feasibility of more standard products is not the question, more logistical and financial matters are the main concern voiced. Another aspect is the traditional nature of the building industry, there were certain reservations regarding changing the status quo of construction. Additionally the question of developing such facade, which also adhere to building codes, was seen as a risky endevour.

Anjelica Cicilia (Syntrus Achmea)

RESPONSE OUTSTANDING

## Roderick Mackay (Egeria)

INTERVIEW OUTSTANDING (08.06.2018)

# 5.Conclusions from case study and interviews

Transforming vacant office buildings into housing, although more frequent in the past years, remains a process subject to difficulties ranging from struggles between involved actors, to the issues encountered when working with existing structures. In the following section the results of the foregone case study and interviews compared and concluded upon. The focus is placed on the relationship between actors, municipal regulations, difficulties stemming from existing structures, service integration in façades, potential standardization solutions for the discussed issues and finally leasing concepts that may provide alternatives to the current approach.

The aim of this discussion is to synthesize the findings from literature, case study and interview, into useful recommendations for a PSS façade systems and subsequent design suggestions concluding this thesis. These conclusions will result in various suggestions for implementations in future projects. The goal of these suggestions is the simplification of the transformation process and providing a financially attractive incentive for developers to aim for more integral transformation solutions, which can be tailored to the individual needs of various target groups.

## 5.1 Actor relationships/Project processes

The current development cycle which determines the final result of transformation projects is inherently linked to the financial gain to be made by the investing and developing party. These parties often have a different goal in mind than the future owners of the property, not to mention the final user groups. This results from the way such projects are approached. Due to the, in most cases, lacking interaction and sharing of interests of these three parties (investors, developers, future users), projects do not achieve their potential. This stems from the practice of investors and developers not developing an integral vision for the properties they have purchased, and discussing this with the parties purchasing the transformed building. Instead of this interaction, the main goal remains turning an investment into the largest possible financial profit. This means that most developers are not willing to invest more in the projects than is absolutely necessary, to ensure that the profit margin remains maximal. As seen in the interviews with both architects and constructors, the developing and investing parties wield their final say with authority. Although the interviewed actors suggested potential solutions to improve the user comfort, and increase building system functionality, these attempts were denied by investing parties not willing to pay for these proposals. Another aspect which demonstrates the short-term vision applied, is the focus on exterior appearance. Although favorable for the attractivity of a city and resulting in a positive impression made on potential buyers, a parallel increased focus on interior functionality would lead to more integrally redeveloped housing.

This can be seen in projects such as the *Bellavista* transformation in which essential services such as sun-shading were cut out of the budget, resulting in continued complaints of renters regarding discomfort experienced (Rode, 2018). Furthermore, the savings on floor heating resulted in the windows, maximized for increased daylight now being partially concealed by convector's as they meant in a smaller investment (Rode, 2018).

Another example is the Van *Vollenhoven Kwartier* project, were the inconvenient depth of the building could have been used for communal spaces or light wells, allowing for more daylight to enter apartments, yet were rejected due to valuable real estate having to be sacrificed (Tabbers, 2018). Another questionable design decision is the acceptance of floorplans with columns in the middle of the living rooms, as to maximize the number of developed apartments. Furthermore, it was chosen to maximize the floor area rather than adding balcony space, through recessed façades in some places. This also had to do with the municipal zoning plan concerning the buildings perimeter (Tabbers, 2018). Although the light falling into the building would have been slightly decreased, the value of balconies was thoroughly discussed in chapter 1 and would have led to higher user comfort. Due to the target group which this project was geared toward, these design decisions, forced by the developing/investing party result in a product of lesser quality.

A potential solution for this issue could be that more investing parties retain ownership of the transformed properties, and as such have an incentive to develop low maintenance, high user comfort residential space. However, as the case studies have shown, in all but five (*La Luna, Bellavista, Koretenaer Kade, GAK, Elsevier*) projects the investing, developing and final owning parties are different. From these cases it can also be seen that the final result reaches higher facade quality resulting in higher user comfort, than in the projects where the developed buildings were sold off after completion. The features implemented resulting in higher user comfort range from balconies to floor heating/cooling, or sun shading. Although *La Luna* is mainly geared towards students, the least demanding of target groups, a profound effort was made to maximize living quality. The feeling of balconies was added via large sliding windows, mechanical installations well insulated facades, and high-quality sun shading glazing. Similarly, the *Bellavista* project may not be ideal due to lacking sun shading and optimal heating, it does come very close to reaching current standards for housing, achieving energy labels of B and A throughout. Similarly the *Elsevier* transformation might not be optimal, but the addition of a double skin façade, mechanical ventilation, and sun loggias increase used comfort.

Another factor contributing to decreased motivation for developers to increase housing quality may be the market situation. Due to the high demand of any sort of housing space, potential renters are desperate enough to take what they can get, regardless of the price (NVM, 2017). The continued increase of costs for housing space, provide little incentive for developing actors to change this approach. Although an increased incentive for vacant offices to be transformed into housing can be seen as a desirable development, improved municipal regulations could contribute to higher housing quality being realized.

## 5.2 Municipal regulation

Although not only beneficial, municipal regulation has lead to an improved starting situation. Though there are also issues that arise from these added regulations, in particular relating to the reduction of building code requirements. From the literature it becomes clear that the role of the municipality has played an important role in the increased amount of vacant offices being transformed into much needed housing space in the past 5-10 years (BAK, 2017). Municipalities which have made an effort to support the transformation process, by amending zoning plans have experienced an increase of such project. This is confirmed by the case studies which show that 7 of the 12 projects studied were developed in the cities Den Haag, Amsterdam and Eindhoven. Although there are also other factors at play such as; more office being built in central locations in large cities, changes in regulation also play an important role. This can be seen in various documents from the municipalities actively designating vacant offices for transformation purposes, and providing developing entities with certain measures to entice their willingness to invest, such as the transformation toolbox which includes support documents concerning changed regulations in the building code, suggestions for investors and developers, matters of sustainability as well as acoustic insulation in transformations (RVO.nl/Toolbox)

One of the main simplifying measure applied by municipalities is the reduction of building code standards that transformed housing projects must adhere to. While some of these amendments are surely of positive influence some lead to investors exploiting these changes to their own advantage. Of the measures which make transformations more feasible, allowing for lower ceiling heights is likely the most useful. As some offices built in the 60s-80s had significantly lower ceiling heights than needed now to account for buildings services, current building codes for ceiling heights could never be achieved. This would significantly decrease the amount of potentially suitable buildings for transformation. (RVO, 2014). However various other exemptions from regulations have less positive effects. The current requirements relating to heating, insulation quality, lighting or energy performance have been increased to increase future building sustainability. However, it is in these fields that shortcomings are being accepted in transformation projects. The thought process behind these changes is understandable, as it lowers the potential costs linked to a transformation and makes successful transformation more feasible, thus enticing developing parties to invest in such building. Yet, these exceptions also entice to investing parties to exploit these loopholes. By reducing the standards regarding the mentioned building elements, developers can market housing which is significantly below the standard which is necessary. Not only regarding the overall sustainability of the building stock, but also regarding user comfort.

Due to the discussed factors municipal regulation is of importance, also in the future, to encourage transformations, however by decreasing the standards for buildings, the effect of adding housing space to the current stock is questionable. Seeing as one large factor for transformations is the element of sustainable re-use of the building stock, redeveloping these offices into subpar housing, defeats the purpose envisioned. Nonetheless providing solutions for buildings with existing structures difficult to work around remains important.

### 5.3 Existing structure

Mutations of buildings over time are a common occurrence, generally all parts of a building age and deform together. When stripping buildings down to their structural members for transformation, multiple opportunities and issues become visible. The method for construction changed dramatically at the end of the 60's when reinforced concrete became a conventional structural material. This allowed for larger spans to be realized, and structures could bear more overall weight with less space being needed for these members. Nonetheless with increased age, these members still suffer from deformation.

One of the most commonly encountered issues when re-developing old buildings are the discrepancies between the construction drawings and the building built. Often the degree of accuracy which was realized is far behind the current standard (Gann & Barlow, 1996). This has multiple reasons, however the advancement in building aids such as laser measurements and GPS coordination, as well as more sophisticated building methods have increased construction precision. A method to minimize issues resulting from these discrepancies is the use of point cloud measurements to map the building, however this is often a question of cost, which developers are not willing pay (Tabbers, 2018). Additionally, increased age of structural members results in floor slabs and beams bending under their own and carried weight, which means floors are no longer level, and ceiling heights become inconsistent. As such a new facade must be able designed with large tolerances in mind. This makes the prefabrication of façade elements more difficult. It also means that the actual ceiling height is often decreased, not only because thicker layers of screed must be applied to level the floor, but building services placed under the ceiling must be installed with sufficient clearance to avoid clashes with deformed structural members.

Another issue often encountered in transformation projects is the fact that buildings of older age were subject to looser building regulations, and as such often carried less weight. Reasons for this are less insulation needed in façades, less installations weighing on the construction, and the fact that office buildings have much lower demands concerning floor coverage to reduce acoustic transfer from floor to floor. Furthermore, the open office plans increasingly constructed after the 60s resulted in minimal extra weight from internal partitions weighing on floor constructions. This tendency is not absolute though, as there are buildings, also seen in the case study, which have grossly over dimensioned constructions that can carry multiple floors added during transformation, such as *Wijnhaven Kwartier, Kortenaer Kade* or *Bellavista* to name a few.

The main effects of the inconsistent structural capacity of old office buildings has resulted in certain methods developed to minimize potential problems. Surprisingly many of these developed projects, as seen in the case studies, and explained in various interviews, implemented timber frame façades, mainly because of the lighter construction weight. Yet a potential drawback is that the minimal load bearing capacity of buildings is used for essentials such as floors and façades. Buildings services and maintenance appliances on the roof are often removed due to lacking structural strength. Additionally, it can be concluded that before extras are added to a building, balconies often are prioritized when developing new housing. As shown in the literature the importance of balconies for future residential users is undeniable. These factors all contribute to difficulties creating standard solutions for transformations projects, outside the trend that transformation façades are based on timber frame façade constructions.

