Life Cycle Costs of Transformation

An LCC model for developers and investors for comparing costs and benefits of different intervention strategies for vacant office buildings

Master Thesis
Real Estate & Housing
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Colophon

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Preface

This report is written in the course of the fourth and final semester of the master programme of the Real Estate & Housing department of the Architecture faculty at the Delft University of Technology. The research is being conducted at the Design and Construction Management laboratory. The total graduation track is divided into 5 survey points, of which this the final Master Thesis report.

This research started with my interest in the vacancy problem in the Netherlands and the transformation of existing buildings. This can be seen as the task for the future, as most of Dutch real estate has already been build. The high vacancy rate in the office market poses problems, but also holds opportunities for the future. Recent developments like the devaluation of vacant office buildings and a growing demand in housing present opportunities for transformation from office buildings into housing.

This report consists of an introduction of the research subject, followed by a research proposal, research method, and research organisation. The context of the research proposal is provided by a literature study on the specific subjects of this research. The theory is then approached from practice in the empirical part of the research. This is divided in case studies and interviews. With the acquired knowledge of both parts of the research an LCC model is made that allows the comparison of different intervention strategies for vacant office buildings. Finally conclusions and recommendations are drawn.

Thanks to everyone who has contributed to my graduation research. In particular my mentors from the TU Delft Peter de Jong and Hilde Remøy, Ton Boon my supervisor from Maarsen Groep, and Vincent van Sabben & Alexander Aksu from IGG Bointon de Groot.

Enjoy reading.

Jelle de Groot // Den Haag, June 2014
Management Summary

Introduction
The current vacancy level of office buildings is almost 15% of the total office supply and is still rising. This comes to over 7 million vacant square meters of vacant office space of the total 48 million square meters supply in the Netherlands (DTZ, 2013). There are different intervention strategies for dealing with these vacant office buildings: consolidation, renovation, transformation, and demolition & new-build.

There is a knowledge deficiency of the costs and benefits of transformation as compared to consolidation, and demolition and new-build. Developers and investors need additional knowledge on transforming vacant office buildings into housing, from a Life Cycle Costing (LCC) perspective. This research limits to the ‘profit’ aspect of transforming vacant office buildings into housing (Chapter 1.13).

Methodology
This research answers the questions how an LCC model can be developed and used to compare the economic costs and benefits of the different strategies for a vacant office building. This is a qualitative research that is divided into a theoretical part, an empirical part, and the building of the LCC model. The theoretical part consists of a literature study to set up a theoretical framework. The empirical part is conducted with the use of case studies and interviews. The three parts of this research were used to address the problem statement and answer the research questions.

Theoretical and Empirical research
The theoretical and empirical research focuses on distinguishing the variables that have a significant influence on the operating costs and benefits of each of the strategies. These variables therefore influence the financial result of each strategy that is used to determine which strategy is financially the best option. The following 7 cases were analysed, with a focus on the operating costs:

<table>
<thead>
<tr>
<th>Cases</th>
<th>Location</th>
<th>Construction Year</th>
<th>Transformation Year</th>
<th>Units</th>
<th>GFA</th>
<th>Information Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>De Stadhouder</td>
<td>1974</td>
<td>2005</td>
<td>70</td>
<td>7500</td>
<td>VvE</td>
</tr>
<tr>
<td>2</td>
<td>Brinkwal 7</td>
<td>1988</td>
<td>2013</td>
<td>25</td>
<td>1851</td>
<td>Corporation</td>
</tr>
<tr>
<td>3</td>
<td>Bomansplaats</td>
<td>1976</td>
<td>2011</td>
<td>107</td>
<td>3600</td>
<td>Commercial Party</td>
</tr>
<tr>
<td>4</td>
<td>Westerlaantoren</td>
<td>1962</td>
<td>2012</td>
<td>45</td>
<td>9000</td>
<td>VvE + Maarsen Groep</td>
</tr>
<tr>
<td>5</td>
<td>Wilhelminastraete</td>
<td>1969</td>
<td>2007</td>
<td>43</td>
<td>8500</td>
<td>Property Manager + VvE</td>
</tr>
<tr>
<td>6</td>
<td>Churchiltorens</td>
<td>1970</td>
<td>1999</td>
<td>120</td>
<td>27840</td>
<td>Property Manager + VvE</td>
</tr>
<tr>
<td>7</td>
<td>De Studio</td>
<td>1960</td>
<td>2011</td>
<td>320</td>
<td>14633</td>
<td>Corporation</td>
</tr>
</tbody>
</table>

With the case studies and interviews the following variables were found to be of a significant influence on the financial result of the transformation project.

Preparation & Construction period
The preparation and construction period of some of the projects was indeed very short compared to a new building project. If this period is shorter, the investment costs are likely to be lower.

Operating Costs
In the operating period the following variables have the largest influence on the costs and benefits: the rent, the maintenance costs, the energy costs, taxes, and the management costs.

UFA/GFA ratio
The UFA/GFA ratio determines a large part of the rental income of a building. The bandwidth of the UFA/GFA ratio is very wide and can be as high as new-build. This is therefore an important aspect of a transformation and needs to be a variable in the LCC model.

Energy Label
The specific energy use of the cases was not retrieved. However the energy use is directly linked to the energy label. The label of a transformed building can be assumed to be lower than the minimum A+ that is required for new buildings.
**Maintenance Costs**
The maintenance costs were the largest part of the cases that were analysed. With all cases the maintenance costs were determined in a MJOP. The MJOP consists of preventive, corrective, and replacement costs. The MJOP however is calculated on element level and far too detailed for the purpose of this research and the decision between the strategies.

**Rental Income & Residual Value**
New-buildings can differ in rental price from transformed building because of a difference in UFA/GFA ratio and the energy label. The rent will have an extremely important affect on the financial result of the strategies. In addition the residual value of the strategies will also differ and influence the financial result.

![Image]

**Conclusions**
The main goal of this research is to compare different intervention strategies for vacant office buildings on their life cycle costs and benefits. The empirical research served as input for the model, as well as to find out what the most important differences between transformation and new-build are. The most important differences are those variables that have a large influence on the costs and benefits of the different strategies. The important variables that were distinguished in the theoretical and empirical research were included in the LCC model and resulted in the following conclusions.

**Consolidation**
The negative financial effects of consolidation only become apparent with a long-term perspective. Consolidation has a negative financial result with a long-term view because of the on-going operating costs and the owner needs to account for the costs that in rented state are for the tenant. In addition vacant office buildings have a small chance of being rented in the future due to the current and predicted market conditions. A vacant office building can be assumed to depreciate to zero in a lifespan of 30 years while the other strategies create value and limit the financial losses.

**Operating Costs**
The most influential categories of the operating costs are the maintenance costs, energy costs, financing costs, and rental income. One of the starting points of this research was the discussion concerning the ratio between the investment costs and the operating costs. Evans (1988) initially set this ratio at 1:5:200 for the investment costs, operating costs, and business costs. This ratio was later lowered to more probable ratios by Hughes (2004) with 1:0,4:12 and IVE with 1:1,5:15 (De Jong, et al, 2014). In this research a ratio of 1:0,55 was found for the investment and operating costs.

**Energy Label**
The most important difference in operating costs between new-build and transformation is caused by the difference in energy costs and benefits. The current Dutch office supply is in poor condition in terms of the energy labels. The few cases from the case studies with energy labels have lower energy labels compared to new buildings. The energy label is mostly in the favour of new-build, this should be a point of interest with transformation. Increasing the sustainability of transformation can help increasing the benefits of transformation as opposed to new-build.

The façade was appointed as the largest cost category of a transformation project in previous researches. If the façade and installations could be maintained, this would have a positive effect on the financial result of a transformation. This short-term approach does not take the effect of these interventions on the
operating period into account. Replacing the façade and installations might negatively influence the investment costs, but it results in a higher energy label and consequential higher rents and value of the building.

**Maintenance costs**
The maintenance costs for new buildings and transformed can be assumed to be the same, if with transformation the installations, roof, etc. are replaced. If elements are maintained it will have an influence on the maintenance costs. Large expenses on major maintenance are divided equally over each year of the remaining lifespan of each element. The total annual maintenance costs can be assumed to be higher with older elements, since the remaining lifespan of these elements is shorter than a new element.

**Rental Income**
The amount of rental income significantly influences the financial result of the different strategies. Two variables that create the difference between transformation and new-build are the UFA/GFA factor and the energy label. These both work in favour of new-build, however with the right focus and building selection transformation can have equal amounts for both of these variables.

**Influence of time**
With each development it is financially beneficial if the preparation and construction periods are kept as short as possible. This can reduce the investment costs, as well as bringing the rental income forward in the cash flow. The case studies showed that the longer a project took, the higher the total investment costs were. The development period can be shorter for transformation than new-build, because the structure can be re-used. This is an advantage that needs to be utilized, since transformation projects also can take a lot longer than expected if not properly prepared. This influence of time was not included in previous financial feasibility study models. Since it plays such an important part in the financial result of a project it has been included in the LCC model in this research.

**Lifespan**
Different types of actors use different lifespans for investments in buildings. Corporations mostly focus on a lifespan of 50 years, while commercial parties are a lot more flexible and focus anywhere between 5 and 25 years. By approaching vacant buildings with a more flexible lifespan, many more transformation might get off the ground. Considering the rapidly changing society and developments of the demographics the question arises whether buildings should be constructed with a long intended lifespan. If the demand changes after a shorter period, a building should be able to adapt to the new situation. Transformation in that case seems a more suitable strategy than a new building that is specially built for a certain demand.

**Scale**
The cases showed a positive relation between the size of a building and the operating costs. This relation can also be found with the investment costs. The larger scale of the building is the reason behind this. In the operating phase this can be explained by the fact that many of the contracts, like for instance cleaning and maintenance, and the management costs are less per m² for a larger building.

**Difference financial feasibility and LCC approach**
Purely looking at the investment costs of the different strategies, transformation is often preferable. This is very case specific, but since transformation starts with an existing structure costs and time can be saved. If the number and costs of the interventions is increased for transformation, the construction costs rise steeply and can become just as high as new-build.

Depending of the UFA/GFA and energy label of the transformation option new-build can result in higher rental income. On the other hand new-build does often require a higher investment. This means on the short-term less investment and transformation might be financially more attractive, but over a lifespan of 30 years the higher rental income of new-build might have a financially better result. Some investors however cannot or do not want to invest more in a development, since more equity is needed.

**Conclusions Test Case & Monte Carlo simulation**
The operating costs have a significant influence on the decision between the different strategies, depending on the input and variables of the model and case. Furthermore a short-term approach can favour a different strategy than a long-term approach.
The Monte Carlo Simulation is capable of providing insight in the risks and uncertainties of the strategies and the certainty of a financially feasible project. The sensitivity analysis gives an overview of the effect of the different variables and assumptions in the model on the end result and NPV. The construction costs for instance, which are normally the focus of feasibility studies, in the simulation of the test case had between 4,1% and 7,4% influence on the end result in relation to the other variables. This is comparable to the effect of the energy indexation that influences the operating costs. This shows that merely looking at the construction costs is an inadequate approach for the decision between the intervention strategies.

The Monte Carlo Simulation is suitable for assisting the user of the model in the decision making process, rather than providing a clearly defined decision. This way it helps reducing risks and uncertainties, as well as increasing the profitability by redefining the input and variables of the project.

Conclusion of the LCC model

<table>
<thead>
<tr>
<th>Energy Label</th>
<th>Transformation</th>
<th>Demolition &amp; New-build</th>
<th>Consolidation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Investment Costs</td>
<td>€ 21.603.491,23</td>
<td>€ 26.392.060,48</td>
<td>€ 2.408.281,57</td>
</tr>
<tr>
<td>Investment Costs / GFA</td>
<td>€ 1.799,99</td>
<td>€ 2.198,97</td>
<td>€ 200,66</td>
</tr>
<tr>
<td>Total Operating Costs / year</td>
<td>€ -404.929,45</td>
<td>€ -528.623,35</td>
<td>€ -404.580,87</td>
</tr>
<tr>
<td>Total Operating Costs (30 years)</td>
<td>€ -12.147.683,41</td>
<td>€ -15.858.700,49</td>
<td>€ -12.137.426,02</td>
</tr>
<tr>
<td>Operating Costs / GFA / year</td>
<td>€ -33.74</td>
<td>€ -44.04</td>
<td>€ -33.71</td>
</tr>
<tr>
<td>Operating Costs / GFA (30 years)</td>
<td>€ -1.012,15</td>
<td>€ -1.321,34</td>
<td>€ -1.011,28</td>
</tr>
<tr>
<td>Ratio Operating / Investment</td>
<td>0,56</td>
<td>0,60</td>
<td>5,04</td>
</tr>
<tr>
<td>Potential Value (GIY)</td>
<td>€ 21.665.670,07</td>
<td>€ 25.015.827,11</td>
<td>€ 7.001.166,67</td>
</tr>
<tr>
<td>Result (year 0)</td>
<td>€ 62.178,84</td>
<td>€ -1.376.231,37</td>
<td>€ 4.592.885,09</td>
</tr>
<tr>
<td>Total Revenues / year</td>
<td>€ 1.098.372,05</td>
<td>€ 1.288.947,78</td>
<td>€ 13.650,56</td>
</tr>
<tr>
<td>Total Revenues (30 years)</td>
<td>€ 32.951.161,56</td>
<td>€ 38.668.433,40</td>
<td>€ 409.516,95</td>
</tr>
<tr>
<td>Revenues / GFA / year</td>
<td>€ 91.52</td>
<td>€ 107,39</td>
<td>1,14</td>
</tr>
<tr>
<td>Revenues / GFA (30 years)</td>
<td>€ 2.765,47</td>
<td>€ 3.223,83</td>
<td>34,12</td>
</tr>
<tr>
<td>Residual value</td>
<td>€ 7.639.716,33</td>
<td>€ 10.287.621,25</td>
<td>€ 409.516,95</td>
</tr>
</tbody>
</table>

The model itself is the answer to the main research question. To compare different strategies with a Life Cycle Costs model the most important costs and variables need to be determined for each strategy. Since the calculations for a transformation project are unique and case specific, a lot of information and input is required. The LCC calculation needs to be on a detailed element level to accurately determine the construction costs and operating costs. Even though this level of detail is necessary to make an accurate calculation of the costs, it is not relevant for the decision between the different strategies.

In the model many assumptions are made. These assumptions are used to indicate what the consequences are of decisions in the investment phase on the operating phase and total life cycle costs. This way the model gives an indication of what financially the best strategy for a vacant office building. The results are then substantiated with a Monte Carlo simulation that focuses on the risks and uncertainty of the development.

The output of the model, shown in the figure above, will not provide the user with clear demarcated decision. The model enables the user to understand the effect of decisions in the initiative phase on the total Life Cycle Costs of the different strategies. The user can therefore adjust the decision to choose financially the best strategy and optimize the total Life Cycle Costs. This is a different approach to finding vacant office buildings that are feasible for transformation or are better suited for demolishing and new-build.
Abstract

Purpose – The goal of this research is to explore the costs and benefits of different intervention strategies for vacant office buildings from a life cycle costing perspective. Taking into account the operating period of transformed office buildings provides insight in the actual financial result of transformed buildings compared to demolished and new-build. With the LCC approach the gap between the developer and the investor, and the investment- and operating costs with transformation can be bridged.

Design/methodology/approach – This research conducted seven case studies of transformed office buildings into housing. The cases were examined with reference to the Life Cycle Costs. Corresponding interviews were held for the cases. Combined with the theoretical framework of the literature study an LCC model could be made that compares the investment and operating costs of different strategies.

Findings – The variables that have the largest influence on the costs and benefits of different interventions strategies were analysed in this research. These variables are integrated in the LCC model.

Originality/value – The Life Cycle approach to the vacancy problem can influence the decision for different strategies.

Keywords: Transformation, Life Cycle Costs, Office Vacancy, Strategies, Decision-Making Process, Sustainable Development
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Research Design
Part 1 | Research Design

In this section the research design of this report is explained. First an introduction to the research subject is given, which serves as background information for the research. This chapter is followed by the description of the research methodology of this research, including a conceptual model. The first part ends with the research organisation.
1 Introduction to the Research Design

This chapter introduces the research design of this thesis. It includes a problem analysis, problem statement, relevance, related research, personal motivation, vision and profile, study targets, related research, and the demarcation with the boundaries of this research.

1.1 Introduction

The current vacancy level of office buildings in the Netherlands is almost 15% of the total office supply. This comes to over 7 million vacant square meters of vacant office space of the total 48 million square meters supply (DTZ, 2013).

According to research of Joëlle Lokhorst et al. (2013) the current hidden vacancy will increase the total Dutch vacancy rate to 28% in the next five years. Hidden vacancy is the excess floor space that companies have and will divest when their contract ends, this will come on top of the already high vacancy rate. This shows that the vacancy problem will only increase in the future. The vacancy problem is a complex problem and is caused by multiple factors. The vacancy problem also holds opportunities, for instance if vacant buildings are depreciated to a lower value (figure 1). This creates opportunities for different interventions strategies for the vacant building.

The qualitative and quantitative mismatch of the current office market will not solve itself without any interventions. Different strategies can be used to address the vacancy problem, of which the determination of the financial feasibility of a strategy often poses an obstacle. Transformation is often assumed to be less costly than demolition and new-build, however this proves to be very case specific and should therefore also be determined specifically for each case.

![Figure 1, Vastgoedmarkt (2012)](image1)

![Figure 2, Office Vacancy retrieved from www.dft.nl](image2)

1.2 Problem Analysis

Market

First of all there is a mismatch between supply and demand in the current real estate market. This mismatch is the cause of the office vacancy problem. There is an oversupply of (low quality) office space, simply put; too much office space has been build. One of the main causes for this mismatch to occur is often described using the pig cycle of Mordecai Ezekiel (1938). This cycle shows the slow reaction of supply to the dynamic characteristics of demand. Around the turn of the century the demand for offices was high. This resulted in an increase in prices, therefore construction started for many new office buildings. When these buildings were finally completed the demand had decreased due to, among others, the economic crisis. There was a surplus of office buildings that could not be filled anymore. This over supply started to shift the Dutch office market from a growth market to a replacement market. In a replacement market new office buildings are delivered, leaving older office building behind vacant.

Supply

The high vacancy rate in the Netherlands is caused not only by the economic crisis, but also due to the unrestricted new building of the past and less need in floor space as a consequence of the New Way of Working (figure 4) (Schmidt, 2012). The vacancy rate is the largest in the satellite towns of the larger cities in the west of the Netherlands in the so-called 'Randstad' (Remøy, 2011). Amsterdam is among the...
worse vacancy rates with 18% of the total supply (Vastgoedmarkt, 2013). Without intervention in these vacant office buildings, most of these buildings will remain vacant (Muller, 2008).

**Demand Offices**
A few trends are noticeable that have an effect on the demand for offices. First of all the number of office jobs is decreasing. The number of office jobs is an indicator for the demand in office floor space. Secondly the average floor space per employee is decreasing, among others due to the new way of working. Figure 3 shows this decline in office space per employee. The decrease in demand is the quantitative mismatch for offices.

![Figure 3, LFA office space (DTZ Zadelhoff, 2013)](image)

Besides the quantitative mismatch, there is also a qualitative mismatch between demand and supply within the office market. The New Way of Working changes besides the quantitative, also the qualitative demand for offices. A different office lay-out is needed, which is different from the old offices. Furthermore a trend towards inner city locations is noticeable, which puts pressure on the outer city office locations.

Joëlle Lokhorst et al. (2013) describe a trend of smaller organisations with an increasing demand for flexible offices with shorter and more flexible rental contracts in buildings with multi tenants. These organisations have neither the demand nor the means to have a new office building developed.

**Housing**
On the demand side, there is a growing need for housing. The reason is that not enough new houses have been built, and the consistency of the households is changing. This is because the average number of persons per household is declining. Especially the demand rises in student, starter and elderly housing. According to Primos institute, another 578.000 dwellings must be added between 2010 and 2020 (den Otter et al., 2011).

The relation between the vacancy problem on the supply side and the housing shortage on the demand side has often been made; transforming vacant office buildings into housing, and by doing so solving both problems at once. Demolition and transformation are ways to reduce the vacant office space. Although transformation of office buildings into housing seems to be a solution where both problems can be solved, it's still not happening on a large scale. Among reasons given for this are; mono-functional office locations, the fictitious high book value of the assets, small financial margins, the inflexibility of investors to change between profiles and the complexity of the transformation projects.

**Operating phase**
In the NEPROM (2012) report ‘Aanpak Kantorenleegstand’ Nicole Maarsen from Maarsen Groep advocates for a Life-Cycle approach to the vacancy problem, where investment and operation are treated as a whole and with a close collaboration between developer and investor, each with its own expertise. The building should not become a ‘tailored suit’ for the first user, since after this user leaves also the next user will need to be able to use the building. Therefore the best building is needed that suits the location and the future needs of the users.

The often quoted ratio of 1:5:200 (Evans, et al., 1998) implicates that the costs of an office building are 1 on construction costs, 5 on maintenance and building operating costs, and 200 on business operating
costs. After an additional research, a different more plausible ratio of 1:0.4:12 was found. Even though these results differ a lot from each other and could not be compared, they show that the largest part of the costs of a building come after the construction phase (Hughes et al., 2004). This means the operating phase of a building is extremely important. Instead of focussing on purely the construction costs, as is currently mostly done by financial feasibility studies, the operating phase should be included. As Mackay (2008) already indicated, in the short-term transformation will be a more expensive option compared to other building interventions. Therefore it seems relevant to look at the long term of a building process, including the operating period. Currently all financial feasibility studies are focussed on simply the investment period.

According to Geraedts and Van Der Voordt (2005) there is a knowledge deficiency on costs and benefits of transformation projects in the operation phase. Since then research has been carried out on this theme, but most research on the feasibility of transformation projects is limited to the investment phase disregarding the operating phase. Looking at the entire life cycle of a building is important for making the right decision between different intervention scenarios for vacant office buildings on the long run. The British Standards Institution (2008) states that LCC is a common way in the UK construction to undertake an option appraisal study in order to evaluate various solutions to a given design and construction problem. This method therefore also seems useful as a tool to evaluate the possible intervention strategies for vacant buildings.

**The operating costs of vacancy**
The investors that own vacant office buildings commonly choose not to take any actions for their vacant buildings for a variety of reasons. They commonly choose to lower the rent and hope for a future tenant. The vacant office is often part of a larger portfolio and the investors have enough return to pay of the financing costs of the building, this will be further elaborated on in chapter 5.5. However often the fact is overlooked that the operating costs of vacant office buildings don’t stop. These costs can even be higher for the investor than a building that is completely rented, because some of the costs like energy costs of the tenant are now for the investor. When assuming that the vacant office building will not find a new tenant, which is very probable with the increase in the vacancy rate, the building will cost more money each year. Only postponing the inevitable needed intervention in the office building (Trouborst, 2012).

The current short-term approach to vacant offices with financial feasibility studies on merely the construction costs therefore does not seem sufficient for addressing the vacancy problem. Since consolidation doesn’t require a large investment as is the case with transformation or demolition & new-build, this scenario will always come out favourable from a short-term financial point of view.

**The influence of time on the financial feasibility study**
In a research recently conducted by DSP-groep several cases were studied and concluded in 7 recommendations. An interesting recommendation is the fact that commercial parties were better at creating a more profitable result compared to the corporations. This difference can be devoted to the smart timing of the acquisition of the objects as well as the careful selection of suitable office buildings and thorough financial feasibility studies (Dieters, et al., 2014).

This recommendation suggests that the timing of the acquisition and the following construction period have a large influence on the financial result of a transformation project. This timing factor is something that is not taken into account in the current financial feasibility studies, which primarily focus on the assessment of the construction costs.

**Demolition & New-Build or Transformation**
It is often claimed that transformation is more sustainable and cheaper than demolition and new-build, however there is no research that compares the costs and benefits of these two interventions. One of the recommendations from research by Laurens Buenting (2012) for follow up research is the sustainability of transformation opposed to demolition and new-build. According to his research actors prefer to demolish and new-build, because it generates more income en is more sustainable.

A study by DHV (2011) found that the demolition & new-build of a former tax office in Utrecht was more sustainable than transformation. The research received a lot of criticism, because DHV only looked at the energy costs rather than all the other costs involved, like material costs. Also Bullen et al. (2009) state that it sometimes can be easier and cheaper to demolish and start from scratch, since new materials and
new installations can reduce maintenance and energy costs. Studies like this contradict the commonly assumed benefits of time and cost savings related to transformation. Even though there was a lot of critique on the way the research on how for example the DHV research was carried out, the studies show that there is no consent as to which intervention method is better. The criticism of the studies shows that the decisions that are made concerning the way the research is carried out and the demarcation of the research have a large influence on the end result of the study.

Little research exists that, besides stating pros and cons of the two options, weighs the actual costs and benefits of the different intervention strategies. The current transformation models and tools are aimed at financial feasibility studies of the construction costs, but are not able to compare different intervention options. Figure 5 shows the knowledge deficiency for developers and investors to find the best strategy for a vacant office building from a LCC perspective, including all costs and benefits during the lifespan.

Figure 5, Problem Analysis; What is the best strategy for a vacant office building from a LCC perspective

1.3 Relevance

Scientific

Firstly there seems to be a knowledge deficiency concerning the decision whether to transform or demolish & new-build. Already research has been done on the financial feasibility (Mackay, 2008) (Muller, 2008) (Schmidt, 2012), environmental feasibility (Jansz, 2012), and functional feasibility (Schenk, 2009). The financial feasibility studies however all focus on the financial feasibility of transformation, rather than comparing the possible different intervention strategies. A better comparison model is needed to assist investors and developers in the decision process for which intervention is financially most suitable for a vacant office building.

Secondly most recent research focuses on the construction costs of a project to measure the financial feasibility. The importance of adding the operating phase to the feasibility study is not discussed in previous studies and is therefore key to this research. The environmental feasibility study of Sascha Jansz does focus on the entire life cycle, but not on the financial aspect of it. A shift towards a life cycle approach is noticeable with developers and investors, who are becoming more aware that taking into account of the operating phase is important for the investors to secure their intended return. Investments in real estate mostly have a payback period of several decades. These investments should therefore be based on a long term perspective rather than focusing on just the investment period. Including the operating phase is a way of creating sustainable buildings with a long-term perspective.

The research that has already been carried out falls short on the two points above; a financial feasibility study instead of the economic comparison of the intervention strategies of transformation, and the focus on the entire life cycle costing and benefits of the options. This will therefore be the focus and starting point for this research.
Societal
With more than 7 million square metres of vacant office space, which is a number that is only increasing, the vacancy problem seems obvious for the society. The vacant office buildings have a negative influence on the surroundings. They negatively influence the liveability and business climate for offices, the image of the location, the social security, and cause impoverishment. Besides that it is a waste of space and capital (Agentschap-NL, 2013). When looking at the current and foreseen future growth in vacancy of office buildings, transformation or demolition and new-build will be the task for the future (Steinmaier, 2011). In order to address the vacancy problem the best intervention for vacant office buildings is important. This research focuses on a life cycle approach to the financial feasibility of different intervention options of vacant buildings. Therefore it helps to solve the societal problem that is caused by the large number of vacant office buildings.

Newspaper articles and real estate magazines show that vacant buildings are finally starting to get revaluated, making it possible for transformation to take place on a larger scale. Therefore it becomes even more important for a model to help support the decision for the right intervention. A decision supportive model helps transformation projects to get started and decrease the uncertainties that come with transformation projects. The uncertainties are an important reason why transformation projects often don’t get off the ground. Besides that the model shows what the long-term financial consequences are of consolidation.

Practical
This research expands the knowledge on the decision making process for strategies for vacant buildings. In practice developers and investors can make use of the results and model to make measured decisions concerning vacant office buildings and transformation projects. This research can therefore substantiate the ‘gut feeling’ on which decisions by developers are often based and support it with quantitative data. It can increase the efficiency of the decision making process and provide more and easier-available knowledge.

There is a sectorial separation of the real estate market, which is created by the different approaches to real estate by developers and investors. In principle investors do not develop, and developers do not invest in real estate for a longer period (Remøy, et al., 2014). If in the initiative phase the LCC model is used, it can provide insight in the financial costs and benefits of both parties.

This research has sought to provide in depth knowledge on the life cycle costs that are involved with transformation projects and put in perspective with other strategies for vacant office buildings. Since the costs and benefits involved are different for each building, the LCC model helps investors with budgeting the costs and benefits of the different strategies for a vacant office building.

1.4 Problem Statement
It is unclear, which intervention strategy is financially the better option for vacant office buildings. Developers and investors don’t have a model yet for comparing the costs and benefits of transformation with demolition & new-build. It is therefore important to look at what the costs and benefits are and how they differ for different actors. When concluding the problem analysis above, the following problem statements results:

- There is a knowledge deficiency of the costs and benefits of transformation compared to consolidation, and demolition & new-build. Developers and investors need additional knowledge on transforming a vacant office building into housing, from a LCC perspective.

1.5 Research Questions
The main question resulting from the problem statement is as follows:

How can a LCC model be developed and used to compare the economic costs and benefits of different strategies for a vacant office building?
Sub-questions:

**Costs & Benefits**
- What are main costs of transformation projects?
- What are main benefits of transformation projects?
- How do these costs and benefits differ from new-build projects?
- To whom are these costs and benefits?
- How can these costs and benefits be determined?

**Transformation Tools**
- Which transformation strategy decision tools are currently available?
- Can these tools be used for the comparison model between transformation and demolition & new-build?

**Decision-making process**
- How is the decision for the intervention strategy currently made? Based on what information?
- Where in the process is this decision made?
- Which indicators or aspects influence the decision for the developer and investor?

**Operating Costs**
- Can existing vacant offices be transformed to the same or better efficiency level as new buildings?
- What is the influence of adding the operating phase in the decision making process?
- Which interventions have the largest influence on the operating costs?
- Under what circumstances is transformation financially a better option than demolition & new-build?

1.6 Final Result

The result and goal of this research is a Life Cycle Costing model based on the NEN2699 (2013) Norm, which can evaluate what the financial results of consolidation, transformation or demolition and new-build of a vacant office building is.

![Figure 6: Final Result LCC Model](image)

As a part of the LCC model the operating costs of transformation projects are gathered. When linked to the interventions made in the transformation these results provide insight in the consequential operating costs of certain interventions.

1.7 Target Group

This research will be aimed at developers and investors, who can use the LCC model to make a well thought-out decision whether to transform a vacant office building or not. An important obstacle for transformation is the discrepancy between the calculation methods of the developer and the investor, which causes a gap at the negotiations concerning the acquisition of land and property (Muller, 2008).

The sectorial separation of the real estate market plays an important role in the current low number of office transformations into housing. The investor and developer have different interests and time horizons in real estate. The developer does not invest in real estate for the long term, while the investor does not actively develop real estate. This distinction has resulted in different financial approaches to real estate (Remøy & Van der Voordt, 2014).
When combining the investment and operating phase in one financial model the financial performance becomes more transparent and this gap can possibly be bridged. The relation and relevance of the developer, investor and other actors to the research subject is further elaborated on in chapter 5.5.

According to Bullen et al. (2009) a key decision that many owners and occupiers are confronted with is whether to demolish or transform a building that does not meet the needs any more, as is the case with structurally vacant office buildings. The Dutch development market is shifting towards a replacement market. Investors are finally willing to revalue towards more realistic book values of their assets. These two trends in the Dutch market make it more than ever important for developers and investors to make the right decision about the proper intervention method for vacant office buildings.

1.8 Motivation
During my master studies I gained interest in a few different themes, which I find to be important for the future. For my final bachelor project of architecture, I did a transformation project of an old gasworks to a theatre. This project started my interest in transformation projects. Since most of the real estate in the Netherlands has already been build, transformation seems to be the task for the future. It’s no secret that there is a big vacancy problem with office buildings in the Netherlands.

Because on the one hand the vacancy rate problem is getting worse and might reach 28% and on the other hand opportunities for transformation seem to be growing, this subject interested me for my graduation thesis. Already a lot of research has been done within the theme transformation and all related research and graduation research are listed in the Position Paper of the Real Estate & Housing faculty of the TU Delft (Remøy, 2013). It concludes with the focus for future research, and the specific topics for which more knowledge is needed. Some of these topics corresponded with my interest and where therefore a good starting point for this research.

1.9 Vision
Building transformation and vacancy are important topics in the current Dutch office market. Still the number of vacant office buildings is increasing and the number of successful transformed offices remains limited. There is a knowledge deficiency on the strategies for vacant office buildings and a lack of long-term perspective. The vision for this research is to provide a foundation for the decision for the best intervention strategy for vacant office buildings.

The role of developers and investors in real estate is changing. A change needs to be made towards a Life Cycle approach of real estate. This demands a close collaboration between developers and investors, where each uses its own expertise. For choosing a strategy we need to look at the entire life cycle costs and benefits rather than just the construction costs, as most financial feasibility studies currently do. This will provide better foundation for the decision which intervention strategy is the best option. With Life Cycle Costing all the costs and benefits of the entire life cycle of the different options will be covered.

The LCC approach is necessary to compare transformation with demolition & new build, because many of the costs and benefits of a building will be in the operating phase. This research can give insight in the actual performance and costs & benefits of transformed office buildings into housing. This research will therefore show the effect of adding the investment costs and operating costs to the financial feasibility studies of the intervention strategies of vacant office buildings.

