Sustainable offices

Author Philip Visser
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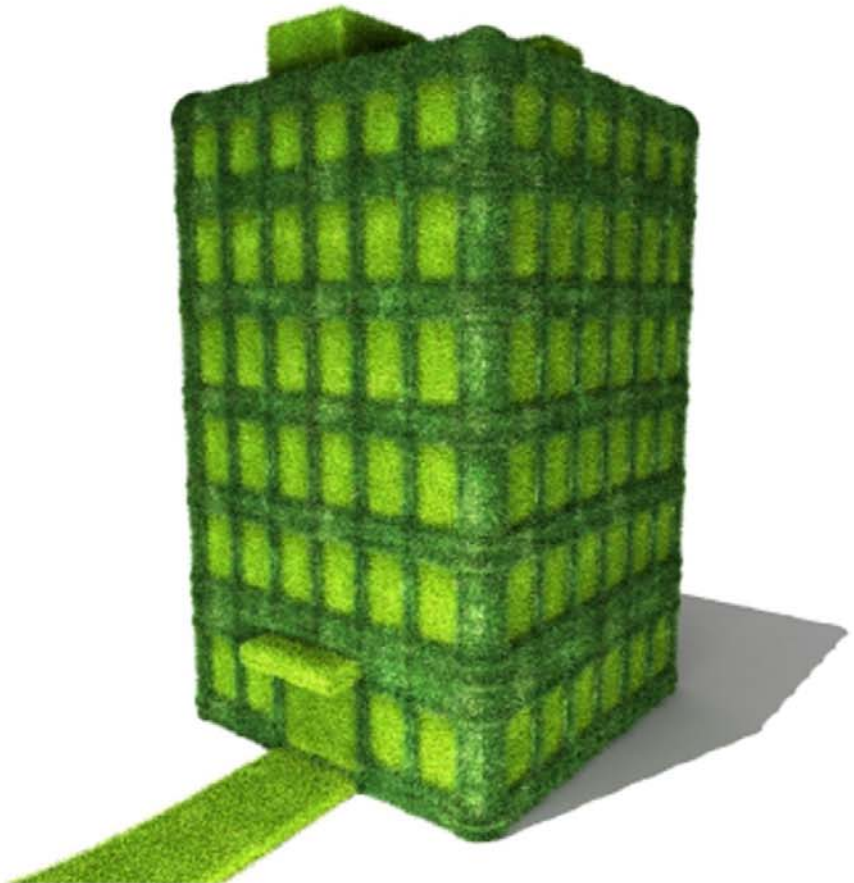
Financially feasible what to what extent?



Colophon

Graduation subject: **Sustainable offices**
Financially feasible to what extent?

Research question: *To what extent are investments in sustainable offices financially feasible, considering the end user's wishes, throughout the entire life-cycle of a (re)development?*

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Personal information
Name student: Philip Karel Visser
Student number: 1178504
Adres: Nassaukade 335 III
1053 LV Amsterdam
Telephone: +31 6 51095959
E-mail: Ph.K.Visser@gmail.com
P.K.Visser@student.tudelft.nl

Graduation organisation
University: Delft, Technical University
Faculty: Architecture
Master: Real Estate & Housing
Graduation lab: Corporate Real Estate Management (CREM)
Lab coordinator: Dr. Ir. D.J.M. van der Voordt
Main mentor: Drs. P.W. Koppels
P.W.Koppels@tudelft.nl
Second mentor: Ir. S. W. Bijleveld
S.W.Bijleveld@tudelft.nl
External examiner: Ir. G.J. Hobbelman
G.J.Hobbelman@tudelft.nl

Graduation company
Graduation company: Jones Lang LaSalle B.V.
Company mentor: Ir. R. A.R. Langbroek MSRE MRICS
Ruben.Langbroek@eu.jll.com
Ir. E. Quispel
Elsbeth.Quispel@eu.jll.com

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Preface

The last phase of the educational program at Delft Technical University (TU Delft), the faculty of Architecture at the department of Real Estate & Housing, is concluded with a master thesis. This report is the result of my master thesis. The master tracks from the faculty of architecture are Architecture, Building Technology, Real Estate & Housing and Urbanism.

The thesis is a research of eleven months assessed by 5 ‘peilingen’ (testing moments), P1 till P5. This report is the assessment for the P5 together with a presentation. This last test moment, shows the final results and conclusions. The presentation is a public presentation at the faculty of Architecture. The report can be found on the repository of the TU Delft library.