## 5.4 Standardization

Timber frame façade constructions have become the most common load bearing construction for transformed façades. As mentioned in the previous section this is largely due to the fact that they place less of a structural burden the construction. This type of façade manufacturing brings multiple benefits with it. Not only can it be pre-fabricated, however it is a very light building method, which allows for well insulated buildings, and non massive build up allows for all sorts of services to be integrated (Barendsz, 2014)).

There are several issues with the standardization of such a façade system for transformation projects. From the cases studied it can be observed many old offices have some similar characteristics. For example, the most commonly occurring construction grids are either multiples of 600mm or 900mm, resulting in grids of 5400mm, 7200mm or 9000mm. However, there are also several outliers which are based on irregular or uncommon grids such as in the *GAK* or *La Luna projects*. Although it could be argued that finding a solution which can be used in all potential projects would be beneficial, it also further complicates the development of such a solution. Nonetheless the width of such elements could be solved by combining several elements and with the inclusion of filler elements as seen in the schematic below (add image of 1st design). More problematic than the width of buildings however are the ceiling heights encountered in various projects.

The ceiling height of office buildings differ greatly and are linked to multiple factors. The age of the building, subsequent materialization of the construction, and the installed systems had an impact on the design decisions regarding ceiling height during the initial development of such buildings (Gann & Barlow, 1996; Remøy, p.217, 2007). As a result there are much larger variances amongst ceiling heights than grid measurements. This can be seen clearly in the case studies, and further complicates the development of standardized façade solutions.

Due to these reasons a more feasible approach to the issue at hand is the standardization of processes. Although the process of façade construction is already greatly normalized, due to factory pre-fabrication, there are still certain short-comings which became apparent from interviews and case studies. One of the main reasons that there is not a greater degree of standardization is the reduction of design freedom that comes with it. In projects geared towards the upper sector, it is not desired by architects (maybe developers too) to design similar or even identical buildings. Furthermore, it can also be argued that a standardized built environment is not a surrounding that most people would like to find themselves in. This is echoed by architects and constructors who argue that the allure of designing and building is coming up with unique solutions, which result from boundary conditions provided by a certain location (Tabbers, 2018; Rode, 2018; Van Spanje, 2018)

Although it can be argued that increased standardization brings certain drawbacks with it, could be beneficial in contributing to more integral buildings service integration in façades, and as such also would be of value in buildings that do not have the space in the interior to add such services.

### 5.5 Integral building service design

One of the main disadvantages of the current process of transformation projects is the disconnect of involved actors, as discussed in the previous chapters. The result is buildings which are lacking integral service design, and limited façade service integration at best. In most projects the only integration is the addition of either ventilation slits or the possibility of opening windows for natural ventilation.

This can be attributed to various factors, however again it is linked to the willingness of investing parties to pay for such services. The example of the *Van Vollenhoven Kwartier* is likely no isolated incident. Although the architects were suggestive of improved service integration, the developer's reluctance to pay for adequate technical consultancy, meant that most proposed design suggestions by the architects were not further pursued and subsequently omitted (Tabbers, 2018). Similar struggles can be seen in other projects, for which the *Bellavista* projects is exemplary. The simple addition of sun shading, which has a profound effect on user wellbeing was excluded, in most projects, due to the choice that users can account for such an investment themselves (Rode, 2018; Van Spanje, 2018). However, the resulting lesser performance of interior sun shading effects the overall energy performance of a building significantly (Alshamrani, Mujeebu, 2015). When there is no integral building service solution, such minor shortcomings can have a great effect. In the case of the *Bellavista*, users have been complaining about discomfort from the moment they moved in (Rode, 2018). Again, the main reasons that spoke against the inclusion of sun shading was the increased cost factor for sun shading able to withstand high wind speeds at higher altitudes (Van Spanje, 2018).

The examples which are more integrally designed are scarce and in this case study are only represented by the *GAK* transformation. Yet the advanced service integration of this project has less to do with the ambition of the developers to achieve a high standard, and more with the compliance with municipal requirements. Due to the buildings pending monument status, the transformation had to be completed in coherence with the previous design. As the *GAK* building was the most sustainable building built in the 60's, the redevelopment had to follow suit. As such the façade of building is of increased quality, has integrate sun-shading as well as façade integrated ventilation units. Furthermore, a double skin façade was installed, not only for improved acoustic performance along the highway, but also to increase the glass façades thermal resistance. The building is also connected to a heat pump system and as such is close to the energetic standard of currently developed buildings.

The example of the *GAK* shows that transformations with integral and high-quality service integration is possible, and apparently not a deterring factor for investors. In fact, the parties involved in the transformation are proud of their achievement. Not only did they manage to maintain the exterior appearance of the old building, however they also reached an EMI score of 9.4 meaning "we realized 94% of all possible energy saving measure, the reason we won the Benelux Aluminum Award with the project in 2013" as project architect Wessel de Jonge stated (Schüco, Footprint). It also shows that there is an awareness amongst some developers and architects for energetic performance and user comfort, who are also able to collaborate in an effective way. As the *GAK* transformation is a special case, yet a positive example for transformation, the following chapter will present a potential solution which could result in more conventional projects also reaching the level of success reached by the *GAK*.

# 6. Design recommendations

## 6.1 Design requirements

The boundary conditions studied and discussed in the previous chapters are converted to design recommendation for a PSS façade in the following section. Additionally, some recommendations relating to conventional payment schemes, and the resulting distribution of the financial burden of a façade, and resulting increased quality, over time will be presented.

A financial scheme should be based on the desire of an investing party to implement a façade of higher quality pertaining to service integration, whom are deterred by the large initial investment sum linked to such a product. By offering the same façade package at a reduced initial cost and spreading this cost over a pre-determined leasing period, a greater incentive to agree to such a scheme can be given. One of the concerned voiced in an interview was the financial capacity of façade manufacturing companies, to fully finance a facade themselves, and in return only receive partial payments (Van Spanje, 2018). A response to this concern could be offering maintenance services, to further entice developers in choosing a leased façade product, and providing a higher financial return. Furthermore, the financial concern would decrease with each subsequent project sold, as a constant cash flow results from a leasing model. As such the financing of the first project is essential for the feasibility of such a provision model. The ability for a company to repay this loan over time however should be possible, considering, a contractual obligation of the investors means constant monthly or yearly payments. Additionally, a successful initial project, would lead to more such projects being sold to both the same investor, or new parties. Although it remains to be seen to what extent this is true, the increased functionality of the façade, and the resulting higher value for users, should provide sufficient incentive for an investor to test the concept.

In relation to the desirable increased intercommunication of actors it may be an opportunity if both façade manufacturing/ construction companies and investing/ developing companies develop a leasing façade together. In this way the features desired by the developers could be more effectively integrated, and the willingness of such parties to take this step towards a new way of doing could be increased. This intercommunication would also have the benefit that potential risks relating to fluctuation of user needs could be mitigated. Some users may have the need for sun shading and façade integrated ventilation while others are not willing to pay for such features. Through proper communication issues arising from such fluctuation could be minimized due to linking façade functionality to rental contracts of users. The deterioration of added features due to frequent assembly and disassembly could also be decreased in this way.

Another issue that would have to be explored and solved is the storage of features, addable to façades. Potential solutions are storage on location, for example in spaces on the roof, or alternatively on the site of the company providing the maintenance services. In addition to the adaptation of the payment scheme, an augmentation of the product provision should be offered to entice investing parties to implement such solutions. Moreover, this façade manufacturer, responsible for the implementation of such features, offering such a product would be an expert pertaining to the regulations discussed in the previous three chapters and could also consult pertaining technical solutions. Additionally, they become specialists in the realization of high quality façades and resulting increased user comfort in the specific case of transformation projects.

Potential features that may result in more qualitative façades, which can lead to higher user comfort are various, however the boundary conditions should be standardized. The element of standardization of such solutions should be limited to the adaptation of the production process of pre-fabricated timber frames. The production of these elements is already subject to factory manufacturing, and substantial developments have been made, which have resulted in improved quality of façades, as well as a quicker assembly process (Herzog et al., 2012). Due to these advancements it would be beneficial to take advantage of them and improve their potential.

The aspects of these façades that could be improved and developed as features added to leasing façade are sun shading, replaceable window glazing or window frames, ventilation units, as well as sensor technology.

- Sun shading has been discussed at length in this paper, and has been shown to have a profound effect on user comfort. The addition of sun shading fixtures, providing the possibility to mount sun shading, depending on user wishes/need.

- The installation of window frames which allow for easy access to glazing panes could be another option, that allow for future changes of the façade resulting in higher comfort. This is not only limited to upgrading of quality over time in relation to higher energy performance, but could also lengthen the façade lime span due to easy maintenance.

- The element of glazing maintenance and replacement could further be improved by adding sensor technology to window frames, or implementing them on the timber frame façade frame. Various types of sensors are currently available. Ranging from temperature and radiance sensors, which can be used to pro actively cool or heat a building, or automatically control the deployment of sun shading. Another type of sensor relating to the pressure within glazing elements can prove beneficial when considering maintenance aspects. These sensors will be further discussed in the following design chapter.