1.10 Profile
This research provides me with better understanding about the way developers and investors approach the current vacancy problem in the Netherlands and the practical experience with transformation projects. This research will provide me with knowledge on the decision to transform or demolish and re-build vacant office buildings. By looking further than just the investment period of the buildings, better decisions can be made. With this research I want to expand the knowledge on the transformation process and strategies for vacant office buildings and go in depth on the modelling of the LCC of buildings.

1.11 Study targets
Aim
The aim of this research is to broaden the knowledge on transformation costs and benefits. So that this research can be used in order to help the decision making process for vacant buildings whether
transformation, demolition & new-build or perhaps doing nothing is a better option. Besides broadening the knowledge, this research will focus specifically on comparing the different intervention strategies. By modelling all the costs and benefits of the investment and operation phase in the Life Cycle Cost model, the model will give an overview of the buildings life cycle of each intervention option. Finally it will be possible to compare the economic results of each option.

**Goal**
The goal of this research is to explore the costs and benefits of different intervention strategies for vacant office buildings from a life cycle perspective. Taking into account the operating period of transformed office buildings in addition to the investment costs provides insight in the total life cycle costs of the different strategies for vacant office buildings.

**Personal targets**
- Knowledge and skills of scientific research
- Gain knowledge on the design and construction process
- Gain knowledge on the transformation process of buildings
- Gain knowledge about managing a (re)development project
- Insights in the way decisions are made concerning vacant office buildings
- Practical experience with developers and investors with transformation projects
- Gain knowledge on costs and benefits analysis
- Gain knowledge on Life Cycle Costing and cost modelling
- Gain knowledge on the Dutch real estate market

**1.12 Related Research**
This research is being conducted in the Design & Construction Management laboratory of the Real Estate & Housing department of the Architecture faculty of the TU Delft. Within the entire department of RE&H, transformation has become the main theme.

Previous research related to my research topic is:
- Agentschap-NL (2010) conducted a research titled "Kiezen voor nieuwbouw of het verbeteren van het huidige kantoor" and is strongly related to this research. The report focuses on the 'planet' aspect of the 3P model and also uses a LCC approach. Different strategies for a vacant office building are plotted against each other. The final assessment model is similar to the LCC model of this research.

Agentschap-NL chose 5 different intervention strategies for vacant office buildings:
1. Consolidation
2. Minor Renovation
3. Major Renovation
4. Demolition & New-Build
5. Demolition & New-Build, after a period of vacancy

The strategies do not include a change of function, as is the case with transformation. The fifth strategy is interesting as it shows the effect of the period of vacancy, compared to the fourth strategy that omits the vacancy period. Furthermore the lifespan is chosen for 10 years for the consolidation strategy, however they assume in this strategy that the building is leased and not vacant. The remaining lifespan for the minor renovation is extended to 25 years. For the major renovation 40 years is assumed, including an additional minor renovation after 25 years. Finally the new-build will have a lifespan of 50 years, also with a minor renovation after 25 years.

The study is carried out by using reference buildings with different years of construction. Two buildings were used from 1980, two from 1990, and two from 2000. The different years of construction can show if there is a different strategy more ideal for those buildings.

The result is the environmental impact per strategy depicted as a shadow price in € per square meter Lettable Floor Area (LFA) per year. In figure 7 the results of the research are shown. It shows that there is definitely a relevant decision that needs to be made for the best intervention strategy. Interesting is that they use the first scenario, consolidation, as comparison for the other strategies.
Since this research only focused on the 'planet' aspect of the strategies, their recommendation is to carry out additional research on the 'profit' and 'people' aspects of the strategies.

- Sascha Jansz (2012) did her thesis on the effect of the Estimated Service Life on the sustainability of vacancy strategies. This is also a LCC approach, which focuses on the environmental aspect. My research in contrast focuses on the economic aspect.
- Mackay (2008), Muller (2008), Schmidt (2012) focused their graduation research on the financial feasibility and building costs of transformation projects. However, they all focus on the investment period of the transformation process and omit the operating period of transformed buildings.
- Schenk (2009) conducted his research paying attention to the functional feasibility of office transformation. He analysed different types of offices in relation to their potential for transformation.

### 1.13 Demarcation

This research needs to be conducted within a defined period of time; therefore the research will be demarcated in order to define the limits of the research.

#### Limitations

This research is limited to transformation of office buildings into housing. Different types of offices and office building characteristics can influence the construction costs involved. Most successful office building transformations are offices on good locations, characteristic offices, built before 1970.

The limitation for office transformation can further be restricted on the following aspects: type of offices, period of offices, and specific new function after the transformation. The decision for this more detailed demarcation is not yet made and is depending on the availability of data and information for the case studies.

#### Period of offices

Zuidema and Elp (2010b) divide the different periods of construction. These periods represent different typologies of office buildings and differ in vacancy rates. In figure 9 the vacancy related to the year of construction of the offices is shown in a graph. Offices can be divided into the following periods: before 1970, 1970-1980, 1980-1990, 1990-2000, 2000-2009, and new buildings. These periods represent different types of offices and different building characteristics. For office buildings mostly a lifespan of 40 years is assumed. However, 80% of the vacant buildings are less than 30 years old.
The different periods when office buildings were built are associated with different office building characteristics. Zuidema and Elp (2010b) list these characteristics in the following elements: façade, construction, height, installations.

**Specific function**

The specific function of the transformed building is also a more detailed demarcation for the research. A distinction can be made for instance between; students, starters, and elderly apartments.

- Due to the structural over-supply and vacancy of office buildings renovation and consolidation are no viable options. Only demolition and transformation reduce the office space and therefore contribute to solving the vacancy problem. Therefore this research will only focus on the decision between transformation and demolition and new-build (Geraedts, van der Voordt, 2005). Despite of that, the consolidation strategy will also be covered and will serve as a base case. This shows what would happen if you do nothing, since this is the option most investors choose now.

- This research is aimed at providing a model in the initiative phase of a project, where the intervention scenario needs to be chosen. This means limited information is available as input for the model and key indicators will need to be used.

- In a similar research carried out by Agentschap-Nl, the focus was on the planet aspect of the triple p model. One of the recommendations was to focus other research on the other aspects of the model. For deciding which intervention scenario is most suited, economic costs and benefits will probably be the most influential. Therefore this research will focus purely on monetary costs and benefits. This means things like monumental value etc. are not taken into account in the decision making process. Figure 8 shows the focus on the ‘Profit’ or ‘Economy’ aspect.

- This research will not focus on:
  - The influence of location aspects
  - The influence of environmental aspects
  - The influence of societal aspects

**Constraints**

- An important constraint is the way the options are compared. The comparison needs to be objective and the options need to be compared with the same ambition level.
- The possibility exists that adding the operating phase to the decision process to choose the most suitable intervention strategy has no significant influence at all.
- It’s possible the best strategy is to do nothing; this is not favourable for addressing the vacancy problem, but this option is usually currently most used by investors and therefore important to include in the research. It will serve as a base case for comparing the other options.
1.14 Definitions

Transformation
Transformation is commonly known as building adaption, adaptive reuse, retrofit, change of use and conversion. In the transformation position paper Hilde Remøy (2013) describes building adaptation as: “any work to a building over and above the maintenance to change its capacity, function or performance” in other words, “any intervention to adjust, reuse, or upgrade a building to suit new conditions or requirements”. In this research transformation will refer to a change in building function.

Structural Vacancy
Structural vacancy is the vacancy of office space, which has been vacant for three years or longer, with no perspective on future tenancy (Remøy, 2010).

LCC
Life Cycle Cost is a technique used in the building and construction industry to estimate the total cost of ownership. It is defined by the ISO 15686-5 norm as: “a methodology for the systematic economic evaluation of the life cycle costs over the period of analysis, as defined in the agreed scope”. The norm divides Life Cycle Costs into 5 categories; Construction, Maintenance, Operation, Occupancy, and End of Life. Each category is broken down into sub-categories with specific costs. By quantifying all costs throughout the building lifecycle it can assist decision making in the development and investment process (Langdon, 2006). In this research LCC will therefore refer to the costs and benefits of an asset for a specified period of time.

Figure 10, Life Cycle Cost (ISO 15686-5)

3P model
The Brundtland report of 1987 (Brundtland, 1987) gives the most commonly used definition of sustainability: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. The triple P model is most used to define sustainable development and derives from the Brundtland interpretation of sustainability. John Elkington (1997) first introduced the triple bottom line, which later was called the triple P model. The three P’s of the model stand for; People, Planet, and Profit. Where ’People’ refers to the social, ’Planet’ the physical, and ’Profit’ the economic perspective on sustainability.
2 Research Methodology

In the methodology of this research there will be a distinction between theoretical research and empirical research as well as a combination of quantitative and qualitative research. The theoretical research is carried out by conducting literature research. The goal is to distinguish the important factors that influence the decision making process and is aimed at designing the theory. In the empirical research cost data is gathered from case studies and the model is build.

2.1 Literature Study

With the literature study research on the specific topics related to my research are discussed and concluded. According to Groat & Wang (2002) a literature study can serve a number of purposes:

- Identify the research question
- Focus the topic of inquiry
- Understand the makeup of the research question
- Understand an idea’s generic roots
- Understand the current conceptual landscape

This literature research will cover the following topics; the Dutch Office Market, Available Tools, Transformation and Demolition & New-build, LCC and model building. This study will serve as a context for the research and as a survey of what has been studied and is already known. It provides a theoretical framework for the empirical part of

This literature study will partially answer the following sub questions:

- What are main costs of transformation projects?
- What are main benefits of transformation projects?
- How do these costs and benefits differ from new-build projects?
- To whom are these costs and benefits?
- How can these costs and benefits be determined?
- Which transformation strategy decision tools are currently available?
- Can these tools be used for the comparison model between transformation and demolition & new-build?

2.2 Case studies

Yin (2003) defines case study as: "A case study is an empirical inquiry that investigates a phenomenon or setting”. Case studies can be characterized by five aspects: 1) focus on cases studied in real life contexts, 2) the capacity to explain causal links, 3) the importance of theory development in the research design phase, 4) a reliance on multiple sources of evidence, with data needing to converge in a triangulating fashion, and 5) the power to generalize to theory.

Case studies can serve different purposes; they can serve an explanatory, descriptive or exploratory purpose. The purpose of choice is depending of the nature of the research question. This research will make use of case studies during two different periods and will serve different purposes. An important part of the case studies is the case selection. Choosing the right cases is can help answering the research questions.

The case studies are meant to serve as input for the construction and operating phase of the transformation scenario of the LCC model. The input is derived from gathered cost data from the cases. Besides the cost data, the key indicators that influenced the decision for transformation need to be identified. The information from the case studies, together with the literature study is used to set up a list of key indicators in the transformation process and the indicators of the LCC model.

When the model is built and the data from the case studies is applied a pilot case will be used to test the LCC model. This case is calculated with the model, and should give an overview of the costs and benefits of the different intervention strategies for the building.

The case studies will partially answer the following sub questions:

- What are main costs of transformation projects?
- What are main benefits of transformation projects?
- How do these costs and benefits differ from new-build projects?
To whom are these costs and benefits?
How is the decision for the intervention strategy currently made? Based on what information?
Where is the process is this decision made?
Which indicators or aspects influence the decision for the developer and investor?
Can existing vacant offices be transformed to the same or better efficiency level as new buildings?
What is the influence of adding the operating phase in the decision making process?

2.3 Interviews
The interviews that will be held are part of the case study. They will have a semi-open character, with questions prepared in relation to the sub-questions of the research. The semi-open character allows discussing different topics and the soft factors and indicators that are decisive when choosing the intervention strategy for a vacant building. As an addition to the cost data from the cases, the information from the interviews will help explain why decisions are made and which factors play an important part of the decision process of the specific cases. The interviews will therefore not provide quantitative data that can be used for the LCC model, but the findings can be used to explain the character of the decision process.

The interviewees will need to be actors with different perspectives to the transformation process of the same case. Appropriate interviewees are developers, investors, owners, corporations, and experts with a specific knowledge of either the investment period or the operating period.

In the interviews experts will give their opinion on the different subjects, which is used to help set up the theoretical framework. The interviews therefore serve as a foundation for answering the following questions:
- What are main costs of transformation projects?
- What are main benefits of transformation projects?
- How do these costs and benefits differ from new-build projects?
- To whom are these costs and benefits?
- How can these costs and benefits be determined?
- How is the decision for the intervention strategy currently made? Based on what information?
- Where in the process is this decision made?
- Which indicators or aspects influence the decision for the developer and investor?
- Can existing vacant offices be transformed to the same or better efficiency level as new buildings?
- What is the influence of adding the operating phase in the decision making process?

2.4 Building the Model
The results of the case studies together with known key figures will be used as input for the LCC model. The results from the literature study should point out which models and tools are currently available for transformations and if they can be used to build the new model.

The most challenging part of the model is the comparison between the intervention options. Since no two identical buildings and locations exist, one of the two buildings will have to be a fictive case. With demolition and new-build a lot of key benchmark figures exist and can for instance be found in the ‘KengetallenKompas Bouwkosten’ of IGG (Vonk et al., 2012). This option is therefore suitable to serve as a fictive case comparable to the case that is examined in the transformation option. The cost data from the transformation model are derived from the results of the case studies.

2.5 Test Case
With the pilot case the LCC model that has been built can be applied to an actual case. With the help of the new model, financially the best intervention strategy can be determined for that particular case. When applying the model to an actual case, errors can be undone and adaptions can be made for better use of the model. The testing of the model indicates the practical use and application of the LCC model. Finally a simulation is applied to the test case to discover the risks, uncertainties, and influence of the variables on the end result.
2.6 Conceptual Model

Figure 11 shows the conceptual model for the research. As stated in the demarcation in chapter one, consolidation and renovation are no solution for the vacancy problem and this research only focuses on transformation and demolition & new-build. The strategy consolidation is added to the study and is used as a base case for comparison with the other strategies. Each strategy is tested for the associated costs & benefits. These costs and benefits are based on key figures for the consolidation and demolition & new-build strategy. The case studies will serve as input for the transformation strategy. The result of the costs & benefits of these three strategies will give most cost effective option.

![Conceptual Model](image)

This research focuses on the entire life cycle as analysis period of the strategies. As the building cycle in figure 12 shows, the focus of the research is after the operating phase of an office building, when the decision for demolition or transformation needs to be made. Each strategy will include the costs of the investment phase, operating phase, and the revenues of the building throughout its life cycle.

![Life Cycle Costs & Benefits](image)
3 Research Organisation

3.1 Scientific Domains
The scientific domains are:
- Transformation
- Life Cycle Costing
- Building Economics

3.2 Mentors
The mentors of my graduation research and related specialty are as follows:
1st Mentor:
Peter de Jong, LCC

2nd Mentor:
Hilde Remøy, Transformation

3.3 Research Design

![Research Design Diagram]

Figure 13, Research Design
Figure 13 shows the research design for the graduation period. As the design shows the research started with a draft version of the research proposal for the P1. Here the problem is analysed and formulated into a problem statement with research questions.

The P2 consists of developing a theory and serves as a context for the entire research. This is done by conducting a literature study and interviews with different actors involved with the process like developers and investors.

After the P2 the empirical research started. The case selection and data collection is an important part of the empirical research. The interviews are used complementary to the case studies and used to
substantiate decisions concerning the LCC model. Simultaneously with the empirical research, the model building is started. The literature and empirical research is used for building the model. In addition the case studies will serve as input for the model.

The finished model was applied to a test case. The test case is used to improve and finish the final model. The research will end with conclusions and recommendations that can be drawn from the research, the model, and the test case.

3.4 Planning
Figure 14 shows the planning for the research for this semester, up until the final P5 presentation. The planning includes all important tasks and parts of the research that lead up to the 4 survey points; P2, P3, P4 and P5.

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Figure 14, Research Planning

3.5 Graduation Company
This research was conducted with the help of 2 companies; Maarsen Groep & IGG Bointon de Groot. Maarsen Groep is the main graduation company, with IGG as a supportive company.

Maarsen Groep
Maarsen Groep is an independent private investment organization that develops and invests with private equity. Their focus is on commercial real estate and apartments. With their knowledge on costs and benefits in the investment phase as well as the operating phase and the necessary case information they will support and fit well within my research.

**[Image: Maarsen Groep]**

IGG Bointon de Groot
In addition IGG Bointon de Groot will assist in developing the LCC model. IGG Bointon de Groot is a building economy consultant, specialized in building costs advice, cost engineering and cost management of complex projects. Besides helping with the model development, IGG offers large cost databases needed as input for the model.

**[Image: IGG Bouweconomie]**
Literature Study
Part 2 | Literature Study

In this section the literature is used to set up a theoretical framework. The following chapters discuss the Dutch office market, the available tools that support the transformation process, the costs and benefits of transformation and demolition & new-build, and Life Cycle Costing. The next chapters are an assessment of existing knowledge related to my research project. It serves a few goals; showing the context of the research project specifically for my research topic, give answers to some or parts of the sub questions, and it is used for developing the LCC model.
4 Dutch Office Market

This chapter focuses on the details of the Dutch office market related to the vacancy problem and transformation. There is a divers supply of offices, which can be characterized in quality, location and size aspects (Djajadiningrat, 2012). A difference in quality of offices is noticed for instance with the New Way of Working (NWW), where the offices require a different layout. This is a change in office quality. With the location characteristics there is a shift towards inner cities, especially in the 'Randstad'. There is little demand for the highways locations and the mono-functional office locations outside the city. Finally the total demand for office space is less than the supply, there is a size mismatch. These examples show there is a mismatch between demand and supply in the current office market. The functioning of the office market will be described in this chapter.

4.1 Imbalanced Market

The office market is often described using the Four Quadrant Model of DiPasquale and Wheaton (1992) and Fischer (1992). The model depicts an ideal situation where the supply, rental price per square meter, market sale price of office space, and construction costs are in balance.

When there is oversupply in the market, the model will respond to the oversupply. The oversupply results in a decrease in rental prices (First Quadrant). This decrease in rental price causes the prices to drop (Second Quadrant) and a decrease of the construction of new buildings (Third Quadrant). Subsequently the oversupply should decrease (Fourth Quadrant), as a result of the increased demand and decreased new construction. Shortly the market should have a new balance due to the decrease of rental prices and the consequential new increased demand.

However the current market is an imbalanced market, where it does not result in a new balance. The rental prices are too low, which puts pressure on the new construction of offices. Technically speaking there should even be more demolished than new being built. In the office market this shows as an increase of non-courant office buildings, while in the higher segment offices a balance does form.

In the current market the decrease of rental prices and the decrease of new construction is already visible. The following increase in demand however is not showing, on the contrary a decrease in demand is expected for the future, putting additional pressure on the rental prices and increasing the oversupply. This is shown in the oversupply of offices as can be seen in figure 17, where the demand A is far less than the supply B. The only way to do something about the vacancy problem in this situation is by extractions of office space from the market. Transformation and demolition are the only two intervention options that extract office space.

In the 4Q model does not take account of the non-courant offices. According to Colwell (2002) the non-courant offices are not seen as competitive office buildings. Therefore they are left out of the model and are seen as amortized with no future perspective on tenancy. This category is the structural vacancy of the office market.

Figure 17, Four Quadrant Model with oversupply (source: adaptation by author (Zuidema & Elp, 2010a)
4.2 Vacancy
Vacancy in the office market is not an extraordinary occurrence. Due to the cyclic character and slow reaction of the office market, a higher vacancy rate is common in a period of declining demand. The figure below shows what these periods of over and under supply look like.

![Figure 15 Phases of the real estate supply/demand cycle (Pyhrr, Rouloc et al., 1999)](image)

Figure 15 Phases of the real estate supply/demand cycle (Pyhrr, Rouloc et al., 1999)

Vacancy is caused by a mismatch between demand and supply. If too much office buildings are being built or have been built, the supply exceeds the demand that causes the vacancy. This is a quantitative mismatch of space. Besides this quantitative mismatch, there is also a qualitative mismatch. This qualitative mismatch is reflected in preferences of office users for different location and building characteristics. The cause of vacancy can therefore be characterized by three different factors: market, location and building (Remøy, 2010).

**Market**
Since the Second World War the commercial real estate market became an investment market. This created opportunities for real estate developers and investors to enter the office market, because a distance was formed between the owner and the occupier of office buildings. The office market is characterised by the demand and supply of office space. Office users search for office space within a specific market. Within this market the office is selected based on location and building characteristics.

The market demand is extremely important factor in the feasibility of transformation projects. If there is no demand for housing, no project will be feasible. The determination of the market demand will therefore precede the steps that are taken in this research.

**Location**
Vacancy is concentrated on specific locations. Higher rates of vacancy can be found in the 'Randstad' for example. Besides that secluded mono-functional office locations pose a real problem. These locations are secluded from any other functions and are not suited for a single building transformation. Only an area development can provide solutions for these locations. According to Remøy & Van Der Voordt (2014) 70% of the vacant offices are located in such mono-functional locations.

Zuidema en Van Elp (2013) distinguish three different location types:

1. Central Locations; Offices in city centres and around central stations in the inner cities.
2. Formal Locations; Office concentration of working locations, like business parks.
3. Other Locations; Separate offices in for instance residential areas or outskirts.

Within the three types of locations, three different quality segments; A, B and C are assumed. The quality reflects the rental prices of the offices and is related to the building characteristics. In total there are therefore nine segments of offices in the market, with three quality segments for all three location segments. The current vacancy rate is the highest in the formal locations. Because the central and other locations are multifunctional locations, they offer more potential for transformation. Of course will a growth region provide more potential than a shrinking region (Zuidema et al. 2012).
The types of vacancy are distinguished. Hulsman & Knoop (1998) name four different types. The real problem and focus of this study is on the structurally vacant office buildings. The types of vacancy are described below.

- **Initial vacancy** is vacancy that arises at the completion of a new office building. This is approximately 1 to 2% of the total supply.

- **Friction vacancy** shows that vacancy is not necessarily negative, because it is required for movement in the office market. The friction vacancy rate is often described to be optimal at 4-5% of the total supply. With the total market at 48 million square metres of office space, the friction vacancy would be approximately 2.4 million square metres of friction vacancy as opposed to the total of 7 million square metres vacant (DTZ, 2013). For an office market with decreasing demand however the question arises whether a 5% vacancy is desirable. For a recovery of the balance in a shrinking office market an even lower rate might be preferable.

- **Conjuncture vacancy** is the consequence of fluctuations in supply and demand due to conjuncture changes.

- **Structural vacancy** is the total floor space that has been vacant for at least 3 subsequent years in buildings that have been completed for at least 3 years with no future perspective in future tenancy. Approximately 60% of the vacant office buildings in the Netherlands are structurally vacant (Lokhorst et al., 2013).

Besides these types of vacancy, recent study shows there is another type of vacancy called ‘hidden vacancy’:

- **Hidden vacancy** is a type of vacancy that is not registered and not taken into account when the current 15% vacancy rate is used. It comes on top of this vacancy rate and is all the surplus space that is leased by companies, but not needed. This space will gradually be released on the market at the expiration of existing lease contracts. The trend toward space efficiency will lead the tenants to choose less floor space that better suits their needs. When including this hidden vacancy in the vacancy rate, the rate can increase up to 24% of the supply by 2018 (Lokhorst et al., 2013).
4.4 Strategies for Vacancy:
Four different strategies for vacancy can be distinguished: consolidation, renovation, transformation, and demolition (Remøy, 2010). Each will be discussed concisely below.

Consolidation
In this option the building is maintained in the current condition. The strategy can be to actively look for potential new users, or to wait for better times or simply sell the building for a lower price. Investors and owners of vacant office buildings mostly choose for this option. Vacancy is even preferred over lowering the rental prices due to the revaluation of the building conform the new rental prices. This revaluation is often more expensive than the ongoing operating costs of the vacant building. Also incentives are used to keep tenants on board or to attract tenants.

Renovation
With renovation the office building is renovated to suit other office markets, or to become a higher quality office building. The decision for renovation is based on a consideration between the costs of renovation and the improved revenues. Especially sustainability is driving the rent level up. However, in the current market conditions, there is a fair chance that the benefits of the renovations do not outweigh the costs. Furthermore this option does not solve the vacancy problem, as it doesn’t extract office floor space from the market.

Transformation
Transformation means the function of the vacant office building is altered. The possibilities to transform vacant offices into different functions are limited. Therefore offices are frequently transformed into (student) housing. Transformation can be expensive and disrupts the income from and the use of the building. Different practical obstacles prevent the transformation of offices to housing on a large scale. Spite of some obstacles transformation can prolong the lifespan of a building and create a positive cash flow for an otherwise vacant office building.

Demolition & New-Build
Like transformation, demolition & new-build creates possibilities for the development of a new building with new functions. When a building is technically in a good condition, it’s considered a waste of resources to demolish. Also demolition & new-build is expensive and disrupts the income from and the use of the building.

The LCC model in this research can be used to help decide which of these strategies is financially the best option when looking at the entire life cycle. As indicated earlier in this research only the options consolidation, transformation, and demolition & new-build will be covered. The costs & benefits of these strategies are discussed in chapter 7.

4.4 Actor Analysis
In this paragraph the role of the main actors that are involved with the vacancy problem or transformation process will be discussed.

Developers
The developers have played a significant role in the origin of the current vacancy problem. The developer simply looks at the price for which it can buy a vacant office building and the price for which it can sell the transformed building. If the selling price, including a developer’s fee, is higher than the investment costs it’s a profitable project. Developers therefore have a short-term perspective on real estate.

As the investors become more critical on their investments and want to reassure their return, it becomes increasingly important for developers to have knowledge of the operating period in order to substantiate their development plans with a solid return. Therefore also for the developers it becomes interesting to look further than just the investment phase and work together with investors.

Investors
Investors have the primary goal to receive return on their real estate by rental incomes in the operating phase or sale of their real estate. Most rental contracts are for 5 years or 2x 5 years. The distinction between owners and investors is that owners posses the real estate to house their organization and
investors only for the return. Four different kinds of investors can be distinguished (Gemeente Amsterdam Ontwikkelingsbedrijf, 2009):

- Institutional investors; invest direct or indirect in real estate. Examples from institutional investors are pension funds, insurance companies, and investment institutions. Direct means the investor has the buildings in their portfolio on their own balance sheet, whereas indirect means they invest by means of a property fund.
- Private investors; choose to invest (part of) their capital in real estate. This is often just a single or part of a single building.
- Professional investors like housing associations; invest primary in (social) housing in order to house the population with affordable housing. Some housing associations also invest in commercial real estate and use the profit for their social housing goals. They can play an important part in transforming offices into housing, for example student housing (Gemeente Amsterdam Ontwikkelingsbedrijf, 2009).
- Besides these investors, property funds also directly invest in real estate. The vacancy problem is mainly located in the portfolios of property funds. The problem with property funds is that they cannot simply change from investing in offices to housing. This means they would have to sell their office building to a different investor that can invest in housing. This means the property fund has to take its loss and depreciate.

Investors can have different strategies for their vacant buildings:
- Actively approaching new tenants
- Waiting for better market conditions and new tenants
- Transformation to a new function (or demolition & new-build)
- Taking their loss (including depreciation and potential selling of building)

In the current market many investors don’t acknowledge the current vacancy as a real problem. The vacant buildings are often part of a larger (international) portfolio. The vacant building has such a small influence on the total income, that if a certain acceptable rate of return is achieved they prefer not to revaluate or actively intervene and invest (Zuidema, et.al., 2010b). Investors therefore choose to wait for increasing demand in office space, which is a strategy that complies with an office market with increasing demand. As stated before however, in reality demand will not increase but decrease in the near future. Even with buildings that have no future perspective on new tenants, investors will prefer to lower the rent than to transform a building. It seems they are only prepared to transform when it is the last real option (Gemeente Amsterdam Ontwikkelingsbedrijf, 2009).

Besides the discrepancy between demand and supply there is another problem. Currently there is also a discrepancy between the market value of an office building and the high book value. According to Brueggeman et al. (2011) there are four motivations for investing in Income Properties; the rate of return, price appreciation, diversification, and tax benefits. Before the financial crisis investors received return after collecting rents and paying operating expenses. Furthermore investors anticipated on the rise of prices of real estate, which meant that when selling an office building after a certain period of time it would add to an investor’s return. This resulted in positive business results. Since the crisis however many of the office buildings became vacant, and therefore do not generate rental income. Besides that the prices of the real estate are decreasing instead of increasing, this also has a negative effect on an investor’s fiscal year. A positive business result will already be difficult due to the crisis, which means that additional negative effects of the real estate are unwanted. Because of this investors currently often prefer to do nothing with their vacant real estate and keep their fictive high book value.

When the vacancy rate in the portfolios of investors keeps on rising however, it will have an effect on the total portfolio. There is a maximum vacancy rate, where the interest rate payments and repayment obligations can just be met. Steinmaier states that with a vacancy rate in a portfolio of 25%, which is an expected average for the Dutch office market, also investors will have trouble maintaining their Loan To Value ratio (LTV). The LTV is the ratio that indicates the ratio between dept and equity capital. If a building is financed with a large amount of dept capital, a higher vacancy rate will have large negative consequences. This is because high interest rates need to be paid on the loan, while the vacant building is receiving little to no revenues.
Financers
Financers play an important part in the construction process, as without them most developments will never get off the ground. The reluctance of the end users and the investors, which are less eager on buying rented out end products, play a role in the reluctance of financers to provide funding for developments (Steinmaier, 2011).

Appraisers
The vacancy problem of offices also relates to building appraisal. Appraisal is the process of determining the market value. There are different techniques for appraising buildings; most of them focus on predicted future revenues. In the current market, where the book value is often a lot higher than the actual market value, the accurate appraisal of buildings is extremely important for transformations to become financially feasible. However one of the fundamental problems of building appraisal is caused by the way appraisers are compensated for their work. Appraisers receive a percentage of the buildings they value. This acts as an incentive for appraisers to incline towards higher market prices (Zuidema et al., 2010b)

Municipality
Although indirect, the municipality has had a large influence on the vacancy problem in the Netherlands. To start with the municipality is involved with the creation of the office vacancy due to their policy that is stimulating new offices. The municipality as a landowner receives revenues with the sale of land. They therefore benefit from new office locations (Zuidema et al., 2010a).

The vacancy problem is in the first place a market problem, however this doesn’t mean the municipality shouldn’t be involved. Vacancy can entail a lot of external negative effects, like the liveability and negative appearance of the surroundings.

In addition the municipality itself owns a lot of square meters of vacant office space, of which large part will be divested in the coming years. This space substantially adds to the total vacant supply, making the municipality an important actor in the vacancy problem.

Developing Investor
As the actor analysis shows, all actors involved in the construction process directly or indirectly have an influence on the vacancy problem. Although all actors are involved in the transformation process and will have to work together, the developers and investors play the most important part in the initiation and completion of the transformation of vacant office buildings. The long-term view of the investors and the visionary view of the developers will together have to find a solution for the vacant office buildings. Therefore these actors will be the focus of this research. A developing investor has both the ownership of the building and the drive of the developer to act and do something.

4.5 Conclusion
The current vacancy problem is complex and related to all stakeholders in the construction process. The market will not solve it with the pig cycle, as it did in the 90’s. In the past decades a financial model was created that encouraged new development of which all actors could benefit. Because of this simply too much office space has been built.
The only way to extract the excess office space of non-courant buildings from the market is by demolition or transformation. This shows the importance of extracting office space as well as the importance of determining what the right strategy is for each unique building. The LCC model in this research should help in the decision process for financially the best strategy for the increasing amount of non-courant buildings.

The developers and investors will play an important part in the initiation of the solving of the vacancy problem. The investor needs to be aware of the financial consequences of vacant office buildings and should adopt a more active approach towards their vacant buildings. A developing investor will have the knowledge and the need to address this problem when looking further in the future. These actors are very important when looking at the costs and benefits of the options. Different costs and benefits will apply for different actors, making it important to distinguish whose costs they are and whose benefits.

The building characteristics will be of influence when deciding which intervention strategy; demolition or transformation, is most suitable. The location and market conditions will be kept equal for both options in this research.
5 Available Tools

Many tools have already been developed that can be applied in the transformation process. In the graduation research of Fikse (2008) all available tools related to the transformation process at that moment where examined. Most developers are not aware and do not use these tools. In this chapter some of the relevant tools are listed with a short summary of these tools and the chapter is concluded with the potential of these tools for this research.

5.1 Tools

The following tools that might be relevant for my graduation are analysed and summarized below.

Vacancy risk meter ‘leegstandsrisicometer’
In a shrinking market, this tool allows to reflect which locations will have the highest risk of vacancy. Also on building level the buildings with the highest risk for vacancy can be determined. It does not elaborate on the costs and benefits.

Transformation potential meter ‘transformatiepotentiometer’
This tool is designed to measure the transformation potential of buildings, looking at location and building characteristics. It discusses the functional as well as the technical and financial feasibility. Also this instrument does not cover costs and benefits.

The Transformation Index ‘Herbestemmingswijzer’
Determining a suitable function is the purpose of this tool. It looks at how a building is transformable into another function. It evaluates 195 different functions, focussing on financial, technical, societal, and organizational feasibility.

ABT-Quickscan
The ABT-Quickscan is used for determining to which function the building can be best transformed. This is done by testing 96 criteria on 10 different functions. The function that requires the least amount of adjustments is seen as the best option.

Triple Jump Method
This tool is used for a quick determination in the function potential of a building after transformation. The focus is on the technical aspects of the building. After that the INKOS is used for the financial feasibility of the project. The tool is similar to the Transformation Index but it is a lot quicker to use.

TOK- Checklist
This checklist looks at the transform potential of offices to housing. It focuses on the technical aspects rather than financial aspects. However many technical difficulties will result in more costs, and will therefore indirectly influence the financial aspects.