I would like to use this moment to thank some of the people who have helped me during the master thesis. I would like to thank both my mentors of the TU Delft, drs. P.W. Koppels and Ir. S.W. Bijleveld and the mentors of Jones Lang LaSalle (JLL): Ir. E. Quispel and Ir. R. Langbroek MSRE MRICS for their professional guidance. I would like to thank all the respondents from the survey and professionals from the in depth interviews for their willingness to perform in my research and openness of sharing their knowledge. The same accounts for Brink Groep and especially the Royal BAM group. Also I would like to thank Paula Vrolijk for her help to improve my English writing. Furthermore I would like to thank the colleagues from the department Strategic Advisory of JLL for their professional help and mental support. Finally, I would like to thank my family, Judith and friends for their support.

Philip Visser
2010

Summary

Research setup

Sustainability is a hot-topic, a lot of awareness is created last few years on the need for sustainability. Copenhagen 15 is an example for this awareness throughout the world. The reason is that since the industrial age, the greenhouse effect increased more than the climate needs. The built environment causes 40% of the greenhouse effect (Bijsterveld, 2008). Therefore a lot can be done in the real estate sector to reduce the greenhouse effect.

But first, a grip is needed on the widely understood concept of sustainability. Elkington's definition of People Planet Profit (PPP) is mostly used: where People, Planet and profit must be in balance to come to an optimal sustainable development (Elkington, 1998).

The Dutch office market faces, a high vacancy rate (13,2%), economic crisis and a current stock without sustainable offices. The high demand for sustainability caused opportunities for the real estate market. Opportunities lie within redevelopment, focusing on sustainability. But the practice shows that stakeholders are struggling with this opportunity. The reason is the stakeholders' unclear preferences, circle of blame 2. This research tries to give more insight into the financial feasibility of sustainable offices to speed up the process of becoming sustainable by investigating each stakeholder.

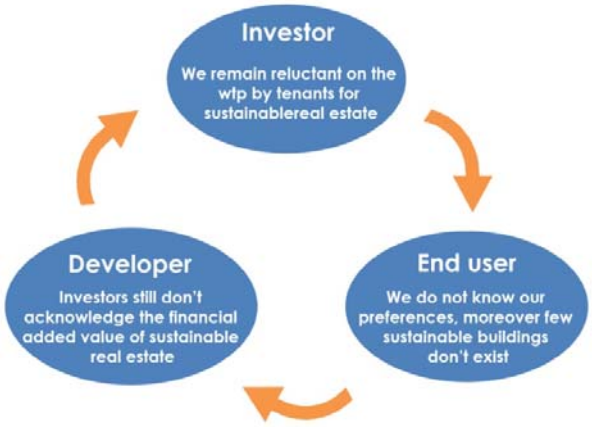


Figure 1 Circle of blame 2

Research question:

To what extent are investments in sustainable offices financially feasible, considering the end user's preferences, throughout the entire life-cycle of a (re)development?

To come to answer, all three stakeholders should be considered. Empirical research is conducted for the end user and developer. For the investor, a literature review is done. A survey was conducted and semi structured interviews were held, to determine the end user's preference and willingness-to-pay (wtp) for sustainability. For the developer, an explorative study was done. The BREEAM Daylighting credit was implemented into the cost calculation model PARAP and a recommendation was made for further implementation.

Theory

All stakeholders desire benefits before they will focus on sustainable real estate. Figure 2 shows the motives. It shows that the advantage of service costs reduction is fully

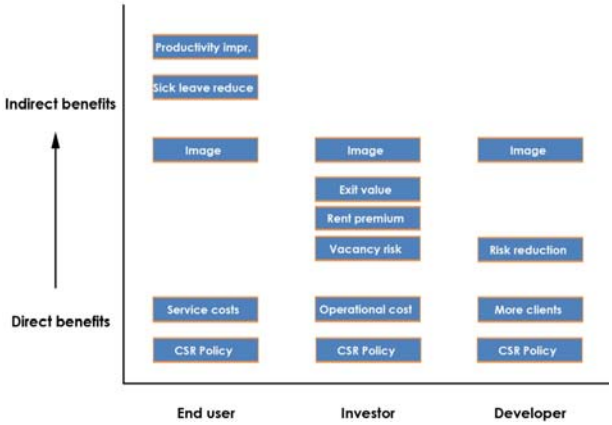


Figure 2 Stakeholders' motives

for the end user. But the investor is the stakeholder who can improve the building's energy-efficiency and therefore makes costs. This incorrect distribution of advantages is called the 'split-incentive' and causes complications in the feasibility. To solve the split-incentive, a new type of contract can be used, green lease. With the use of green lease, investors and end users make agreements on the distribution of the operational costs.