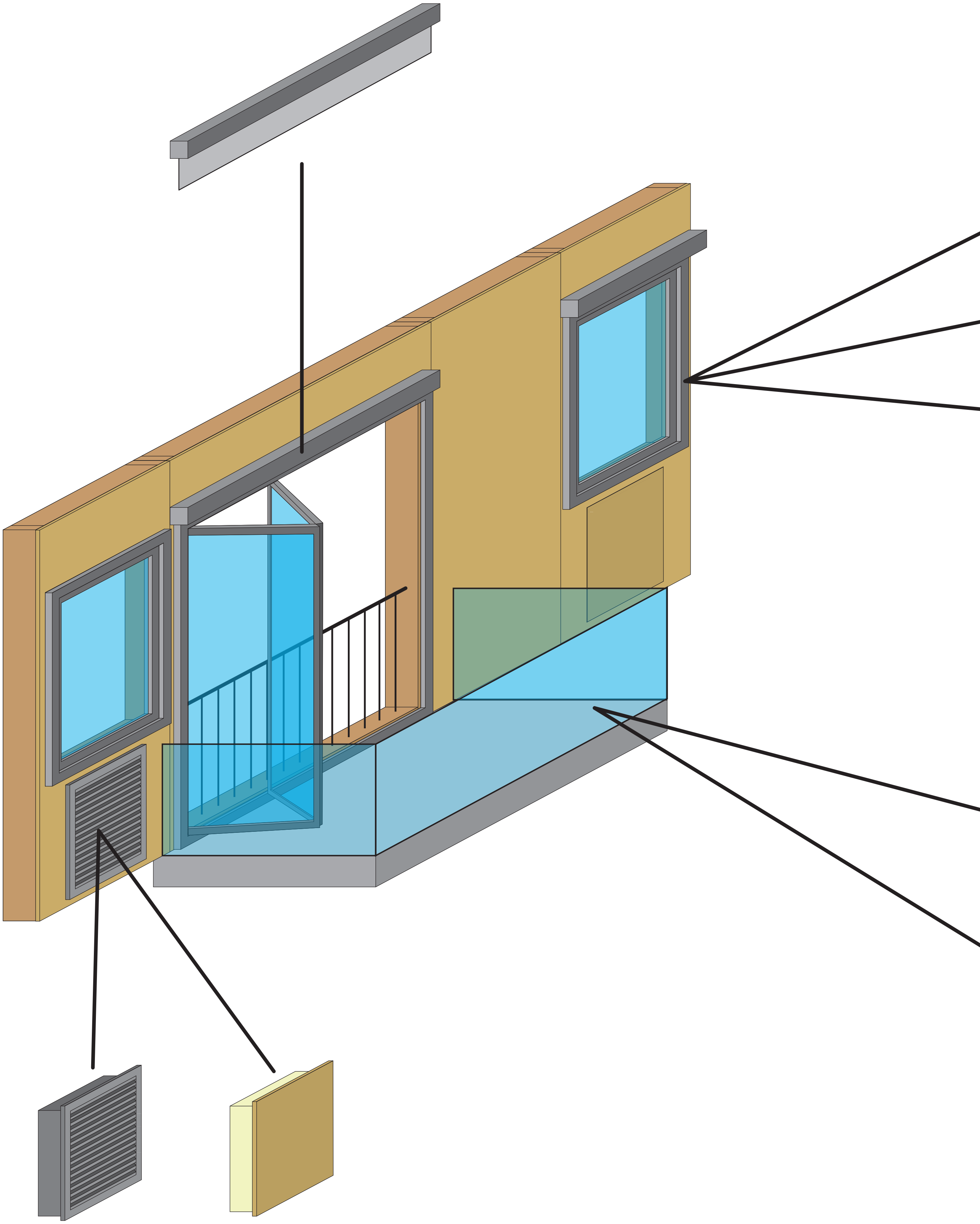
- Façade integrated ventilation units could also prove as a post building transformation addable feature. Although issues could arise with the installation of such elements in an already mounted façade, detailed solutions should be possible to develop.

- Implementation of balcony fixtures in the existing structure, and thus providing the potential possibility of adding balconies post transformation. The method applied in the *Wijhnaven Kwartier* transformation will be the basis for this. The easy assembly and mounting of these balconies due to their light weight, due to their foam filling, could prove as a potential solution, for an otherwise difficult to add feature.

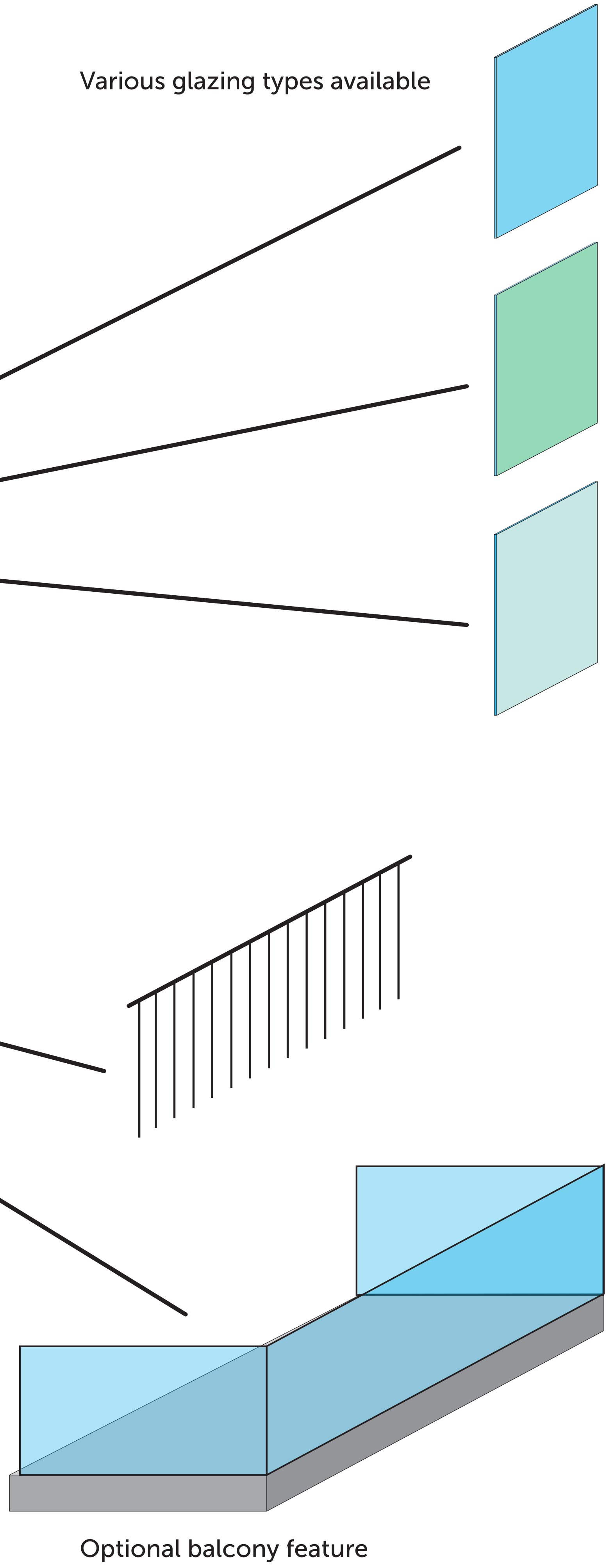
In the next section these features will be shown on the basis of a standard timber frame element, and the various features will be

# 6.2 Design: Leasable facade features

Optional sun shading feature



Optional facade ventilation feature




The facade proposed is based on the most frequent base construction encountered in the case studies: a timber frame. This frame has the previously discussed advantages concerning pre-fabrication, and ease of assembly. In addition to these benefits, the envisioned product has various features which can be added and removed, as explained in the section above. Another element which will be taken from the seen case studies is the balcony replacement seen in the *Groene Toren*. The outwards folding vertical windows allow for maximal daylight to enter the space behind, and allow for ease maintenance and cleaning from the outside. Furthermore due to the proposed variable balcony feature, it is essential that the two systems are easily inter-changeable. Any large scale transition which require the replacement of whole facade elements would be unreasonable.

In this proposed system the existing doors can still be used, should the French balconies be exchanged for real balconies. The image shown here does not take facade cladding into account, as this should remain a design aspect that architects can freely develop, regardless of the final features selected by the building users or exploiters.

In the next section these features will be explored in a design proposal, and potential implementation of these features in a pre-fabricated timber frame façade.

### 6.2.1 Optional Sun shading feature

One of the most common shortcomings of the studied cases was the omission of sun shading for residential functions. As discussed in depth in the previous chapters, the lack of this feature has lead to significant user complaints in the *Bellavista*, and likely also in all other projects without sun shading.

Due to the positive effect of proper sun shading in housing, this is an essential feature. The main concerns voiced relating to sun shading was the issue of height, and thus fear of mounting external sun shading. To increase the benefit of this feature, it the choice falls on external sun shading. This is not only chosen due to superior thermal performance compared to internal sun shading, but also as the ease of post building completion assembly. As this is feature which should be addable based on need this is an essential quality.

The product suggested is the Schüco CTB external aluminum sun shading, as pictured below. The product provides complete shading for sun angles above 20 degrees and is also suitable for installation at high altitudes, able to withstand wind speeds of up to 30 m/s. Furthermore it can be installed on top of an existing facade, by leaving space above the window frames, and behind the final cladding layer (Schueco.com). The post transformation installation might not be as easy as during initial construction, however with this system, a high quality feature option is available to building owners, wishing to upgrade the product they purchased from the initial investors/developers

Schüco CTB shading
http://www.adalalum.com/index.php/front/techproducts/5/20/115

Schüco CTB shading in facade system
https://www.schueco.com/web2/image/cachedcrop/data/w555/h555/id15294146/ctb_1_gallery.jpg

### 6.2.2 Optional facade ventilation feature

When looking at all cases studied, it is clear that in many projects, the focus was not on placed on an ideal internal climate, as mechanical ventilation units are rarely found. Interestingly both architects interviews, Sylvia Rode, and Matthijs Tabbers, suggested that they see mechanical ventilation units increasingly being the solution for high quality residential spaces. Due to this a facade ventilation feature is unmissable.

The unit chosen for this study is the Trox FSL-B-ZAB/SEK under sill decentralized ventilation unit. This box, seen below, can be easily installed below windows, due to its relative small size, of only 1085 x 630 x 320 mm. As such it is also well suited to be fitted into a timber frame facade base, which is usually around 300 - 350 mm wide, as can be seen in the case studies. In addition to its small size it does not require substantial connections, other than a main water in and out pipe, and condensation water out pipe (trox.de).