INKOS
The INKOS instrument is aimed at giving a fast indication of the feasibility of a transformation project. Besides that it is possible to compare different variations of financial feasibility, looking at the costs and benefits of the options. The model is part of Life Cycle Costs and Benefits modelling, aiming to show the costs and benefits of the entire life cycle in the model.

BBN advisors Transformation Calculation Tool (2012)
This tool focuses on the investment costs and predicted revenues of a transformation. It is an easy to use tool, needs little information and makes use of key benchmark figures. This tool only looks at the investment period, by adding the operating phase to this model it can possibly serve as a starting point for my model.

Vastgoedmarkt Vastgoed Exploitatiewijzer (2011)
The Exploitatiewijzer uses key benchmarking figures for the determination of the operating costs in an early stage. Data is used to bundle different prices per Lettable Floor Area (LFA) per year for different types of buildings. These key figures can be used when adding the costs in the model.
KengetallenKompas Bouwkosten (2012)
The KengetallenKompas Bouwkosten is a collection of all key figures for construction costs, demolition costs, and additional costs different types of buildings. Interesting is that 3 levels are given for all costs; basic, low, and high costs. These key figures can be used as input for the fictive case of demolition & new-build.

Research Mackay (2008)
The building costs research of Mackay analysed the costs of different building elements, discerning the costs of the elements and finding the cost bearers of a transformation projects. Although the results of the research were not significant enough to be generic for all office buildings, is does give a good overview of which parts of an office building are high in costs.

Research Robin Schmidt (2012)
Robin Schmidt did the most elaborated research on financial feasibility of transformation I’ve come across in my literature study. It focuses on transformation costs and even a stub for comparing transformation with demolition and new-build, excluding the operation level.

Research Sascha Jansz (2012)
Sascha Jansz approached the different intervention strategies from the ‘planet’ aspect, also focusing in the Life Cycle. In her model the effect of the estimated service life of different strategies with regards to the sustainability of each strategy is calculated. In a certain way the approach to the vacancy problem is equal to this research. This research however focuses on the financial aspects.

Davis Langdon (2006)
The research of Davis Langdon Management Consulting (2006) was aimed at developing a common methodology at European level for evaluating life cycle costing. The essential components of a common LCC methodology are as follows:

- **A process model**: the intention of the model is a practical implementation of LCC representing the decision process. The necessary criteria, analysis tools and techniques are used for an effective LCC evaluation.
- **Common uses of LCC**: examples of projects at different stages of the life cycle with the different actors involved. The examples provide a means of focusing the methodology on the most likely application.
- **Data requirements and cost classification**: an important part of the methodology is the way in which the cost data can be classified to aid analysis and comparison.
- **Economic and financial analytic tools**: the methodology incorporates a number of economic, financial and other analytic tools and techniques.
- **Other analytic and evaluation tools**: i.e. sustainability assessment, risk analysis, sensitivity analysis, IT tools and other techniques are identified and integrated in the common methodology.
- **Applicability to public procurement**: the methodology incorporates various approaches of public procurement.

Research of Craig Langston
Craig Langston published multiple studies on the transformation potential of buildings. The focus in these researches is modelling the life cycle of buildings, in order to take property management decisions and strategic assessment of building transformation opportunities.

In his research that was published in the Habitat International, Langston et al. (2013) applied ‘Adaptive Reuse Potential’ (ARP) modelling to determine the most effective way to transform buildings in Hong Kong. The model calculates the useful life of a building as discounted physical life (figure 22). The factors physical, economic, functional, technical, social, legal, and political obsolescence are taken into account. The scores reflect the building’s life so far, not just the current status. The scores are expressed as percentages, where the higher the score, the higher the potential for transformation (figure 21). This provides a way of benchmarking the results of different scores.
In current research from Langston et al. (2014) the ARP model is compared with the adaptSTAR model. AdaptSTAR is a design-rating tool from Australia, made for analysing transformation projects. It helps decision makers to achieve optimum efficiency and useful life from developments. The seven categories of design criteria from the adaptSTAR model align with the seven obsolescence categories in the ARP model. This makes it possible to compare the results of both models (figure 23).

5.3 Conclusion
The characteristics of the INKOS instrument suit the intentions of this research. It is focused on the entire life cycle and is able to compare the financial costs and benefits of different options. The rest of the tools are mainly focused at looking at the transformation potential or the most suitable function and are not suited to compare different options. Furthermore, the cost data from 'BouwkostenKengetallen' & 'Vastgoed Exploitatiewijzer', research from Mackay, and research from Schmidt, can all be used as input for in the model.

The common LCC methodology from Davis Langdon provides a sort of step-by-step plan for setting up a life cycle costing analysis. This common methodology can serve as a foundation for setting up the life cycle costing in this research.

The transformation potential modelling from Craig Langston is mainly focused on the sustainability of the life cycle of building interventions. While my research focuses on the financial aspect, rather than the sustainability, the approach to the life cycle and the models that was used can be useful for the monetary focus of the life cycle of building interventions.
6 Transformation or Demolition & New-build

This chapter will elaborate on all costs and benefits of transformation and demolition & new-build. The aim is to determine important indicators of vacant buildings that can help decide in an early stage whether transformation or demolition financially is the best option. These are gathered from literature and interviews. The results of this chapter will serve as input for the LCC model.

6.1 Extractions from the Market

As discussed in chapter 5, from the four different strategies for vacancy only transformation and demolition & new-build are ways to extract floor space from the office market. Figure 25 shows the extraction from the office market from 2003 to 2011.

![Extractions from the market (Bak, 2012)](image1)

Figure 24 shows the percentage of extractions from the market by demolition and by transformation to different functions. In total demolition and transformation approximately both account for half of the extractions. Transformation of offices to housing specifically takes up 25% of the total amount of extractions. The total effect of the extractions however is still minimal. Between 1990 and 2010 only 1.8 million square meters of the office supply is extracted. This is less than 0.5% annually (NVM, 2009). This shows that the current interventions are not nearly close enough in solving the vacancy problem. Both the number of transformed and demolished office floor space will need be increased.

De Jonge from the TU Delft estimates that from the current office supply only 15 to 20% is eligible for transformation, besides that a part can be used for a lower segment of offices, but a large part will have to be demolished (Simons, 2012). The largest part of the vacant offices is expected to have no view on future tenancy or transformation into another function. It seems that demolition for these vacant office buildings is the only solution. Demolition and transformation will therefore both play important roles in the solving of the vacancy problem in the Netherlands.

6.2 Feasibility Studies

At the start of every new construction process a feasibility study is required. The feasibility is analysed on different aspects; Societal, Legal, Technical, Functional, and Financial (Wamelink, 2007).

Societal Feasibility

One of the important criteria with a development is whether there is social support for the development. The demand and needs determine the societal feasibility, as well as support the politics that in the end determines if a development is possible. An often-named advantage of transformation is that resistance from the neighbourhood is less likely, since the building already exists. This can favour the societal feasibility of transformation projects.

Legal Feasibility

With legal feasibility the intended development is checked if it is not in violation of any laws and regulations. The most important in the Netherlands are ‘het bestemmings plan’ (zoning plan) and ‘het bouwbesluit’ (building act). On different levels, regional and local, many procedures are connected that result in applications for permits. These procedures and permits require a lot of time and can eventually even result in budget and time overruns or the cancellation of a development. A difference can be seen with the legal feasibility of new-build and transformation. Acquiring permits for transformation projects
is a more difficult process, because for instance for the function change of a transformation, the zoning plan has to be changed.

**Financial Feasibility**
A financial feasibility study examines whether a project is financially feasible when looking at the investment budget in relation to the potential revenues and operating costs. A development is financially feasible when the net present value of the expected revenues exceed the net present value of the costs. But the financial feasibility is more than just the financial calculations. It’s about the demand for housing or the ‘fitness for use’ and what the user is ‘willing to pay’ for it.

The risk analysis is an important part of the financial feasibility study. Risk is expressed in the study by giving a minimum and maximum limit of costs and benefits of the project. Most financial feasibility studies focus on a limited set of key figures, which in the beginning of the project is hard to be accurate since little information is known.

When establishing the financial boundaries of project key benchmarking figures are often used. The investment budget is based on key figures from previous realized projects. The problem with using key figures is that each building is unique and key figures can therefore not be generalized.

Cost modelling is a method that is better able to add project specific information in the calculations. The computer is used to simulate the entire life cycle. Also cost modelling is depending on the availability of information, however the results can be more accurate than by just using key figures.

In this research the financial feasibility is integrated in the LCC calculations. The feasibility of a project and the risks of a development are not only noticeable in the construction process, but the risks will have an affect on the owners/investors of the real estate for the remainder of the operating period. The method of determining the budget and relation with the investment costs, operating costs, and revenues are covered in chapter 8.

**Technical Feasibility**
The technical feasibility studies differ a lot between new-build and transformation projects. With new-build in the early stages of the development process not enough information is known to perform a realistic technical feasibility study. With a transformation project however the technical feasibility is one of the most important aspects. It’s essential to inspect the technical conditions of a building to reduce the risks and the associated financial consequences. In the technical condition analysis the structural condition as well as the installations are mapped. The parts that are reusable and the ones that need to be replaced are examined. This technical feasibility analysis is prior to other feasibility studies with a transformation projects. Technically it is basically always feasible to transform an office building into housing, if the interventions however become too expensive, the technical feasibility influences the financial feasibility. These are therefore closely related.

**Functional Feasibility**
If the building meets the demands and wishes of the future users is determined in the functional feasibility. It is a 2 or 3 dimensional representation of the brief. Therefore this representation depicts the dimension and position of functions, including the horizontal and vertical accessibility. In transformation projects the new brief will have to fit in the existing building, while in a new building the dimensions can be designed specifically for the brief. A transformation project needs brief that suits the existing building, or it has to be possible to adapt the building to the brief.

This research basically compares the financial feasibility of the options transformation and demolition & new-build to see which of the two has a better final result. The focus of this research is on the financial feasibility, because in practice the financial feasibility will have the largest impact on the decision between intervention options.

**6.3 The Transformation Process**
Before a building is built or is transformed it undergoes a certain process. The process for transformation is quite different than the construction of a new building. When the best suitable intervention strategy for a vacant building needs to be found, basically the best possible use for that building is determined. The
Highest and Best Use (HBU) method is a way of determining the values of the different possibilities of intervention for structurally vacant office buildings (figure 26).

HBU is defined by the Appraisal-Institute (2001) as the probable and legal use of undeveloped land or real estate that is physically possible and financially feasible and results in the highest value. The four aspects; legal, physical, financial feasibility and highest value are the important factors of the HBU method.

The future use is depending on the legal feasibility, which in its turn depends on the current and future zoning plan and the environmental regulations. If an intervention is not in line with the zoning plan, the municipality can sometimes make adjustments to the plan. Involvement and positive collaboration of the municipality is therefore important for transformation projects.

The physical feasibility assesses if the intervention is transformation is physically possible. Tools for this assessment are for instance the ABT quick scan and the transformation potential meter. Important with the physical feasibility is also the costs that are related to the actions that need to be carried out. The financial feasibility is therefore closely related to the physical feasibility. The final factor is to determine which of the options is the maximum financial output. The HBU method will not be used in this research, but the steps of the model do show where this research is positioned in the transformation process.

Figure 27 shows the process starts with demand from the market or the market potential of a vacant building. This means an intervention is needed in the current building in order to reach a better use. The market demand and vacant building are then tested if what’s legally possible. After the legal feasibility the technical, functional, and aesthetic feasibility is assessed. The next step is the addition of this research. The financial feasibility is replaced by the comparison of all intervention options on life cycle costing. The result will therefore be the best use and optimal use in relation to the Total Cost of Ownership (TCO) of the building. This results in the costs and benefits per Gross Floor Area (GFA) of the different intervention options.
6.4 Costs & Benefits
In this paragraph the frequently cited costs & benefits and advantages & disadvantages of transformation and demolition are listed. Subsequently they are linked to the actors who bear the costs or benefits.

Transformation
Advantages:
• Older office buildings often have been depreciated and therefore have low acquisition costs (Schmidt, 2012): If costs can be saved with the acquisition of a building this will benefit the developer as their profit is the difference between the investment costs and the selling price. By lowering the acquisition costs the profit is increased or more buildings become financially feasible to transform.
• Construction cost savings (Schmidt, 2012); because the construction, foundation and other parts of the building can be reused, material costs can be saved.
• Construction time savings; because the construction, foundation and other parts of the building can be reused, the construction period can be shorter. This also influences the finance costs, if the period of financing is shorter.
• Nearby residents are used to the building in their surroundings, therefore objection against a transformation will be less likely than a new building. Besides that, transforming a vacant office building into a new function will only benefit the liveability of the neighbourhood.
• On locations where there is no more room for new buildings for instance for housing. The locations that are already built on can be used. Of course demolition & new-build shares this benefit, as also if the building is demolished the location can be used for the new function in a new building.
• An often claimed benefit is that transformation is more sustainable than demolition & new-build. The arguments used for this are that by reusing the old construction and possibly installations or façade etc. less demolition waste is produced and the depreciation of the materials is spread out over a longer period of time (Van Der Voordt, 2007).

Disadvantages:
• Technical complexity (Van Der Voort, 2007); the transformation of an office building into housing is technically very complex. However the problem mostly is not that it’s technically not possible, but a modification can be so costly that the transformation is not financially feasible anymore.
• Organisational complexity; the whole transformation process is a complicated process due to inter alia the involvement and interests of all different parties involved with the process. Many of the parties don’t have a lot of experience yet with transformation projects.
• Financial complexity; first the prices of offices are expressed in LFA and housing in UFA. The ratio LFA of the offices and UFA with apartments is detrimental for transformation. Secondly houses aren’t charged with taxes, while offices are. The construction costs of the transformation into housing is not tax deductible (Van Der Voordt, et al., 2007).
• Legislation; Legislation on building level can get in the way of realisation of transformation projects. A new building permit is needed that complies with the municipal building regulations, the ‘Welstandsnota’, the Monumental act, and the zoning plan. All these regulations can make the transformation financially less feasible (Zuidema et al., 2010b)
• Limited possibilities due to the lay-out (Benraad, 1994); The construction, depth and height of the building, and façade are decisive in the new building.
• Installing the new installations in an existing building is more expensive compared to in a new building, since standard sizes and fittings are less often possible compared to new buildings.
• Higher standard requirements on building climate performance and fire resistance are obligated for dwellings compared to offices. Again these higher standards also apply to the new building (Benraad, 1994). New regulations for transforming offices into housing are less strict than the regulations for new buildings.
**Demolition & New-Build**

Many of the demolition & new-build benefits are equal to transformation or the exact opposite.

**Advantages:**
- New-Build is more sustainable, because a new building can be made more energy efficient compared to a transformed building. When looking at the life cycle of an office building the energy costs will be lower.
- The costs of new buildings are easier to predict than transforming existing building. This means that new buildings will have fewer risks of unforeseen circumstances that can increase the construction costs. Key indicators can be used in cost calculations for demolition and construction costs of new buildings, with transformation the use of key indicators is still limited among others due to the unique character of buildings.
- The construction period can be shorter, because the legislation and regulations are better organized for new buildings.

**Disadvantages:**
- It seems a waste to not reuse the available foundation, construction and other elements of the building like the façade and installations. The reuse of these could save money on materials and time on the construction period.
- Demolition can cause resistance from the neighbourhood. Transformation is assumed to have less of an impact on its surroundings.

Strikingly some of the benefits of transformation and demolition & new-build cited contradict each other. This can be explained by the facts that buildings are unique. For each building the different costs and benefits will apply, making that no generic statements concerning the costs and benefits of these can be made. Key indicators however can be linked to the costs and benefits. Making it possible to base decisions on the costs and benefits related to indicators.

**'Ja, Maars' of Transformation**

In 2013 id&dn produced a factsheet on behalf of the Ministerie van Binnenlandse Zaken (Gelinck, 2013). In the report ten most frequently mentioned prejudices of transformation were drawn up and tried to refute them with the help of examples from practice. The ten prejudices are:
- The acquisition costs of offices are too high
- The construction costs of transformation are higher than new-build
- The Building Regulations requirements are too high (Building Regulations before 2012)
- No one wants to live among office buildings
- Transformed offices are only suitable for students and artist
- Transformation is not a sustainable solution
- Zoning changes take too long
- Office locations can never meet the noise- and parking norms that are applicable for housing
- Municipal organizations are not prepared for transformation
- Office transformation are very hard to finance

Many of these prejudices could be refuted with the help of the case studies. These prejudices are therefore also important points of interest when analysing the cases in this research.

**6.5 Risk Indicators**

The purpose of this paragraph is to set up a list of potential key risk indicators that can be identified in the beginning of the process. These indicators can have big consequences for the costs or benefits later in the process and can therefore be decisive for the right intervention decision. Listing and validating these indicators are used to substantiate the decision model.

These indicators basically are a way of showing which risks are involved with a transformation project. There are many definitions for risk, but they all consist of a consequence multiplied by the likelihood of that consequence. Gehner (2011) names all different definitions of risk used in literature, one commonly used is the one that will be used in this research from ‘Stichting Bouw Research’ (2000): ‘Risk = Chance of failure x consequence’.

The list of indicators mentioned above is called a risk checklist. The checklist is one of the methods to identify risk. The checklist consists of relevant risks of the list, supplemented with the project specific
risks of the transformation project. It’s a simple technique giving an overview of all possible risks (Claes, 2004).

Frank Veen (2012) gathered all the known risks with project development from multiple sources in literature. A few distinctions can be made between risks. First of all there are specific and systematic risks. According to Huysmans (2011) the specific risks can be influenced, while on the contrary the systematic risks cannot be influenced due to their autonomous character. Secondly there is a difference between the risk profile of developers and investors. The developer has a different risk profile for every project; this makes it hard to categorize the risk for a developer. A developer is for instance willing to take more risk, if the return is higher (Veen, 2012). The risk profile of the investor is easier to classify. An investor has long-term data sequences of results from the past related to the type of real estate. Besides differences in risk profile, the developer and investor also have similarities of which the market risk is the most important. Both parties heavily depend on the autonomous developments in the real estate market.

Below the systematic, process specific, and project specific risks are divided in different categories.

<table>
<thead>
<tr>
<th>Systematic</th>
<th>Developer</th>
<th>Investor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surroundings</td>
<td>Matching, strategy, scenario</td>
<td></td>
</tr>
<tr>
<td>risk</td>
<td>Market</td>
<td></td>
</tr>
<tr>
<td>Regulations</td>
<td>Interest</td>
<td></td>
</tr>
<tr>
<td>Politics</td>
<td>Credit and leverage</td>
<td></td>
</tr>
<tr>
<td>Governance</td>
<td>Portfolio, style, period</td>
<td></td>
</tr>
<tr>
<td>Societal</td>
<td>Object</td>
<td></td>
</tr>
<tr>
<td>Financial parameters: Costs</td>
<td>Tenant</td>
<td></td>
</tr>
<tr>
<td>Financial parameters: Benefits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demographic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specific</th>
<th>Institutional Investment risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process risks</td>
<td>Legal and contract</td>
</tr>
<tr>
<td>Structure</td>
<td>Reputaion and image</td>
</tr>
<tr>
<td>Processes</td>
<td>Mandate</td>
</tr>
<tr>
<td>Culture</td>
<td>Supervision</td>
</tr>
<tr>
<td>Staff</td>
<td>Integrity and compliance</td>
</tr>
<tr>
<td>Compliance</td>
<td>Insurance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specific</th>
<th>Operational Investment risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project risks</td>
<td>Quality</td>
</tr>
<tr>
<td>Space</td>
<td>System, administration</td>
</tr>
<tr>
<td>Technical</td>
<td>Information</td>
</tr>
<tr>
<td>Collaboration</td>
<td>Outsourcing</td>
</tr>
<tr>
<td>Operation</td>
<td></td>
</tr>
</tbody>
</table>

Figure 28. Risk profile (source: adaptation by author (Huysmans, 2011))

A note to the specific risks is that the consequence of these risks is small within the operating phase. With the exception of vacancy and leasehold.

6.6 Success Indicators

A recent research into the success indicators of transformation projects by Bosma & de Ridder (2013) compared 164 successful and 81 unsuccessful transformations. A project is considered successful when a project is commercially successful, but also preservation of valuable real estate, preventing demolition. Non-successful transformation projects are mainly those that did not get off the ground. By comparing the different projects the differences are and the success and failure factors were determined.

The success indicators and therefore the indicators with the highest potential for success resulting from the research are as follows:

- It concerns a temporary redevelopment
- It concerns a certain specific functions (original or new) of the real estate
- Technically simple transformation
- Stimulating role by the government
- Early involvement of future users
- An appropriate book value, based on future cash flows
- The ability to utilize stimulating legislation and funding
- Small-scale projects
- A good location
• The use of unorthodox financing
• The real estate is more sustainable after transformation
• An extensive preparation

The failure factors are basically if these success factors cannot be met like: a lack of financing, legislation that cannot be met, or a lack of interest from potential buyers and users. When the decision is made between transformation and demolition & new-build certain indicators can have an influence on the decision. For instance a higher ceiling results in higher energy costs, making it purely financial a less interesting option. However the higher ceiling could result in an easier to sell or rent apartment, and therefore influence the decision. These indicators will therefore also be distinguished in the case studies.

6.7 Conclusion
Currently demolition extracts more floor space of the office market than transformation. Accurate feasibility studies of both options, weighing of the pros and cons, the risk and success factors, and help make the decision for the right intervention strategy for a vacant office building. If a vacant office building is cheaper to demolish and build a new building instead of transforming, only significant arguments and other benefits of transformation case specific projects can in that case cause to choose for transformation.

The named success indicators and advantages of transformation can be used as focus topics and compared to the results of the cases studies of this research.
7 Life Cycle Costing

In this chapter the principle of Life Cycle Costing (LCC) will be explained. LCC is no new phenomenon. Already in the 70's way of thinking behind LCC started, where the focus shifted from the investment costs to the entire life cycle. The financial feasibility calculation as discussed in chapter 7 is expanded with the operating period. With the LCC approach all costs and benefits will be weighed against each other, providing a financial feasibility analysis with a life cycle approach.

When looking at the costs and the benefits it is important to realise whose costs and whose benefits it is. With the calculation of the life cycle costs different actors are distinguished; the developer, the investor/owner, and the user/tenant. The NEN2699 (2013) divides the life cycle costs & benefits in:

- The costs & benefits of the investment (from the developers point of view)
- The costs & benefits of operating (from the investors/owners point of view)
- The costs & benefits of the accommodation (from the users point of view)

The NEN norm in the Netherlands and the British Standard International Standards Organisation (BS ISO) in the UK both give standards for various aspects of planning the service life of buildings and constructed assets. The NEN norm is a Dutch standard and the BS ISO is an international standard. Because this research focuses on the Netherlands the NEN norm will be used. The NEN2699 is the updated version of the NEN2631 Norm of 1979. Is integrates the investment and operation costs into one Norm, focusing on Life Cycle Costs. NEN2699 divides the Life Cycle Costs into Investment costs, Operating costs, and Revenues. These will be covered in this chapter.

The NEN norm divides the building life cycle into the initiative phase, design phase, implementation phase, and operating phase. The corresponding costs are divided into 5 levels, going from global to detailed. Level 1 are the different categories in which the costs are divided, Level 2 are different cost clusters, Level 3 is divided in elements clusters, level 4 covers all the different elements, and level 5 is of such a detail level that it’s not included in the norm. The phase in which the LCC model of this research is relevant is the initiative phase focuses on the feasibility and will therefore be at level 3 (figure 29).

![Figure 29, Levels of the NEN2699 norm (NEN2699, 2013)](image)

**Pareto Principle**

The Pareto Principle is an economical rule also known as the 80-20 rule and was established by the Italian economist Vilfredo Pareto in 1906. Joseph Juran generalized the rule and describes the effect as
80% of the results are caused by 20% of the causes. Although this principle does not make it possible to exactly estimate the life cycle costs, it does enable the costs and benefits to be classified into the most important categories of costs.

Robin Schmidt (2012), J.M. Huysmans (2011), and Frank Veen (2012) use this principle in their research in order to determine the most important construction costs of transformation and respectively to classify the risks of transformation.

Since the life cycle costs of a building are extensive and cover many different costs this is a suitable way to focus on the most important costs. Previous research classified the façade costs, the structure costs, the installations, and the inner walls as the most important elements of the construction costs of transformation projects. When calculating the construction costs of transformation, Robin Schmidt (2012) focused on these four ‘vital’ elements. This focus is adopted for determining the construction costs in this model. The 20% most influential costs of the remaining investment costs and operating costs of the total investment costs also need to be determined.

7.1 Investment Costs

The investment budget for the acquisition is based on the expected revenues of the building. The potential revenues minus the investment costs and profit give the budget left for the investment. The investment costs includes all costs needed for the realization of the building. The investment costs can be divided into the following categories: Land costs, Construction costs, Installation costs, Additional costs, Unforeseen Costs, Taxes, and Finance Costs.

<table>
<thead>
<tr>
<th>Investment Costs (NEN 2699, 2013)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Costs</td>
</tr>
<tr>
<td>acquisition costs</td>
</tr>
<tr>
<td>demolition - environmental costs</td>
</tr>
<tr>
<td>infrastructure facilities</td>
</tr>
<tr>
<td>Above ground settlements</td>
</tr>
<tr>
<td>Construction Costs</td>
</tr>
<tr>
<td>construction works</td>
</tr>
<tr>
<td>installations</td>
</tr>
<tr>
<td>permanent layout and facilities</td>
</tr>
<tr>
<td>terrain</td>
</tr>
<tr>
<td>general implementation costs (AUK)</td>
</tr>
<tr>
<td>Installation Costs</td>
</tr>
<tr>
<td>operating installations</td>
</tr>
<tr>
<td>separate installations</td>
</tr>
<tr>
<td>Additional Costs</td>
</tr>
<tr>
<td>additional costs land</td>
</tr>
<tr>
<td>additional costs construction</td>
</tr>
<tr>
<td>additional costs layout</td>
</tr>
<tr>
<td>initial costs</td>
</tr>
<tr>
<td>Unforeseen Costs</td>
</tr>
<tr>
<td>unforeseen</td>
</tr>
<tr>
<td>Taxes</td>
</tr>
<tr>
<td>turnover taks</td>
</tr>
<tr>
<td>specific taks</td>
</tr>
<tr>
<td>Finance Costs</td>
</tr>
<tr>
<td>finance costs/interest (land)</td>
</tr>
<tr>
<td>finance costs/interest (construction)</td>
</tr>
</tbody>
</table>

Figure 30, Investment Costs (source: edited by author (NEN2699, 2013))

Land Costs

The budget for the lands costs, as explained above, is the expected revenues minus the remaining investment costs and profit. This is the maximum amount that can be paid. The land costs can be divided in: acquisition costs, demolition and environmental costs, infrastructural facilities, and above ground settlements. Together with the construction costs, this is the largest part of the investment costs.

In this research for both transformation and demolition, not only the land costs will have to be paid, but also the above ground settlements that in this research means the vacant office building. One of the major obstacles for the financial feasibility of the transformation projects is the acquisition cost of the office in relation to the expected revenues. If the land costs can be decreased the financial feasibility of the project is increased. The trend of reevaluating the office buildings has been started, with owners and investors reevaluating courant office buildings with 5 to 10% and non-courant buildings up to 50%. The lower prices in the market are now €1.000 per square meter LFA as opposed to €1.500 before the economical crisis. However only when the price drops to €500 per square meter LFA, vacant offices become feasible.
for transformation. Even though the revaluating process has started, this is something that needs to happen incrementally and will therefore take some time (Oudemans, 2011).

An often mentioned important factor for a successful transformation from a financial point of view are low acquisition costs. When transforming or demolishing the pain of the depreciation needs to be taken at once. With the consolidation strategy the building can be depreciated over several years. This is why many investors choose to gradually take their losses. The period that the building is vacant however costs money, and it’s only postponing the inevitable necessary intervention in the vacant building.

**Construction Costs**
The construction costs exist of; the construction works, installations, permanent interior and facilities, terrain, and general implementation costs. There is a difference between the construction costs of transformation projects and new buildings. With transformation projects the construction costs are dependable on the building characteristics of the building that needs to be transformed and the characteristics of the new building. While with new buildings the construction costs only depends on the characteristics of the new building. Since every building is unique, the costs of transforming the old buildings cannot be generalized and is very hard to predict.

Many financial feasibility studies focus on these construction costs of the transformation project in order to predict these costs and the feasibility. Examples are the research of Mackay (2008) with a focus on the construction costs of transformation projects, and the research of Schmidt (2012) with the construction costs of building elements.

The construction costs of demolition & new-build for the reference case will be gathered from key benchmarking figures.

In the Netherlands two different methods of budgeting the construction costs are used; STABU and NL-SfB. STABU is mostly used by contractors and is not officially certified by a normalisation institute, while NL-SfB is officially used by the NEN norm and is divides the costs into elements, called the element method. For this reason, in this research the NL-SfB will be used.

**Installations/Interior costs**
The installation or interior costs will be on the account of the tenant of the apartment. The actual building installations like the E-Installations (Electric), W-Installations (Mechanical), and Transportation installation are part of the construction costs.

**Additional Costs**
Additional costs are the costs prior and during the construction needed for the construction process. This includes fees for architects, construction engineers, advisors, etc. The Additional costs are divided into: additional costs land, additional costs construction, additional costs interior, and initial costs.

**Unforeseen Costs**
Almost all projects include unforeseen costs. In the NEN2699 norm these are kept as one costs for the entire project. It’s interesting to see if there is a big difference with the unforeseen costs of transformation compared to demolition & new build. According to Schmidt (2012) the unforeseen costs can be higher for transformation, because some projects cost more than was budgeted.

**Taxes**
Tax and transfer tax can influence the decision for the intervention strategy for a vacant office building. Figure 31 shows that different tax rules apply for offices and housing. Extraction of commercial real estate from the market by transformation it’s not attractive in fiscal terms. Transformation to functions without VAT accounting, like housing, is therefore more costly than transformation to functions that do (Buitelaar et al., 2013). These tax regulations are always subject to changes and an additional complex matter for the transformation process. In order to make renovation and transformation more appealing, the VAT rate for renovation and transformation has temporarily been lowered to 6%.

In this research the options demolition & new-build and transformation will have the same function change, and same new tax rules applied with the new function. The tax regulations will therefore be left out of the research.
Finance Costs

The finance costs are the interest costs that need to be paid over the loan needed for financing the construction costs. The longer and the higher the costs and loan is, the higher the interest costs will be. A difference in finance costs for the intervention strategies can have an important influence on the total costs each option. More information on the finance costs is in chapter 7.2.

The LTV has nothing to do with the intervention strategy, it’s a decision of the investor based on other reasons. The finance costs are depending on the height of the loan. The loan depends on the investment costs of the project. The loan and the LTV ratio will influence the interest costs and height of the annual repayments. Here will again be a difference for transformation and new-build. The investment costs are different for transformation and demolition & new-build, which results in different annual repayments and interest costs for both strategies.

7.2 Operating Costs

The operating costs are the costs during the life cycle of the building necessary for the use of the building. According to the NEN2699 norm operating costs of real estate are the recurring costs that derive from:

- The ownership of real estate
- Maintaining the real estate ready for use
- The partially or fully use of real estate

The operating costs are divided into: Accommodation, Services & Resources, ICT, External Facilities, and Facility Management of which only the first two are covered in this norm. These are costs that are related to the land and/or the real estate. The costs are registered and budgeted annually. The NEN norm covers all the costs involved with the building. It is however important to realise to whom these costs belong to. During the operating phase a distinction can be made between the costs of the owner and the costs of the tenant. The figure below gives an indication of the distribution of the operating costs of an office building. Of the total operating expenses the rental income, maintenance, energy, and cleaning costs have the most influence and will therefore be discussed more elaborately in this research than other costs.
Accommodation

The accommodation costs consist of the following costs; providing accommodation, taxes, insurance, maintenance, mutations, consumption of energy/water/etc., management, and interest. The costs of accommodation can largely be determined using key figures from Vastgoedexploitatiewijzer (2013).

Providing accommodation

Providing accommodation is basically the depreciation of the object. Depreciations are costs that may be deducted from the revenues. There are three ways of calculating the depreciation costs; the linear method, the progressive method, and the digressive method. Of these the linear is most suitable for this research and most commonly used in practice. With a linear depreciation the annual costs are equally spread out over the lifespan. The annual depreciation can be determined by deducting the residual value from the current value and divide it by the lifespan.

Taxes & Levies

These are the so-called fixed costs. The taxes and levies of a building consist of; OZB or property tax, water tax, and sewer tax. These costs depend on the location of the building and the WOZ value. The OZB or property tax is divided into an owner's part and a users part. The water tax consists of the waterboard levy and pollution tax. Finally the sewer tax is determined by the connections to the sewer system. Owner of a building has to pay the sewer tax for each connection.

Insurance

The insurance that needs to be paid is divided into building insurance for the owner and theft and fire insurance for the tenant. The owner's part is determined by a fixed percentage of the WOZ value.

Maintenance

The maintenance costs are an important part of the operating costs. They can be determined using key figures in euro per m2 GFA. Furthermore the results from the case studies will be used.

Mutations

Mutations are the alteration to the building, like a reconfiguration. These reconfigurations can cause parts of the building to be vacant and therefore loss in rental income. The vacancy rate of mutations will be included in a vacancy percentage in the model.