End user

The choice for a survey comes from Breidert et al.'s Measuring wtp. The survey was built up step-by-step, using Sekaran's *'Research methods for business'*. Semi-structured interviews were held to support the survey's results. The survey had 163 respondents, who are representative for the Dutch office market and have a decision making role within the organisation.

Results:

In 2010 the planning of end users to be housed sustainable is longer than it was in 2008. This can be explained by the economic crisis and increased knowledge on the implementation of sustainability. But sustainable accommodation still has become increasingly important. Two years ago, only 38% of the Dutch office users stated sustainable accommodation to be important, in 2010 this is 70%. This is likely to result in an increase in demand for sustainable offices. According to the survey's results, this increase will continue in the coming five years. In 2010 45% of the end users implement their ambitions for sustainable accommodation, 55% of the respondents think they are in 2015. Besides this demand, the end user seems to be willing to pay. If advantages such as improvement of productivity or image improvement are obtained, the end user is willing to pay a rent premium of 6%. But to solve the split-incentive, end users state they are only willing-to-pay 32% of their service costs savings back to the investor in a rent premium. This could result in some difficulties to implement the green lease type of contract.

Table 1 Results on rent premium and green lease willingness-to-pay by end users

	Rent premium	Green lease
Stated preferences		
Visser (2010)	6 %	32 %
Snoei (2008)		76 %
JLL (2008)	5 %	
Corenet global & JLL (2009)	3,2 %	
Revealed preferences		
Eichholtz (2008)	3 %	
Pot (2009)	1,5 - 18 %	
Heineke (2009)	3,7 %	
Case study		
Berkhout (2010)	5 %	

To compare the wtp of end user, on rent premium and green lease, calculations using a fictive building are made. Table 24 shows the results. Input for the comparison comes from literature review, PARAP and results from the survey. End users seem to be over 5 times more willing-to-pay for a rent premium, excluding the service cost advantages. This would mean that end users are, by far more willing-to-pay for advantages such as image improvement and productivity increase of employees, than they would be for energy-savings.

Table 2 Comparison between the end users wtp for rent premium and green lease

Input	Quantity	Source
Full-time equivalent	200	PARAP
Lettable floor area (m2)	5089	PARAP
Average rent/m2/year	€ 150	JLL
Total rent per year	€ 763.350	
Total service costs per year	€ 66.000	PARAP
Average energy savings potential	40%	CBRE

Annual service costs savings	€ 26.400

WTP End users	
Green lease	32%
Rent premium	6%

Additional profit investor		
Service costs	€	8.448
Rent	€	45.801

Developer

For the developer part, an explorative study was done. A start was made to implement BREEAM into PARAP. PARAP makes calculations on both investment costs as well as operating costs on an element level, needing little input from the user of the model. The goal for this part is to explore the possibility on implementation of BREEAM into PARAP.
To do so, the credit Daylighting from the Health & Wellbeing category is implemented. According to the survey, end users prefer Health & Wellbeing together with Energy the most. The choice was made for Health & Wellbeing because this category is building specific, together with the fact that Energy would be too complex. Within Health & Wellbeing, Daylighting is one of the more building specific credits. Furthermore a total inventory on directly building related BREEAM aspects is made to get a feeling on which credits would be relatively easy to implement in PARAP.

To keep the use of PARAP simple, the user only sees two workbooks. PARAP uses hidden workbooks to make calculations. For the BREEAM credit an additional hidden workbook is made. The criteria for the daylighting credit are implemented in this extra workbook. It uses information from PARAP, literature and the BREEAM guide to make calculations and determine whether the credit is achieved. The daylighting credit criteria are:

a) An average daylighting factor higher than the minimum value of 2%.
b) A uniformity ratio of at least 0.4 or a minimum point daylighting factor of at least 0.8% (spaces with glazed roofs, such as atria, must achieve a uniformity ratio of at least 0.7 or a minimum point daylighting factor of at least 1.4%).
c) A view of sky from desk height (0.7 m) is achieved.
d) The room depth criterion $d/w+d/H_w < 2/(1-R_a)$ is satisfied.

To achieve the daylighting credit, requirements *a* and *b* or *a*, *c* and *d* need to be met for all the occupied rooms and/or areas.

With the standard PARAP input, HEA1 Daylighting is not achieved. The LCC of this standard input is compared, to a variant that achieves the credit using minimum requirements. The type of façade and percentage of windows need to be changed in PARAP to achieve the credit. The results show that extra investments of € 100.000,- (0,5% of the total investment costs) are needed to achieve daylighting. And the yearly operating costs will rise: €38.000,- per year higher (2,5% increase). This first attempt to implement BREEAM in a life-cycle cost model is successful. Further implementation is possible.