The performance of this small ventilation unit is also versatile in its functionality. Not only can it provide sufficient ventilation in rooms, of up to 6m deep, but it can also provide cooled or heated air, depending on the situation. This means that it does not only fulfill the need for proper air quality in a dwelling, but can also be used to supplement the installed, heating and cooling services (trox.de). This ventilation unit can be particularly useful in projects were sub par services were installed.

One of the main concerns with this feature is the technical implementation. Not only is the post assembly potentially difficult with regards to air and water tightness of the building, however to allow for assembly of such units, piping connections would have to be fitted during the transformation of a given project. Furthermore the cost of installing large quantities of these units in a project d quickly reach unfordable heights.

TROX FSL-B-ZAB/SEK
https://cdn0.scrvt.com/trox/18623f8a4cf40da4/aab8ddfb5aeb/v/b641b9658f74/00248372_0.png

TROX FSL-B-ZAB/SEK in an office
https://cdn0.scrvt.com/trox/628960e7303415f0/1eab1cc6dd36/v/83bd3be7f7af/00106591_0..png

### 6.2.3 Various glazing options

The third feature deemed useful in increasing the technical performance of transformed buildings, and user comfort is the glazing installed. Generally the technical life span of insulated glazing reaches beyond the provided guarantee of manufacturers of 10 years (Brown, 2014). However as the facade proposed is envisioned in a way that the exploiters or users of a building can adapt certain elements throughout a buildings life time, different or new glazing could provide increased technical performance and user comfort. As seen in the cases studied the most common glazing installed in HR++ glazing. Although this is not of poor quality there are products available on the market which perform better in certain circumstances.

The three types of glazing selected as part of the facade feature leasing package are all Pilkington products. The types are Pilkington Insulight Active clear (4mm Optitherm inner pane) with an insulating Rc value of 1.0 $W/m^2K$ which includes an argon filling. This glazing has high insulating properties, while also having a high transmittance of 72%. In addition to these qualities a self cleaning coating is added to reduce the frequency of cleaning needed (pilkington.com).

To offer a more cheaper alternative to the self cleaning glazing while still providing high thermal and shading qualities, Pilkingtons Suncool glazing is suggested. Again the option with argon filling was selected which results in an acceptable Rc value of 1.1 $W/m^2K$ (pilkington.com).

As seen in various projects, the element of acoustic insulation played an important role, and had to be dealt with. In the two cases studied, this was dealt with by installing a double skin facade. However this a costly design choice, and a glazing option which can also reduce noise levels at the glazing level would be valuable. As most projects studied are in central city locations, proper acoustic insulation is an important feature for residential spaces. The selected glazing is the Pilkington Optiphon glazing. This glazing can provide up to 50dB of damping at facade level (pilkington.com).

Pilkington Sun Clear glazing
https://www.pilkington.com/~/media/Pilkington/Site%20Content/_base/Banners/Products/optitherms3c.jpg?w=700


Pilkington Activ glazing
https://www.pilkington.com/en-gb/uk/householders/types-of-glass/self-cleaning-glass

### 6.2.4 Optional balcony feature

The question of balconies and their benefit for residential functions has been discussed in depth throughout this thesis. Due to this a post completion addable balcony system is part of the features suggested. The system implemented in the *Wijnhaven Kwartier*, as shown on the corresponding case study on page 34 has various benefits, which make it suitable as a feature for the proposed facade concept. The system realize on balcony fixtures mounted to the floor and beam system. These fixtures are then used to mount the lightweight balconies, as seen on the two images below. The balconies are constructed with light ferro concrete, and has a foam filling. To make the balconies mountable, the counter parts to the pre-installed fixtures, are also already integrated in the balconies (Crone, 2017). The image below also shows that the balconies were mounted after the facade was already installed. This proves to be beneficial to the system prosed, as the addition of balconies after the completion of a transformation is thus feasible.

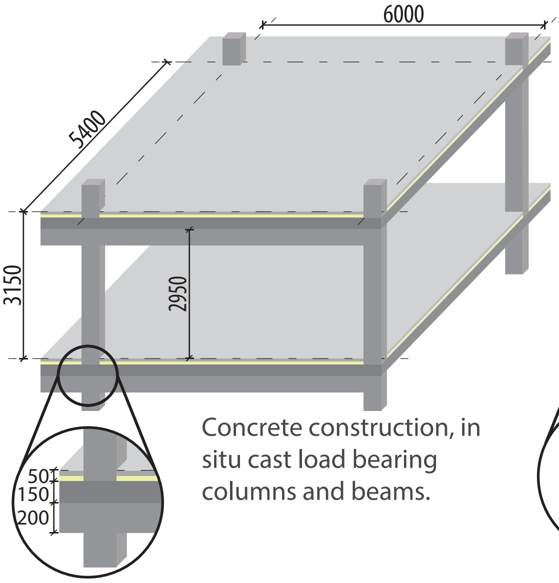
Some points which must be considered in the implementation of such a balcony system is the load bearing capacity of the structure at hand. However if this allows for extra weight to be added then this is a suitable feature. The possible addition of balconies is beneficial in projects were time constraints didn't allow for municipal permission to be gained as in the *Van Vollenhoven Kwartier*, or the potential extra costs were not desired by the investors, such as in the *DNA* transformation. The implementation of features shown in this section will be shown in the next section and briefly analyzed.

Assembly of balconies Wijnhaven Kwartier
https://tasfilms.nl/portfolio/bedrijfsvideo-bouw-film/

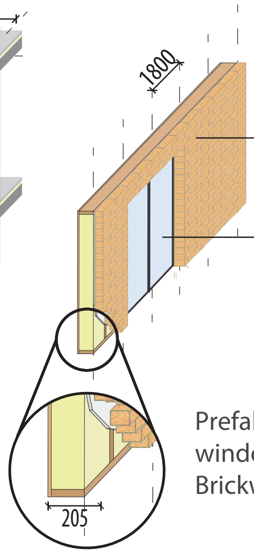
Assembly of balconies Wijnhaven Kwartier
https://tasfilms.nl/portfolio/bedrijfsvideo-bouw-film/

# 6.3 Design implementation in two cases

## *van Vollenhoven Kwartier* current design



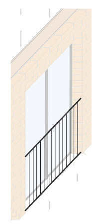

Concrete construction, in situ cast load bearing columns and beams.




Prefab Timberframe
Creme and gray brick
U value: .22 W/m²K

Bronze anodized aluminum
HR++ glazing

Prefab timberframe with windows installed. Brickwork layed on site.

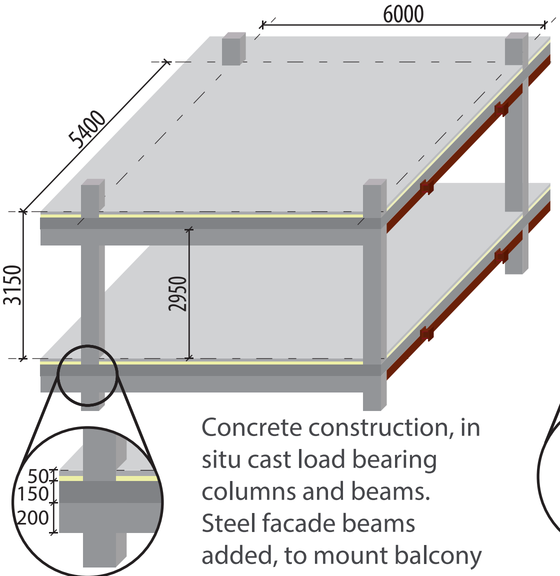


French balconies added to appartements. Roof top terraces also added in somce cases.

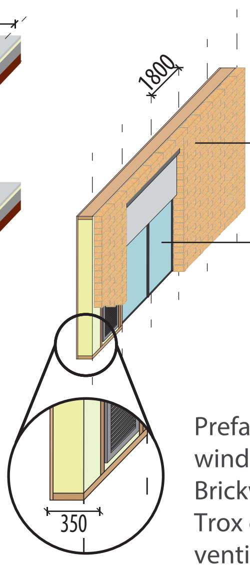
The main issues which become clear when looking at the *Van Vollenhoven Kwartier* is the lacking facade integration, and the unwillingness of the investors to pay for extra functionality.

The implementation of the proposed facade system which allows future owners and users of the building to upgrade the building skin based on their current demands. The features presented can lead to an increased technical quality of the project, as facade integrated ventilation units can be installed post completion. Furthermore the addition of external sun shading decreases the heating load experienced by the users. Finally the replacement of the French balconies and inwards opening doors with outwards opening folding doors, and balconies, also increases the user comfort of the users. Based on these alterations, the apartments construction are likely more valuable to investors, and users.