Consumption of Energy

The consumption of energy is divided into; electricity, gas, water, and district heating. Even though the total energy consumption is a large part of the total operating costs, these costs will mostly be for the tenant, apart from the energy costs of the communal spaces. The costs savings of less energy use, will therefore be for the tenant. The cost savings of investing in a lower energy use of a building therefore needs to be compensated in the rent level.
Management
The management costs are the costs of managing the property. These costs are often a percentage of the basic rent and can differ for corporations and commercial parties.

Interest
The interest is the compensation that needs to be paid for the debt capital. The interest is determined by the debt capital and the interest rate. The interest rate is calculated over the part of the remaining loan. Since the loan will decrease with each repayment, the total cost of the interest will therefore also decrease each year.

Service & Resources
The only costs of Services & Resources that will be included in the LCC calculations are the cleaning costs. These cleaning costs are directly related to the building, and are divided in interior and exterior cleaning costs. Also the cleaning costs are a significant part of the operating costs. However the cleaning costs will be for the user and therefore have no influence on the costs of the owner.

<table>
<thead>
<tr>
<th>Operational Costs (NEN 2699, 2013)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipality</td>
</tr>
<tr>
<td>Accomodation</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td>Services &amp; Resources</td>
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<tr>
<td></td>
</tr>
<tr>
<td>ICT</td>
</tr>
<tr>
<td>External Facilities</td>
</tr>
<tr>
<td>Facility Management</td>
</tr>
</tbody>
</table>

Figure 33. Operating Costs (source: edited by author (NEN2699,2013))

When addressing the vacancy problem it is important to understand what the effects of the on-going operating costs of a vacant office building are. As discussed in chapter 4.5, most investors or owners of vacant offices do not consider their vacancy as a problem. As long as the other they maintain a positive return on their total equity capital and can pay the interest on their loans. This short-term view however is not sufficient and overlooks a few fundamental problems with a vacant office building.

First of all the operating costs that continue are significant. What is not commonly known is that the costs of a vacant office building can be higher for the owner than a rented out office building. For instance the coverage of the insurance decreases, which can have large financial consequences. The energy costs might decrease in total, however the energy costs in a rented out building are mostly for the tenant, in a vacant building all energy costs will be for the investor. Furthermore the pipes will need to be free of frost and electricity is needed for emergency lighting, outdoor lighting, security installations, elevators and maintenance.

Technical maintenance and cleaning is still required as the building needs to remain presentable for potential tenants. Also some management costs like staff costs and accounting costs will continue.

Finally the highest operating costs will be the capital costs, if a building is financed partly with a loan (Trouborst, 2012). It is very common to finance a building with dept capital. The capital costs consist of repayments and interest costs. With each repayment the interest costs will decrease. Most loans for buildings are 5 to 10 years. These financing costs can results in heavy losses each year.
According to Gerard Kohsiek in practice these operating costs of vacant buildings can be lower much lower. Buildings can be completely shut down. Legally they have to remain presentable for potential buyers, but practice proves differently. In a legal way implicating temporary functions in the building like anti-squad can also lower the costs. For this research however it will be assumed that the operating costs will continue as described and no temporary function is added.

7.3 Revenues
As stated in chapter 7.1 the financial feasibility of a building can be increased by reducing the costs or by increasing the revenues. The revenues are determined by the market, location and building characteristics. In the graduation research of Muller (2008) he investigated the different possibilities for increasing the revenues of a transformation project. The location, possibilities for changing the floor space surface, and the possibilities for a commercial function on the ground floor, the plinth function, have the largest impact on the revenues.

The location will be equal for all the different intervention options and is not included in this research. ReUrba (2000) gathered a list of all the different ways to change the total surface of buildings, consisting of 8 different categories:

1. Thicken (opdikken)
2. Down-topping (aftoppen)
3. Excavate (uithollen)
4. Attach (aanpuisten)
5. Combining Floors (bovenkameren)
6. Topping (optoppen)
7. Adding new build (aankoppen)
8. Using the plinth (uitplinten)

Figure 34, 1. Thicken (Schmidt, 2012)

Figure 35, 2. Down-topping (Schmidt, 2012)
Figure 36, 3. Hollow (Schmidt, 2012)

Figure 37, 4. Attach (Schmidt, 2012)

Figure 38, 5. Combining Floors (Schmidt, 2012)

Figure 39, 6. Topping (Schmidt, 2012)
NEN2699 (2013) divides the revenues in land use, construction/transformation project, and building use. The costs of all three sub-categories are divided in periodic revenues like rental income and one-off revenues like sale and transfer income.

**Revenues Land Operation**
The benefits of the land operation will be for the municipality and the developer. These are benefits of temporary rent of the land and the selling of the land.

**Revenues Construction/Transformation Project**
The developer that carries out the development will mainly receive the benefits of the construction/transformation project. In this research these revenues will be incorporated in a fee for the developer.

**Revenues Building Operation**
The benefits of the building operation are the rental income, service costs, additional services and the residual value of the building. Both the rent and the residual value will be important when comparing the different strategies. The rent level is calculated in Useable Floor Area (UFA) as opposed to the Gross Floor Area (GFA) that is used for determining for instance the construction costs.

<table>
<thead>
<tr>
<th>Benefits/Revenues</th>
<th>Municipality</th>
<th>Developer</th>
<th>Investor</th>
<th>User</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues Land Operation</td>
<td>periodic revenues</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>one-off revenues</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Revenues Construction Project</td>
<td>periodic revenues</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>one-off revenues</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenues Building Operation</td>
<td>periodic revenues</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>one-off revenues</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

**7.4 Calculation Methods**
Investors can use many different methods for carrying out the financial feasibility studies. Some of these methods are also used for valuating real estate. Although the investment and valuation methods look very
similar, in practice there are differences. The most commonly used methods in the Netherlands are explained in by van Gool et al. (2007), and are as follows:

- Bruto-aanvangsrendementmethode (BAR method)
- Netto-aanvangsrendementmethode (NAR method)
- The X-Times–Rent method
- The Discounted Cash Flow method (DCF method), which has three different variations; the investment value method, internal rate of return (IRR method), and the unprofitable top method
- The Replacement Costs method

**BAR and NAR method (Gross Initial Yield)**

The BAR and NAR method play an important role in investing in real estate. The BAR and NAR can give a first impression of the return of an investment. The BAR is used a lot more than the NAR in the Netherlands. The BAR is the Gross Initial Yield, and the BAR method essentially expresses the Gross Initial Yield in a percentage of the investment.

\[
Y_{bar} = \frac{BH_{1}}{I} \times 100\%
\]

\[
Y_{nar} = \frac{[BH_{1} - E_{1}]}{I} \times 100\%
\]

Where
- \( Y_{bar} \) = Gross Initial Yield
- \( Y_{nar} \) = Net Initial Yield
- \( BH_{1} \) = Gross Annual Rent in the first year of operation
- \( I \) = Total Investment
- \( E_{1} \) = Total Operating Costs in the first year of operation

The disadvantage of both of these methods is that only the initial yield is calculated, which has little to do with the return from the rest of the operating period, the so-called Internal Rate of Return. Besides that it does not include aspects like vacancy, rent incentives, major maintenance, yield changes, leverage and tax matters. Therefore the BAR and NAR method are not appropriate methods for calculating the LCC.

**The X-Times-Rent method**

This is a simple method that basically is the opposite version of the BAR method. Investors don’t use this method a lot but brokers do due to the quick calculation. In principle the method is not different from the BAR method, because the \( X \) and the BAR are each other’s reciprocal.

\[
X = \frac{1}{BH_{1}}
\]

**DCF method**

The DCF method or Net Present Value method (NPV) essentially makes the cash flows of the operating period and the selling price present. Project costs that occur at different points in the life cycle of a building cannot directly be compared, because of the varying time value of money. These cash flows therefore need to be discounted back to their present value. The discounting of the cash flow gives the Present Value (PV) of the costs and benefits. The costs and benefits are converted with the discount rate, which is “the interest rate used to convert future expenditures to their present value at the base date, taking into account the investor’s time value of money”(DavisLangdon, 2006). This gives the amount of money that would need to be invested today, at an interest rate equal to the discount rate, in order to have that amount of money available in the future. The NPV is the sum of all present made costs and benefits.

\[
NPV = \sum_{t=1}^{T} \frac{C_{t}}{(1 + r)^{t}}
\]

Figure 43, NPV (DavisLangdon, 2006)

Where
- \( NPV \) = Net Present Value
- \( C_{t} \) = Cost of item \( t \)
- \( r \) = Discount Rate
The DCF method can be used to calculate:

1. The Investment Value method
2. The Unprofitable Top method
3. The Internal Rate of Return (IRR) method

1. The investment value method is used when the DCF method is used for investment analysis. It simply calculates the value the investors assign to an object based on its own required return. Institutional investors commonly use the investment value method, because the results are easily comparable and it gives a first impression of the value of the object.

\[ IV = \left( \frac{CF_1}{(1+ER_0)^1} \right) + \left( \frac{CF_2}{(1+ER_0)^2} \right) + \ldots + \left( \frac{CF_n}{(1+ER_0)^n} \right) \]

Where

- \( IV \) = the Investment Value
- \( CF_n \) = the Cash Flow in period \( n \)
- \( ER_0 \) = the Expected Return of the object

2. The Unprofitable Top method is used by corporations to calculate the discounted cash flow of the unprofitable top. The method basically subtracts the total investment sum \( I \) from the Investment Value \( IV \). With social housing this subtraction results in a shortage, which is called the unprofitable top.

3. Finally the DCF method is used to determine the Internal Rate of Return (IRR) of an object. The IRR shows the return period of an investment. In contrast to the investment value, the discount rate is calculated rather than given. The IRR is mainly used by institutional investors. The advantage of the IRR over the Investment Value method is that the return period is easily calculated, besides that it is possible to include the effects of debt and tax. The IRR's of different options can be compared, which makes it a good method for comparing different intervention options.

A central feature of LCC is the application of Net Present Value. On purely economic grounds however the NPV makes it less attractive to spend money now, but more in the future. This is due to the fact that even with a modest discount rate the NPV reduces rapidly. This makes long-term performance unattractive to the developer.

**The Replacement Costs method**

Besides the methods that capitalize the rent or calculate a return, also other methods exist like the replacement costs method. The method basically calculates the price for which the building can be build or respectively rebuild. The construction price is then compared with the potential selling price. If the selling price is higher, the investment can be interesting.

**The Differences between calculation methods for Developers and Investors**

The developer and investor each have their own method for calculating the return on their investment. The acquisition cost of an office building is one of the most important factors in the financial feasibility of a transformation project. And it’s at the negotiations of the acquisition price where the investor and developer collide. The developer calculates the residual value in a certain period in time, while the investor focuses on future income and expenses. The gap between these calculations and resulting values is an important cause for the failure of a financially feasibility study (Van Der Voordt, et al, 2007).

For a long time developers used the Return On Investment (ROI) or BAR method, and for a long period of time 10% was seen as a minimum return requirement. ROI and BAR give the ratio between return and the investment. If the investment results in loss, the ROI will be a negative figure. It’s relative easy to calculate when the investment and the generated revenues are easily expressed in monetary values. The disadvantage is that the ROI and BAR are not linked to the life cycle of a project.
Developers also started using other methods like the IRR and Weighted Average Cost of Capital (WACC). The IRR is part of the DCF calculations and therefore better in analysing future cash flows. In the acquisition phase the developer will mainly rely on key figures, form factors, and other benchmarking figures to do the calculations.

In order to calculate the internal rate of return, an investor uses the DCF method to make the future cash flows present. The method is depending on a few essential variables. The four most important cash flows from the operating period are rental income, annual operating costs, major maintenance, and the end value. The rental incomes at the start are equal to the rent in the contract. The developer will try to capitalise the rents as high as possible, when selling the building to an investor, as a higher rent will result in a more expensive building. An investor benefits from a low rent in the beginning, in order to prevent depreciation caused by lower rents in the future (Huysmans, 2011) (Figure 45).

**Variables DCF method**  
*source: adaptation by author (Huysmans, 2011)*

This research will make use of the DCF method, because it enables all costs and revenues of future cash flows to be made present. Within the DCF method multiple financial parameters can be incorporated, for instance the costs of vacancy, indexation of rental prices, and inflation. The only problem with the parameters and variables in the DCF method is the large influence they have on the end result. This will need to be taken in consideration when applied to the LCC model.

**7.5 End of Life**

If at any time during the life cycle of a building the LCC analysis shows that the building is no longer economically viable, the decision will need to be taken to invest in the disposal stage. Owners will try to maximise their return. They will need to choose whether they want to dispose, retain, refurbish, demolish, or transform the building.

Important for all DCF calculations is that the residual value, which is the expected sale price of the object at the end of the operation period, is determined. The residual value is part of the cash flow of the last operation annum. The residual value of the building can have a big influence on the outcome of the

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**Variables**  
*source: adaptation by author (Huysmans, 2011)*

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price increase/decrease</td>
<td>Change in costs and benefits during lifespan</td>
</tr>
<tr>
<td>Value increase/decrease</td>
<td>Change of the WOZ value during lifespan</td>
</tr>
<tr>
<td>Lifespan</td>
<td>During which period the investment is held</td>
</tr>
<tr>
<td>Costs Dept Capital</td>
<td>Interest costs as a result of the use of dept capital</td>
</tr>
<tr>
<td>GIY</td>
<td>Gross Initial Yield, used to determine the market value</td>
</tr>
<tr>
<td>NIY</td>
<td>Result of the market rent subtracted by the operating costs and investment</td>
</tr>
<tr>
<td>Market Rent</td>
<td>Estimated rent level of future rental income</td>
</tr>
<tr>
<td>Contract Rent</td>
<td>Rent level according to the contract</td>
</tr>
<tr>
<td>Operating Costs</td>
<td>Accommodation and Service costs</td>
</tr>
<tr>
<td>Residual Value</td>
<td>The residual value is determined with the Exit Yield</td>
</tr>
<tr>
<td>Internal Return</td>
<td>IRR, return over a long period and relates to the discount rate for making future cash flows present</td>
</tr>
</tbody>
</table>

**Revenues**  
*source: adaptation by author (Huysmans, 2011)*

<table>
<thead>
<tr>
<th>Revenues</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing</td>
<td>start sale (price increase)</td>
</tr>
<tr>
<td>Commercial</td>
<td>delivery (cpi)</td>
</tr>
<tr>
<td>ROI</td>
<td>delivery (residual value)</td>
</tr>
</tbody>
</table>

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**Calculation method in this research**

While the BAR, NAR, and x-times-rent method are suitable for giving an in initial impression of financial feasibility, the end result is unclear since it’s only a percentage. These methods are therefore not suitable for this research.

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**Figure 44, Construction Costs calculations developer source: adaptation by author (Huysmans, 2011)**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment Costs</td>
<td>indexation to:</td>
</tr>
<tr>
<td>Land Costs</td>
<td>acquisition land (cpi)</td>
</tr>
<tr>
<td>Construction Costs</td>
<td>start construction (bdb)</td>
</tr>
<tr>
<td>Additional Costs</td>
<td>start construction (cpi)</td>
</tr>
<tr>
<td>Unforeseen Costs</td>
<td>start construction (cpi)</td>
</tr>
<tr>
<td>Finance Costs</td>
<td>-</td>
</tr>
</tbody>
</table>
different intervention options. The consolidation option requires the least investment costs, however the end value of this option will probably be the lowest. There are several ways for determining the end value of a building:

- Building and planting method
- Value development method
- Current value method
- Exit-yield method
- Yield value method

The exit-yield is the most common method of calculating the residual value of a building. Also Maarsen Groep uses the Exit-yield to calculate the residual value of a building. Therefore in this research the exit-yield will be applied for calculating the residual value. In the model it is interesting to pay attention to the different residual values of the strategies. The Exit-yield works exactly the same as the Gross Initial Yield, only the last years rent + 1 is used to calculate the residual value.

7.6 Sensitivity Analysis

A sensitivity analysis measures the impact on the return by changing one variable, while the other variables are kept the same. The results will show, which variables have the largest influence on the end result and are therefore the largest costs and benefits of the transformation process. The problem with the sensitivity analysis is that it doesn't include the probability of the different outcomes. Still it is commonly used in practice due to its easy to use character (Veen, 2012).

Scenario analysis derives from the sensitivity analysis. The method calculates three scenario's; pessimistic, realistic, and optimistic. The bandwidth of the outcomes is wide, because the pessimistic scenario adds all negative values and respectively the optimist adds the positive values. When the decision maker is capable of estimating the probability of the different scenarios, this method is called the Expected Monetary Value (EMV) (Veen, 2012).

The Monte Carlo simulation is a technique that creates a probability distribution for the costs and benefits; this makes it possible to calculate the probability of the return of a project. Monte Carlo randomly uses parameters over a range of values from a specified frequency distribution. The advantage of the simulation is the positive and negative consequences and the dependent and independent are linked using a correlation matrix. This enables developers and investors to see what the effects of interventions are. Spite of the advantages the Monte Carlo simulation is not commonly used inter alia due to the complexity of the technique and the difficulties with generating reliable input data (Boussabaine et al, 2004) (Veen, 2012).

7.7 Lifespan

Life Cycle Costing is about determining the costs and benefits during the entire life cycle of a building. In order to be able to calculate the life cycle costs of a building, the lifespan of the building needs to be determined.

According to Van Nunen (2011) it’s important to put the lifespan of buildings in perspective. His method of ‘lifespan thinking’ focuses on the sustainability of long term strategies. As an example he approaches houses with an average lifespan of 120 years. In these 120 years interventions are needed to be able to comply with the performance requirements (figure 46).
When deciding for the right intervention strategy, this will influence the course of the life cycle of the buildings as figure 47 shows. Interventions in buildings therefore require a life cycle approach. Sascha Jansz (2012) expanded this way of thinking in her thesis with the addition of the Estimated Service Life (ESL) to the Greencalc+ results when comparing different vacancy strategies. The estimated service life is the remaining timespan on which the environmental impact can be deducted. The Greencalc* method assumes that new buildings have a lower energy use than transformed buildings. When looking at the total environmental load however, also the material costs and water needs to be taken into account. A new building requires a lot more materials than transformation, which negatively influences the total environmental load.

The research shows that a longer ESL means that the environmental load caused by materials can be deducted over a longer time period and the annual environmental load per year will therefore be lower. The ESL for a new building is assumed to be longer than a transformed building. Because of this, even though the environmental load of the materials is higher for a new building, it can be deducted over a much longer period of time. This is of course a case specific approach, but it shows that the remaining service life of a building has an influence on the different strategies for vacant office buildings from an environmental point of view.

Even though this research focuses on the economic aspects of Life Cycle Costing, the link with sustainability is inevitable. The idea behind LCC with the integral approach of all costs of the entire life cycle is required in order to realise sustainable projects (Van Doorn & De Jong, 2012). While sustainable development is a much more comprehensive concept than just energy use (chapter 1), it’s the energy costs of a building where profit and planet meet in this research. The energy savings are expressed in terms of monetary costs and benefits, rather than the environmental impact.

Van Der Voordt (2004) divides the lifespan into the economical, technical, and functional lifespan. The reason buildings become vacant is because one of these lifespans ends.

**Economic Lifespan**

The economic lifespan is basically the period of time where the financial benefits outweigh the costs. When looking at the economic lifespan all the costs and benefits are made present. If a building is does not meet the functional needs of the users they will look for a different building, if a new tenant can not be found for the building this is also the end of the economical lifespan. The building will then have a residual value that can be positive as well as negative.

With refurbishment and transformation the economic lifespan of a building can be extended. Figure 48 below shows the course of the economic lifespan, and how investments like major maintenance and renovations can boost the revenues. When the revenues drop below the costs in the figure, the economic lifespan has ended.
**Figure 48**: Schematic progress of costs and benefits (Vijverberg, 2004)

**Technical Lifespan**

The technical lifespan is the period of time where all the technical elements of a building, like the installations and the construction etc. function up to the standards and do not hinder the functional lifespan of the building. When a building deteriorates technically, this has an influence on the functional performance of the building. Investing in the building by conducting major maintenance or renovation can extend the technical lifespan.

The technical life cycle of an office building is 40 to 50 years (Zuidemal et al., 2010a). The technical lifespan of 50 years with offices outlives the current economical lifespan of around 10 years easily. The buildings are technically still meeting the demands of the users, however functionally a different building is required, or there is simply just no tenant due to the over supply which means no rental income and an end of the economical lifespan.

**Functional Lifespan**

The functional lifespan can be defined as the period of time that the building meets the demand and wishes of the user. When the building does not meet these demands anymore, the functional lifespan will end that will influence the economical lifespan. When this functional lifespan comes to an end actions are required. These are the different strategies for vacant buildings; doing nothing means there will be no tenant and no rental income, renovating can extend the functional lifespan and renew the rental income, transforming into a different function also requires an investment, or the building can be demolished ending its lifecycle for good.

Because the functional and therefore economical lifespan of office buildings is often ended long before the technical lifespan is over. This discrepancy between the different lifespans causes office buildings to be vacant, while technically they are still good enough to function as an office building. A structurally vacant that is functionally obsolete while the technical lifespan has not ended can possibly be transformed.

**7.9 Conclusion**

The NEN2699 norm categorizes all the costs and benefits for the entire life cycle of a building. It’s therefore very useful as a method for this research. The DCF method is the most suitable method for calculating the future cash flows and making them present. This method will therefore be used with the NEN2699 norm. An important aspect when calculating the life cycle costs is the lifespan that is chosen for a building. The intervention strategy and lifespan influence the decisions that needs to be taken. Finally the end value of the different intervention strategies will also have a large influence on the end results of the research. It’s important that the decisions concerning the different methods, variables, etc. is well analysed as all these decisions will affect the course of this research and the final results.
Empirical Research
This section covers the empirical research of the report. In this part the interviews and case studies are discussed, followed by an elaboration on the results. These results will then serve as input for the LCC model as well as substantiating the theoretical framework that was set up in the theoretical part of this research.
8 Case Analyses

In this chapter the analysis of the case studies is presented. A multiple ex-post case study was conducted focusing on different aspects of each case. First the selection criteria for the cases are discussed, followed by the information that is gathered per case. Consequently all cases with the relevant information will be covered. Finally the data from the cases need to be processed into usable input for the LCC model.

8.1 Case Selection

The cases were selected on the availability of cost data and project specific information concerning the decision process. In chapter 1.13 a demarcation for this research was set up, which is incorporated in the selection criteria. The selection criteria for the cases in this research are among others:

- The availability of the investment cost data
- The availability of operating cost data, therefore preferably the buildings have been in use for some years
- Availability of project specific information; floor plans, surface area, façade area, materials used
- Availability of information on the transformation process
- Only office buildings between 1960 and 1990 are selected, buildings from this period have the highest vacancy rate. Furthermore the buildings from this period have specific building characteristics. Buildings older than 1990 are not suitable for transformation since the book value of these offices can be assumed to be too high.

Chapter 2.2 describes the purpose of the case studies. For that reason special attention is paid to the following subjects of the case studies:

- Specific function change
- The different ambition levels of the cases
- The different form factors
- The volume or floor space of the different cases
- Information on the actors involved in the process
- The offices are non-characteristic offices (no monumental value etc.)

The case studies should reveal the following:

- What has the largest influence on the investment and operating costs
- What is the influence of adding the operating costs to the decision making process of the intervention strategies for a vacant office building
- What is the influence of the different construction periods of the strategies and the associated costs is of the different strategies
- How do transformed buildings actually perform financially compared to new buildings looking at the entire Life Cycle
- What is the difference in end-value of the different strategies
- If higher investments in the investment period result in lower operating costs. For instance completely replacing the façade results in lower energy costs

The following is expected from the case studies:

- The operating costs are higher for transformation than new-build
- The operating costs will have an influence on the decision making process
- The transformed offices are less efficient than new buildings in terms of; energy use, floor space use, and therefore overall €/GFA
- Consolidation will be financially more favourable in the short term since no investment is made, but in the longer term it will prove more expensive because of the continuing operating costs, less chance on tenancy, and low residual value
- Higher investment costs could result in lower operating costs

The next figure shows the list of selected cases, with some case specific information and information source. An important point of interest is that the cases that are selected are not representable for the total supply of offices. Since these cases have been transformed and in turn have already been selected to be feasible for transformation. The results of these seven cases therefore might come out more favourable for transformation as opposed to the total supply of vacant office buildings.
8.2 Data Collection

The data for the case studies is collected using interviews, cost sheets derived from the annual accounts, filled out cost sheets, and former research. The data retrieved from the case studies will need to be processed into organized usable data conform the NEN2699 norm. Tables and graphs are therefore a suitable method for organizing the cost data and make it possible for comparing the data from the different cases. Besides that for each case the general project information will textually be described.

By using an a priori specified list of variables, which is equal for all cases, the comparison between the cases can easily be made. The data that needs to be collected for the analysis will be characterized as follows:

- General project information
- Descriptive project information
- Cost information of the entire life cycle

General Project Information

The general project information consists of multiple variables that can be used for comparing different cases. These variables correspond with the input variables of the LCC model. The general project information includes:

- Location
- Construction year original office
- Start transformation year and year of completion
- GFA (m2) old office
- LFA (m2) old office
- GFA (m2) new building
- UFA (m2) new building
- Volume (m3)
- Gross surface (m2) façade
- Number and type of new apartments
- Vacancy rate in new building
- Layers
- Old function
- New function
- Ambition level
- Interventions Construction
- Intervention Façade
- Intervention installations
- Energy performance
- The actors involved (developer, investor, contractor)
- Other functions added

Descriptive Project Information

The descriptive project information describes in text the transformation of the vacant office building and some project specific information concerning the building. Here important case specific matters like success factors, risk indicators, and lessons learned are discussed. This information is mainly retrieved from previous researches and the interviews of the case studies that will be discussed in the next chapter.
**Cost Information**

Finally the cost information will be organized in graphs and tables, to give a clear view on all the costs involved and allows for easy comparison.

The cost information is categorized as follows:

- **Investment costs**
  - Acquisition
  - Demolition
  - Construction
  - Additional costs
  - Unforeseen costs
  - Finance Costs

- **Operating costs**
  - Accommodation
  - Taxes & Levies
  - Insurance
  - Maintenance
  - Mutations
  - Energy
  - Management
  - Interest
  - Cleaning

- **Revenues**
8.3 Cases

1 De Stadhouder // Alphen aan den Rijn

Located in the city centre of Alphen aan den Rijn, de Stadhouder is a former office building. The financial feasibility of transformation as well as demolition & new-build was calculated, and was more favourable for transformation. It was transformed into an apartment building, housing 70 starters apartments with a surface varying between 45-100m². The ambition level was low, basic, and high, with sale prices in the low, mid, and one in the higher segment. The entire development time-span upon delivery took approximately two years from the first drawings, which is relatively short. The short development time contributed to creating a positive financial result.

The structure allowed for the addition of 2 layers on top of the building, which resulted in an increase of 2000m² GFA. Furthermore the entire façade was completely replaced, because the old façade was not insulated and because the strip windows are not suitable for housing. The installations were completely replaced for new installations. Since the pre-stressed floors did not allow for large openings, the service shafts were placed on the outside of the building.

---

De Stadhouder // Alphen aan den Rijn

<table>
<thead>
<tr>
<th>General Project Information</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Year</td>
<td>1974</td>
<td>2005</td>
<td>Ambition level</td>
<td>Low, Basic, and High</td>
<td>2 years</td>
</tr>
<tr>
<td>GFA (m²)</td>
<td>5500</td>
<td>7500</td>
<td>Intervention façade</td>
<td>Completely Replaced</td>
<td></td>
</tr>
<tr>
<td>UFA (m²)</td>
<td>5685</td>
<td></td>
<td>Intervention construction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UFA / GFA Ratio</td>
<td>7%</td>
<td></td>
<td>Intervention installations</td>
<td>Completely Replaced</td>
<td></td>
</tr>
<tr>
<td>Layers</td>
<td>7</td>
<td>9</td>
<td>Actors involved</td>
<td>Giesbers-Maasdijken Ontwikkeling</td>
<td></td>
</tr>
<tr>
<td>Function</td>
<td>Office</td>
<td>Apartments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of new apartments</td>
<td>70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Cost Information</th>
<th>Investment Costs</th>
<th>Total</th>
<th>per m²/ GFA</th>
<th>%</th>
<th>Total</th>
<th>per m²/ GFA</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition</td>
<td>€ 5.283.753,10</td>
<td>€ 704,50</td>
<td>47,4%</td>
<td>Additional Costs</td>
<td>€ -</td>
<td>€ -</td>
<td>0%</td>
</tr>
<tr>
<td>Demolition</td>
<td>€ -</td>
<td>Unforseen Costs</td>
<td>€ -</td>
<td>€ -</td>
<td>0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction Costs</td>
<td>€ 5.870.836,78</td>
<td>€ 782,78</td>
<td>52,6%</td>
<td>Financing Costs</td>
<td>€ -</td>
<td>€ -</td>
<td>0%</td>
</tr>
<tr>
<td>Total Investment Costs</td>
<td>€ 11.154.589,88</td>
<td>€ 1.487,78</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operating Costs</th>
<th>Total/year</th>
<th>per m²/ GFA/year</th>
<th>%</th>
<th>Consumption of:</th>
<th>Total/year</th>
<th>per m²/ GFA/year</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing</td>
<td>€ -</td>
<td>-</td>
<td>-</td>
<td>Electricity</td>
<td>€ 10.385,92</td>
<td>€ 1,38</td>
<td>12%</td>
</tr>
<tr>
<td>Taxes</td>
<td>€ 4.185,29</td>
<td>€ 0,56</td>
<td>5%</td>
<td>Gas</td>
<td>€ -</td>
<td>€ -</td>
<td>0%</td>
</tr>
<tr>
<td>Insurance</td>
<td>€ 41.249,23</td>
<td>€ 5,50</td>
<td>47%</td>
<td>District Heating (Stadsverwarming)</td>
<td>€ -</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Maintenance:</td>
<td>€ 4.372,98</td>
<td>€ 0,58</td>
<td>5%</td>
<td>Management</td>
<td>€ 14.164,70</td>
<td>€ 1,89</td>
<td>16%</td>
</tr>
<tr>
<td>Building</td>
<td>€ -</td>
<td>-</td>
<td>-</td>
<td>Interest</td>
<td>€ -</td>
<td>€ -</td>
<td>0%</td>
</tr>
<tr>
<td>Installations</td>
<td>€ -</td>
<td>-</td>
<td>-</td>
<td>Cleaning</td>
<td>€ 11.930,13</td>
<td>€ 1,59</td>
<td>14%</td>
</tr>
</tbody>
</table>

| Total Operating Costs | € 87.812,04 | € 11,71 |  |  |  |  |  |
| Revenues [WOZ] | €109.000 | €235.000 | per unit |  |  |  |  |
2 Brinkwal 7 // Nieuwegein

Corporation Jutphaas wonen is focused on transforming vacant office buildings into housing. In a short period of time. Their starting point is an efficient transformation process, set up according to the ideology of the 'LEGOLisering' of construction. This means standardized and prefab elements that can be applied to different projects. Jutphaas uses a lifespan for 50 years, which is common for corporations. In these 50 years they completely depreciate the building.

Brinkwal 7 was transformed into 25 starters apartments in a total time-span of 10 months. With the acquisition in October 2012 and delivery in August 2013. The construction started in April 2013 and only took 4 months. This dramatically reduces the investment costs and results in an earlier start of the rental income of the project. The construction costs were kept low, by giving the contractor a maximum amount of €700,00 per m2 GFA for the transformation. It was the contractor's responsibility to stay within this limit.

The façade was left intact; only new double glazed windows replaced the single glazing. The label is estimated to be label E, due to the poor insulation. The installations were replaced. However it used to be a dentist office and therefore a lot of the distribution could be reused. No additions to the GFA were made, leaving most of the building untouched and investment costs relatively low.

<table>
<thead>
<tr>
<th>Brinkwal 7 // Nieuwegein</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Project Information</td>
</tr>
<tr>
<td>Construction Year</td>
</tr>
<tr>
<td>GFA (m2)</td>
</tr>
<tr>
<td>LFA/UFA (m2)</td>
</tr>
<tr>
<td>GFA / UFA ratio</td>
</tr>
<tr>
<td>Layers</td>
</tr>
<tr>
<td>Function</td>
</tr>
<tr>
<td>Number of new apartments</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost Information</th>
<th>Valuation date: 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment Costs</td>
<td>Total per m2 / GFA</td>
</tr>
<tr>
<td>Acquisition</td>
<td>€ 945,000,00</td>
</tr>
<tr>
<td>Construction Costs</td>
<td>€ 1,579,050,00</td>
</tr>
<tr>
<td>Total Investment Costs</td>
<td>€ 2,424,050,00</td>
</tr>
</tbody>
</table>

| Operating Costs | Total per m2 / GFA | % |
|------------------|----------------------|
| Housing | € - | € - |
| Taxes | € 8,750,00 | € 4,73 | 12,7% |
| Insurance | € 5,500,00 | € 2,97 | 8,0% |
| Maintenance: | € 34,725,00 | € 18,76 | 50,3% |
| Building | € - | € - |
| Installations | € - | € - |
| Interest | € 20,000,00 | € 10,80 | 29,0% |
| Cleaning | € - | € - |
| Total Operating Costs | € 68,975,00 | € 37,26 |

| Revenues | Total Rent / year | Rent / GFA / year |
|------------------|----------------------|
| € 172,500,00 | € 93,19 |
3 Bomansplaats // Eindhoven

Camelot purchased the Bomansplaats building with the intention of transforming it. One of the selection criteria for transforming a vacant office building is a favourable UFA / GFA ratio. The selling party was willing to depreciate almost 50% of the value, which helped increasing the financial result of the project. The design phase started in 2009 and ended mid 2010 with the building permit application. The construction phase that followed took less than 7 month, with the delivery in July 2011. Also this project was focused on creating a short preparation and construction period. The bathrooms were standardized and helped in shortening the construction period. For transformation projects Camelot calculates the financial result of the building for the coming 20 years.