BREEAM counts 70 credits. An extensive work is needed for further implementation. For each BREEAM category an advice is mentioned in this report. Some general recommendations for implementation are:

- Implementing all credits will be very time-consuming; therefore a planning must be made to determine the time needed and the time available.
- The PARAP group must make a decision on how to handle credits which will be determined by rough assumptions. Rough assumptions are not characteristic for the model.
- Some credits are complex to determine. A credit specific plan of approach must be made for these credits.
- Certifying costs. Substantial extra costs are needed for the certification of the BREEAM label. These must be taken in account into the investment costs.
- Extra expertise. Expertise of sustainability and BREEAM in particular can speed up the process of implementation.

Investor

According to the survey, the investor can expect to obtain a rent premium. But investor remain reluctant on the recognition of the financial added value of sustainable real estate. Investors still consider sustainable real estate as a risk.

Conclusions

Besides the conclusions mentioned in the previous paragraphs, the final chapter mentions three situations to give extra grasp on the financial feasibility: quick-wins, energy-efficient and green labels. The situations are discussed on an owner-occupier and owner-tenant situation.

- Quick-wins are easy to achieve for both owner situations. Quick-wins however, are not so ambitious on a sustainability level.
- Energy-efficient is easy to achieve in an owner-occupier situation. An owner-tenant situation has the split-incentive problem. Green lease can be a solution for this problem.
- Green labels incorporate many aspects. Costs are likely to rise. But according to the survey, the end users are more wtp for other advantages than energy-efficient. This increases the feasibility. Moreover results from the survey show an increase in demand is likely to occur in the coming years. This could help investors to realize green labels.

Apart from these conclusions, recommendations for theory and practice are mentioned in this last chapter.