## *van Vollenhoven Kwartier* with leasing features



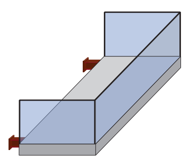

Concrete construction, in situ cast load bearing columns and beams. Steel facade beams added, to mount balcony fixtures




Prefab Timberframe
Creme and gray brick
U value: .28 W/m²K

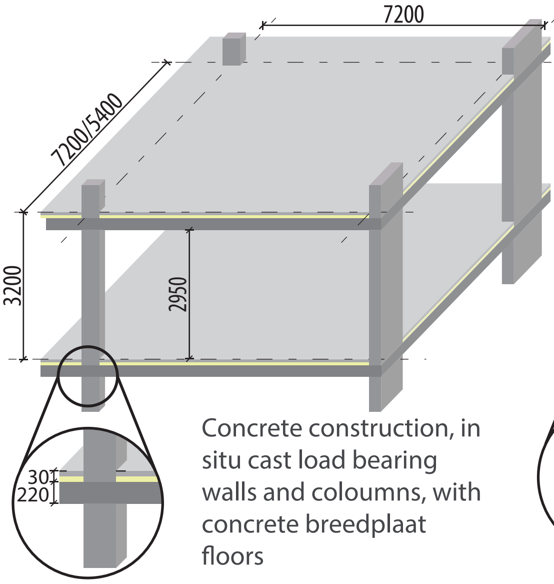
Bronze anodized aluminum
Insulight glazing 1.0 W/m²K
Facade integrated sun shading

Prefab timberframe with windows installed. Brickwork layed on site. Trox decentralised ventilation units installed

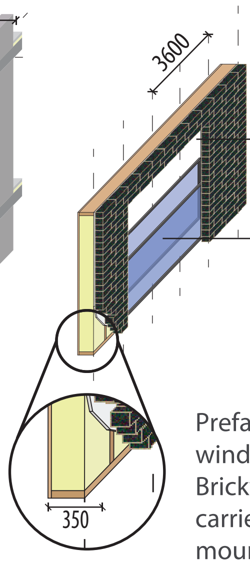


Ferro concrtete balconies with foam filling, up to 8m² mounted to fixtures on building structure

# *DNA* current design




Concrete construction, in situ cast load bearing walls and coloumns, with concrete breedplaat floors




Prefab Timberframe light and dark brick U value: .28 W/m²K

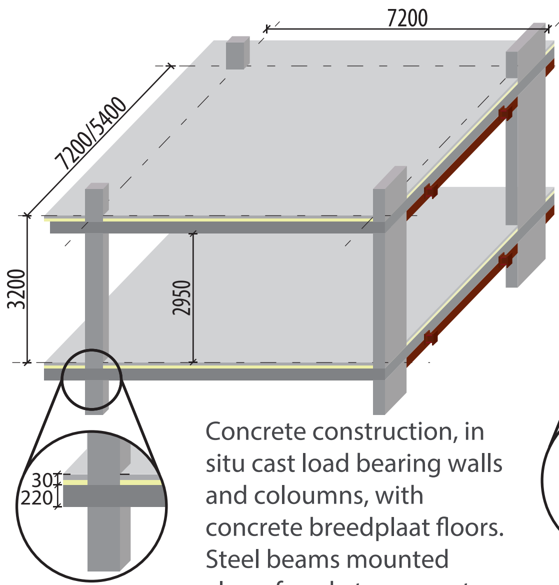
Anodized aluminum vertical opening windows HR++ glazing

Prefab timberframe with windows installed. Brickwork layed onsite, carried by angle mounted to floors/wall

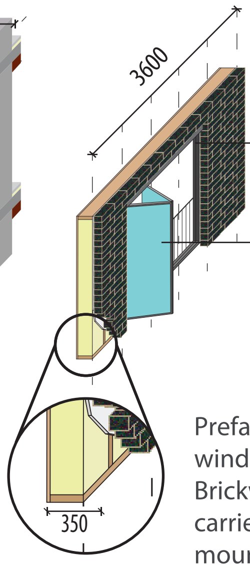
No balconies added, however large vertical sliding windows allow the facade to open facade half way.

The main issues which an be seen when examining the *DNA* transformation are that the students rooms created are not foreseen with proper balconies, nor with sun shading. Mechanical ventilation however was installed. In total the project is not poorly executed, and is suitable for the target group students. However the possibility of these apartments being fully used as long stay homes for the higher sector is there. Currently a part of the building is used for this. A change in target group would demand other functionality of the building though, and the current design does not allow for this. Through the implementation of leasable building features, this target group could be satisfied. Rather than placing vertical opening vertical sliding windows would allow for future balconies to be mounted. The addition of steel fixtures for balconies,would make this possible as shown below. Furthermore the implementation of sun shading fixtures would further increase the performance of the *DNA.* Additionally the current HR++ glazing could be replaced by Optifon glazing, decreasing the noise pollution caused by the harbor and water way near by.

# *DNA* with leasing features



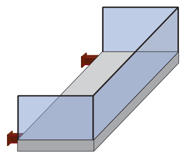

Concrete construction, in situ cast load bearing walls and coloumns, with concrete breedplaat floors. Steel beams mounted along facade to support balcony fixtures




Prefab timberframe Light and dark brick U value: .28 W/m²K

Anodized aluminum Horizontal folding windows Optiphon glazing

Prefab timberframe with windows installed. Brickwork layed onsite, carried by angle mounted to floors/wall



Ferro concrtete balconies with foam filling, up to 8m² mounted to fixtures on building structure. Optionally folding windows as french balcony

# 7. Conclusion

This graduation thesis has discussed the current market situation, transformations of vacant offices to housing, presented various such cases, discussed these in conjunction with interviews of experts in the field, and made suggestions regarding a potential facade system, which allows for the addition of features contributing to increased building performance and user comfort. These steps have shown that the implementation of PSS products in transformations is not as straight forward as expected at the beginning of this process.

Not only has it become clear that the process of transformations is a convoluted construct of various actors, pursuing various goals, but the technical implementation of transformations poses various difficulties. The large variance of actors seen throughout this paper range from developers to architects and final users. It has become clear that in particular developers place a different focus on transformed buildings that the users that finally use these spaces. This often results in residential spaces that do not fulfill the current housing need, and are not maximized towards user comfort. This can mainly be contributed to the custom that investors and developers often are not the final exploiters of the transformed buildings. As such their interest in implementing the highest potential technical performance and user comfort is limited. This trend is further exacerbated by municipal regulation, which is well intended, however provides investors with various loopholes which they can exploit to minimize their investments.

In three fourths of the cases studies this has resulted in façades which are no more than the bare minimum. There are four examples in which higher standards were reached, however this was more often than not a result of the boundary conditions. In three cases it might be attributable to the fact that the developing party and exploiting party were the same, and thus were interested in exploiting a product of high quality. In the cases of lower quality this could often be attributed to developers looking to turn a quick profit on the vacant property purchased.

This trend can also be seen when looking at the integral design of services, and façade integrated services. In most projects the result was that any form of sun shading was ommitted due to cost saving measures. Furthermore most projects rely on natural ventilation, while on a limited selection installed mechanical ventilation.

Based on the research presented in this thesis the question asked at the beginning of this paper:

*Can offering façades as a PSS in the case of transforming offices to housing, contribute to the building, more reliably being adaptable to various user needs and thus extending its life time and increasing user comfort and* façade *quality?*

can be answered. Offering PSS façades in the case of office transformations into residential functions is not suitable as initially envisioned. Leasing a complete facade is not feasible as due to various factors. Assembly, disassemble and subsequent assembly on another location is technically difficult due large variances in structural boundary conditions. Furthermore the act of mounting and dismounting cladding, window frames or complete façade elements will result in significant deterioration regarding quality. Furthermore, finding space to store these elements for future use would be a significant issue to overcome. A concern voiced by architects and constructors alike is the design freedom which would have to be sacrificed for such a standardized system to become functional.

Another aspect which limits the benefit of such a system is the question of financial responsibility having to be taken by a facade manufacturer. As seen in the interviews conducted there are serious reservations of actors concerning this issue.

The proposed design, which is based on a prefabricated timber frame facade construction, used in most cases studied, allows for the adaptation of certain facade elements throughout time. The changeable features suggested are: sun shading, decentralized ventilation boxes, various types of glazing and the optional addition of balconies. By giving future users or exploiters of a property to fine tune the final building with these features, the potential technical quality and achieved user comfort can be increased.

This system however is only a suggestion which requires more research towards functionality and technical feasibility. Furthermore it would be valuable to discuss such features with relevant market actors, ranging from architects, constructors facade buildings to investing and developing parties.

This research could be further validated by conducting similar case studies in areas which suffer from an even more extreme need for housing such as Asian mega cities like Mumbai, Singapore or Hongkong. In these cities the amount of office space is even greater, and will likely result in large amounts of vacant real estate in the future, which can form the basis for many more transformation projects, which can continue to aid in fulfilling the global housing need.

# 7.1 Reflection

For this graduation thesis the main topic that was examined is the effect of the façade selection process on the success of transformation projects from vacant offices to housing, and how these can be made more feasible by offering facades as Product service systems.

The main question posed is; can offering façades as a PSS in the case of transforming offices to housing, contribute to the building, more reliably being adaptable to various user needs and thus extending its life time and increasing user comfort and facade quality.

This thesis is positioned between the chair of Building Technology and the Chair for Management of the Built Environment. As the topic of the graduation is partially focused on vacant office space and how this is dealt with, and building management it is not a common BT graduation. However the redevelopment of products and the reorganization of production and sales strategies of façade manufactures, which come along with a transition to a PSS company, would lead to an more tools being available to building managers during transformations. The main benefit of a PSS façade is that through the change from profiting from sales, companies must find a way to produce goods which they can exploit for as long as possible. Additionally, a façade is not only mounted once in its life span, but ideally is circulated through a variety of buildings. This should result in products being produced with more durable materials, which means less products must be produced in total. Furthermore, the produced facades should result in buildings becoming more flexible. As the façade can be circulated, and can be adapted throughout its lifetime, based on the grounds of the leasing contract linked to the façade.

From the preliminary literature study it became clear that although the amount of transformation projects successfully completed is increasing, the large costs involved are still a deterring factor. Simultaneously, a potential option to significantly decrease initial investment costs; offering facades as a service (PSS), is difficult to develop without increased communication between all parties involved in the building process. As such one of the main goals of this graduation is to discuss the concept of PSS facades with parties involved in construction: architecture, construction and manufacturing firms, developers and investors. To answer the question of the thesis the research was split into two parts, a quantitative (case study) and a qualitative (interviews) art.

The approach for this graduation was to verify the literature concerning transformations. From the literature a variety of conclusions regarding; building and location characteristics, were found. However as this literature is up to 10 years old in some cases, current projects may no longer be subject to these characteristics. Furthermore, to make a justifiable suggestion regarding the qualities a leasing façade must have, the current characteristics of implemented facades in transformations must be understood. To sufficiently gather information regarding these characteristics a case study was conducted.