The façade is left mostly intact, only replacing the windows, leaving the building with energy label D. The reason not more extensive interventions were made to the façade was because this was the first transformation project of Camelot. By maintaining most of the façade the investment costs were kept low. Now a few years later however, Camelot has decided yet to upgrade the energy label of the building by insulating the façade. Besides that PV cells have been placed on the roof in order to upgrade the energy label.

Of Bomansplaats only the service costs, which are directly passed on to the tenant, were retrieved.

<table>
<thead>
<tr>
<th>Bomansplaats // Eindhoven</th>
</tr>
</thead>
</table>

### General Project Information

<table>
<thead>
<tr>
<th>Construction Year</th>
<th>Original</th>
<th>Transformation</th>
<th>Preparation period &amp; Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFA (m2)</td>
<td>3600</td>
<td>3600</td>
<td></td>
</tr>
<tr>
<td>UFA (m2)</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>UFA / GFA ratio</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><em>layers</em></td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Function</td>
<td>Office</td>
<td>Apartments</td>
<td></td>
</tr>
<tr>
<td>Number of new apartments</td>
<td>107</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambition level</td>
<td>High</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention façade</td>
<td>Maintained, insulate &amp; replace windows</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention construction</td>
<td>Maintained</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention installations</td>
<td>Completely replaced</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actors involved</td>
<td>Camelot, van Niekerk &amp; Schellekens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valuation date: 2014</td>
<td>€5,200,000.00</td>
<td>€1,444,44</td>
<td></td>
</tr>
<tr>
<td>UFA (m2)</td>
<td>3600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GFA (m2)</td>
<td>1976</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GFA (m2)</td>
<td>2012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Investment Costs</td>
<td>€5,200,000.00</td>
<td>€1,444,44</td>
<td></td>
</tr>
<tr>
<td>Operating Costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total / year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxes</td>
<td>€16,143,11</td>
<td>€4,48</td>
<td></td>
</tr>
<tr>
<td>Insurance</td>
<td>€ -</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>€8,351,76</td>
<td>€2,32</td>
<td></td>
</tr>
<tr>
<td>Building</td>
<td>€ -</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Building</td>
<td>€ -</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Buildings</td>
<td>€ -</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Installations</td>
<td>€ -</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Terrain</td>
<td>€ -</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Mutations</td>
<td>€ -</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Cleaning</td>
<td>€6,796,47</td>
<td>€1,89</td>
<td></td>
</tr>
<tr>
<td>Total Operating Costs</td>
<td>€144,673,37</td>
<td>€16,07</td>
<td></td>
</tr>
</tbody>
</table>
4 Westerlaantoren // Rotterdam

The Westerlaantoren was a 19-storey office tower, of which after the transformation the first 10 layers remained offices and the upper 9 were turned into apartments. The original tower was completely offices and used to be 16 layers. In order to add the 3 layers during the transformation 2 layers needed to be demolished and followed by the addition of 5 lightweight layers. Furthermore the existing construction was reinforced to carry the extra weight. The façade was completely replaced by a new one, covered in ceramic tiles. Also the installations were completely replaced.

Because of the inefficient use of floor space of the tower, demolition & new-build might have been financially a better option. Westerlaantoren is a good example that a high energy label is achievable with a transformation project. This was accomplished by applying energy-use reducing measures and a focus on sustainability. The higher energy label did result in additional investment costs, which were in line with the high ambition level of the building.

<table>
<thead>
<tr>
<th>General Project Information</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Year</td>
<td>Original</td>
<td>Transformation</td>
</tr>
<tr>
<td>Construction period</td>
<td>9 Quarters</td>
<td></td>
</tr>
<tr>
<td>Ambition level</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>GFA (m²)</td>
<td>14000</td>
<td>19000</td>
</tr>
<tr>
<td>GFA (m²) Apartments</td>
<td>9000</td>
<td></td>
</tr>
<tr>
<td>UFA / GFA ratio</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>Layers</td>
<td>16</td>
<td>19 (9 for housing)</td>
</tr>
<tr>
<td>Function</td>
<td>Office</td>
<td>Office &amp; Apartments</td>
</tr>
<tr>
<td>Number of new apartments</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Energy Label</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

| Cost Information | Valuation date: 2014 |                      |                      |
|-------------------|----------------------|----------------------|
| Total Investment Costs | € 47.427.823,84 | € 2.496,20 | |
| Housing | € 15.544.860,00 | € 818.15 | 33% Additional Costs | € - | € - | 0% |
| Demolition | € 2.747.030,66 | € 144.58 | 6% Unforeseen Costs | € - | € - | 0% |
| Construction Costs | € 29.135.933,18 | € 1.533,47 | 61% Finance Costs | € - | € - | 0% |
| Total Operating Costs | € 117.996,68 | € 13,11 | |
| Revenues (WOZ) | €394.839 - €546.163 | per unit | |
5 Wilhelminastaete // Diemen

Rabo Vastgoed transformed their former office in Diemen into elderly housing, due to the high demand for this target group. The initial plan was to demolish the building build a new building. It wasn’t a popular building in Diemen and demolishing had little critique. However the structure of the building lent itself easily for transformation into housing, with only minor problems with the building decree. The façade was replaced completely due to the poor state it was in. No interventions on the structure would easily for transformation into housing, with only minor problems with the building decree.

The ambition level of the building was high, with large apartments that sold for €181.828 to €651.482. It’s a good example of a financially successful transformation. The operating costs were provided by Cats Vastgoedbeheer, who manages the building on behalf of the board of the owners association.

<table>
<thead>
<tr>
<th>Function</th>
<th>Number of new apartments</th>
<th>Rabo office</th>
<th>Apartments</th>
<th>Actors involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost Information</td>
<td></td>
<td></td>
<td></td>
<td>Rabo Vastgoed, Heddes Bouw, Van Rossum Ingenieurs, Rappange &amp; Partners, Cats Vastgoedbeheer</td>
</tr>
<tr>
<td>General Project Information</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wilhelminastaete // Diemen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Original / Transformation / Preparation period</td>
<td>1969 / 2007 / 1,5 year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GFA (m2) / UFA (m2) / UFA / GFA ratio</td>
<td>6700 / 8500 / 7031 / 83%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Layers / Intervention façade / Intervention construction / Intervention installations</td>
<td>4 / 83% / - / -</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambition level / Completely replaced / Distribution reused</td>
<td>Basic &amp; High / - / -</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Function</th>
<th>Voluation date: 2014 Excl. VAT Total per m2 / GFA</th>
<th>%</th>
<th>Total per m2 / GFA</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition</td>
<td>€3.625.637,87 / €426,55</td>
<td>34%</td>
<td>€ - / -</td>
<td>0,00%</td>
</tr>
<tr>
<td>Demolition</td>
<td>€7.137.974,55 / €399,76</td>
<td>66%</td>
<td>€ - / -</td>
<td>0,00%</td>
</tr>
<tr>
<td>Construction Costs</td>
<td>€ - / -</td>
<td>-</td>
<td>€ - / -</td>
<td>-</td>
</tr>
<tr>
<td>Total Investment Costs</td>
<td>€10.763.612,42 / €1.266,31</td>
<td>-</td>
<td>€ - / -</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operating Costs</th>
<th>Total / year per m2 / GFA / year</th>
<th>%</th>
<th>Total per m2 / GFA / year</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing</td>
<td>€ - / -</td>
<td>-</td>
<td>€ - / -</td>
<td>-</td>
</tr>
<tr>
<td>Taxes</td>
<td>€ - / -</td>
<td>-</td>
<td>€ - / -</td>
<td>-</td>
</tr>
<tr>
<td>Insurance</td>
<td>€9.775,85 / €4,87</td>
<td>17,8%</td>
<td>€ - / -</td>
<td>-</td>
</tr>
<tr>
<td>Maintenance:</td>
<td>€17.934,11 / €8,94</td>
<td>33%</td>
<td>€7.026,24 / €0,83</td>
<td>12,8%</td>
</tr>
<tr>
<td>Building</td>
<td>€14.649,02 / €7,30</td>
<td>27%</td>
<td>€ - / -</td>
<td>-</td>
</tr>
<tr>
<td>Installations</td>
<td>€ - / -</td>
<td>-</td>
<td>€ - / -</td>
<td>-</td>
</tr>
<tr>
<td>Terrain</td>
<td>€ - / -</td>
<td>-</td>
<td>€ - / -</td>
<td>-</td>
</tr>
<tr>
<td>Mutations</td>
<td>€ - / -</td>
<td>-</td>
<td>€ - / -</td>
<td>-</td>
</tr>
<tr>
<td>Total Operating Costs</td>
<td>€54.814,21 / €6,45</td>
<td>-</td>
<td>€ - / -</td>
<td>-</td>
</tr>
</tbody>
</table>

| Revenues (WOZ)  | €181.282 / €651.482 | | | |

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6 Churchilltorens // Rijswijk

The two Churchill towers in Rijswijk were built in 1970 and originally consisted of 20700m2 of office space. The building became vacant when the tenants GAK and Holland International moved out in the 1990s. The functional and financial feasibility of a transformation into housing was conducted by the architect and developer. They concluded that a transformation into 116 apartments, as well as the topping addition of 2 penthouses on each tower was feasible. The apartments were delivered casco.

Outdoor space was realized in the form of a sort of loggias by adding an additional internal façade. Although the additional façade was added, the original outside façade would be sufficient for housing. All installations were replaced, except two lifts that were reused. Two unnecessary lifts were removed and shafts were used as service ducts.

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### General Project Information

<table>
<thead>
<tr>
<th>Construction Year</th>
<th>Original</th>
<th>Transformation</th>
<th>Preparation &amp; Construction period</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFA (m²)</td>
<td>24400</td>
<td>27940</td>
<td>2 years</td>
</tr>
<tr>
<td>UFA (m²)</td>
<td>20700</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UFA / GFA Ratio</td>
<td>74%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Layers</td>
<td>11</td>
<td>12</td>
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### Cost Information

<table>
<thead>
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<th>Investment Costs</th>
<th>Valuation date: 2014</th>
<th>Excl. VAT</th>
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<tbody>
<tr>
<td>Acquisition</td>
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<td>€ 314,50</td>
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<tr>
<td>Demolition</td>
<td>€</td>
<td>€</td>
</tr>
<tr>
<td>Construction Costs</td>
<td>€ 10.715.946,00</td>
<td>€ 384,91</td>
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</table>

### Operating Costs

<table>
<thead>
<tr>
<th>Housing</th>
<th>Taxes</th>
<th>Insurance</th>
<th>Consumption of:</th>
</tr>
</thead>
<tbody>
<tr>
<td>€</td>
<td>€</td>
<td>€</td>
<td>Electricity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>€ 18.249,00</td>
<td>€ 21.519,00, € 0,77, 9%</td>
</tr>
</tbody>
</table>

| Maintenance: | Building | Installations | Terrain | | |
|--------------|----------|---------------|---------|---|
| €           | € 131.869,00 | € 12.485,00 | € 2.288,00 | |
|             | € 4,74 | € 0,45       | € 0,08 | |
|             | 58% District Heating (Stadsverwarming) | 5% Management | Interest | |
|             | € 19.488,00 | € 19.488,00 | € 22.375,00 | |

| Mutations | € | € | € | |
|-----------|---|---|---| |
|           | € | € | € | |

| Total Operating Costs | € 228.273,00 | € 8,20 | |
| Revenues (WOZ) | €135.910 - €444.320 per unit | |
De Studio was bought in 2002 by AM. Rochdale and Stadgenoot joined the development in 2004 for the development of social housing and social real estate, divided into 50% AM and 50% corporations. Because the building was turned into a monument, the original plans of demolition were not applicable anymore.

One of the biggest problems of the building is the sheer size of the building. Bought before the economic crises for high office prices, the 36,000m2 proved to difficult to fill. The high acquisition and interest costs had negative effects on the budget of the project. This project is an example of the risk of a high acquisition price and long preparation period. In 2009 Rochdale stepped out the development and AM and Stadgenoot made two decisions for the building: due to the large surface the building will need to be phased and it will be transformed into small owner-occupied houses and student housing.

In 2013 the first phase, the North wing, of a total of three phases was delivered. The GFA of the North Wing comes to 16,095m2. The total investment was well above a €100 million, of which the North wing is approximately €44 million. The north wing consists of 320 apartments, 170 sale and 150 rental apartments. The façade at the side of the highway was completely replaced by a façade to a similar design as the original façade. An additional façade was placed for thermal and sound insulation. The installations were completely replaced. New entrees were realized, as well as a new staircase for evacuation.

The total investment costs were higher than new-build, caused by the high acquisition and interest costs (Gelinck, 2013). The construction costs per m² were approximately the same as a new building. These high costs can be explained by the ambition level and high costs of the façade.
8.4 Data analysis

After all the data was gathered from the different parties the data was categorized according to the NEN2699 norm. Besides categorizing, all costs & benefits had to be made present in order for comparison. Most annual budgets have differing categories and not all costs could be divided into the right category. This was followed by a cross case analysis used to analyse the results of all the cases. Relations between different interventions, the investment costs, and the operating costs can be found with this analysis. In the figure below the results from the case studies are shown.

Table 50. Results Case Studies

At the start of this research the 1:0.4:12 ratio of Hughes et al. (2004) was used as an example to illustrate the ratio between the initial costs, the operating costs, and the business operating costs. The cases analysed in this research show a ratio of 1:0.55, which is comparable to the ratio of Hughes.

Figure 51. Investment Costs/ Operating Costs relation

The operating costs that are discussed here however are just the operating costs of the owner and not the total operating costs. A large part of the total operating costs like the energy costs of the apartments is for the tenant, and not included in the annual budgets of the operating costs retrieved from the different cases.
Operating Costs
The operating costs were the focus of this case study analysis. In the literature study (chapter 7) it was expected that the energy costs, maintenance costs, and financing costs would be the most significant of the operating costs. These consider however the total energy costs, while the owner of the building will only pay the energy costs of the communal spaces. In the case of rental apartments, he energy costs of the apartments are for the tenant and therefore not included in the annual budget. The annual budgets of the VvE used for the sale apartments also exclude the energy costs of the individual apartments. This explains why the energy costs are not a smaller part of the total operating costs than expected in the analysed case studies and not as much as the maintenance costs. The financing costs weren't included in any of the cases. The financing costs are very project specific and depend on the loan structure that is used.

The maintenance costs have a large bandwidth of costs per m2 GFA. The average maintenance costs are €25,02 per m2 GFA per year. The budgeting of the maintenance costs is a difficult process and is normally carried out on element level. Each element has its own materialization, with corresponding corrective, preventive, and replacement maintenance costs. The height of the maintenance costs therefore largely depends on the number of- and materials of the elements.

8.5 Correlation
In this part the cases are compared on their operating costs and relation with different variables. This is done by creating scattered graphs in excel, based on a list of two different variables. All the points represent the values of the specific variables of the cases. The relation between the two variables is then shown by drawing a regression- or trend line through the cloud of points. The correlation indicates the significance of the relation between the two variables and its result is a number between -1 and 1. The further from the 0, the more significant the relation is.

Brinkwal 17 and Bomansplaats deviate a lot from the average operating costs. Both cases include the service costs, which cause for a much higher operating costs per m2 GFA. The service costs are directly passed on to the tenant and therefore not part of the operating costs of the owner of the building. When comparing the different cases, this case will therefore skew the average results. This is called an ‘outlier’. The outliers are taken into account when analysing the relations and trend line of the results. For a better representation of reality it is interesting to take a look at the trend line if the outliers are removed from the data.

An important side note to the testing of the significance of this research is the small number of case studies. Seven case studies are simply far too little in order to make quantitative reliable data. This is a qualitative research therefore the relations found with the cases can be used to support the conclusions from the interviews of the cases, the interviews in general, and the theory from the literature study.
Investment Costs / Operating Costs
The graph below shows the relation between the investment costs and the operating costs. As the regression line shows, there seems to be a positive correlation between the investment costs and operating costs. Where higher investment costs result in higher operating costs. This relation seems likely and can be explained by the fact that a higher ambition level results in higher investment costs, but also in higher maintenance costs and therefore operating costs.

![Graph showing investment costs vs operating costs](image)

The outlier number 2 Brinkwal and 3 Bomansplaats have aberrant high operating costs. The management costs of Brinkwal are calculated per household and result in factor 10 higher management costs as the rest. Below is the same graph, but without the Brinkwal and Bomansplaats case. The graph still shows a positive relation, but the cases deviate less from the trend line.

![Graph showing investment costs vs operating costs without outliers](image)

Investment Costs / Preparation & Construction Period
This relation is one of the important starting points of this research. The relation between the investment costs can point out the effect of a long preparation & construction period. In this research it’s assumed that transformation can have a shorter preparation & construction period. If the investment costs and period therefore have a significant positive correlation, it indicates that a longer construction period indeed results in higher investment costs.
The reason why the investment costs of De Studio are so high is not only due to the very long preparation period. The office was bought in 2002, when the prices of offices were still very high. The difference between the preparation & construction period of transformation and demolition & new-build is therefore important to incorporate in the LCC model. To predict the length of this period is however extremely case specific.

**Operating Costs / Construction year**

In the literature study the different building characteristics like the structure, façade, etc. were linked to the year the offices were build. In previous research carried out by Mackay (2008) these characteristics were already linked to the construction costs. It seems interesting to know if there is a relation to these office characteristics and the operating costs.

The outliers with the high operating costs distort the expected relation between the original construction year and the operating costs. A logical relation would be higher operating costs for an older building. When removing the outlier, the graph indeed shows the expected relation between the construction year and the operating costs.
Operating Costs / Transformation year

The year the building was transformed could be related to the operating costs. It sounds plausible if the operating costs are lower for a newer building, because newer building are often of higher quality and could require less maintenance costs. According the graph below shows however the opposite is true, as it shows that for the analysed cases the earlier the building was transformed, the lower the operating costs.

When removing the outlier, the graph shows the same positive trend line.
Operating Costs / UFA/GFA ratio

The UFA/GFA ratio indicates the relation between the Usable Floor Area and the Gross Floor Area. A higher ratio means that relatively seen more space is in use, which could result in higher operating costs. A higher UFA/GFA ratio might however also indicate that there is less structural and non-structural inner walls, façade etc. that might require less maintenance and would therefore result in lower operating costs. The graph doesn’t show any relationship between the operating costs and the operating costs. This relation is further elaborated on in the conclusion.

![Graph of UFA/GFA ratio vs Operating Costs](image1)

**Figure 61, UFA/GFA ratio / Operating Costs relation**

Operating Costs / Size

The relation between the operating costs and size shows if there is an effect of scale on the operating costs. Here one would expect the operating costs of larger buildings to be smaller. Indeed when looking at the graph it shows a negative correlation, meaning that a higher GFA results in lower operating costs per m² GFA.

![Graph of Size vs Operating Costs](image2)

**Figure 62, Size / Operating Costs relation**

The graph without the outlier also shows a (less) negative relation between the size and the operating costs. The operating costs can therefore be assumed to be lower for larger buildings. This can be explained by the scale advantage of larger building on for instance contracts like cleaning or management costs per m².
8.6 Conclusions

Although the seven case studies are not sufficient for quantitative data, some important conclusions can be drawn. From the case studies the following can be concluded.

Classification

Classification in practice deviates significantly from the NEN2699 (2013) norm. Most categories are more specific in the NEN norm compared to actual budgets and annual accounts. The deviating classification used in practice either needs to be adapted to the NEN2699 if possible. Another approach is adapting the NEN2699 categories to the classification used in practice. This can mean that detailed categories are merged into one category. The classification of the costs from the cases into the right categories for this research might have costs fuzziness in the results.

In the annual accounts of the owners associations the maintenance costs are mostly at least divided into general maintenance, MJOP (maintenance planning), and the lift maintenance as separate posts. The MJOP is by far the largest part of all annual accounts.

Preparation & Construction Period

Three of the seven studied cases had a short preparation and construction period as a goal for the project. These three succeeded in achieving this short period. Preparing as much as possible before acquiring the building and standardization during constructions were methods used for accomplishing this.

Preparation and construction period is very specific for each project and cannot be specified from the results. As an example the difference in preparation & construction period is Brinkwal (10 months) and de Studio (90 months). Users of the model will therefore need to estimate this period and manually insert as input. However successful transformations had a focus on a short preparation and construction period in the transformation process.

UFA/GFA ratio

The average UFA/GFA ratio from the cases comes to 78%. The cases prove to be able to reach a similar ratio as new-build. When adding another 17 cases from research carried out by Muller (2008), the average of the cases remains 78%. The fact that these cases have been transformed and might have been selected on a favourable UFA/GFA ratio needs to be kept in mind. The bandwidth of the total of 24 cases varies between 64% and 86%.

These results show a high ratio is possible for transformation, but the buildings need to be selected and transformed with a focus to a favourable ratio. Eventually this ratio determines the total rental income of a building.

Energy Label

Of the cases analysed only 3 have an energy label. The labels are less than the currently required A+. However in the time they were transformed the minimum requirements were less. Still even with that in
mind, the energy performance of the transformed buildings is less than minimal requirements of new buildings from that period. In 2012 the requirements of the Dutch Building Regulations were softened for renovation and transformation.

The label A of the Westerlaantoren proves that a high energy label is possible with transformation. This can be dedicated to the focus on sustainability, like; efficient lighting systems, high insulation values, and the use of district heating.

**Asbestos**
With a number of cases asbestos was found and had to be removed. The removal of asbestos is a costly intervention and can be a serious risk. In the analysed cases where asbestos was found, clear agreements were made considering which party had to pay for the costs. This is almost always the seller of the building. If however these agreements are not made, the buyer will run the risk of having to pay high costs of removing the asbestos, which seriously influences the financial feasibility of the transformation. Also in previous research of Schmidt (2012) asbestos played an important factor with the cases analysed. The removal of asbestos however can be assumed to be equal for transformation and for new-build and therefore don’t influence the decision between the strategies.

**Feasibility studies & Selection criteria**
For some of the cases besides a feasibility study for transformation, also a feasibility study was made for demolition & new-build. This concerned financial feasibility studies for both strategies and obviously in these cases transformation came out more profitable (not taking into account monumental value). This is only the case if the offices are suitable for transformation into housing, without having to make to many adjustments that are linked to the height of the final construction costs of the transformation. The consequential operating costs were not taken into account in the calculation.

When selecting vacant office buildings for transformation Camelot created their own checklist (appendix). The veto criteria used first look at the location and market aspects. If those criteria are met, the building is checked for technical feasibility. Camelot focuses here on a high realisable UFA / GFA factor. This results in more rentable surface, and therefore higher rental income.

From the selected cases the corporations use a 50 year lifespan for their transformed buildings. This is standard for corporations. The only commercial party interviewed, Camelot, uses a lifespan of 20 years. According to Paul Keijzers this makes them more flexible with transformation. A building with a remaining lifespan of 20 years needs less investment than a building that needs to last for another 50 years. Some projects can therefore prove to be feasible for 20 years and not for 50 years.

**8.7 Cost Data Input**
The cost data from the case studies was needed to substantiate the differences in life cycle costs between transformation and new-build. In this part the data gathered from the case analyses is used to determine what the most important values of the variables are that influence the total costs and benefits.

Wherever possible, the data of the cases is used as input for the costs in the LCC model. The problem with the cost data from the case studies is that it is not in the same format as the NEN2699. Therefore the data will have to be converted from various types into the element method in level 3 of the NEN2699 norm.

**Different variables**
The different variables that will be focused on in the LCC model are as follows:

**Preparation & Construction period**
The preparation and construction period of some of the projects was indeed very short compared to a new building project. This is a benefit of transformation that will need to be taken advantage of, by focusing strongly on keeping this period as short as possible. If this period is shorter, the investment costs are likely to be lower.

**Operating Costs**
In the operating period the following variables have the largest influence on the costs and benefits: the rent, the maintenance costs, the energy costs, the taxes, and the management costs. In each of the cases the annual accounts consisted of a predetermined budget of the operating costs and actual costs spent.
UFA/GFA ratio
The UFA/GFA ratio determines a large part of the rental income of a building. The bandwidth of the UFA/GFA ratio is very wide and can be as high as new-build. This is therefore an important aspect of a transformation and needs to be a variable in the LCC model.

Energy Label
Although the specific energy use of the cases was not retrieved, three of the cases were labelled. The energy use is directly linked to the energy label, but is of course depending largely on the user. Still the energy label or EPC value is directly linked to the characteristic energy use of a building. The energy label of a building after the transformation therefore needs to be calculated in the LCC model.

Maintenance Costs
The maintenance costs were the largest part by far of the cases that were analysed. With all cases the maintenance costs were determined in a MJOP. The MJOP consists of preventive, corrective, and replacement costs. With the MJOP the costs of maintenance are spread out equally over each year, preventing deviating large expenses in certain years. The MJOP however is calculated on element level and far too detailed for the purpose of this research.
9 Interviews

The goal of the interviews is to find out what the motives were for decisions made during the process and to find case specific information. Also some of the sub-questions can be answered with the help of the experts in the interviews. The interviewees are different actors with different perspectives and interests with transformation projects. Among the interviewees are; developers, investors, asset managers, corporations, transformation experts, and building costs experts.

<table>
<thead>
<tr>
<th>Interview</th>
<th>Type</th>
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<th>Name</th>
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<tbody>
<tr>
<td>1</td>
<td>(Re)Developer</td>
<td>Office Up</td>
<td>Roderik Mackay</td>
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<tr>
<td>2</td>
<td>(Re)Developer</td>
<td>NieuwHolland</td>
<td>Dennis van den Broek</td>
</tr>
<tr>
<td>3</td>
<td>Investor</td>
<td>Maarsen Groep</td>
<td>Gerard Kohsieck</td>
</tr>
<tr>
<td>4</td>
<td>Asset Manager</td>
<td>Maarsen Groep</td>
<td>Maarten Muijssen</td>
</tr>
<tr>
<td>5</td>
<td>Developer</td>
<td>Maarsen Groep</td>
<td>Ton Boon</td>
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<tr>
<td>6</td>
<td>Corporation</td>
<td>Jutphaas Wonen</td>
<td>Marco van Dijk</td>
</tr>
<tr>
<td>7</td>
<td>Building Economy Consultant</td>
<td>IGG</td>
<td>Vincent van Sabben</td>
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<td>8</td>
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<td>IGG</td>
<td>Alexander Aksu</td>
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<td>9</td>
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<td>Camelot</td>
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<td>Investor</td>
<td>Merin</td>
<td>Henno van Eijk</td>
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<td>11</td>
<td>Transformation Expert</td>
<td>Transformatie Team</td>
<td>Jean Baptiste Benraad</td>
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<td>K &amp; C Eigendom Management</td>
<td>Ronald Lansbergen</td>
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<td>13</td>
<td>Corporation</td>
<td>Stadgenoot</td>
<td>Ruud Segers</td>
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<tr>
<td>14</td>
<td>Corporation</td>
<td>Stadswonen</td>
<td>Peter van Gennip</td>
</tr>
</tbody>
</table>

Figure 64. Overview interviews

The empirical value of the interviews is limited since it concerns only a few interviews and the interviews are short. The interviews were semi-structured and evolved during the period they were held in. The interviews consist of a pre made question list and didn't take longer than an hour. The interviews therefore mostly serve as additional information for the cases and the practical use of the LCC model and as confirmation of the theory in the literature study.

9.1 Results Interviews

The results of the interviews are divided into different subjects, based on the different categories of the interview questions. The questions in turn are aimed at answering some of the research questions as well as the opinion of the interviewees on the LCC model. The subjects are; strategies for vacant office buildings, main operating costs, calculation methods, the residual value, lifespan, model, and the important variables.

Strategies for vacant office buildings

How the decision for transformation is currently made differs for each party. Some have transformation as their core business and don't even consider demolition & new-build. Developers will be less interested in any costs after the delivery of the building. For investors the costs and benefits of the lifespan are interesting, but it depends on the investor how detailed he wants to make the calculations.

Most actors that are experienced with transformation use their own criteria list for the selection of a vacant office building. After verifying the market potential and the technical feasibility of the building, the financial feasibility of the object is analyzed. Some only calculate the financial feasibility of transformation, others also focus on the option of demolition & new-build.

Merin has a portfolio of around 200 offices and business spaces. They have divided their portfolio into four different categories; long-leases, lease-ups, repositioning, and eject. The long-lease have long running contracts and don't need much attention besides ensuring the client satisfaction, the lease-ups have high potentials for which new concepts and investments are made, the repositioning have potential for instance due to their location but need some rigorous interventions, finally the eject category has no potential and are mostly at the worst locations and are sold for around land costs. The repositioning is the most interesting category for this interview. For this category creative plans are made including financial feasibility studies. Mostly when the building permits can be applied for these plans the buildings are sold with the plans, increasing the selling price of the building.
Unforeseen Costs

The unforeseen costs are mostly calculated by multiplying the construction costs with a certain percentage. The unforeseen costs are based on cost overruns of construction projects. For new-build a predetermined percentage is used. With transformation it frequently occurs that the actual construction costs exceeded the budgeted costs, with a larger amount than is common for new build projects. For that reason the percentage unforeseen costs of transformation should be higher than new-build. Schmidt (2012) concluded this with his case studies and this was the reason why it is included in the interview topics.

One of the respondents from a developer’s point of view confirms this assumption that for transformation a higher percentage for the unforeseen costs needs to be used. The reason being that the risk the construction costs overruns the budget is higher with transformation. Jean Baptiste Benraad on the other hand states that from the extensive experience with transformation with Stadswonen, the risk of the budget overruns can largely be avoided. This is depending on the experience of all involved actors with transformation projects and early cooperation of actors that later in the process influence the feasibility, for instance concerning; the permit conditions, legal demands, and spatial planning. In addition since the Building Regulations were softened in 2012 for transformation, the minimum requirements are a lot less for transformation. An optimal re-use of the existing building can help lower the unforeseen costs.

Main operating costs

The main operating costs according to all interviewees are the energy costs and the maintenance costs. The finance costs are also a large part of the operating costs, but depend on the agreements made concerning the loan and not the building characteristics. The interviewees were asked if they thought if there would be a difference between the specific operating costs of transformed buildings and new buildings. Some approach transformed buildings as if they are exactly equal to new buildings. Others do underline the fact that there can be differences.

Calculation methods

Depending on the actor the operating period is included in the financial feasibility study for a transformation project. Obviously the corporations and (developing) investors are interested in the return of the building for the years coming.

The developers are less interested in the future costs and benefits of the asset. At Maarsen Groep for instance the developer works with a simplified cash flow model of 10 years. The cash flow is only used to calculate the profit, with the use of a BAR and a very rough estimate of the operating costs. The operating costs consist of some key figures for the operating costs and the finance costs of the project. Finally the Return On Invest is calculated for a 10-year average. Ton Boon states that for a specific project they used the simplified method as well as a detailed calculation of the total costs and benefits of which the results were almost equal. This approach should therefore from the developers’ point of view be sufficient for the calculations.

Paul Keijzers of Camelot says they calculate the costs and benefits for the entire lifespan they want to invest in. Their focus is on keeping the operating costs as low as possible, for instance by using a minimal amount of m2 GFA per building in order to keep the management costs per m2 low. This approach does require a model that is able to calculate the effects on all costs and benefits.

Lifespan

The lifespan chosen for the calculations differs for commercial and corporations. Corporations are very inflexible in this sense, with a standard lifespan of their buildings of 50 years. According to Jean Baptiste Benraad this is an obstacle for some transformation. As an example he names a corporation that, for a transformation project, could not get a financially feasible business case. This was due to the fact that in order to accomplish a 50-year lifespan, many costly interventions were needed. These interventions drove the investment costs up. If a lifespan of for instance 10-20 years was chosen, fewer interventions would be needed and a feasible project could have resulted. This idea is confirmed by the way Camelot approaches their projects. Paul Keijser (Camelot) claims that one of their advantages over corporations is that they can approach projects with a lifespan of for instance 20 years. Therefore they are more flexible, which results in more financially feasible business cases for vacant office buildings.
Stadswonen depreciates a building after transformation completely in 40 (now 50) years, this is the same for Jutphaas Wonen. This means after this period the value of the building is down to merely the land costs, or even less when the demolition costs are included. Peter van Gennip (Vestia, former Stadswonen) stresses the fact that because you transform the building and use an older structure, the aging of the structure will show a difference at the end of the life cycle for a new building and a transformed building. In reality the transformed building might still be worth more than just the land costs after 50 years. However this does show that there is a difference in the value owners or investors ascribe to a new building after 50 years and a building that has been transformed after 50 years.

**Model**
The actors that are active with transforming vacant office building are interested in a model that focuses on the long term financial consequences of the strategy chosen for the vacant office building. As output they would like to see the costs and benefits of the different strategies for the predetermined lifespan. From a developer’s point of view an elaborate overview of all costs and benefits over the entire life cycle is less interesting.

**Variables**
An important goal of the interviews as well as the cases was to find out which variables have the largest influence on the costs and benefits of transformation and differ between transformation and new-build. The following variables result from the semi-open interviews that were steered towards the potential variables that derived from the literature study and remarkable observations of the case studies. The variables correspond to the variables found in the case studies. These variables will therefore play an important role in the LCC model.