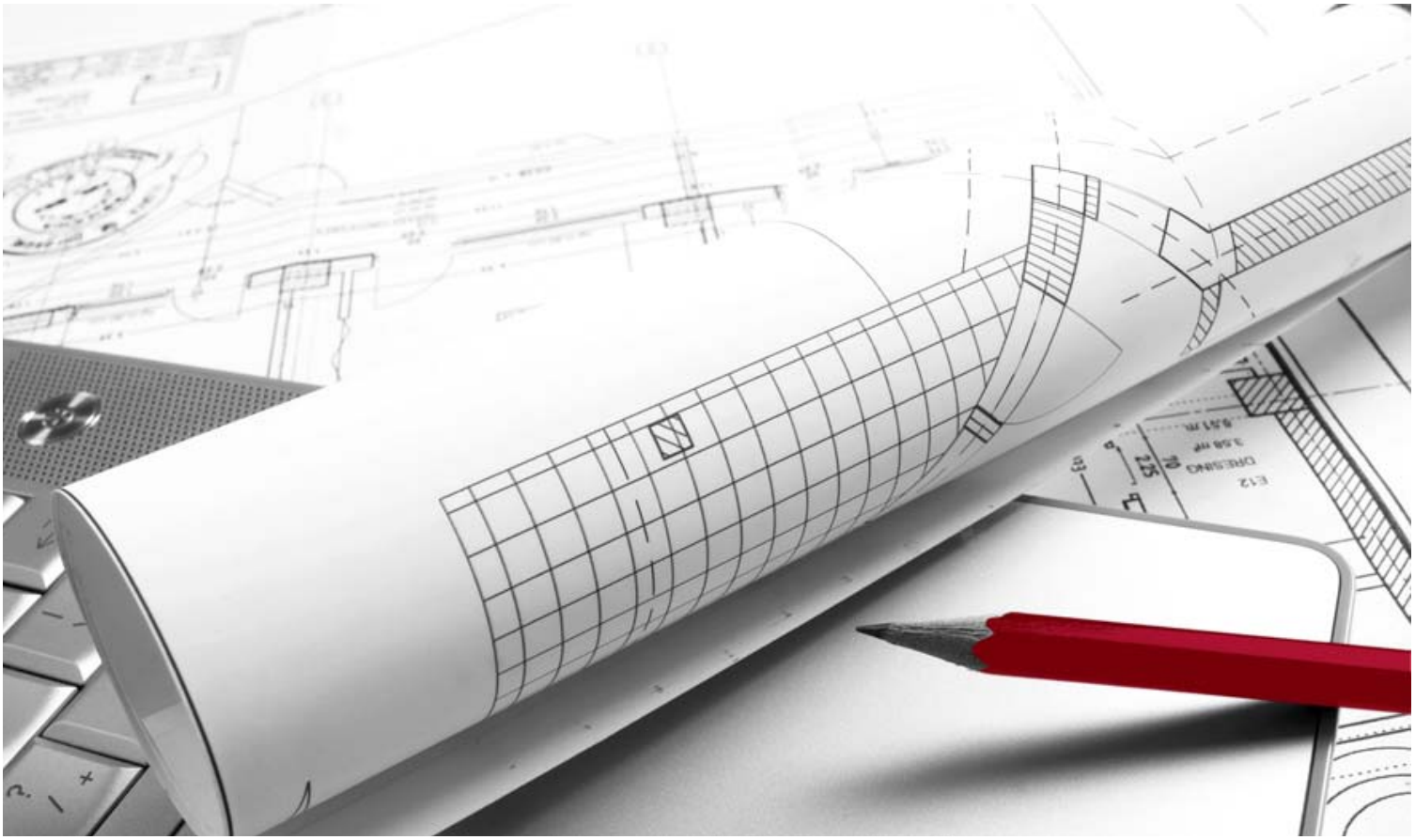
Table of content

List of figures – Tables - Equations

Abbreviations

ASRE	Amsterdam School of Real Estate
BE	Building Economics
BBP	Better Building Performance
BOMA	Building Owners and Managers Organisation
BREEAM	Building Research Establishment Assessment Method
BRE	Building Research Establishment
BRL	Used by BREEAM for Judgement Guidelines
CfPB	Center for People and Buildings
CHP	Combined heat power
CSR	Corporate Social Responsibility
DCF	Discounted Cash Flow Model
DGBC	The Dutch Green Building Council
EPBD	Energy Performance Building Directive
EU	European Union
FQD	Financiële Quickscan Duurzaamheid (financial quickscan sustainability)
FTE	Full-time Equivalent
GIY	Gross Initial Yield
GSHP	Ground source heat pump
HEA	BREEAM's category Health & wellbeing
IVBN	Vereniging Institutionele Beleggers in Vastgoed, Nederland (Dutch institutional investors organisation)
JLL	Jones Lang LaSalle B.V.
LEED	Leadership in Energy and Environmental Design
LCA	Levenscyclus Analyse (life-cycle analysis)
LCC	Life-cycle costs
PPM	Parts Per Million
PPP	People Planet Profit
PPPP	People Planet Profit Project
RE&H	Real Estate & Housing
REM	Real Estate Management
SUREAC	Sustainable Real Estate Accountancy and Certification
TNO	Technisch Natuurwetenschappelijk onderzoek (technical scientifical research)
TU Delft	Delft, Technical University
USGBC	United States Green Building Council
WKO	Warmte-koude opslag (see GSHP)
WKK	Warmte-kracht koppeling (see CHP)
WTP	Willingness-to-pay

Research setup



1 Research setup

This first chapter of the master thesis discusses the set up of the research that was conducted. Neither results nor conclusions can be read in this chapter. The first section addresses the motive of the subject. Aspects discussed here are the social relevance of the subject, definition of sustainability and interaction between sustainability and real estate. The second section discusses the origin of the problem that is addressed in this research and concludes with the problem statement. The third discuss which stakeholders are involved in the financial feasibility. The fourth section discusses objective and intended end product. To support the end product, the conceptual model is shown here. The fifth section states the research questions. The sixth section shows the research design with a textual explanation. The seventh section discusses the chosen demarcation. The eighth section is a reader's guide. The ninth section scientific relevance mentions the relation to the research department of the TU Delft and states the graduation organisation. The tenth section mentions some brief information on the firm this research was conducted.

1.1 Motive

This section discusses the reason the topic is addressed from a societal perspective. Furthermore it discusses why sustainability is important for real estate. Aspects addressed are: social relevance, definition sustainability and sustainability and real estate.

1.1.1 Social relevance

According to the United Nations, the greenhouse effect is a natural effect in which the heat of the earth is used to keep the earth warm enough to live. If this phenomenon would not exist, the natural temperature would be 2 degrees Celsius lower and it would be less comfortable to live.
CO_2 emission is the second most important gas which causes this effect. Before the industrialisation, the atmosphere faced a CO_2 emission of about 280 ppm (parts per million). At the moment this is about 385 ppm. This increase of the greenhouse effect will eventually result in a climate change with huge consequences for the living area (United Nations, 2009).

From 7-18 December the United Nations Climate conference 2009 in Copenhagen was held to come to agreements, with 192 countries, to reduce the greenhouse gas emissions. The results of this meeting were intended to be the follow up of the Kyoto protocol from 1997 (Bezemer, 2009). The results were limited.
Even though results were limited, sustainability is an issue for countries all over the world and struggle with the implementation of sustainability in the correct order to reduce the greenhouse effect.