The case study was focused on buildings that resulted in more than 100 housing units being added to the stock. In this way it was assured that the façade area of the building was significant enough that the facades costs (±50%) of the transformation would carry a high price. Resulting from this criterion 10 buildings were selected in the Netherlands, completed between 2015 and 2018/20. The smallest project composed 116 units and the largest, still in the design phase 840. The data gathered is enough to draw some conclusions.

One concern with the method of case study is that the required data is hard to come by. Most architecture firms are not willing/not interested in sharing building data/ drawings, required to fully complete the case study. As of now the response rate is 50% Although a significant amount of information can be found by conducting research via the Internet and searching through construction journals, it is not enough in all cases. As such 85% of the selected buildings have a complete analysis. To complete the missing case studies, original building documents have been requested at various municipal archives.

To cater to the literature concerning PSS, to better understand the decision making process for façade selection in transformation projects, and spread knowledge of PSS interviews will be conducted with relevant parties. Currently the parties which have confirmed their participation are: Investor/ Developer (Wijnhavenkwartier, Den Haag: Anjelica Cicilia, Syntrus Achmea), constructor (Bellavista, Rijswijk: John van Spanje, AKOR), architect (Bellavista, Rijswijk: Sylvia Rode, Rijnboutt)(VanVollenhovenkwartier,Rotterdam: Mathijs Tabbers RoosRos), Investor/Developer Hermes City Plaza (Roderick Mackay, Egeria)

As with the case study conducting interviews makes the results very dependent of exterior factors. The strength of the interviews comes from speaking with parties looking at transformations from various perspectives, and analyzing their view on the façade selection process. Additionally it is valuable to gauge the interest, and understanding of these parties of Façade PSS. At the same time it is hard to verify the valilify of some claims made, due to lack of other opinions and literature. As such the interviews give an interesting view on the situation, however should be viewed with caution.

The design presented at this stage of the graduation is the weakest part of the study. The design of a features facade in its self is a potential solution for the problem at hand, however the development of this facade to this point is still worth improving. A brief study regarding the technical implementation of the suggested features would lead to a more sophisticated result. Furthermore the Marconi Tower transformation is a suitable project which could be used for an extensive case study. As the building is not yet transformed, it would be interesting to propose an alternative design, which makes use of the possible features presented.

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# Appendix A

| | | | | | | Pro |
|---|---|---|---|---|---|---|
| **Name** | **CONTACT** | **Suitable for further analysis?** | **Architect** | **Construction company** | **Façade manufacturer** | **Investor** |
| De Admiraliteit | info@klunderarchitecten.nl | Maybe | Klunder Architecten | ABB Bouwgroep | | Bouwfonds IM |
| Marconi Torens/Europoint Towers II + III | Tom Kuipers: t.kuipers@diederendirrix.nl | potentially many infos/contacts | diederendirrix | | | |
| La Luna/Potentiaal | Tom Kuipers: t.kuipers@diederendirrix.nl | YES, seems like info may be readily available.. | diederendirrix | Dura Vermeer | Rollecate | Dura Vermeer, DBM |
| Wijnhaven | info@geurst-schulze.nl | Many contacts, building interesting due to balconies | Geurst & Schulze architecten | Heijmans | Rollecate | Rabobank Pensioen fonds, BPL (Syntrus Achmea) Anjelica Cicilia |
| Hermes City Plaza | info@vanwilsumvanloon.nl | maybe | Van Wilsum Van Loon | Du Prie bouw & ontwikkeling | Blitta | Egeria, Erasmus Universiteit |
| Rembrandtpark Building | zzdp@zzdp.nl | Maybe, HOTEL | ZZDP architecten | BAM Noordt Oost, De Nijs en Zonen | AKS | ProNam Aurora |
| Scheepvaartkwartier/Van Vollenhovenkwartier | info@roosros.nl | Maybe | RoosRos (Mathijs Tabbers) | ABB Bouwgroep | ABB | Trivestor? |
| Bellavista | HAAC, Frederik Vermeesch (Rijnboutt) Sylvia Rode | Yes, also close to home | Rijnbout (Sylvia Rode) | AKOR/Vastbouw | Decomo Concrete panels, Windows ?, maybe also ABB | Urban Interest (EKA Vastgoed V b.v. ?) |
| De Kortenaer | zzdp@zzdp.nl | Maybe, close to home | ZZDP architecten | De Vries en Verburg | | Provast & Syntrus Achmea Real Estate and Finanace |
| De Groene Toren | Paul Diederen: p.diederen@diederendirrix.nl | façade fully transformed, complete building strip/ half hotel | diederendirrix | Stam & De Koning (Volker Wessels) | Reynaers (installed by Van Hoesel | Strabane Holding Investments |
| Elsevier Gebouw | info@knevelarchitecten.nl or b.robichon@knevelarchitecten.nl | Yes, became monument | Knevel Archiecten | Bouwbedrijf de Nijs en Zonen | Bouwbedrijf de Nijs en Zonen | Woonstichting Rochdale |
| GAK Gebouw "de Studio" | Wessel de Jonge Architecten/ZECC | YES | Wessel de Jonge Architecten/ZECC | HSB Bouw | System from Schüco, mounted by Blitta BV | AM, Stadgenoot, |
| Phillips Terrein | no chance | no, however interesting to contrast as monumet | Diederen Dirrix | Stam + De Koning Bouw (Volker Wessels) | | Foolen & Reijs Vastgoed |

oject

| Previous Owner | User | Current Owner | Developer | Purchase price of building | Renovation costs | Completion | Functions |
|---|---|---|---|---|---|---|---|
| WealthCao | CityPads: students renting | CityPads (maybe user) Sold to 3 investors | ABB, B.V. en U Vastgoed, Citypads | 52.1 million | | 2016 | Housing, ammenities |
| Gemeeente | TBD | CityPads, tB\|BHW Projects | | 8 Million for II, | | expected 2019 | Housing, Restaurant |
| TU Eindhoven | Camelot real-Estate, TU/e: Students renting | Camelot | Camelot, Dura Vermeer, TU/e | 36 million | 40 million ? Or 34 million | 2017 | Housing, ammenities |
| Ministry of Justice, and Internal Affairs | Leider University, commercial users, renters | | Heijmans Vastgoed, Proper Stok Roffa | | 65 Million | Februari 2016 | Uni, Housing, commercial |
| Credit Suisse?? Purchase for 16 mil in 2008 | Erasmus University? | Wolf Huisvestingsgroep | Hermes City Plaza B.V. (Weird) | | | Q4 2017 | student housing, commercial |
| ProNam Aurora | Ramada Hotel | Peak Development | ProNam Aurora | | | 2012 | Hotel, conference, restaurant |
| | | | ABB, DBOG, Trivestor | | | Q4 2018 | Housing, Commercial |
| Urban Interest (current owner) | Urban Interest | Urban Interest | Urban Interest | | | 2016 | Housing , Commercial |
| Rijksgebouwendienst | Renters | Provast & Syntrus Achmea Real Estate and Finanace | Provast & Syntrus Achmea Real Estate and Finanace | | | May 2016 | Housing, commercial, restaurant |
| KPN? Potentially only user | NH Collection, Eindhoven2Stay | Sold to Various private investors | Foolen & Reijs Vastgoed BV, Eindhoven2Stay? | 6 million | | Q2 2017 | Hotel, conference, restaurant, housing |
| Elsevier Publishing Company | DUWO/Rochdale (offices) | DUWO/Rochdale (offices) | Woonstichting Rochdale | 11 million | DUWO Purchased for 17.5 million (6 mil maybe) | Q4 2015 | Office Space 750m2, student housing |
| Municipality | Various, Stadgenoot and steenvastgoed renting, bar and cafe at street level | AM Sold their Appartments, Stadgenoot is renting theirs, Steenvastgoed is renting theirs | Amstelland Multi (AM), Stadgenoot, Steenvastgoed | ? | 21 million for north part | 2013 part 1 2015 part 2 2016 part 3 (center) | Housing, commercial, hotel? |
| | | | | | | 2016 | |

## Location characteristics

| Location | Address | Location Summary | Distance from Center |
|---|---|---|---|
| Rotterdam | Admiraliteitskade 40, 50, 60 | Central, close to Local universities. Student neighbourhood, close to city green. Basic amenities and leisure available | +- 1 km to center |
| Schiedam | Marconistraat | central to district, Schiedam | Central Location, HUB |
| Eindhoven | De Lampendriessen 31 | University Campus (TU/e), | 1.3 km to center |
| Den Haag | Turfmarkt 94-96 | Central Business district, Central axis connecting station to city center | 800m to center |
| Rotterdam | Stadhuisplein 30 | Central: .7km to Station. Statino within walking distance, otherwise also well connected. Housing within the larger area, but mainly commercial. All city central amenities and services as within a small radius. Limited | Central as can get |
| Amsterdam | Staalmeesterslaan 410 | Housing, shopping location for neighbourhood Commercial hub. Park location | 3km from Center, Highway location (A10) |
| Rotterdam | Van Vollenhovenstraat 3 | Close to Cultural center, Shopping, amenities, city greenery within reach. | Central Location, 1.5km from central station |
| Rijswijk | De Savornin Lohmanplein | shopping location, central to beighbourhood (HUB) | HUB, 4km from den haag city center, however location in rijswijk is central and most important shopping hub |
| Den Haag | Kortenaerkade | Housing neighbourhood, varios shopping walking distance, services, beach reachable by public | Close to city center, 10 minute walk, Amenities close by, shopping and leisure |
| Eindhoven | Vestdijk 9 | Central: across from station, 800m to TU/e, | in the city center, short walk from central station, as well as central shopping district. Within walking distance from Tu/e |
| Amsterdam | Krelis Louwenstraat 5 | Central to Slooterdijk, 900m to station, the location does have a poor chaaracter, however improvements are iminent, and direct surrounding "hip". Most services close | 500 m from Bos en Lommer center, 2km to Slotermeer. Mainly housing in direct area, directly located next to A10 highway. |
| Amsterdam | Bos en Lommerplantsoen | Right in the Middle of Bos en Lommer, various shopping, social options in direct surrounding. Vicinity to the center palpabl, as well as central services. Multiple parks and sports terrains in area. | Central to Bos en Lommer, 1.3 km to Slotermeer, 2.5 km to Jordaan. |
| Eindhoven | | | |