From the interviews held so far the variables that have the most influence on the LCC costs can be categorized into:

- The effect of the preparation and construction period. One of the advantages of transformation often referred to is time and money saving in the construction (chapter 6). This results in a lower total investment as well as an earlier start of rental income.

- The rental price will not so much differ for an apartment of the same size and ambition level of a transformed building compared to a new building. However the interviewees assume newer buildings will have a more favorable UFA/GFA ratio. Therefore a new building should be more efficient and fits in more apartments.

- The energy costs are a large part of the total operating costs. Besides that energy prices are increasing with a larger indexation compared to other costs and will therefore become even more predominant over the operating costs. Not all interviewees agree on the question if transformed buildings have higher energy costs. Some approach a transformed building, which has been stripped to the structure, as a new building. However others believe these costs might be higher, for instance because offices have higher floors, more façade surface etc.

- The maintenance costs are also an important share of the operating costs. Since with most transformations the installations are completely replaced, these costs can most be assumed to be equal for transformation and new-build. However the lift and transportation installations are often reused. This saves money in the investment, but can increase maintenance costs or even require a replacement or refurbishment later in the operating period.

- The end- or residual value of the buildings at the end of the strategy becomes important when comparing transformation and demolition & new-build with the consolidation strategy. Since consolidation doesn’t require an investment. Furthermore the construction of a transformed building is older than a new building, which would rationally mean that the technical lifespan is less than new-build. The end value should therefore be lower than a new building.
9.2 Conclusions Interviews

All parties that were interviewed that deal with vacant office buildings have their own checklists and strategies to deal with vacancy. The financial feasibility always plays an important role in the decision making process.

From the interviews an important factor stood out. Both Camelot and Jutphaas Wonen focus on the timing of the acquisition of the vacant object as well as reducing the preparation and construction phase. This is something that is not covered in previous studies, while this time factor has a large influence on the financial result of the projects.

Multiple parties emphasize the importance of the risk of asbestos. The costs of the removal of asbestos can be substantial and can seriously influence the financial result of transformation project. The most common way of dealing with asbestos is to make clear agreements about who is paying for the asbestos removal. If these agreements are made up front, mostly the costs will be for the seller of the building. Some of the interviewees however point to some examples for practice where no such agreements were made, resulting in very high extra costs for buyer. The risk of asbestos however will not influence the decision between the strategies and therefore not necessary to focus on in the model.

Gerard Kohsiek (Maarsen Groep) stresses the importance of the acquisition cost of the vacant office building, in relation to the book value and the current market value. With transformation and demolition & new-build the pain of devaluation will need to be taken at once, while consolidation spreads it out over multiple years. This however is intentionally not covered in this research and is a worth a research on its own.

One of the reasons why Merin is successful in dealing with vacant buildings is that their entire portfolio has already been depreciated close to market value when it was taken over by TPG Capital and Patron Capital. One of the biggest obstacles for any vacancy strategy, the high book value and necessary depreciation, is already overcome. Merin is therefore much more flexible in intervening with the vacant buildings in their portfolio. This example confirms and stresses the importance of the book value and market value of vacant office buildings and the necessity to depreciate in order for transformation to be financially feasible.

No consensus was reached among the interviewees whether the energy and maintenance costs of transformed buildings are higher than a new building. However when you realize transformed offices often have higher floor height and subsequently a higher façade / UFA ratio compared to new buildings, and the Energy Performance Coefficient (EPC) is calculated based on the UFA in relation to the area where energy is lost, mostly the façade (chapter 10). Then a transformed building will score less on the EPC purely based on these given fact. This means in theory just looking at these factors the energy costs of transformed buildings should be higher than new buildings. The cross case analysis already showed that the energy labels of transformed buildings are mostly lower than the minimum requirements of the Building Regulations for new buildings. Even though the energy costs per m2 GFA of transformed could not be compared to new-build, the observation that transformed buildings will most likely have a lower energy label is logically followed by higher energy costs per m2.

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LCC Model
Part 4 | LCC Model

This section covers the explanation of the LCC model, Test Case, and Monte Carlo simulation. The building of the model covered a large part of this research. The starting point of the model is the classification of the NEN2699 norm and combines a developer's model with an investor's model. This way the gap between the two calculation methods of both actors can be bridged. The test case is used to be able to draw specific conclusions, as the model itself only allows for generic conclusions.
10 LCC Model

The goal of the LCC model is a swift calculation of the costs and benefits of the different strategies for a vacant office building. The output of the LCC model should point out which strategy is financially the best option for the vacant office building. Previous research on the construction costs of transformation projects, like Schmidt (2012) and Mackay (2007), will be used as a starting point. The focus of this model will therefore be on the operating costs and the time factor of the costs and benefits in the cash flow.

10.1 Theory of the Model

In the LCC model the cash flows of both the investment and the operation phase are integrated. With the transaction or delivery of the building, the field of the developer and the investor meets. The cash flows of both parties are different from one another. The cash flow of the developer is mostly for a short time span, only the development period. The cash flow consists of a number of one-off payments like acquisition costs and construction costs. The costs of the developer are compensated with the sale of the building to the investor.

The long-term cash flow of the investor consists of a one-off purchase of the asset, followed by periodic revenues of rental income and expenses of the operating cost. Finally the asset has a residual value, which can be either positive or negative. The residual value of the asset will have a large influence on the financial result of the different intervention strategies.

Figure 64 shows the two cash flows that are integrated in the LCC model. The grey cash flow in the left represents the life cycle of the office previous to where the model starts. The office once had a tenant, with rental income and operating costs. Once the contract ended and no new tenant could be found, the building became vacant. While the rental income stopped, the operating costs continue. This is the starting scenario for the model and shows what the situation is with the current structural vacant office buildings.

In the grey area the owner of the vacant building has to decide whether he invests in the building, sells it, or do nothing. Doing nothing is the consolidation strategy in this research, meaning the operating costs will continue. Investing in this research means he will either transform it into housing, or demolish and re-build. Selling in this research is assumed to an investor who will invest and therefore also chooses whether to transform or demolish and re-build. If the owner chooses to invest, the building will internally be transferred to the developer. If the building is sold, the transfer will be externally.

The orange area represents the link between the two cash flows of the developer and investor. Here the developer sells the building to the investor. Again this can be either to an external party, as well as internally to a different department. The latter is also the case with Maarsen Groep.

Because the risk and time horizon of both cash flows are different, developers and investors have different return requirements and different ways of calculating the return. As explained in chapter 7 the developer uses the BAR or ROI method to calculate the required return on the investment. This disadvantage of this method is it doesn’t include to the time value of the costs and benefits.
The investors use the DCF method to calculate the required return; this method is also explained in chapter 7. For the LCC method the model of the developer and the investor will be combined into one model with a cash flow from the start of the project, the acquisition of the vacant office building, until the end of the predetermined life cycle.

The theory of LCC that includes all the costs and benefits of the entire life cycle is a lot more detailed than the cost sheets used in practice. According to NEN2699 (2013) it’s customary that the balance of the investment is drawn up without taking into account the value differences derive from the fact that not all costs are made at the same moment in time. The influence of time on the financial feasibility as is shown in the cash flow figure is important for the LCC model. This is where the model distinguishes from previous financial feasibility studies for vacant office buildings. The reason this time factor is so important for vacant office buildings is stated in a study conducted by DSP-groep (Dieters, et al., 2014).

The reason commercial parties are better at creating a positive return with transformation projects and corporations are not is because of the timing of the acquisition of the object and short construction period. In theory transformation can have a shorter preparation and construction period. If that is the case the transformation strategy will have a lower investment in the beginning of the cash flow as well as an earlier start of rental income. Whereas demolition & new-build requires, in theory, a higher initial investment due to the higher construction cost and has a longer construction period. Therefore the rental income will start at a later point in time.

This of course doesn’t always have to be the case. Studio GAK in Amsterdam for instance had a preparation and construction period of just over 10 years, which eliminates one of the largest advantages of transformation.

### 10.2 Explanation of the model

The model is set up as a quick indication of the total costs and benefits of the different intervention strategies. In order to make the elaborated calculations many assumptions were made. Default values are used in some of the input sheets, which represent probable values or ten-year averages for certain variables. The person using the model can adapt the values of all the variables and default values, which will create more specific results. The model is not intended to generate absolute financial values of the strategies, but it can approach each vacant office building and give an indication of the LCC of the different strategies as well as the influence of the different variables on the financial result.

The model consists of a number of excel sheets. First there are four input sheets, where project specific data can be added. The sheets are deliberately separated to have a clear distinction of the information that is put in. The first sheet consists of information about the original building. The second sheet input is needed for each of the three different strategies. The third input sheet covers the benefits from the rental income of each strategy. The final input sheet contains the economic variables.

The input sheets are linked to a cost data sheets that will determine the cost data input for the investment costs and operating costs sheet. These two sheets show all the costs and benefits give an overview of all the costs of the different strategies. All the costs and benefits of the investment and operating phase of each strategy is plotted in the cash flow sheet. The results of the different cash flows are summarized in the summary sheet for each of the intervention strategies.

Important for the model is that all input that is entered as well as the cost data can always be changed manually. For instance when an extreme deviation of a standard value is expected, the bandwidth might not be accurate any more. Therefore the person using the model is always in control of the data and input that are being used in the calculations. The figure on the next page is a schematic representation of the total LCC model.
### Input Sheets

- **Office input**
  - Specific building characteristics

- **Benefit input**
  - Rental income & WOZ-value

- **Strategies input**
  - Specific decisions concerning new building strategies

- **Economic Variables**
  - Macro economic variables, indexation & other economic variables

### Cost Database Sheets

- For each strategy:
  - Investment Costs
  - Operating Costs

### Investment Costs Sheets

- For each strategy:
  - A summary of all Investment Costs

### Operating Costs Sheets

- For each strategy:
  - A summary of all Operating Costs

### Cash Flow Sheets

- For each strategy:
  - All Costs & Benefits plotted and indexed over the lifespan

### Summary/Output Sheet

- For each strategy:
  - Investment Costs
  - Operational Costs
  - Revenues

---

Figure 66, Sheets of the LCC model
10.3 Input
The input of the model influences the costs involved with each strategy. The first four sheets of the model are input sheets and are coloured blue. The selection of the variables and input needed for the calculations is based on the literature study, previous research, the case studies, the interviews, and with the help of Maarsen Groep and IGG. These variables have the largest influence on the costs and benefits involved and will show the differences between the strategies. The input variables are divided into the categories: Office building, Strategies, Benefits, and Economic variables. Each category is discussed in a separate section in the chapter.

10.3.1 Office Building input
The category Office Building requires specific input of the existing office building. The input sheet is divided into general, construction, façade, floors, installations, and energy input. Each part is briefly explained below. Almost all information that is required as input is available for any office and can therefore easily applied as input.

<table>
<thead>
<tr>
<th>General Information</th>
<th>Location</th>
<th>City Centre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location year</td>
<td>1971-1980</td>
<td></td>
</tr>
<tr>
<td>Transfer of building</td>
<td>external</td>
<td></td>
</tr>
<tr>
<td>Acquisition price</td>
<td>€ 2,000,000,00</td>
<td></td>
</tr>
<tr>
<td>GFA (total)</td>
<td>5500 m²</td>
<td></td>
</tr>
<tr>
<td>GFA (ground level)</td>
<td>780 m²</td>
<td></td>
</tr>
<tr>
<td>GFA (upper levels)</td>
<td>780 m²</td>
<td></td>
</tr>
<tr>
<td>Number of layers</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Width building</td>
<td>15 m</td>
<td></td>
</tr>
<tr>
<td>Length building</td>
<td>30 m</td>
<td></td>
</tr>
<tr>
<td>Height building</td>
<td>21.5 m</td>
<td></td>
</tr>
<tr>
<td>Layout</td>
<td>Core Access</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Construction</th>
<th>Floor height (ground level)</th>
<th>3.5 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Staircases</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>No. Elevators</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Demolition costs</td>
<td>Basic</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Façade</th>
<th>Structural façade</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open/Closed ratio</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>Openable windows</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Installations</th>
<th>Year</th>
<th>&lt;1989</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lift</td>
<td>&gt;1995</td>
<td></td>
</tr>
</tbody>
</table>

| Energy               | Label                        | Unknown |

Figure 67, Office Input Sheet

General Information
Location
The location of the office is important for the market demand. A mono-functional office location for instance cannot be transformed into housing without an area development. As discussed in the demarcation of this research, the location market aspects are left out of this research. The location will therefore not be used in the model. The location has an influence on the rent prices. In this model the location is set at Amsterdam that is linked to the corresponding rental prices.

Construction Year
The original construction year of the building says something about the building characteristics. The construction years are divided into the different periods of construction year, which relate to the vacancy rate. In the model the construction year is only linked to the energy label, if the current label is not known for the office building.

Transfer of the building
The transfer of the building can either be internally, when the vacant building is already owned by the investor, or externally when an investor and developer are actively looking for a vacant office building to transform or demolish & new-build. Transfer tax and acquisition costs are included if a building is
acquired externally. With an internal transfer the acquisition is just an accounting formality in the books of the investor.

Besides the transfer method, the acquisition price or current value needs to be filled in for the building. The value of the building normally derives from the rental income. This value is also a big obstacle for transformation, as the book value is mostly higher than the actual value (chapter 1). Because of the complexity of determining the actual value of a vacant office building, the acquisition cost is an input field in the model and needs to be determined by the user of the model.

**Gross Floor Area**
The surface of the office is set out in the Gross Floor Area. Since rent for offices is paid in Lettable Floor Area and rent for houses is paid in Usable Floor Area it makes it hard to compare the different types of buildings. Therefore the GFA will be used as a standard in the model and all costs will linked to the m2 of GFA.

**Number of Layers**
The number of layers influences the construction and demolition costs. The number of layers of the office is used as input for the transformation costs. The costs of adding layers on top are considered equal to new-build. The current number of levels of the office building is therefore required as input.

**Dimensions building & Layout**
The dimensions of the building will be linked to the form factors by which the construction costs are calculated. The form factors allow for a project specific calculation of the construction costs. The building layout influences the construction costs because of the façade and surface ratio.

**Construction**

**Floor Height**
The floor height of the building is first of all a veto criterion to see whether transformation is legally possible. This veto-criterion is build into the input sheet. The height needs to be above the minimum height set in the building act. Almost all offices are assumed to have at least the minimal required height. Besides that the floor height will influence for instance the energy costs and efficiency of a building. In the input a distinction is made between the height of the ground level and the floors above, since the ground level is mostly higher. The floor heights are linked to the measurements of the building, which are used to calculate the construction costs of for instance the façade.

**Structure**
For the structure a distinction needs to be made between a structure with a central core, stability walls, and with stability connection. The type of structure is linked to the total surface of inner walls. As the inner walls are one of the largest costs of a transformation project, they have an important influence on the construction costs.

**No. Elevators and Staircases**
The number of elevators and staircases needs to be at least the minimum for apartment. For offices the number of elevators and staircases is mostly higher than housing. The number of elevators and staircases tells something about the number of cores in a building as well.

**Demolition costs**
The demolition costs can either the low, basic or high. The person using the model needs to make an assumption if the costs of demolition for the building will be higher or lower than a standard building. If for instance a building is on a difficult to reach location, the demolition costs can turn out higher.

An interesting fact about the demolition costs is that the costs per GFA are higher for demolition. This can be explained for two reasons; demolition to the façade needs to be carried out much more accurate than total demolition. The second reason is that with total demolition the demolition company benefits from the steel and other materials that can be reused. These benefits are often put in reduction of the demolition costs of the tender.
Façade
For the façade it’s important to know whether it’s a structural façade or not. A structural façade will be a lot more costly to transform than a non-structural façade. Furthermore the open / closed ratio needs to be filled in, as an open façade is more costly than a closed façade. This is because exterior wall openings are costly due to inter alia the frames, glazing, and doors that need to be added.

Installations
According to Gemeente Amsterdam Ontwikkelbedrijf (2010) the installations in offices can be partly reused if they’re less than 25 years old. This is therefore set as a boundary, where if less than 25 year the user of the model can decide whether or not to replace the installations. Not replacing the installations will have a negative effect on the operating costs.

From previous research it becomes apparent that in most transformation projects the installations are completely replaced. This can be explained by the fact that the layout of the installations and the use of the installations are different for offices and for housing. Camelot doesn’t even consider reusing the installations and always replaces them.

Only the lift is more commonly reused. Reusing the lift can save costs in the investment period. However when looking at a lifespan of 30 years, the lift might need to be replaced later in the life cycle or require higher operating costs.

Energy Label
In the model the label of the existing building can be entered as input. The energy label influences the investment costs, operating costs, and benefits. This will be elaborated in more detail further in this chapter. If the label not known for the building or is not known by the person using the model, an assumption can be made based on the construction year of the office. In 2010 only a third of all offices had an energy label. Kok et al. (2012) used the database of Agentschap NL to find what the relationship between the construction year of an office is and the energy label. Figure 68 shows the number of each label per construction period. For this research the average label for that period will be used. By filling in the construction year in the model, the associated label is determined.

When looking at the figure it’s noticeable that the worst label, label G, is relatively consistent between the 1940’s and 1990. However the influence of this label on the total consistency of labels decreases, due to the increase in the number of offices in total. Until the 1970’s offices will therefore be assumed to have label G, for the period 1971 to 1980 level F. Between 1981 and 1990 label E is the most common. For 1991 to 2000 the label is assumed to be label D. After 2000 the average label is C. The poor performance of the total supply of offices can be explained by the fact that demands for energetic performance only exist since 1996.

![Label per Bouwperiode](image)
10.3.2 Strategies Input

On the next sheet input is needed for the different strategies. The input is separated for the three different strategies; Transformation, Demolition & New-Build, Consolidation. In the figure below the input sheet for transformation and new-build is shown.

<table>
<thead>
<tr>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program 'Transformation'</td>
</tr>
<tr>
<td>Code:</td>
</tr>
<tr>
<td>Program 'Demolition &amp; New-build'</td>
</tr>
<tr>
<td>General</td>
</tr>
<tr>
<td>Total GFA new</td>
</tr>
<tr>
<td>Total UFA new</td>
</tr>
<tr>
<td>Layers of housing</td>
</tr>
<tr>
<td>Ambition level</td>
</tr>
<tr>
<td>Width building</td>
</tr>
<tr>
<td>Length building</td>
</tr>
<tr>
<td>Height building</td>
</tr>
<tr>
<td>Floor Height (ground level)</td>
</tr>
<tr>
<td>Floor Height (upper levels)</td>
</tr>
<tr>
<td>Open/Closed Ratio façade</td>
</tr>
<tr>
<td>Preparation period</td>
</tr>
<tr>
<td>Construction period</td>
</tr>
<tr>
<td>Housing</td>
</tr>
<tr>
<td>Apartment (UFA)</td>
</tr>
<tr>
<td>UFA/GFA</td>
</tr>
<tr>
<td>Interventions</td>
</tr>
<tr>
<td>Façade</td>
</tr>
<tr>
<td>Open/Closed ratio new</td>
</tr>
<tr>
<td>Outdoor Space</td>
</tr>
<tr>
<td>Access</td>
</tr>
<tr>
<td>Installations</td>
</tr>
<tr>
<td>Internal Walls</td>
</tr>
<tr>
<td>Lift</td>
</tr>
<tr>
<td>Label increase</td>
</tr>
<tr>
<td>New energy label</td>
</tr>
<tr>
<td>Additions</td>
</tr>
<tr>
<td>Added GFA</td>
</tr>
<tr>
<td>Added Layers</td>
</tr>
<tr>
<td>Type of Addition</td>
</tr>
<tr>
<td>Floor Height</td>
</tr>
</tbody>
</table>

Figure 69, Strategies input

Transformation

General

The ambition level needs to be filled in and is equal for new-build and transformation in order to have a fare comparison (Chapter 1.13). The ambition level has a large influence on the construction costs of a project as well as influencing the maintenance costs. The ambition level should correspond to the intended target group. According to research of Mackay (2007) the ambition level can influence the costs per m² GFA with €150.

The only further general information input that is needed is the expected preparation period and construction period. The preparation period and construction period can be expected to differ for new-build and transformation and is important variable to take into account. The case studies and interviews showed that it's possible to reduce this period with transformation, which significantly influences the investment costs.

Housing

In this part the Usable Floor Area of the apartments is required. Furthermore the user of the model needs to make an assumption of the UFA / GFA ratio. With the total GFA, the UFA per apartment, and the UFA/GFA ratio, the potential number of apartment is calculated. There will be a difference for the UFA / GFA ratio of transformation and new-build. With transformation the existing office floor plans need to be used, which were designed as offices and can be assumed not to be optimal for housing. This means new-build can have a more favourable UFA / GFA ratio.

Interventions

The interventions with the transformation are divided into a few elements that have the largest influence on the costs or are needed to carry out the calculations. These include the façade, the addition of a balcony or loggia, the addition of a gallery for access, the installations, the lift, and the preferred energy label.

To make transformation into housing legally, technically, and financially more feasible the rules and regulations concerning transformation and renovation were softened in the 'Bouwbesluit' of 2012. The
demands for transformation can be described to meet the level of 'het rechtens verkregen niveau', which means after the transformation the minimal demand is the level of the existing building.

Therefore for instance lower demands are for the energy label of a new than transformed building. A lower energy label might have lower investment costs, but will result in higher energy costs during the operating phase (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2013).

Besides being linked to the additional construction costs, these interventions will also be linked to the operating costs. More specifically the energy costs and benefits during the operating period. The interventions that influence the energy label, like the façade and installations are linked to the corresponding energy label. This way the new energy label can be determined, based on these interventions. The chosen new energy label is needed to calculate the additional costs between these steps (figure 82).

**Additions**

Since most transformations include an addition of surface to make it more feasible, information concerning the potential addition can be added. Topping additional layers on the existing building is a common addition with transformation, which costs differ from the transformation costs and are basically the costs of new-build. In the calculations the original office building and added layers are separated from each other.

**Demolition & New-Build**

**General**

As an addition to the general information of transformation, the open/close ratio of the new building needs to be decided. This new ratio can be in the favour of the new building. Again the preparation & construction period is required as input.

**Housing**

Also the UFA of the apartments of new-build is needed. This is only used to calculate the number of apartments. The rental income is linked to the total m2 of UFA and not the rental price per apartment.

Since 2011 the EPC norm is set at 0.6, which means that for new buildings a label A++ or A+ is demanded.

**Reference Project IGG**

To determine the costs of a the new building, the input is linked to the cost data base of IGG. In the Kengetallenkompas Bouwkosten (2014) a reference project can be chosen. Linked to the form factors that follow from the input of the specific project, the construction costs are calculated.

![Figure 70, Example reference projects (IGG Bo Benton de Groot, 2014)](image)
Consolidation
With this strategy no interventions or investments are made for the vacant office building. The input needed for consolidation is mainly focused on the current operating costs of the building. The operating costs will continue, even with a vacant office building. Even more important, the operating costs will even by higher for an investor with a vacant building than an office building that is fully in use. This is because some of the operating costs like energy and maintenance costs, even though it’s lower in vacant building, will now become costs for the investor (Trouborst, 2012).

10.3.3 Benefits input
The benefits input calculates the potential rental income of a building, or if the potential rent is known by the user of the model it can be filled out.

<table>
<thead>
<tr>
<th>Rental Income</th>
<th>Default</th>
<th>Low (€)</th>
<th>Basic (€)</th>
<th>High (€)</th>
<th>Own input (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing</td>
<td>993,00</td>
<td>661,80</td>
<td>993,00</td>
<td>1,323,60</td>
<td></td>
</tr>
<tr>
<td>Total GFA</td>
<td>7100</td>
<td>7100</td>
<td>7100</td>
<td>7100</td>
<td>7100 m2</td>
</tr>
<tr>
<td>Total UFA</td>
<td>5538</td>
<td>5538</td>
<td>5538</td>
<td>5538</td>
<td>5538 m2</td>
</tr>
<tr>
<td>Apartments</td>
<td>92</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Rental Income</td>
<td>91,653,90</td>
<td>61,084,14</td>
<td>91,653,90</td>
<td>122,168,28</td>
<td></td>
</tr>
<tr>
<td>Energy Label premium / apartment / month (energy savings)</td>
<td>7,36</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Label increase (point system)</td>
<td>20,28</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rent per apartment / year</td>
<td>12,155,36</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Rental income</td>
<td>1,118,661,12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAR 5,5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WOZ-value / UFA</td>
<td>3,684,65</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WOZ-value Total Building</td>
<td>20,339,293,09</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 71, Benefits input of Transformation

Rent
The rent level is based on a number of variables. The most important variables that influence the rent level are; the location, UFA, ambition level, and energy label.

In 2010 DTZ Zadelhoff (2010) released a report with the average rental prices per GFA in the Netherlands for different locations. Amsterdam, which is chosen as location for this study, has a bandwidth of €8 per GFA to €20 per GFA. However for the city centre it varies from €10 to €20. This report is 4 years old, which means the rent has increased for 4 years. With an average rent increase of 2,5% of the past 10 years (senternovem.nl/database) this results in the following rental prices; low €11,03, basic €16,55, high €22,06 per month per GFA. Important point of interest is that the rents in Amsterdam are the highest of the Netherlands. The construction costs are not linked to the location and can be assumed to be equal everywhere in the Netherlands. By changing the location, also the rental income changes, which influences the total benefits of the project.

In the benefits sheets the rental income of the different strategies is used as input. A new building will be more efficient than a transformed building; therefore the GFA/UFA ratio is used to indicate the difference in rental income.

The ambition levels low, basic and high influence the rent levels with corresponding rent. Where low decreases the average rent level and high increases the average level. If the person using the model knows the rental income for the certain location, a value can be given that overwrites the rent level based on the other input.

WOZ value
The WOZ value is the value for tax purposes and determines the height of some taxes related to the building, like the OZB and water taxes. The taxes are part of the operating costs and the WOZ value will therefore need to be determined. The WOZ value is based on a taxation of the building. For this research the WOZ value is determined by the rent per UFA per year divided by the Gross Initial Yield.

Consolidation
The rental income for a vacant office building is of course 0. However the WOZ value of the vacant office building needs to be determined in order to be able to calculate the operating costs of the building.

If a building is completely vacant the possible rental income is determined by using the rental income of a building on a similar location, with similar characteristics (Muller, 2008).
10.3.4 Economic Variables

The macro economic variables will have a large influence on the life cycle costs of the strategies. The accuracy of the calculations of the NPV is largely based on the economic variables. The economic variables are assumptions of the future value of these variables based on either the average of the past indexation of the variables, or on recommendations by Maarsen Groep.

<table>
<thead>
<tr>
<th>Economic Variables</th>
<th>low</th>
<th>basic</th>
<th>high</th>
<th>Input model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indexation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflation (CPI)</td>
<td>1,1%</td>
<td>1,8%</td>
<td>2,5%</td>
<td>1,8%</td>
</tr>
<tr>
<td>Rent increase on top of CPI</td>
<td>0,0%</td>
<td>1,0%</td>
<td>5,0%</td>
<td>1,0%</td>
</tr>
<tr>
<td>Electricity</td>
<td>-5,0%</td>
<td>5,1%</td>
<td>23,0%</td>
<td>5,1%</td>
</tr>
<tr>
<td>Gas</td>
<td>-7,0%</td>
<td>8,1%</td>
<td>9,0%</td>
<td>8,1%</td>
</tr>
<tr>
<td>Construction Costs</td>
<td>-4,9%</td>
<td>0,3%</td>
<td>6,0%</td>
<td>0,3%</td>
</tr>
<tr>
<td>Other Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vacancy rate housing</td>
<td>0,0%</td>
<td>3,0%</td>
<td>10,0%</td>
<td>3,0%</td>
</tr>
<tr>
<td>Discount rate</td>
<td>3,5%</td>
<td>5,5%</td>
<td>6,5%</td>
<td>5,5%</td>
</tr>
<tr>
<td>Interest on Construction Costs</td>
<td>4,0%</td>
<td>5,0%</td>
<td>8,0%</td>
<td>5,0%</td>
</tr>
<tr>
<td>Interest on Dept Capital</td>
<td>4,0%</td>
<td>5,0%</td>
<td>7,0%</td>
<td>5,0%</td>
</tr>
<tr>
<td>LTV</td>
<td>30,0%</td>
<td>65,0%</td>
<td>85,0%</td>
<td>65,0%</td>
</tr>
<tr>
<td>Annual Repayment</td>
<td>0,0%</td>
<td>2,0%</td>
<td>6,0%</td>
<td>2,0%</td>
</tr>
<tr>
<td>Initial Yield / BAR (housing)</td>
<td>3,0%</td>
<td>5,5%</td>
<td>9,0%</td>
<td>6,0%</td>
</tr>
<tr>
<td>Exit Yield (housing)</td>
<td>3,0%</td>
<td>8,0%</td>
<td>10,0%</td>
<td>8,0%</td>
</tr>
<tr>
<td>Exit Yield (office)</td>
<td>0,0%</td>
<td>18,0%</td>
<td>20,0%</td>
<td>18,0%</td>
</tr>
<tr>
<td>Period of financing</td>
<td>10 yr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifespan</td>
<td>30 yr</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 72, Economic Variables

Indexation

Inflation

Inflation is the increase in the price level in an economy over a period of time. The Consumer Price Index (CPI) shows the price development, which is recorded by the Centraal Bureau voor Statistiek (CBS) in the Netherlands. CBS gives an average inflation of 1,8% of the past 10 years in the Netherlands. The minimum inflation of the past 10 years is 1,1% and the maximum is 2,5% (retrieved from: http://www.tradingeconomics.com/netherlands/inflation-cpi) (retrieved from: www.cbs.nl).

Rent Increase

Rent levels in practice tend to rise at the same rate as inflation (Geltner, et al., 2007). The Rijksoverheid gives a maximum of 4% for the rent increase per year on top of inflation. However in the liberated sector there is no maximum for rent increase and the rent increase will be determined by location and market factors. Maarsen Groep uses a maximum of 5% increase.

For this research a probable rate of 1% is used on top of inflation, this will be the default value. (retrieved from: http://www.rijksoverheid.nl/onderwerpen/huurwoning/huurverhoging)

Vacancy Rate

The vacancy rate of the apartments will have to be taken into account. This ‘friction’ vacancy is set at a standard of 3%, but can be changed by the user of the model. The vacancy rate will be deducted from the rental income.

Energy price increase

The energy prices are increasing with a greater rate than the CPI. This is caused by the increasing fuel prices in the world. Even though the prices dropped in 2008 due to the economic crisis, the prices started increasing again in 2009. The gas price essentially follows the oil price. Between 2002 and 2012 the gas price has increased with 8,1% average. The electricity price has increased 5,1% in the same period.

For the future different scenarios exist for the different potential energy price increase. The price increase will influence the effect of the energy label on the total energy costs. (retrieved from: statline.cbs.nl) (retrieved from: senternovem.database.nl)
Construction Costs
The indexation of the construction costs is often included in the contract by the contractor. This means the later the construction starts, the higher the costs of the construction will be. Due to the economic crisis and the consequential decrease in construction production the construction costs indexation has been decreasing since 2008. Because of this the average indexation of the past ten years is 0,3. However as the figure below shows, the construction costs can be expected to rise more steeply in the coming years.

Figure 73, Expectations price increase construction costs source: (Twynstra Gudde, 2014)

The following figure shows the progress of the different indexations over the past 10 years. The energy indexation and construction costs show a high fluctuation, which suggest high uncertainty with these variables.

Figure 74, Progress indexation economic variables
Other Variables

Discount rate
The discount rate influences the end result of the comparison of the different intervention strategies. The height of the discount rate is determined by the required return, inflation, and a risk premium. The required return on the investment is the most important factor of the discount rate. Commercial parties will use a higher required return, since these parties have a profit objective, but these parties also have to pay higher interest on their loans. The required return of private parties depends on many factors including the Loan To Value (LTV) ratio, the interest rate on loans in the capital market. The so-called risk free discount rate is specified at 2,5%, which is equal to the average finance costs. The risk premium is based on the risks involved with the uncertainty of the future cash flow (Rienstra, et al., 2012).

At Maarsen Groep a discount rate of 5,5% is acceptable. As a bandwidth 3,5% to 6,5% will be used (Nuiten, et al., 2014).

Interest on dept capital
The interest rate on the dept capital is depending on the height of the interest rate and the height of the loan. Since the interest on dept capital is very case specific and depends on the agreements that are made concerning the loan, this will need to be filled in as input by the user of the model.

LTV
As explained in chapter 4 the LTV is the ratio between dept capital and equity capital that is used to finance the investment. This is different for each project and actor and is therefore easy to choose in this sheet.

Annual Repayment
The annual repayment is a fixed number as a percentage of the dept capital that is repaid each year. This again depends on the agreements that were made concerning the loan. With each repayment the dept capital decreases, causing the rent on the dept to decrease as well. The repayments are not included in the total operating costs. They influence the LTV ratio, where with each repayment the equity capital of the owner increases compared to the dept capital.

Initial & Exit Yield
The GIY is only used to calculate the WOZ value of the building, for tax purposes. The GIY differs per location and is set at Amsterdam for this research (DTZ, 2012).

The Exit yield is depending on many factors and is hard to predict, especially with a time horizon of 30 years. The Exit Yield can however be expected to be higher than the Gross Initial Yield (Brons, 2012), because a building deteriorates over the years. The exit yield is required as input from the person using the model.