Not only governments are aware of the importance of sustainability, so are its citizens. One of the contributors for this is Al Gore. Gore made the film '*An inconvenient truth'* in 2006 about the greenhouse effect. His goal was to increase the awareness of people for the consequences on the climate of our consumption. Another example to create public awareness is a famous Dutch slogan from the nineties: *"Een beter milieu begint bij jezelf."* (Van Kempen). It states that 'a better environment starts with yourself.'

Companies translated this demand for sustainability into a Corporate Social Responsibility (CSR) policy (in Dutch this is called Maatschappelijk Verantwoord Ondernemen (MVO)). This CSR policy sets out guidelines to contribute to a more sustainable world and decrease of the greenhouse effect. So companies recognise the demand of citizens and governments for a more sustainable world. According to Dirks, commercial director OVG, it can be put even

stronger: "*The society thinks you aren't a good company if you do nothing about sustainability.*" (Dirks, 2009).

The above shows that all layers of society acknowledge the need for reducing the greenhouse effect.

1.1.2 Definition sustainability

People struggle with the definition of sustainability. This section explains the three most used definitions in chronological order. These are: Brundlandt, PPP, PPPP

Brundlandt:

In 1987 the first official report on sustainable development was made: the Brundlandt report. It states sustainable development is: '*social and economic advance to assure human beings a healthy and productive life, but one that does not compromise the ability of future generations to meet their own needs.'*(World Commission on Environment and Development, 1987). This definition is still widely accepted and often used in corporates' CSR policies.

People Planet Profit (PPP):

The definition of sustainability most used these days, is the 3-P approach of Elkington. In 1998 Elkington has come up with the 3-P approach, People Planet Profit (PPP), where People Planet & Profit must be in balance to achieve optimal sustainability. The people aspect considers the well-being, health, freedom of choice, social cohesion and security. The planet aspect considers the world, energy, water, material, mobility and pureness. The profit aspect considers prosperity, profit and affordability (Elkington, 1998). The figure below shows the scheme of PPP. It also illustrates the consequences of achieving only two out of the three P.

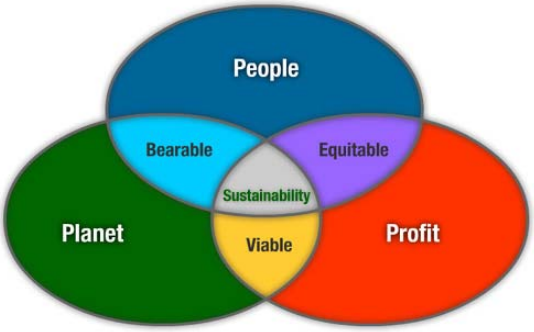
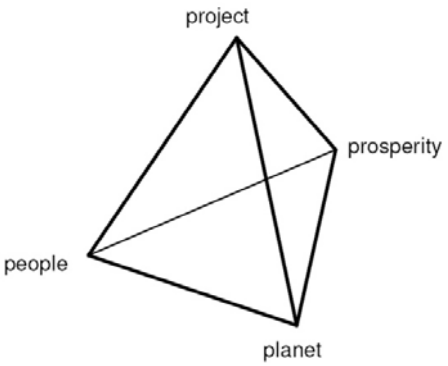


Figure 3 People Planet Profit
source: http://www.cwcdvan.com/triple_bottom_line.html

People Planet Prosperity Project (PPPP, 4-P approach):

In 2009 Prof. ir. C.A.J. Duijvestein of the TU Delft introduced a fourth P to this model to give the built environment extra grip. The fourth 'P' stands for project which means the spatial quality. Duijvestein's model is called: the 'milieu-tetraëder' (environmental tetraëder) and is often called the 4-P approach or PPPP(Duijvestein, 2009).



Figuur 1 DuijvesteinTetraëder
source: http://www.boomdelft.nl/index.php?id=14

1.1.3 Sustainability and real estate

Buildings and construction works have the largest single share in global resource use and pollution emission. To give an impression: in OECD countries (Organisation for Economic corporation and Development) the built environment is responsible for around 25-40% of total energy use, 30% of raw material use, 30-40% of global greenhouse gas emissions and for 30 to 40% of solid waste generation (Lorenz, et al., 2008)). According to Bijsterveld, the built environment even causes 40% of the total CO_2 emission of the world (Bijsterveld, 2008). Therefore reducing the CO_2 emission in the built environment can have a huge impact on the greenhouse effect.

The Dutch government and the European commission, set out law and regulation to reduce the CO_2 emission of the built environment. Since 1996, the Dutch government uses an energy performance coefficient standard (energieprestatie coefficient norm (EPC-norm), to which new buildings must comply. This is an index to determine the energy efficiency of a building. Throughout the years, higher demands are set for this standard. The norm can be seen in the figure below. It can be seen as a predecessor for the energy label which is regulated by the European Union (EU) since 2008.