| Accessability | Services | Parking | Monofunctional? | Vacancy in Neighbourhood | Size | Time Vacant |
|---|---|---|---|---|---|---|
| Good: Public transport by bus and Tram, and train. Close to main car axis, connecting to highway (Maasblvd) | Good: supermarket, restaurants, sports in direct area, also close to botanical garde. Close to the Erasmus campus, ideal for students | underground parkings available aclose to location | NO | 7 - 11% | 40.000 m2 | multiple years |
| Optimal: Car via highway, Public: train, tram, bus | Good: Schools, commercial, eating, housing, leisure | Available on location | NO | 3 - 7 % | 80.000 | 2 years |
| Optimal: Car, bike OK: Public transport, reachable via foot from station | Limited as university campus | Some on campus, limited to users of uni | Semi: on university campus | 5 % | 23.350 m2 | ? |
| Optimal: Car, Public Transport, Train, Tram, Bus | Close to transport HUB, eating, living, leisure | 700 in building, 224 for project, surrounding limited | NO | 13 % | 51.500 m2 | ? |
| Good: Public transport: train, tram, bus, reachable by car, however Rotterdam can be difficult. Reachable from station by foot | Good: Commercial, eating, housing, leisure | Throughout center in garages | Improving towards NO | 15 % | 9.500m2 | ? |
| Good: Public transport (tram 13 bus 8, ,753), car via highway and roads, Tram 7, 15: 500m walk Metro within walking distance | Good: schools, commercial, housing, leisure | Yes in garage and parkingdeck on location, surrounding | YES (in direct surrounding) | 7 % | 39.000 m2 | ? |
| Good: Publich transport, via Tram, Bus, Metro. Car via central roads | Good: Within walking distance (500m) commercial, leisure, housing, center | 200 + underground | NO | 9 - 19% | 30.000 m2 | 2-4 years 7 of 15 floors |
| Good: by public transport (3), car, bike, foot. Near housing | Good: schools, commercial, housing, leisure | Integrated in shopping center next to tower | NO | 10 % | 13.000 m2 | several years |
| Good: Car, bike, foot, public transport (1, 16, bus) | Good: schools, commercial, housing, leisure, Central services | Available, however limited (Roadside), limited underground parking | NO | 18 % | 15.000 m2 | 8 years |
| Optimal: Public transport HUB, via car and bike also reachable. Can be reached by car from central roads | Due to central HUB location, and city center, and services within the building well connected | Available on location throughout center, underground | NO | 17 % | 13.000 m2 | Never fully vacant, restaurants remained during cons |
| Good: Tram close, sloterdijk station walking distance, metro and bus reachable | due to vicinity to sloterdijk and bos en lommer, most services available: shopping, leisure, housing, sports and parks | Available on terrain, otherwise on street | NO | 5% however sloterdijk office terrain 72% vacant | 11.750 m2 | 11 years |
| optimal: trams, bus, metro in direkt vicinity. Highway exit very close, train station can be reached however further away | due to vicinity to sloterdijk and bos en lommer, most services available: shopping, leisure, housing, sports and parks | Available on terrain, parking garage in vicinity, parking on street | NO | 5% | 36.000m2 | 9-11 years |
| | | | | | 43.000 m2 | |

| Original Construction | Floors | # of Units | Average unit size | Target group | Purchase Price | Avg Rent/month | Car Parking |
|---|---|---|---|---|---|---|---|
| 1989 | 12 | 658 or 587? | 20 - 55 m2 | Students, Young professionals | NA | not available | 250 |
| 1975 | 24 | 2 of 3 towers, each 420 units (840 Total) | 40 - 70 m2 | Starters | | | 1.100 |
| 1965/71 | 14 | 411, 2.500m2 commercial, 3.000m2 amenities | 18 - 31 m2 | Students (shortstay) | NA | € 390 + (top floors for 800+) | none added |
| 1980 | 20 | 132 rent, 38 sale | | Students, Elderly, Starters, couples | NA | € 825 - 1.750 | 224 |
| 1953 | 7 | 218 | 18 m2 | Students | NA | € 595 | |
| 1972 | 18 | 128 student rooms, 446 Rooms, 8 conference rooms | Single rooms | Students, Hotel guests | | ~ € 541 for students studying at Skotel | 511 |
| 1970 | 10 | 202 | 40 - 115 m2 | Young Prof, ondernemers | € 185.000 - 395.000 + interior package | | 200+ Underground |
| 1968 | 18 | 116 | 77 - 130 m2 | Luxury appartments for the higher sector | NA | € 840 - 1380 including parkingspot | on shopping center deck |
| end 1960s | 9 | 149 rent, 4 penthouses sale | 57 - 177 m2 | Starters, young preofessionals, higher rental segment /penthouses avilable for sale | Only 4 for sale, rest Rent | € 885 + | 100 on location |
| 1974 | 14 | 120 Hotel rooms (NH), 64 Long stay, 47 shortstay housing | 20 - 68 m2 | Starters, Commuters, Students…? (shortstay) | | € 751 + | ? |
| 1964 | 12 | 245 | 21 - 39 m2 | Students | NA | € 350-400 | 73 |
| 1959 | 11-13 | 331 south 320 North 120 Middle 781 Total | South 28 - 47m2 North 25 -35 m2 Middle 40 - 110m2 | Students, Starters | South 70-130.000 North 75-115.000 | South 116 rentals Middle 120 rentals > €900 | garage built next to building as part of transformation |
| 1980 | 8 | 616 | 38 - 69 m2 | Young starts, expats (shortstay) | NA | Rent? | |

| Bike Parking | Structural system | Structural Grid | Floor Type |
|---|---|---|---|
| 800 | Concrete columns and load bearing walls, cast in situ concrete floor | 7200 x 7200/5400mm | 220mm breedplaat, 30 dekvloer |
| Not Specified, available around location | | | |
| Not Specified, available around location | Steel columns inside concrete, floor system. TT Floors | 6200 x 6200mm | TT Floors: 386mm with 90 top layer, 78mm screed + insulation, total 554 |
| Not Specified, available around location | steel Columns, filled up with concrete system, TT floors. Beams also steel | 9000 x 7200mm | TT Floors 600-670mm 80mm screed, 40mm insulation…. Hollow Core in uni |
| Not Specified, available around location | Concrete Load bearing | | |
| Not Specified, available around location | concrete core, columns in façade, beams, monolothic. TT Floors | 1850 x ? | TT floors (130mm) + extra |
| Not Specified, available around location | Concrete Load bearing, column beam | 6000 x 5400mm | cast insitu concrete floors, 150mm with 50mm converage |
| Not specified ,avialable at mall directly adjecent | Load bearing core, columns. Structure adapted, core walls removed, columns decrease in size as building height increases. Topped up 2 floors due to its overdimensioning | 9000 x 9000mm | cast insitu concrete floors, 280mm with new 50mm screed 30 mm insulation |
| Not Specified, available around location | Concrete central core, load bearing walls as central hallway, façade beams. In situ floor with added screed. Balconies added via "stemvorkonstructies" attached to coloumns. Bearin walls also extend to façade at 3 grid lines | 9000 X 1750mm | in situ floor (230mm) screed and insulation 100mm |
| 84 in building | In situ Beams, columns, and floorslabs. Steel beams used to reinforce façade, reused in transformation. Topped up construction steel concrete system | 7200 x 7200mm | In Situ slabs (210mm) additional layer of screed (100mm). |
| 331 added in basement | Concrete structural core (walls at center, staircases at building edge) beams with insitu concrete slabs | 3600 x 7200mm | in situ slabs |
| bike parking in basement of building for users | steel columns and beams, thin concrete prefab with 40mm topping. | 4000 x 7200mm | Prefab elements, 40mm, topped up with 20mm insulation 60mm anhydryte screed |
| | | | |

## Building Characteristics

| Floor Span | Ceiling Height | Façade transformed | Façade area | Façade Grid |
|---|---|---|---|---|
| 7200mm | 3200mm<br>F2C 2600mm | Yes | ±12.500m2 | 3600mm |
| | | Yes | | 1800mm |
| 6200mm | 3750mm<br>F2C 3196mm | Yes | 8.330m2 | 6200mm / 5 1240mm |
| 9000mm | 3400mm F2F 2960mm | Yes | 18.633m$^2$ | 900mm |
| | | Yes | | |
| | | Yes | | 1850mm |
| 6000mm | 3150mm,<br>F2C 2950mm | yes, although not curtain wall | 7.270m$^2$ | 2m and 1.8m |
| 9000mm | 3250mm,<br>F2C 2670mm | Yes | 7.623m$^2$ | 1800mm subdivided into 600mm chuncks |
| | | Yes | 5.500 | 1750mm |
| 7200mm | 3200mm<br>F2F 2400-2750 mm | Yes | 6.200 | 1800mm |
| 3600mm | 3300mm F2F | Yes, fully replaced | 6.240 | 1800mm |
| 4000mm | 3260mm F2F 2800mm free height | Yes, Fully replaced, keeping with previous design | | 1000mm |
| | | | | |