Lifespan
The lifespan and operating period that is used in the calculations has an impact on the different strategies and the end results. It’s therefore important to set a lifespan a priori when conducting the calculations. According to research conducted by DSP-Groep (Dieters, et al., 2014), there is a difference in the operating period commercial parties and corporations use. The commercial parties assume an operating period of ‘more than 5 years’ to 25 years. While the corporations assume an operating period of 25 years to 40-50 years. In this research the operating period will be set at 30 years.
### 10.4 Investment Costs Sheet

The investment costs sheets are separated sheets for the different strategies. They are the result of the input sheets that are linked to the cost databases and give an overview of all investment costs. The cash flow sheets will be linked to categories of costs of the investment costs.

#### Investment Costs 'New-Build'

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Unit</th>
<th>Low</th>
<th>Mid</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Investment Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1A</td>
<td>Land costs</td>
<td>€ / m²</td>
<td>0</td>
<td>200,86</td>
<td>2,008,26</td>
</tr>
<tr>
<td>1B</td>
<td>Development costs</td>
<td>€</td>
<td>1%</td>
<td>6%</td>
<td>8%</td>
</tr>
<tr>
<td>3A</td>
<td>Professional fees</td>
<td>€</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3B</td>
<td>Legal obligations</td>
<td>€</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3C</td>
<td>Installation costs</td>
<td>€</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3D</td>
<td>Inflation compensation</td>
<td>€</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Investment Costs</strong></td>
<td></td>
<td>€</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2A</td>
<td>Demolition</td>
<td>€</td>
<td>18%</td>
<td>12%</td>
<td>8%</td>
</tr>
<tr>
<td>2B</td>
<td>Operating installations</td>
<td>€</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2C</td>
<td>Construction works</td>
<td>€</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Investment Costs 'New-Build'</strong></td>
<td></td>
<td>€</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Construction Costs

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Unit</th>
<th>Low</th>
<th>Mid</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>4A</td>
<td>Construction sub-structure</td>
<td>€</td>
<td>5%</td>
<td>6%</td>
<td>7%</td>
</tr>
<tr>
<td>4B</td>
<td>Construction super-structure</td>
<td>€</td>
<td>25%</td>
<td>23%</td>
<td>20%</td>
</tr>
<tr>
<td>4C</td>
<td>Infrastructure</td>
<td>€</td>
<td>2,714,017,95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4D</td>
<td>Roads</td>
<td>€</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>4E</td>
<td>Streets</td>
<td>€</td>
<td>10%</td>
<td>15%</td>
<td>20%</td>
</tr>
<tr>
<td>4F</td>
<td>Fencing</td>
<td>€</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Total Construction works</strong></td>
<td></td>
<td>€</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Construction Costs</strong></td>
<td></td>
<td>€</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Installation Costs

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Unit</th>
<th>Low</th>
<th>Mid</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>5A</td>
<td>Installation costs</td>
<td>€</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5B</td>
<td>Installation materials and equipment</td>
<td>€</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Installation costs</strong></td>
<td></td>
<td>€</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Additional Costs

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Unit</th>
<th>Low</th>
<th>Mid</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>6A</td>
<td>Additional costs</td>
<td>€</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Additional Costs</strong></td>
<td></td>
<td>€</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Total Costs

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Unit</th>
<th>Low</th>
<th>Mid</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Costs</strong></td>
<td></td>
<td>€</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
10.5 Operating Costs Sheet

The operating costs sheet is also a summary sheet of the results of input sheets that are linked to the maintenance costs database. The total operating costs each year is summarized at the bottom. The costs for each category is linked to the cash flows of the different strategies. The purple areas in the following figure represent the cost-data that was focused on in the case studies of this research.

**Figure 76, Operating Costs Sheet**

10.6 Cash Flow sheet

The investment costs and operating costs are combined in the cash flow sheets. The costs and benefits are set out in time and indexed with inflation or specific indexation. At the bottom of the cash flow the Return On Equity (ROE) is used to determine the profitability of the investment. Consequently the Net Present Value is calculated by multiplying the entire operating income with the discount rate. The figure below shows a part of the first three years of the development and the transition of the investment phase to the operating phase.

**Figure 77, Part of Cash Flow sheet**
10.7 Summary Sheet

The final output of the model is depicted in the summary sheet. It is divided in the investment costs, operating costs, revenues, and total LCC of the building. This summary shows the financial comparison of each strategy and enables the user of the model to see the differences between the strategies and make a decision based on this information.

<table>
<thead>
<tr>
<th>Energy Label</th>
<th>Transformation</th>
<th>Demolition &amp; New-build</th>
<th>Consolidation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Investment Costs</td>
<td>€ 21,603,491,23</td>
<td>€ 26,392,060,48</td>
<td>€ 2,408,281,57</td>
</tr>
<tr>
<td>Investment Costs / GFA</td>
<td>€ 1,799,99</td>
<td>€ 2,198,97</td>
<td>€ 200,66</td>
</tr>
<tr>
<td>Total Operating Costs / year</td>
<td>€ -404,929,45</td>
<td>€ -528,621,35</td>
<td>€ 404,580,87</td>
</tr>
<tr>
<td>Total Operating Costs (30 years)</td>
<td>€ -12,147,831,41</td>
<td>€ -15,858,700,49</td>
<td>€ -12,137,426,02</td>
</tr>
<tr>
<td>Operating Costs / GFA / year</td>
<td>€ -33,74</td>
<td>€ -44,04</td>
<td>€ -33,71</td>
</tr>
<tr>
<td>Operating Costs / GFA (30 years)</td>
<td>€ -1,012,15</td>
<td>€ -1,321,34</td>
<td>€ -1,011,28</td>
</tr>
<tr>
<td>Ratio Operating / Investment</td>
<td>0,56</td>
<td>0,60</td>
<td>5,64</td>
</tr>
<tr>
<td>Potential Value (GIY)</td>
<td>€ 21,665,670,07</td>
<td>€ 25,015,827,11</td>
<td>€ 7,001,166,67</td>
</tr>
<tr>
<td>Result (year 0)</td>
<td>€ 62,178,84</td>
<td>€ -1,376,233,37</td>
<td>€ 4,592,885,09</td>
</tr>
<tr>
<td>Total Revenues / year</td>
<td>€ 1,088,372,05</td>
<td>€ 1,288,947,78</td>
<td>€ 13,650,56</td>
</tr>
<tr>
<td>Total Revenues (30 years)</td>
<td>€ 32,951,161,56</td>
<td>€ 38,668,433,40</td>
<td>€ 409,516,95</td>
</tr>
<tr>
<td>Revenues / GFA / year</td>
<td>€ 91,52</td>
<td>€ 107,39</td>
<td>€ 1,14</td>
</tr>
<tr>
<td>Revenues / GFA (30 years)</td>
<td>€ 2,745,47</td>
<td>€ 3,221,83</td>
<td>€ 34,12</td>
</tr>
<tr>
<td>Residual value</td>
<td>€ 7,639,716,33</td>
<td>€ 10,287,621,25</td>
<td>€ 409,516,95</td>
</tr>
<tr>
<td>Total LCC / GFA / year</td>
<td>€ -1,38</td>
<td>€ -5,22</td>
<td>€ -99,26</td>
</tr>
<tr>
<td>Total LCC / GFA (30 years)</td>
<td>€ -41,33</td>
<td>€ -156,64</td>
<td>€ -1,177,82</td>
</tr>
<tr>
<td>NPV</td>
<td>€ -496,016,89</td>
<td>€ -1,880,016,17</td>
<td>€ -14,136,190,64</td>
</tr>
<tr>
<td>IRR</td>
<td>5.38%</td>
<td>5.11%</td>
<td>N.A</td>
</tr>
<tr>
<td>ROE</td>
<td>5.20%</td>
<td>5.00%</td>
<td>#DIV/0</td>
</tr>
</tbody>
</table>

Figure 78, Summary Sheet

At the bottom of the Cash Flow sheet an accumulated annual discounted cash flow table is used to make an overview graph of the costs and benefits. The graph reflects the costs and benefits similar to the cash flow figure in chapter 10.1. For each strategy this graph is made and all are placed underneath the summary sheet. The next figure shows the accumulated cash flow graph of the new-build strategy.

Figure 79, Accumulated Cash Flow graph
10.8 Determination of the Operating Costs

As explained the largest costs of the operating are the maintenance costs and the energy costs. The determination of the energy and maintenance costs is covered in this part. In the figure below an overview of the different operating costs and the way they are determined is shown. The determination of the energy costs and maintenance costs is discussed more elaborately.

<table>
<thead>
<tr>
<th>Operating Costs</th>
<th>Costs of</th>
<th>Determined by</th>
<th>Source</th>
<th>Estimation used</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing</td>
<td>Building</td>
<td>The accommodation costs is the depreciation.</td>
<td>N.A.</td>
<td>N.A</td>
<td>Depreciation is incorporated in the difference between the end and initial price</td>
</tr>
<tr>
<td></td>
<td>Storage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxes</td>
<td>GEB</td>
<td>Still rate of specific location * WOZ value</td>
<td><a href="http://www.amsterdam.nl">www.amsterdam.nl</a> &amp; Vastgoedmarkt Exploitatiewijzer (2013)</td>
<td>0.0000% (housing), 1.1913% (office)</td>
<td>WOZ value is determined by rental income and GEB value</td>
</tr>
<tr>
<td></td>
<td>sewer</td>
<td>Fixed rate per building</td>
<td>Vastgoedmarkt Exploitatiewijzer (2013)</td>
<td>€</td>
<td>149.41</td>
</tr>
<tr>
<td></td>
<td>levies</td>
<td>Water tax = built levy + water treatment levy</td>
<td>Vastgoedmarkt Exploitatiewijzer (2013)</td>
<td>0.5% levy + 0.01% of WOZ water treatment = 5,44 per unit</td>
<td>Depends on location (Amsterdam in this research)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Compensation non-deductible VAT</td>
<td></td>
<td>22%</td>
<td></td>
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<tr>
<td>Insurance</td>
<td>Building</td>
<td>A fixed percentage of the WOZ value</td>
<td>Vastgoedmarkt Exploitatiewijzer (2013)</td>
<td>0.4% for housing, 0.65 for offices</td>
<td></td>
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<tr>
<td></td>
<td>furniture</td>
<td>0% &amp; Staff insurance</td>
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<td></td>
<td>0% for the tenant</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Building</td>
<td>Preventive, Corrective, and Replacement costs per m² GFA for the ambition levels low, basic, and high</td>
<td>Result Case Studies</td>
<td></td>
<td>Depends on the maintenance costs for transformation are higher than these basis</td>
</tr>
<tr>
<td></td>
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<tr>
<td>Mutations</td>
<td>Re-arrangement</td>
<td>The mutations made to the building</td>
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<tr>
<td></td>
<td>Termination</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Energy</td>
<td>Gas (apartments)</td>
<td>Based on the average energy use per Energy label</td>
<td>senternovem.nl/database</td>
<td>€ 982 per apartment (label D)</td>
<td>Costs are for the tenant</td>
</tr>
<tr>
<td></td>
<td>(office)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electricity (apartments)</td>
<td>Based on the average electricity use</td>
<td>senternovem.nl/database</td>
<td>€ 1,168 per apartment</td>
<td>Costs are for the tenant</td>
</tr>
<tr>
<td></td>
<td>(office)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Heat heating (district heating)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administration</td>
<td></td>
<td>% of basic rent</td>
<td>Vastgoedmarkt Exploitatiewijzer (2013)</td>
<td>3% housing</td>
<td>For a vacant office building the administrative cost will be 1,1%</td>
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<tr>
<td>Internal</td>
<td></td>
<td></td>
<td><a href="http://www.bloomberg.com">www.bloomberg.com</a></td>
<td>1.1%</td>
<td>1% year average</td>
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</tr>
<tr>
<td>Cleaning</td>
<td>Internal</td>
<td>Costs per m² divided into open &amp; shared spaces</td>
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<tr>
<td></td>
<td>External</td>
<td>Costs per m²</td>
<td><a href="http://www.beharenwonen/huiskosten.nl">www.beharenwonen/huiskosten.nl</a></td>
<td></td>
<td>Only internal cleaning costs if there are common spaces</td>
</tr>
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Figure 80. Overview operating costs

Energy Costs

The energy performance of a building influences the energy costs and therefore the operating costs. The Dutch energy label derives from the Energy Performance of Buildings Directive (EPBD), the European guideline for energy performance. The energy performance can be categorized into the Energy Performance Coefficient (EPC) for new buildings and the Energy Performance Advice (EPA) for existing buildings. The energy label is obligated since 1 January 2008 for new buildings as well as at the transfer with the sale of a building or start of a rental contract (BBN adviseurs, 2012). The different energy labels for buildings are listed in the figure below. The numbers next to the labels are the corresponding ‘Energy Performance Coefficient’ (EPC) values.

Figure 81. energy labels and corresponding EPC values (bbn adviseurs, 2012)
According to the agreements made in the 'Lente-akkoord' the Netherlands are working towards energy neutral buildings in 2020. This means that all new build dwellings need to be almost energy neutral in 2020, or an EPC value of almost zero. An interim step is set on 01-01-2015 with a minimum EPC value of 0,4 as opposed to the current requirement of 0,6 (Nuiten, et al., 2013).

Choosing for a better energy performance of the new building influences the model and its results in three ways; the increase of investment costs, decrease of energy costs, and increase of rental price or value of the houses. The maintenance costs of the installations of a higher energy label can also be assumed to be higher, this will not be included in this research. Subsidies and tax benefits of sustainable measures are not taken into account in this research, but can have a positive effect on the financial results of a better energy label.

**Increase of investment costs**

The increase of the investment costs is based on the research of BBN advisors (2012). The research calculates what the additional investment costs are to improve to a higher label. BBN advisors calculate these energy label increases for offices, for this research it's assumed that the increase of costs per label for offices is equal to the increase per label for houses.

First of all the offices are divided into offices in poor condition, label G and from before 1989 and offices in reasonable condition label D and from 1990-1999. The second division is of small offices (3.000 m² GFA) and large offices (18.000 m² GFA). This leaves four different categories in which the office buildings can be divided. To be able to determine the costs increase per label, different interventions are needed. The different interventions that are needed as well as the costs involved with the intervention per m² GFA are listed for each of the four categories in the figure below.

![Interventions and costs per label increase](source: Author, based on bbn adviseurs (2012))

The results show the influence of scale on the costs involved with the label increase. This works in favour of the larger scale, resulting in lower costs per m² GFA. Besides the influence of scale, also the steps for each energy level have higher costs when starting from a label G compared to starting with a label D.

**Decrease of energy costs**

The higher label results in lower energy use and therefore lower energy costs. This decrease can be calculated with the help of the NEN5128 norm. The NEN5218 uses the following formula to calculate the EPC value. When the EPC or energy label is known, it can be used to calculate the energy use Q in Mega Joule (MJ). The Q is calculated by multiplying the EPC with the GFA surface and the surface where energy is lost, in this case the façade. The EPC is either required as input by the person using the model, or linked to the construction year; and the surfaces are based on the form factors that are calculated with the help of the input.
With the help of this formula I created an index of the energy savings per label. It can be assumed that label D is the average and corresponds to the average energy costs per household (figure 86). The average electricity costs in 2014 are €548 ex VAT per household per year. The average gas costs are €982 ex VAT per household per year (figure 84). The Q in the formula consists of the characteristic energy use and will therefore be indexed.

\[
EPC = \frac{Q_{\text{er}}}{330 \times A_{\text{wini}} + 65 \times A_{\text{veni}} - c_{\text{EPC}}}
\]

wherein:

- **EPC** is de EPC van de woonfunctie of het woongebouw;
- **Q_{\text{er}}** is de getalswaarde van het karakteristieke energiegebruik, bepaald volgens 5.3.1, in MJ;
- **A_{\text{wini}}** is de getalswaarde van de gebruiksoppervlakte van de woonfunctie of het woongebouw, bepaald volgens 5.3.2.6, in m²;
- **A_{\text{veni}}** is de getalswaarde van de totale verliesoppervlakte van de woonfunctie of het woongebouw, bepaald volgens 5.3.2.3, in m²;
- **c_{\text{EPC}}** is de getalswaarde van de correctie ten opzichte van vorige versies van deze norm.

Figure 83, EPC calculation formula source: NEN5218 (2004)

The next figure shows the energy use and cost saving index for each label. The form factors of new-build and transformation are used to calculate the energy use in MJ per GFA for each EPC value (with corresponding energy label) with the help of the EPC formula of the NEN5128 norm. Again label D is assumed to be average. For new-build the energy labels A and lower are not applicable and coloured grey, since new-build needs to be a minimum label A+.

This indexation with the help of this EPC calculation formula is of course a rough estimate of the potential energy savings, but it does indicate the energy use differences per label. Furthermore it theoretically confirms that, assuming transformation has higher floor heights and therefore a larger energy loss surface, the energy costs of transformation will be higher.

The actual energy use depends largely on the use of the buildings and can be either higher or lower than the values calculated in the figure below.
The energy costs of the building are separated for the costs of the tenant and the costs of the owner. Basically the owner pays the energy costs for the communal spaces and the tenants pays the energy costs of their own apartment. The owner will mainly see the financial effects of the energy savings in the benefits resulting from the label increase.

The higher rents and value of the building caused by the additional investment however also negatively influence the operating costs. The higher investment leads to a higher WOZ value, which is used to calculate the property tax and insurance. The operating costs will therefore increase.

**Higher rents/value of the asset**

Finally the energy label influences the value of the building. A higher energy label can be assumed to be easier to rent, have a lower vacancy risk, higher rental prices, lower incentives with lease contracts, and appraisers can put a higher value to the building (Kok, et al., 2012). This means that a higher label results in higher rent.

Although the energy label is currently not directly linked to the value of an asset or rental prices in the liberated sector, studies show that tenants are willing to pay more for a better energy label with consequential energy savings. This way the investor receives higher rent for the investment in a more
energy efficient building. In 2015 the EPC of new buildings as well as existing buildings will be linked to financial instruments like the housing appreciation system (RVO, 2014).

**Ontwikkeling EPC-eisen per gebruiksfunctie**

Getallen in blauw en vet geven een wijziging van de eis aan.

<table>
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<tr>
<th></th>
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<th></th>
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<td>0,8</td>
<td>0,6</td>
<td>0,4</td>
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</tbody>
</table>

Figure 87, Development EPC-demand (Nuiten, et al., 2013)

In the Netherlands the liberated sector rents are not regulated. In the non-liberated sector rents are regulated by the government. The maximum allowable rent is determined by a point system. The energy label has a large influence on the total points that can be achieved. If the energy label is not available the corresponding label is based on the construction year of the building. The following figure is a list of the number of points with the corresponding maximum rent per unit. For this research therefore the price increase of the non-liberated sector will be used to examine the effect of the increase of a label on the rent.

**Maximale huurprijsgrenzen voor zelfstandige woningen per 1 juli 2013**

<table>
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<th>punten</th>
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<th>punten</th>
<th>bedrijf</th>
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<td>803,38</td>
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</tbody>
</table>

Figure 88, Rental prices according to point system in the non-liberated sector source: www.huurcommissie.nl

The average price increase of the point system above comes to an increase of the rental income of €5,07 per point. The rental income in the model can therefore be indexed for €5,07 per point per month. As the
The figure below shows, the difference in points between a label G and label A++ is 44 points. This would mean the rent difference between a label G and a label A++ according to this is 5.07 x 40 = €203 per household each month. This increase in rent seems a bit high as opposed to the potential energy cost savings for the tenant.

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<td>Label C</td>
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</tr>
<tr>
<td>Label G</td>
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<td>0</td>
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</table>

Figure 89. Number of additional points per household source: adaptation by author (www.rijksoverheid.nl)

Figure 90 shows the number of households per label based on the database of Senternovem (www.senternovem.nl/database). The average label derived from this list is label D. The average energy costs, as explained earlier in this chapter, per household are also given by Senternovem. The average energy costs they use should therefore correspond to the average label of the households in the Netherlands, which is label D. This means if a better label is intended, the rent needs to be indexed starting from the 11 points of label D as the table in figure 89 shows. Any label higher than D will therefore receive higher rental income and lower than D will receive lower rental income, depending on the number of points corresponding to each independent label step.

Balance cost savings and rent
When all factors for the energy costs are filled out, the energy cost savings and the rent increase due to the label need to be in balance. The difference in energy costs for a label D (€1530,00) and a label A+(€670,76) is €859,24 per household per year. These savings seem plausible. The rent increase due to the label should therefore correspond to the energy costs savings.

The energy label factor for the rent increase between label D and label A+ is 25 points, which according to the point system would mean €126,75 a month rent difference. This would come to €1521 rent increase each year per apartment, as opposed to the €859,24 energy savings each year. This means the rent increase more than the energy savings with a factor 1,77.
The fact that the rent increases more than the energy saves can be explained by the fact that not only energy costs are saved, but also the quality of the housing is improved. However if we want to increase the rent with the same level as energy costs are saved the new rental increase per point will be $5.07 / 1.77 = €2.86$ per point. The new rent difference for a label D and label A+ is now equal to the energy cost savings and this seems a more realistic approach to the costs and benefits.

![Figure 91, Schematic representation of the Costs & Benefits of a higher Energy label](image)

**Maintenance Costs**

Since maintenance costs is one of the largest parts of the total operating costs, it's important to have an accurate determination of the maintenance costs. The crux of determining the maintenance costs is the detail level that is involved with the multi-year maintenance budget. The budget is based on specific element level with the involved preventive, corrective, and replacement costs. These costs are divided into the average costs per year in order to make the multi-year maintenance budget (retrieved from: http://www.beheerenonderhoudkosten.nl).

The first assumption I made concerning the maintenance costs is that a high ambition level in the investment period would result in lower maintenance costs. When using the cost information of Vastgoed Exploitatiewijzer (Van de Waeter, et al., 2013) it shows no such relation can be assumed. This can be argued by the fact that a higher ambition level requires a higher level of maintenance to maintain the same level. When looking into a smaller detail level of a single element the complexity of determining the entire maintenance costs becomes clear.

For example for window frames different materials can be chosen that have different investment costs, as well as different operating costs. The frames can be made of aluminium, wood, or can be synthetic. The synthetic, or plastic frames will have the lowest investment costs, but do not fit with a high ambition level. Wooden frames have a higher investment costs that goes with a higher ambition level, however also the operating costs of wooden frames will be higher than the plastic frames. Even within different types of wood the investment and maintenance costs will differ.

<table>
<thead>
<tr>
<th>Window Frame</th>
<th>Investment Costs</th>
<th>Maintenance Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Preventive</td>
</tr>
<tr>
<td>Aluminium Frame</td>
<td>€ 382,55</td>
<td>€ 2,73</td>
</tr>
<tr>
<td>Wooden Frame</td>
<td>€ 336,86</td>
<td>€ 9,53</td>
</tr>
<tr>
<td>Plastic Frame</td>
<td>€ 285,49</td>
<td></td>
</tr>
</tbody>
</table>

![Figure 92, Example maintenance costs window frames](image)

This way for each element in each category of the SfB-NL elements system the corresponding maintenance costs can be determined. However this is of such a detail level, which is irrelevant for the purpose of this research. The decision between the different strategies will not be determined on this element level. The determining of the maintenance costs will therefore need to be simplified.

If with transformation all installations and other important elements are replaced it can be assumed to have the same maintenance costs per m2 GFA as a new building. However when installations or for instance the façade is maintained, it can be assumed it influence the maintenance costs in two ways.

First the maintenance costs will be higher because the condition the element is in is worse than a new element. The maintenance is assumed to be more extensively and therefore higher in costs.
Secondly the elements that are maintained will need to be replaced earlier than a new element. Each different element has its own lifespan. The frames for instance have an expected lifespan of 30 years. Since we're not focusing on this kind of detail level, the addition of all life cycles is too elaborate for this model.

In this model the maintenance costs will be used from the Vastgoed Exploitatiewijzer and the results of the case studies will be equal for transformation and new-build, as long as the installations are replaced. If the installations are maintained the maintenance costs will be increased with a certain factor.

10.8 Steps Model

In this part the steps prior to the model and steps of the model are discussed. Since the LCC model focuses on the financial part of the building characteristics. The market and location aspects need to be checked prior to conducting the LCC calculations.

Strategy Decision making process:
Step 1: Veto criteria Transformation potential; This step is divided into market, location, building, and organisation criteria. The criteria focus on the few basic criteria to which a vacant building has to comply.
Step 2: Gradual criteria Transformation potential; the gradual criteria are divided into functional, cultural, juridical, functional, and technical criteria. Each of these categories consists of a few specific criteria.
Step 3: LCC model
- Fill out office input sheet, with all necessary information regarding the current vacant office building
- Fill out the strategy specific information
- Choose the ambition and energy level of the new building
- Choose the interventions for transformation
- Choose possible additions to the building (topping with extra layers)
- Choice of reference building from 'BouwkostenKentegallenKompas' (Vonk, et al., 2014)
- Fill out the potential revenues of the building
- Fill out the economic variables for the calculations
Step 4: Determining risk of the project by applying Monte Carlo simulation to the most important variables
Step 5: (Optional): Sustainability calculations of strategies (for instance; Greencalc+, EST, BREEAM, etc.). Since the financial aspect is one part of sustainable development, the financial LCC calculation can be supplemented by a sustainable LCC calculation of the different strategies. This way also the environmental impact is included in the decision making process.

Figure 93, Steps LCC Model
11 Test Case & Monte Carlo Simulation

11.1 Applying Test Case
In order to test the LCC model it is applied to a building in the portfolio of Maarsen Groep. This is not a validation of the accuracy of the results, but it is used to test the practical application of the model. When applying the model in practice, small errors and shortcomings of the model are tested as well as extremely deviating values.

Figure 94, Weena A. source: Maarsen Groep

For the test case ‘Weena A’ at Weenapoint in Rotterdam will be used. The building is part of the portfolio of Maarsen Groep and is currently rented out. The current tenant however will move out in the near future, leaving the building behind vacant. The building is in need of an intervention and Maarsen Groep is currently calculating several scenarios and options for the building in collaboration with IGG.

For this case all necessary information and determination of variables is available and therefore ideal as test case of the LCC model. The specific case information of ‘Weena A’ is confidential and is included the appendix. The findings while using the model with the test case and the limitations of the model are discussed below.

Findings while using the Model
Many of the operating costs, like taxes and levies are based on the value of a building. This poses a problem for the consolidation strategy, since the current taxes and levies are based on the current book value, which is often far higher than the actual value. In my model the value of the building derives from the acquisition costs. In the consolidation strategy however, the original high book value will be used to calculate the taxes and levies. The actual operating costs of consolidation can therefore even higher than calculated in this model.
The level of rent as a result of its location has an enormous impact on the feasibility of a project. The difference between Rotterdam (€200 per m2 GFA) and Amsterdam (€705 per m2 GFA) influences the results and could influence the decision between strategies.

The operating costs of consolidation are very easy to determine, because the annual account of the existing building can be directly used as input in the model. Making it an easy and accurate determination of the consolidation strategy.

Many values used in the model might differ from the actual values of specific cases. While using the model however it became clear that these case specific values could be altered in very easily. Besides the input in the first four input sheets, values in the investment costs or operating costs can easily be changed. This puts the user of the model in the position to make very case specific calculations, beyond the detail level of the general LCC model.

Initially when increasing the preparation and construction period the NPV went up, while in reality a longer preparation and construction period should have a negative influence on the NPV. This was due to a wrong formula in the financing costs of the investment phase in the cash flow sheet. After altering the formula a longer preparation and construction period indeed results in higher investment costs.

Limitations LCC model
During the application of the test case in the LCC model some limitations in usage were discovered:

- Rent was based on Amsterdam, while the rent on other locations is much lower. This influences the feasibility as well as the decision between the strategies. This limitation was solved by adding a sheet with all the different rent bandwidths in the model.
- The remainder of contracts cannot be included in the model. Weena A for instance will only become vacant in July 2015. Until this period there will still be rental income from the offices and construction will only start after this period.
- Only rectangular floor plans with similar floor plans for each level can be inserted in the model. Deviating floor plans, like for instance the first two floors of Weena A, cannot be used in the model.
- Currently only the addition of topping the building with new layers can be used. Any of the other seven ways of adding surface area (chapter 7) can’t.
- Only the function housing is included in the model, while you see in practice that mostly with transformation projects there is a mix of functions. For instance a commercial plinth, or with Weena A a combination of short stay hotel and office. Being able to compare different functions in relation to the location is very important and interesting. This however requires an expansion of the model on investment costs, operating costs, and rental income.

11.2 Monte Carlo Simulation
One of the disadvantages of the DCF method, as explained in chapter 7.5, is the large influence the variables have on the end result. Since a lot of the variables are filled in by the person using the model or are predetermined in this research, these factors are subjective and might overshadow the importance of the costs and benefits of the strategies. The variables are therefore subjected to a Monte Carlo simulation. This analysis can help making an informed decision concerning the right intervention strategy. Making it possible to compare the return and risks of the different strategies.

The LCC model lends itself well for the application of a Monte Carlo simulation. For most of the variables a bandwidth is built into the model. This bandwidth is necessary input for the Monte Carlo simulation.

Crystal Ball Software
In this research the software ‘Crystal Ball’ is used. Crystal Ball is an excel add-in and a quick method for running thousands of simulations in a few seconds. The software is able to produce visual presentations that make it easier to understand and interpret the results and risks of the simulation of the development. This way the effect of the assumptions and variables in the model can be presented in the form of different charts.

When applying the Crystal Ball software for a Monte Carlo simulation with a certain development a few steps are necessary. Byrne (1984) has distinguished the following five steps:

1. Set up of the NPV calculation
2. Determine probabilistic variables
3. Determine correlations between variables
4. Run simulation
5. Analyse results

The first step, setting up the NPV calculation, is basically the LCC model, which calculates the NPV. This calculation has already been set up and is the result of this research. The model is directly suitable for running the simulation.

The second step is very important for the simulation. The determination of the probabilistic variables is essential in order to calculate accurate forecasts. The variables that are used in the simulation are the economic variables of sheet 4 of the LCC model and already have been defined. For each variable a probabilistic distribution needs to be determined. The input can be based on either historic data from the market or experience and knowledge of experts. Four main types of probability distributions can be distinguished: the normal distribution, the lognormal, the triangular, and the uniform distribution. The surface underneath the distribution always adds up to 1 (or 100%).

**SOFTWARE INPUT VARIABLES’ ASSUMPTIONS**

![Distribution Variables](http://www.ogj.com)

Figure 95, Distribution Variables source: http://www.ogj.com

In the Crystal Ball add-in first the assumptions need to be defined under ‘Define Assumption’ (figure 96). The triangular and uniform distributions are always limited with a minimum and maximum value, the normal and lognormal distributions can, but don’t need to have limits. Veen (2012) states that in practice limitations in the distributions is common in order to eliminate extreme and unrealistic values. With the Monte Carlo simulation in this research the BetaPERT distribution is used. It’s a combination of a triangular and (log)normal distribution. It has a minimum, a maximum and a most likely parameter just like the triangular. However the peak of the triangle is smoothed to a curve like a normal distribution, but it eliminates extreme and unrealistic values.

Lastly if a distribution is symmetrical the chance that the value will be higher than the mean is equal to the chance a value will be lower than the mean. Again it can be assumed that in reality the variables can be assumed to be a-symmetrical (Veen, 2012). The definition of the right assumption and values therefore depends on the available information as well as the experience of the user of the model.

![Figure 96, Defining values for assumptions](image1)

With the third step the correlation between the variables of the project need to be determined. If these correlations are not defined the model will generate inaccurate results. The GIY for instance is negatively correlated to the rental price. Adding the correlation in the Crystal Ball simulation is very easy by 'Define
Correlation'. The determination of the right correlation is a time-consuming process. Lots of information and input is needed to determine the correlation between the assumptions. For this reason, this step is not included in the simulation in this research. The quality of the input of the model determines the quality of the output. The exclusion of the correlation in the model is therefore an important point of interest. The setup of the Monte Carlo Assumptions Sheet is shown in the following figure.