JAAR	EPC NORM KANTOORFUNCTIE
2009	1,1
2008	1,5
2007	1,5
2006	1,5
2005	1,5
2004	1,5
2003	1,5
2002	1,6
2001	1,6
2000	1,6
1999	1,9
1998	1,9
1997	1,9
1996	1,9

Figure 4 EPC-norm throughout the years source: http://www2.nen.nl/cmsprod/groups/public/documents/bestand/201135.pdf

In January 2008, the Energy Label was introduced for buildings by the Energy Performance Building Directive (EPBD). From that point on, all EU member states are obliged to use this label. (European Parliament and Council, 2002). In the Netherlands, the Energy Label for buildings is mandatory during a building's transaction. Even though the energy label is obliged, it is remarkable that no penalties are given when the energy label is not used during this transaction period (Vastgoedmarkt, 2009).

Another action done by the Dutch government, is its housing policy. Since January 2010, the government only rents space in office buildings with an energy label C or higher (RGD, 2009). This works as a stimulant for market parties involved in real estate since the government is the organisation who uses the most m_2 of office space. The RGD manages around 8% of the total office stock and therefore is a major player on the office market(Louter & van Eikeren, 2007).

Despite these regulations and stimulant, little sustainable real estate has been developed so far. According to Cadman in 2007, the reason is the circle of blame. After three years this circle of blame still relates to the current situation of the built environment. The circle of blame is a scheme, showing the point of view from the occupiers, constructors, developers and investors where they all blame each other for not focusing on sustainable real estate. The circle of blame is reasoning in a circle. If the circle of blame remains, sustainable real estate will never be realised. This circle of blame is shown in the figure below.

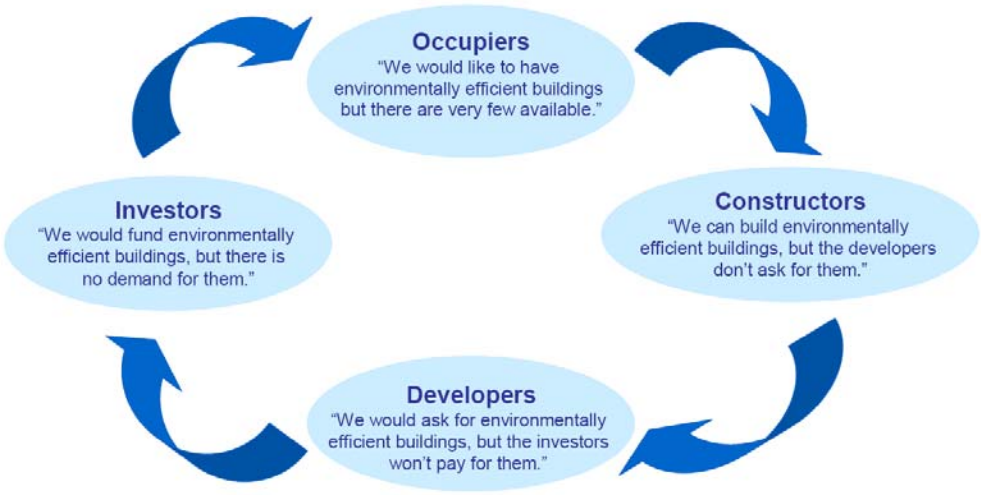


Figure 5 Circle of blame(Cadman, 2007)

But what is sustainable real estate? Several institutes developed green certificates to rate the level of greenness of the building. These certificates can be helpful for the definition of sustainable real estate. The certificates used the most in The Netherlands are: LEED, BREEAM-NL, Greencalc+, GPR-gebouw and Energy label. Energy label, as the name reveals, is about the energy performance of a building. The other certificates are based on different sustainable aspects such as health and wellbeing, transport. BREEAM-NL is translated by the Dutch Green Building Council (DGBC) from the English version developed by the Building Research Establishment (BRE). BREEAM-NL is likely to become the leading green certificate for buildings in the Netherlands due to its international character and the many different aspects it involves. Section *2.1* will go more into detail about green certificates.

1.2 Problem

This section discusses the problem incorporating sustainable offices. Firstly the financial crisis and free market in real estate are discussed. Secondly is discussed that sustainability caused a different type of demand. Thirdly how this evolved into the circle of blame. In the end the circle of blame's current situation is mentioned and therefore the problem statement.

1.2.1 Changing real estate market

The real estate market faces a review to address current and future problems. Two reasons can be appointed for this. The first is the financial crisis which affects all stakeholders. The second is an oversupply which resulted in a high vacancy rate throughout the Netherlands which mostly affects the investors and the aesthetics of the location facing a high vacancy rate.