s

| Façade type | Façade material | Façade services | Façade U Value | Energy Label (self advertised) |
|---|---|---|---|---|
| Prefab Timberframe back construction with windows pre assembled, brickwork carried by façade carrier layed on site. Mounted against existing floor and load bearing exterior wall. Aluminum windows between | Light and dark brickwork, dark colored sliding aluminum windows | Motorized window opener | <.28 W/m2k HR++ windows | B or A |
| | | | | |
| Element façade prefebricated, timber shadowbox units with glass infill or aluminum cladding. Curtain wall on groudn floor | aluminum cladding, glass shadowboxes at appartmentt division | Manual ventilation flap | Closed .26 W/m2K Windows 1.1 W/m2K | A |
| pre-fab timber frame elements with windows, cladding fixtures and pre-fab cladding mounted afterwards | Natural Stone, Ceramic cladding | | | |
| | | | | |
| Washed grindbeton only cleaned. | Bronze colored aluminum, HR++ Glas | | | |
| Timberframe, masonary on site | Bronze colored aluminum window frames, HR++ Glas, crème, white gray brick | natural ventilation.. | Closed .22 W/m2K | |
| Aluminum window frames, Timberframe fillings etween apps. Clad with powedercoated aluminium | White Concrete façade elements, Coated aluminum cladding, aluminium windows elements | None | Closed .28 W/m2K Windows HR++ <1.6 W/m2K | A - B EI: < 1.10 (calculated by engineers) |
| anodised aluminum windows, curtain walls penthouse and ground floor. Lihtly sunshading glazing. | Alumunium cladding, coated with sand and painted rust color. | | | |
| Aluminum windows + sandwichfacade Window profile: Reynaers CS77 (fixed & folding windows) | Glass in aluminum framing. Staircases (north and south facade) (insulated) sandwich paneling bronze sandwich facade. (reducing finishing costs) Aluminum fencing. Green tint glass | none | < .6 W/m2K | |
| Timberframe, cladding, window frames. Double skin on West side to shield from highway (acoustic insulation) | | | | A (EI .94 - 1.08) calculated by energy engineers |
| Floor to Floors aluminum facades, with sandwhich blind elements, West facade facing highway double skin with built in ventilation units, and operable window | | Ventilation, operable windows | | |
| | | | | |

| Installations | Outside space? | Outside space added? | Balcony Size | Window Wall Ratio |
|---|---|---|---|---|
| Central heating, per ap, mechanical ventilation | Semi, large operable windows, inside = outside | Semi,large operable windows. Balustrade was cutout to make space for larger windows. | NA | |
| | Semi, large operable windows, inside = outside | Semi,large operable windows | NA | |
| ? | NO | NO | NONE | |
| Climate ceiling University | yes | yes, hanging | 2200 x 3500mm 7.7 - 7.9$m^2$ | |
| | | | | |
| | | | | |
| Warm water and heating via central heating, mechanical exhaust ventilation. Floor Heating, solar panels on roof | Semi | French balconies added, some extra on roof of lower volume | 1st roof 22-27 $m^2$ French (4.5m2) 4th roof 17-59$m^2$ | |
| Solar panels on roof, LED lighting, mechanical ventilation (Balans Ventilatie) lack of sun shading posing problematic. Heating and warm water from central heating network | yes | yes hanging, added during construction as part of the cladding balustrade | 7.8 - 30.2 $m^2$ | |
| natural ventilation via suskast in façade | yes | Yes French, balconies were increased in size | | |
| all building services were renewed. Initial the offices were heated by a central gas fueled heating system. Currently the appartments and hotelrooms etc. are heated (and cooled) fully electric by air using fancoil units. A balanced ventilation system is integrated which extracts and reuses heat from the exhausted air. A downsized gasconnection remained for the stove in the rooftoprestaurant. | Internal French balconies, large vertical operable windows | SEMI, Large foldable windows, verticalfolding | NA | |
| Building is attached to the central heating grid, mechanical ventilation in hallways. Central warmwater pipe allows for heating and warmtap water per appartment. (surely also via heat exchanger) | Some appartements have minimal outside space due to Loggia added, this mainly for sound insulation | Minimal | <3.6m2 around 1.2m2 | |
| floor heating and cooling, balance ventilation, heat pump system | minimal, sound insulation space also a semi outside space (Serre) *windows open 135mm | not really, sunspace on highway side | 2m2 | |
| | | | | |

| Cost of Façade Trans | Cost of services trans | Façade Service integration? | | | |
|---|---|---|---|---|---|
| | | Curtains | | | |
| | | | | | |
| NA | NA | Minimal: natural ventilation | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| 2.5 - 3 million | | Low: Natural ventilation, sun shading | | | |
| | | None | | | |
| | | | | | |
| 2,6 mil | ? | none | | | |
| | | none, operable windows, curtains on building interior | | | |
| ? | ? | ventilation box, sun shading | | | |
| | | | | | |

# Appendix B

Questions for Architects: (to understand what effected the façade choice, in particular the design of the façade, how these choices effected the final result, and could this result have been improved?)

**Part 1: the boundary conditions**

*Future of transformation?*

1. What were the main requirements for the transformation as defined by developing party?
   a. Focus on sustainability
   b. User comfort?
   c. Focus on staying below/on budget
   d. Speed: from design to turnkey?

2. Was there a future/long term vision you were asked to pursue, or was the long term future of the building not considered?
   a. If so which design decisions were taken to insure the future proofness of said transformation? Timberframe?

3. Would you say that the building in its current redeveloped state is equipped to face the trial of time?
   a. Do you think that anything could have done to make this so? What could have been done to ensure this to a higher extent?

**4.** What would you say is the biggest difference between a conventional project and transformations?

**Part 2: The façade design**

5. Why was the final façade type chosen and what was the decision process?
   a. Was there any room for discussion in this decision process?
   b. Who made this decision (based on what)?

6. Was maintenance considered as an aspect of the façade design?
   a. Lifecycle costs of building vs initial cost…

7. Did the existing construction of the building effect the design decisions regarding the façade?
   a. Material, grid, ceiling height of the building

8. What was the financial impact of the façade design on the rest of the project, and what were the consequences? Or did the façade choice result from other design decisions?
    a. Such as services, balconies, structural costs, interior

9. Why were/weren't building services integrated in the building façade?
    a. Did energy consumption/production effect the façade design?

10. If you could change any aspect of the project, what would it be?

**Part 3: The future vision (PSS):**

11. Do you think that the reduction of initial costs would lead to facades of higher quality being used for transformation projects?
    a. With regards to services, balconies, energy consumption/production, integration with existing building

12. Which of these aspects would have the largest effect on increased user quality and why?

13. What would the drawbacks or advantages of a PSS façade solution be for you?

14. How do you think these advantages could be best exploited, could the drawbacks be overcome?

Questions for Constructors/Building entity: (to understand what effected the façade choice, who made the final decisions, which difficulties were encountered during construction, and the qualities a PSS façade should possess to be implemented consistently)

**Part 1: the boundary conditions**

1. What were the main requirements for the transformation as defined by developing party?
    a. Focus on sustainability
    b. User comfort?
    c. Focus on staying below/on budget
    d. Speed: from design to turnkey?
    e. Why transformation?

2. Do you think that the project was transformed in a way that ensures long term use until the end of life of the construction?
    a. Was the scenario of future vacancy considered during the design phase, and how this can be prevented, or dealt with if it occurs?

3. Was the design made by the architects changed in any substantial way?
    a. If so what was changed and why?
    b. Was maintenance considered during the façade choice and the design?

4. Who made the final decision regarding the façade type and how it would be built/assembled
    a. Was this decision limited by the boundary conditions?
        i. If so which conditions?

5. Why was the choice made to not implement any building services in the façade
    a. Such as ventilation, sun shading

**Part 2: building process**

6. What was the biggest difficulty regarding assembly of the façade during construction.

7. What in your opinion is the biggest difference between a transformation project and a conventional building project?
    a. How did this effect your approach to the assignment as a contractor?

8. Was any thought put into the cost of ownership (life cycle design of the façade)

**Part 3: future vision (PSS)**

9. If so do you think that budgets would decrease, or would building projects then increase in quality
    i. Sustainability
    ii. User comfort
    iii. Future proofness

10. Who do you envision would take the leading role in the implementation and servicing of a PSS facade?
    a. Maintenance, assembly, service, management

11. PSS will likely result in a more modular and standardized product, do you welcome this or do you see it as a hinderance?
    a. What would your concerns be? Technical, subcontracting?

12. Do you see such a product working in the building industry?
    a. What would the requirements be for such a façade, looking from your discipline?

Questions for Developers/Investors: (to understand why the transformed building was chosen, if there was a long term vision, what the requirements and goal was, how PSS façade may influence future decision making)

**Part 1: the boundary conditions**

1. Why are transformation projects a lucrative investment (An investment worth the risk)?

2. What did the decision process look like, in choosing the given project for transformation?

3. What qualities of the transformed project made it suitable to be transformed?
    a. Would you say the transformation was successful? Why?

4. To what extent did the target group choice effect the process of the development?

5. Why did you decide to retain the property after completion and not sell it to a future exploiting party, and how did this influence your decision making process during development?

**Part 1: the Project**

6. Do you think that the project was transformed in a way that ensures long term use until the end of life of the construction?
    a. Was the scenario of a different need on the market considered during the design phase, and how it can dealt be with should it occur?

7. What were your main requirements of the development of the building?
    a. In particular regarding the façade, were requirements made from your side as to what the façade should be able to do?
        i. Building services, user comfort, balconies

8. What was the main goal to be reached with the transformation project?
    a. Fulfill the need for housing
        i. Do this in a sustainable way?
    b. Remove vacant real-estate in a useful fashion?

9. To what extent are you involved in property management of a project after completion?
    a. Were aspects such as façade maintenance considered during the planning phase of the project, and who would take be responsible for this task?

**Part 3: looking ahead**

10. Have you had any experience with leased products in previous projects you were involved in?
    a. If so why, and if not what do you think is the reason for this?

11. What, in your opinion is the main advantage of conventional products, and what would the requirements for new products be?

12. If it meant that the design decisions became more limited, as the façade product was standardized to a certain degree, to allow for future changes to be made, would this deter you from wanting to implement such a product?
    a. Is this a choice that you would actively influence in the planning/building process?

13. Would the decreased financial burden of a leasing façade (as paid in rates) lead to an increased willingness to take the risk of transformation projects?
    a. And do you think that this decreased cost factor would lead to more transformation projects being realized?