### Economic Variables

<table>
<thead>
<tr>
<th>Indexation</th>
<th>Input model</th>
<th>low</th>
<th>basic</th>
<th>high</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation (CPI)</td>
<td>0.0%</td>
<td>1.1%</td>
<td>2.1%</td>
<td>2.5%</td>
</tr>
<tr>
<td>Rent increase on top of CPI</td>
<td>0.0%</td>
<td>0.0%</td>
<td>1.0%</td>
<td>5.0%</td>
</tr>
<tr>
<td>Electricity index</td>
<td>0.0%</td>
<td>-5.0%</td>
<td>5.1%</td>
<td>23.0%</td>
</tr>
<tr>
<td>Gas index</td>
<td>0.0%</td>
<td>-7.0%</td>
<td>8.1%</td>
<td>9.0%</td>
</tr>
<tr>
<td>Construction Costs index</td>
<td>0.0%</td>
<td>-4.9%</td>
<td>0.3%</td>
<td>6.0%</td>
</tr>
<tr>
<td>Vacancy rate housing</td>
<td>0.0%</td>
<td>0.0%</td>
<td>3.0%</td>
<td>10.0%</td>
</tr>
<tr>
<td>Discount rate</td>
<td>0.0%</td>
<td>3.5%</td>
<td>5.5%</td>
<td>6.5%</td>
</tr>
<tr>
<td>Interest on Construction Costs</td>
<td>0.0%</td>
<td>4.0%</td>
<td>5.0%</td>
<td>8.0%</td>
</tr>
<tr>
<td>Interest on Dept Capital</td>
<td>0.0%</td>
<td>4.0%</td>
<td>5.0%</td>
<td>7.0%</td>
</tr>
<tr>
<td>LTV</td>
<td>0.0%</td>
<td>30.0%</td>
<td>65.0%</td>
<td>85.0%</td>
</tr>
<tr>
<td>Annual Repayment</td>
<td>0.0%</td>
<td>0.0%</td>
<td>2.0%</td>
<td>6.0%</td>
</tr>
<tr>
<td>Initial Yield / BAR (housing)</td>
<td>0.0%</td>
<td>3.0%</td>
<td>5.5%</td>
<td>9.0%</td>
</tr>
<tr>
<td>Exit Yield (housing)</td>
<td>0.0%</td>
<td>3.0%</td>
<td>8.0%</td>
<td>10.0%</td>
</tr>
<tr>
<td>Exit Yield (office)</td>
<td>0.0%</td>
<td>0.0%</td>
<td>15.0%</td>
<td>20.0%</td>
</tr>
<tr>
<td>Period of financing</td>
<td>10 yr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifespan</td>
<td>30 yr</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Other Variables

- Rent per m²
- Construction Costs T
- Construction Costs NB
- Unforeseen Costs T
- Unforeseen Costs NB
- UFA/GFA Transformation
- UFA/GFA Demolition & NB
- Preparation Period T
- Construction Period T
- Preparation Period NB
- Construction Period NB

### NPV Monte Carlo

- NPV Transformation
- NPV Demolition & New-Build
- NPV Consolidation
- ROE T
- ROE NB

Figure 98, Monte Carlo Assumptions sheet

The fourth step is to run the simulation. The forecasts are defined on the NPV value of each strategy. When running the simulation the number of trials, which basically is an individual scenario, needs to be determined. For each of these trials a different value is used as input for each variable. This way the Crystal Ball software calculates for instance 1000 or 10000 different scenarios in a very short time.

The fifth and final step, the analysis of the results, is the visualization of the simulation in charts. The probability distribution is given as output. By changing some of the settings many useful information can be extracted from the results. The main results that will be subtracted from the simulation are: The forecast chart, statistics chart, and sensitivity chart.

The forecast chart shows the probability distribution of the NPV of each strategy. Furthermore, the mean, standard deviation, and certainty can be presented in the forecast chart.

Figure 99, Step 5: Run the simulation
The statistics view can be produced in a split view with the histogram and shows the most important statistics of the simulation. Besides the mean NPV, the minimum and maximum NPV are given. The standard deviation of the NPV can give an indication of the risk of a project, where a higher deviation indicates a more risky development.

Finally a sensitivity analysis chart can be selected. The sensitivity chart is able to determine how much each assumption affects the result of the NPV. The total list of variables that is incorporated in the simulation is shown in figure 97. The sensitivity chart ranks the assumptions from most important down to the least important. The results are given in percentages of the influence on the end-result. The sensitivity is calculated with regards to the uncertainty of the assumption and the sensitivity in the model. A positive value in the sensitivity analysis indicates that an increase in the assumption relates to an increase in the forecasts' NPV and vice versa (Oracle, 2008).

**Simulation Results**

The model was set to run 10,000 trials on extreme speed with a confidence level of 95%. In total 50 assumptions of 25 variables were defined. The information Crystal Ball calculates holds a lot of useful information about the risk and uncertainty involved with the development. First a forecast chart is given, followed by a statistics view, and finally a sensitivity analysis chart.

**Forecast Charts**

By changing the certainty on the left to zero, the chance that the development will have a minimum NPV of zero is given. This results in the certainty level for a successful project. The mean, median, standard deviation, and probability distribution fit are added to the chart to include more information.

![Figure 100, Forecast Chart NPV Transformation](image)

![Figure 101, Forecast Chart NPV Demolition & New-Build](image)
The three figures above show the forecast charts of the different strategies. Consolidation has a 100% certainty that it will have a negative NPV and therefore is the worst strategy by far. Transformation has the highest certainty of being a financially feasible project with a certainty level of 71.35%. Demolition & New-Build has a lower certainty level of 58.35%. The higher certainty level of Transformation means in this case that Transformation will more likely be a successful project with a higher NPV. This simulation therefore can substantiate the decision of the user of the model to choose for the transformation strategy.

Statistics Chart
The standard deviation of New-Build is higher than Transformation (figure 103). This indicates a higher uncertainty with the new-build strategy and therefore a more risky project. The higher certainty level and lower standard deviation indicate that the transformation strategy is in this case preferable over demolition & new-build.

Sensitivity Chart
The sensitivity charts of the simulation are shown on the next page. The focus only should be on the variables that have the largest effect on the result, in accordance to the Pareto principle (Chapter 7). The assumptions that have the least influence can be ignored or discarded and eliminated from the final simulation (Oracle, 2008). Besides the variables with minor influence, some variables are predetermined in agreements and therefore have no uncertainty or risk. These variables can therefore also be eliminated from the final simulation.

When looking at the sensitivity charts on next page (figure 104 & 105) it becomes clear that the assumption with the largest influence on the NPV are the; rent increase, discount rate, rent per m2. These three variables are about 20% of the total amount of variables and have a combined effect of approximately 80% on the end result, in line with the Pareto principle.
The rent increase has the largest influence by far approximately 50% for both sensitivity analyses. The increase of the rent depends mostly on the developments in the market and is hard to influence. The same goes for the Discount Rate (12.4%) and Rent per m² (9.8%) significantly influence the NPV.

Figure 104, Sensitivity Chart: NPV Transformation (all assumptions)

Figure 105, Sensitivity Chart NPV: Demolition & New-Build (all assumptions)
Figure 106, Sensitivity Chart: NPV Transformation (selected assumptions)

Figure 107, Sensitivity Chart: NPV Demolition & New-Build (selected assumptions)
Figure 106 and 107 have excluded the variables that are predetermined and therefore not an uncertainty, which are; LTV, interest on dept capital, interest on construction costs, and annual repayment.

Interesting is the influence of the Exit Yield on the NPV. The Exit Yield in the NPV calculations is only used for determine the taxes and levies, which are part of the operating costs. This indicates the operating costs have an influence on the end result.

An important point of interest is that the electricity and gas index have a significant influence on Demolition & New-Build and not on Transformation. This is due to the fact that the higher costs of a higher energy label of New-Build are only beneficial with an increase of energy costs. The average label C of the transformed building scenario is less influenced by the energy indexation. This also explains why in this case the construction costs have more influence on the Transformation strategy than the New-Build strategy.

Unexpectedly, the preparation and construction period showed very little to no influence on the NPV. This can mean either the other chosen variables have a far larger impact or it can indicate a mathematical or typographical error in the model.

11.3 Energy Scenarios
As an addition to the Monte Carlo simulation, the Energy variable will be further elaborated on. The indexation of the future energy prices will influence the effect of the energy label. The more the energy prices rise, the higher the effect of energy cost savings and rental income will be, while the investment costs remain the same. The energy label increase will therefore be more favourable if the prices increase.

Scenario studies are a common used tool to determine potential future energy scenarios. The European context is important for the future Dutch energy scenarios. The figure below shows the different potential scenarios in relation to the corresponding primary energy supply in 2050.

![Figure 108, European Primary Energy Supply in 2050](source: Weterings, et al., 2013)

Also for the Dutch future energy supply many different scenarios have been written. Some focus at 2020 and 2030, others try and predict the energy scenarios until 2040 or 2050. In a report by TNO eight scenario studies were used to draw conclusions and similarities between the different scenarios (Weterings, et al., 2013). The scenarios that are used are:

- Greenpeace: Energy Revolution Scenario
- Low Nuclear
- Delayed CCS (CO2 Capture and Storage)
- High RES
- Diversified Supply
- Energy Efficiency
- Current Policy
- Reference

Each of these scenarios is characterized by high investment costs, doubling of the proportion of the electric energy use, much energy savings, and an increase in energy prices for households.
With the results statements are made about the future energy scenarios for the Netherlands. These results are used to set up a bandwidth for the future energy prices in 2050. In the following figure the bandwidths in assumptions are shown, the current energy price is the black mark.

The following bandwidths for the price indexations can be derived form the figure above: for electricity an annual indexation of -5% to 23%, for gas -7% to 9%. This is a relatively broad bandwidth and can be explained by the fact that the different scenarios vary in application, approach, and assumptions. Therefore the predictions differ in future energy use, energy supply, CO2 emissions, and energy prices. Altogether the future energy prices are hard to predict and depend on many different global developments. The large bandwidth causes the energy index to be a risky variable in the model.

The effect of the bandwidth of the energy price indexation and energy labels in relation to the decision between the different intervention strategies is covered in the covered in the appendix A.

![Figure 109, Bandwidth in scenarios energy prices 2050 source: Weterings, et al, 2013](image)

**Sensitivity Analysis Energy Label**

The goal of this research was to find the influence of the Life Cycle Costs on the financial result for each of the different intervention strategies; Consolidation, Transformation, and Demolition & New-Build. The influence of the operating costs on the NPV will be demonstrated with regard to the energy label and the energy index. The operating costs for a large part consist of the energy costs, which in this model have been incorporated in the rental price.

For the energy index the NPV of a pessimistic, realistic, and optimistic scenario is calculated for each energy label. The scenarios cover the entire bandwidth of the different future energy scenarios in figure 107. The pessimistic scenario has an indexation of 23,0% for electricity and 9,0% for gas, the realistic has 5,1% for electricity and 7,1% for gas, and the optimistic scenario has -5,0% and respectively -7,0%. For new-build only the label A+ and A++ is calculated.

The full results of the sensitivity analysis of Weena A can be found in the confidential information in the Appendices. In the case of Weena A with the optimistic and realistic scenario Transformation has the most favourable NPV with a label G. This means the least investments are made and the additional investments for a higher energy label will not pay themselves back with the higher rent. If however the indexation is higher, like the pessimistic scenario, the additional investment for a higher energy label will be profitable. This pessimistic scenario also shows that New-Build is preferable over Transformation. The differences in NPV’s in this sensitivity analysis are purely based on different energy costs and energy indexation. Since the energy costs are part of the operating costs, this means that the operating costs do influence the decision for financially the most feasible strategy and should therefore be taken into consideration when making the decision for the financially most feasible strategy.

Finally it can also be the case that a short-term perspective has a different favourable strategy from a long-term perspective. In the summary sheet below the electricity index has been slightly increased in order to illustrate this contradictory approach between short and long term. The Result at year 0 is calculated with the GIY and first year rent subtracted with the investment costs. In this approach the transformation strategy is favourable. The NPV of the 30-year lifespan however shows that demolition & new-build has a more favourable NPV and IRR compared to transformation. This contradiction will be case specific and largely depending on the macro economic settings, but highlights the importance of both approaches.
11.4 Conclusions Test Case & Monte Carlo Simulation

Since each office building and transformation project is unique, the LCC model itself is not suitable for drawing generic conclusions. However when applied to a specific test case, specific conclusions can be drawn from the results of the model and related to the generic conclusions. The model is therefore generic as it is applicable to all different unique cases and buildings.

The test case proved that the operating costs do have a significant influence on the financial result of the different strategies, depending on the input and variables of the model and case. Furthermore it showed that a short-term approach favour a different strategy than a long-term approach. These observations emphasize the importance of a LCC approach towards development projects, the vacancy problem, and the decision making process concerning the different intervention strategies.

The scenario analysis that was specifically focused on the energy indexation in relation to the energy labels and different strategies also proved that the energy costs, as part of the operating costs, influences the NPV of each strategy. These results could therefore affect the decision for the financially best strategy.

In regard to the Monte Carlo simulation the results can be used to give a clear overview of the risk and uncertainty of a development. The Monte Carlo provides insight in the risk and effect of the variables on the NPV or ROE of the strategies. The most important thing is that the user of the model can help making the decision, rather than that the simulation results in an absolute decision for a strategy.

The simulation assumes that the determination of the variables is accurate. The quality of the output of a Monte Carlo simulation is determined by the quality of the input: rubbish in = rubbish out. The input for the variables in this simulation is based on some historical series and own input in consult with Maarsen Groep. This makes the input somewhat subjective. The absence of clear historic databases for the input as well as the subjectivity of some of the input makes the results less reliable. Defining the correlation also adds to the reliability of the results, but was not included in this simulation due to the time consuming process. More knowledge and information is needed to determine the assumptions and correlations more accurately and more reliable simulations.
Conclusions & Recommendations
In the final part the conclusions and recommendations of this research are discussed and the main research question is answered. The conclusions concern the empirical research, the LCC model, the test case, and the Monte Carlo simulation. The recommendations are divided into recommendations for practice, Maarsen Groep and recommendations for follow-up research.
12 Conclusions & Recommendations

12.1 Conclusions
In the construction industry it's prevalent that development, and therefore transformation, is traditionally carried out by a project developer. The developer therefore was the initial target group of this research. However the obstacles of transformation and the problems of vacancy and depreciation are detrimental to the building owners rather than the developers. Building owners and investors should therefore adopt a more active approach towards the vacancy problem (Veen, 2012). This is something that is currently separated by sector in the real estate market (Remøy, et al., 2014).

Financial feasibility models of transformation projects should not be restricted to a short-term approach, only covering the potential development profits. For transformation projects, or any other development for that matter, a long-term perspective is preferable where the short- and long-term approach and the calculations of developers and investors are combined. With this integral approach the impact of decisions in the initiative phase of the development on the investment costs as well as the operating costs and revenues during the life cycle are made clear. Developers and investors can then base their decisions on financially the best strategy and optimize the total Life Cycle Costs of each strategy.

Conclusions of the Theoretical and Empirical research
The main goal of this research is to compare different intervention strategies for vacant office buildings on their life cycle costs and benefits. The empirical research served as input for the model, as well as to find out what the most important differences between transformation and new-build are. The most important differences are those variables that have a large influence on the costs and benefits of the different strategies.

Influence of time
The fact that the moment in time that costs and benefits are made has an influence on the financial result of investment is a known fact. In the calculation of a cash flow it's beneficial if income starts as soon as possible and costs are made as late as possible. What's important for the LCC model in this research is to determine what the differences in the time factor are between the different strategies.

With each development it is financially beneficial if the preparation and construction period are kept as short as possible. This can help lowering the investment costs, as well as bringing the rental income forward in the cash flow. In line with the expectations, the case studies showed that the longer a project took, the higher the total investment costs were. One of the often-named main advantages of transformation is the short development period. Indeed the development period can be a lot shorter with transformation than new-build, mainly because the structure of the building can be re-used. However this is an advantage that needs to be utilized, since transformation projects also can take a lot longer than expected if not properly prepared. The cases with a short construction period achieved this by selecting an easy to transform building that needs little interventions. Some cases also used standardized elements to shorten the construction period. This method however is of course equal in time saving for transformation and new-build.

In a recent research of DSP-groep (2014) one of the conclusions was that commercial parties are better at creating a positive return than corporation due to a smart timing of the acquisition, selection of buildings that require little interventions for transformation, and a focus on a short construction period. The results from the case studies and interviews confirm these conclusions. Several parties focus their project on making sure that their preparation and construction period are as short as possible. The selection of the right building is the first important step. When selecting a building special attention should be paid to the required interventions of transforming the building into apartments, and the potential UFA/GFA ratio that can be achieved.

In addition before the acquisition of a building an extensive preparation should be carried out. An early collaboration with the municipality can help shortening the process of a zoning change and building permit application. This shortens the preparation period and can therefore have a positive effect on the financial feasibility.
This influence of time was not included in previous financial feasibility study models. Since it plays such an important part in the financial result of a project it has been included in the LCC model in this research.

**Energy Label**
The most important difference in operating costs between new-build and transformation is caused by the difference in energy costs and benefits. The current Dutch office supply is in poor condition in terms of the energy labels. The cross-case analysis showed that only a small percentage of the buildings have an energy label. The few cases with energy labels have a lower energy label compared to new buildings.

If with a transformation interventions to the façade and installations are made the energy label of the building will most likely increase. New buildings however need a minimal energy label of A+, which is practically always higher than the label that transformed buildings achieve. The Building Regulations of 2012 concerning the required energy performance of transformed buildings have been softened to make transformation more feasible. An important point of interest is however if it is desirable to maintain this lower energy label. This might keep the investment costs lower, but when the energy costs savings due to the energy label are incorporated in the rent level they significantly influence the revenues during the lifecycle. The effect of the energy costs saved and corresponding increase of rental income is depending on the indexation of the energy costs.

The façade was appointed as the most important cost factor of a transformation project in previous researches. If the façade and installations could be maintained, this would have a positive effect on the financial result of a transformation. The previous financial feasibility studies of transformation exclude the effect on the operating period of these interventions. Replacing the façade and installations negatively influences the investment costs, but results in higher rents and value of the building.

The energy costs are separately indexed in the LCC model. The indexation in the model is based on the average increase of the past 10 years. However energy prices are expected to rise in the future, which increases the influence of the energy costs and energy label of a building.

Since the energy label is mostly in the favour of new-build, this should be a point of interest with transformation. Increasing the sustainability of transformation can help increasing the benefits of transformation as opposed to new-build.

**Maintenance costs**
The maintenance costs for new buildings and transformed can be assumed to be the same, if with transformation the installations, roof, etc. are replaced. If elements are not replaced it will have an influence on the maintenance costs. Maintenance costs are normally specified in a multi annual maintenance planning (MJOP). Large expenses on major maintenance are divided equally over each year of the remaining lifespan of each element. The total annual costs can be assumed to be higher with older elements, since the remaining lifespan of these elements is shorter than a new element and will need earlier replacement. On the other hand the replacement costs of the elements is moves further down the lifespan, which saves interest costs.

The MJOP requires a specification of costs at individual element level. This approach is too detailed for the LCC model in this research and not relevant for the decision between different interventions strategies for vacant offices. The maintenance costs are therefore increased with a certain factor if the façade or installations are maintained with the transformation.

A higher ambition level, with a higher level of finishing, causes higher maintenance costs. This can be explained by the fact that it costs more to maintain this high level of finishing (Vastgoedmarkt, 2013). The same goes for a higher energy label, where it can be assumed that the added materials and installations require more maintenance (Nuiten et al., 2014).

**Rental Income**
The amount of rental income significantly influences the financial result of the different strategies. It can be assumed that a new buildings and a transformed building have the same rent level. However a difference in the total rental income can be caused by two reasons.

First of all with transformation the layout for the new function housing is bounded to the existing office layout. This layout was never intended for apartments and can result in a less favourable Usable Floor
Area/Gross Floor Area ratio (UFA/GFA). Offices for instance commonly demand more staircases than apartments. The surface of the staircases is deducted for the calculation of the UFA. A higher UFA/GFA ratio results in more lettable square meters and hence more rental income per m² GFA.

The actual ratio is very case specific and also differs for new-buildings. The cases showed that the average of the transformed buildings that were analysed is 78%, with a bandwidth of 64% to 86%. According to the BouwskostenKengetallenkompas (IGG Bointon de Groot, 2014) new buildings can, depending on the reference project, attain an 83% GBO/BVO ratio. This indicates that with the selection of a building for transformation, it is important to select a building that allows for a favourable GBO/BVO ratio in relation to the rental income that is associated with it.

Secondly the energy label of the building influences the rental income. Currently in the liberated sector rent levels are not directly linked to the energy label. In January 2015 however the EPC certificate becomes voluntary, but will be linked to financial instruments like the property valuation system in the non-liberated sector (Rijksdienst voor Ondernemend Nederland, 2014). This way the energy savings that will be of benefit to the tenants can be incorporated in the rent level.

**Scale**
The cases showed a positive relation between the size of a building and the operating costs. This relation can also be found with the investment costs. The larger scale of the building is the reason behind this. In the operating phase this can be explained by the fact that many of the contracts, like for instance cleaning and maintenance, and the management costs are lower per m² for a larger building.

This contradicts one of the success factors of transformation that Bosma & De Ridder (2013) stated (chapter 6.6). Namely that smaller transformation projects were more successful than large projects.

**Lifespan**
The lifespan can have an influence on the decision of the best strategy. Even though it is very case specific the interviews showed that some projects were not feasible for a lifespan of 50 years, but for 20 years it was possible to make it feasible. This can be explained by the far lower investment costs that were required in those cases.

Corporations commonly only focus on investments in housing with a lifespan of 50 years. By approaching vacant buildings with a more flexible lifespan, many more transformation might get off the ground. There is a large gap between temporary transformation (1-5) years and the 50 years corporations use (Hendriks, 2014). Considering the rapidly changing society and developments of the demographics the question arises whether buildings should be constructed with a long intended lifespan. If the demand changes after a shorter period, a building should be able to adapt to the new situation. Transformation is a more suitable strategy than a new building that is specially build for a certain demand.

The residual value of a building at the end of the lifespan plays an important part in financial result of the LCC calculation. Currently the determination of the market value of a vacant office building is one of the largest barriers for transformation. The residual value of the buildings is calculated with an exit yield at the end of the chosen lifespan. The problem with determining the residual value is that it is a rough estimate and is basically the same problem as determining the current value, but then 30 years in the future from now.

Even though a transformed building has an older construction and therefore could be considered to have a shorter remaining life span, the residual value does not take into account the adaptability of the building. A transformed building will at the end of its lifespan most likely still have a flexible floor plan and will be easy to transform again.

**Difference financial feasibility and LCC approach**
Purely looking at the investment costs of the different strategies, transformation is often preferable. This is very case specific, but since transformation starts with an existing structure costs and time can be saved. If the number and costs of the interventions is increased for transformation, the construction costs rise steeply and can become just as high as new-build.
Depending of the UFA/GFA and energy label of the transformation option new-build can result in higher rental income. On the other hand new-build does often require a higher investment. This means on the short-term less investment and transformation might be financially more attractive, but over a lifespan of 30 years the higher rental income of new-build might have a financially better result. Some investors however cannot or do not want to invest more in a development, since more equity is needed.

Consolidation
The negative financial effects of consolidation only become apparent when looking at the long term. Because this option does not require additional investments, it will always be favourable with a short-term vision. However because of the on-going operating costs of consolidation this option is financially mostly the worst decision. This has a number of reasons.

First of all with the current and predicted market condition, the vacant office building is likely not to be leased in the future. This is the first problem of many building owners, which assume there is still a small chance that if they lower the rents they will find a new tenant.

Secondly not only will the normal operating costs, to a lesser extent, continue also the costs that normally belong to the tenant like for instance the energy costs. If the building is financed with a loan, the interest costs have a large negative influence on the financial result. Especially when the loan ends and new agreements have to be made with the bank, which can result in a higher interest rate (Trouborst, 2012).

Furthermore the building can be assumed to depreciate to 0, during the 30 years remaining lifespan used in the research. After this period the building is only worth the land costs minus the demolition costs or potential sale value. This means the inevitable decision of intention is only postponed 30 years. However the vacancy costs of 30 years are added to the problem.

Operating Costs Data
One of the starting points of this research was the discussion concerning the ratio between the investment costs and the operating costs. Evans (1988) initially set this ratio at 1:5:200 for the investment costs, operating costs, and business costs. This ratio was later lowered to more probable ratios. By Hughes (2004) to 1:0,4:12 and 1:1,5:15 by Ive (De Jong, et al, 2014). In this research a ratio of 1:0,55 was found for the investment and operating costs. With these results needs to be taken into consideration that the cases did not include the energy costs and finance costs, which can drive the operating costs up quite a bit. If the ratio is higher in favour of the operating costs, the effects of lowering the operating costs will have a more significant influence on the financial result.

It is commonly assumed that separation between the investment costs and operating costs causes the total costs of ownership to increase. While this research does not provide any evidence for this statement, the model does enable the user to see what the effect is of decisions in the investment phase on the operating costs and benefits during the life cycle.

When gathering the cost data of the operating costs it was noticeable how difficult it was to obtain the right information. There is very limited available cost data of transformed buildings, especially concerning the entire life cycle costs. While the investment costs by most actors are clearly categorized in the STABU-NL elements method, everyone uses their own categorization for the operating costs. Also previous research on operating costs is very limited. The only way to make an accurate budgeting of the maintenance costs is to make a Multi-Year Maintenance budget on element level. This takes a significant amount of time and is not suitable for the comparison of intervention strategies in the initiative phase. New techniques and instruments like BIM and bream-in-use are suitable for collecting data from the operating period and can provide future research with usable data for further research on operating costs.

Conclusions of the LCC model
Usefulness and necessity of the Model
The model was intended for the comparison of the Life Cycle Costs & Benefits of different intervention strategies. The model enables the user to make case specific calculations of the investment costs, operating costs, and revenues of the different strategies. No absolute values are calculated, nor does it give the user a demarcated decision for a certain strategy. The results on the summary sheet as well as the results from the Monte Carlo simulation assist the user of the model in the decision making process.
and illustrate the impact of decisions in the initial phase on the rest of the lifespan. This is in line with the initial purpose of the model, as described in Chapter 1. Many assumptions were made in this research that influence the end result of the model. Many of these assumptions however are equal for each strategy and therefore don’t influence the decision between the strategies.

The empirical research and model revealed that the life cycle approach is important for addressing the vacancy problem. The operating costs of the strategies influence the decision of financially the best strategy as opposed to merely looking at the construction costs.

**Difference financial and sustainability approach of transformation**
This study was among others based on previous research of Agentschap NL (2010) and Jansz (2012). The difference is that the focus of this research is on the financial aspects of LCC instead on the environmental impact of the previous research.

This enables a comparison between the financial and environmental approach to the same problem. An important conclusion of both researches named above is that the remaining lifespan influences the environmental performance of building. This works in favour of new-build, where the remaining lifespan can be assumed to be longer. In other words for a short remaining lifespan transformation seems more favourable and for a longer lifespan new-build. From a financial point of view transformation often has lower investment costs than new-build, while new-build can yield higher rents. On the long term new-build might therefore be favourable. This is all very case specific, but it is interesting to compare a case on the financial life cycle cost and sustainability of the different strategies.

**Transparency of Costs & Benefits**
Important when looking at the costs and benefits, is whose costs or benefits they are. Often with additional investments the person making the additional investment is not the one reaping the benefits. A good example is additional investments for a higher energy label. The developer or investor makes these higher investments, while it is the user that benefits from the energy savings. The LCC model is able to give an overview of these costs and benefits and can therefore make clear whose costs and whose benefits it is. In case of the energy label, the rent can be increased with the energy savings due to the label. The investor in this way can recoup its investment (BBN adviseurs, 2012).

**Conclusions of the Test Case & Monte Carlo Simulation**
The operating costs do have a significant influence on the decision between the different strategies, depending on the input and variables of the model and case. Furthermore a short-term approach can favour a different strategy than a long-term approach.

The Monte Carlo Simulation is capable of providing insight in the risks and uncertainties of the strategies and the certainty of a financially feasible project. The sensitivity analysis gives an overview of the effect of the different variables and assumptions in the model on the end result and NPV. The construction costs for instance, which are normally the focus of feasibility studies, in the simulation of the test case had between 4,1% and 7,4% influence on the end result in relation to the other variables. This is comparable to the effect of the energy indexation that influences the operating costs. This shows that merely looking at the construction costs is an inadequate approach for the decision between the intervention strategies.

The Monte Carlo Simulation is suitable for assisting the user of the model in the decision making process, rather than providing a clearly defined decision. This way it helps reducing risks and uncertainties, as well as increasing the profitability by redefining the input and variables of the project.

**12.2 Answering the Research Questions**
With the conclusions of the case studies (chapter 8), interviews (chapter 9), and the final conclusions (chapter 11) the sub-questions of this research were answered. The research was set up to address the problem statement and to answer the main research question. With the answers to these sub-questions and the established LCC model the main research questions can be answered.

**The main research question:**
*How can a LCC model be developed and used to compare the economic costs and benefits of different strategies for a vacant office building?*
To compare different strategies with a Life Cycle Costs model the most important costs and variables need to be determined for each strategy. Since the calculations for a transformation project are unique and case specific, a lot of information and input is required. The LCC calculation needs to be on a detailed element level to accurately determine the construction costs and operating costs. Even though this level of detail is necessary to make an accurate calculation of the costs, it is not relevant for the decision between the different strategies.

In the model therefore many assumptions are made. These assumptions are used to indicate what the consequences are of decisions in the investment phase on the operating phase and total life cycle costs. This way the model gives an indication of what financially the best strategy for a vacant office building. The results are then substantiated with a Monte Carlo simulation that focuses on the risks and uncertainty of the development.

The output of the model will not provide the user with clear demarcated decision. The model enables the user to understand the effect of decisions in the initiative phase on the total Life Cycle Costs of the different strategies. The user can therefore adjust the decision to choose financially the best strategy. This is a different approach to finding vacant office buildings that are feasible for transformation or are better suited for demolishing and new-build.

### 12.3 Recommendations for practice

While the concept of Life Cycle Costs has been around for long time, most developments in the construction industry still focus on the construction or investment costs. In practice this can lead to high operating costs during the buildings life cycle. Since the operating costs, as shown in this research, have a significant influence on the financial result of different strategies, they should be incorporated in the initiative phase. Steering on keeping operating costs low can help in creating financially better projects and optimize the total cost of ownership of the strategies.

**Decision between the strategies**

First of all it is important to realise that not all buildings are suitable for transformation. Besides market and location aspects that are the first veto-criteria for a transformation project, the building characteristics will also play an important part in the transformation potential. With the LCC model the costs of transformation, new-build, and consolidation are made clear.

The financial margins with transformation projects are assumed to be small (Boon, et al, 2014). When looking at the financial feasibility of a transformation project it is not sufficient to only calculate the potential return of the transformation strategy. The question should not be just if the transformation strategy is feasible, but it should be contrasted against the financial result of demolition & new-build and consolidation. The decision for the right strategy should be based on this comparison, since the costs of consolidation can run high with transformation as a solution for limiting the financial loss of a vacant building. The option with the best result, or least loss, is the best option.

**Integrated Approach**

For the financial feasibility of transformation projects an integral approach and close collaboration between all actors is needed. This way the gap between the world of the developer and the investor can be closed. By an early inclusion of the municipality the preparation and construction process can be kept short, which is necessary to utilize one of the most important advantages of transformation.

**Transparency Costs & Benefits**

The effect on the life cycle costs of investments in for instance a higher energy label should be made more transparent. A LCC model can provide insight in the investment costs and cost savings. This way different actors can make agreements concerning who benefits and who pays. Currently the person making the additional investment is not the one reaping the benefits (BBN advisors, 2012).

**Energy Label Transformation**

New buildings according to the Building Regulations need a minimum energy label A+. Transformed buildings have lower requirements and often lower energy labels than new buildings. The case analyses showed that a high energy label is possible with transformation, but requires additional investment costs. If more attention is paid to lowering the costs of achieving a high energy label with transformation, one of
the advantages of new-build can be reduced. Since investments in sustainability pay off on the long term, a life cycle approach is required for sustainable measures.

12.4 Recommendations for follow-up research

The gap between the approach of the developer and investor has often been mentioned in this research. The LCC model in this research attempts to bridge this gap by combining both the investment phase and operating phase into one discounted cash flow model. The model is a means and not an end to achieve this. The practical implementation of the LCC thinking in the construction industry is an elaborated process, where the collaboration of all actors will shift. A qualitative research concerning this process change, with the perspective of different actors on the subject is an interesting addition to this research.

More Scenarios

The model is now focused on transformation of offices into rental houses. When choosing an intervention strategy however it is interesting to see what the financial results of other scenarios is. For instance hotels, shorts stays, sell houses, etc. might point out a different strategy. Furthermore the addition of other functions like parking and a commercial plinth can be added to the model. This enables the developers and investors to determine what financially the best strategy is.

Market and Location aspects

This model focuses on the building characteristics. The addition of market characteristic to a model will influence the result of the strategies. After all not each location has a different demand and therefore potential new function. This will make the model more specific and realistic for each situation.

The effect of adding temporary transformation in the model

This is left out of this research, but temporary transformation is a common used strategy for vacancy currently. The advantage is that the investment costs are really low, and the negative effects of vacancy averted. Interesting is to see what temporary transformation does to the overall life cycle costs of for instance the consolidation strategy.

Flexible Lifespan

The lifespan is set at 30 years in this study. As the conclusions pointed out, a flexible lifespan can affect the decision of the financially best strategy. By making the lifespan adjustable in the cash flow of the LCC model, the effect of the lifespan can be demonstrated for each case.

More Cases

Only seven cases were analysed in the case analysis of this study. In combination with the literature study and the interviews this was enough to draw interesting conclusions, but not enough to provide usable quantitative data. A greater number of cases could improve the empirical value of the results as well as the practical applicability of the data.

Residual Value of a transformed building

An important part of the financial result of a strategy is the residual value. The determination of the residual value of a transformed building is a complex problem and was not studied in this research. With regard to aspects like the flexible floor plan and future adaptability buildings, a study to determine the residual value of transformed buildings in comparison of new-buildings after an initial life cycle can be an important subject.

Linking the 3P’s approach to the vacancy problem

Where this research focused on the ‘profit’ aspect of the LCC of different strategies, previous research of Sascha Jansz (2012) and Agentschap-NL (2010) focused on the ‘planet’ aspect. The comparison between these two approaches to the vacancy problem with regard to specific cases in the Netherlands can give interesting results for the decision making process.

Monte Carlo Simulation

A Monte Carlo simulation holds a lot of potential as an addition to the traditional financial feasibility study. It provides usable information for the decision making process for the strategy of a vacant office building. Veen (2012) already concluded that the practical implementation of the Monte Carlo simulation however requires a lot more work. Especially the reliability of the input needs to be increased.
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