The financial crisis affected many countries, sectors and people. It was triggered by an overvaluation of assets in the U.S.A. in 2007, with housing in particular (Ivry, 2008). This resulted in the collapse of financial institutions, a large downfall of the stock market and the car industry (Bailey & Elliot, 2009). The Netherlands, like many countries, were affected as well, banks needed state support and stock markets dropped drastically. Investors of diverse markets draw back their investment or put them on hold and banks became extremely precautious on loans. This resulted in the fact that assets need revaluation which can cause a depreciation of the concerning assets. This revaluation, precautious loans and depreciation reflected on the real estate market: properties, projects under construction were put on hold and new projects became extremely difficult to finance. This caused a search, for a different approach on real estate to get the market up and running again.

One could say, the economic crisis had a bad timing for the Dutch real estate market. The Dutch real estate market faces a high vacancy rate for several years now. For office buildings this is 13,2% in 2010 (Fokkema, Schepman, Hofmann, van der Veen, Shishegar, & Blokland, 2010). This problem is increasingly difficult to solve during a period of crisis. But the Dutch organisation for institutional investors (IVBN) is medium positive and states the focus needs to be on redevelopment instead of newly built to solve the problem (IVBN, 2009).

Figure 6 vacancy rate Dutch office market
Source: Fokkema et al. 2010

Stroink states that before the crisis, a developer would develop a building without a search for a future tenant. Why? Because the municipality liked to sell its land and the investor would buy the building anyway, so there were 'no risks' involved for the developer. This caused an oversupply and therefore the vacancy. This changed the position of the tenant (Stroink, 2010). The tenant has become a lot more important than before. Now, first a tenant needs to be founded, before starting a development. Furthermore the building needs to be flexible to comply with the future wishes of another tenant if the tenant moves out again.

1.2.2 New demand

The urgency for sustainability created demand for sustainable real estate. Different stakeholders involved in real estate are focusing on sustainable real estate.

- Investors want their portfolio to be sustainable.
- According to developers and constructors business opportunities lie within sustainable real estate, even more since the economic crisis.
- End users want their organisations to recite in sustainable offices.

1.2.3 Origin circle of blame

According to the preceding sections, there is a demand for a new type of real estate, sustainable real estate. But 'new' is often 'scarey'. Stakeholders ask questions such as: do the tenants really want this? What does it cost me? Will I gain extra benefits? This causes uncertainties for commercial parties and resulted in reluctance for sustainable real estate.

This problem is visualised in Cadman's circle of blame (2007) where all stakeholders blame one another for this reluctance in sustainable real estate.

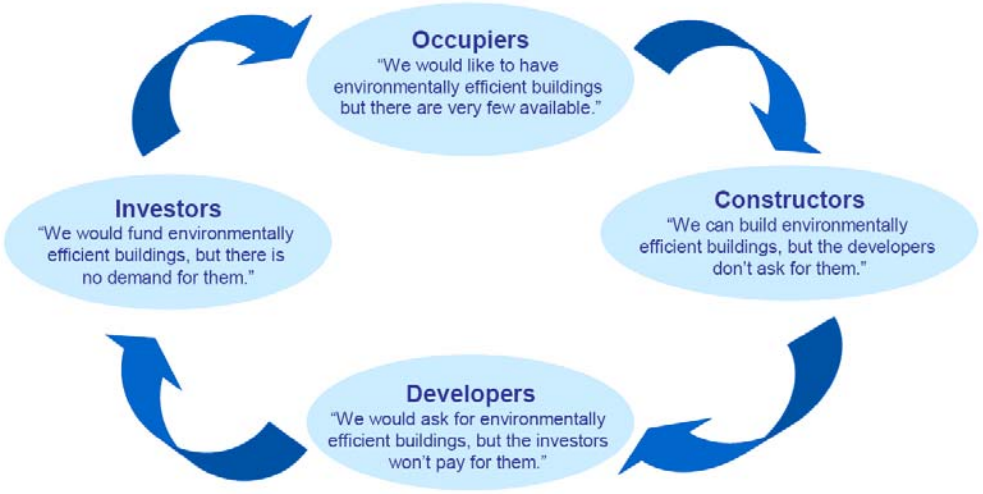


Figure 7 Circle of Blame
Source: Cadman 2007

1.2.4 Partially broken circle of blame

The circle of blame clarifies that the development pace of sustainable real estate must speed up. However the circle of blame as presented in 2007 is not entirely up to date and partially broken. Several literature is written on the advantages of sustainability for the stakeholders involved, and some real estate companies mainly focus on sustainability. According to Langbroek of JLL a shift is going on towards investing more and more in sustainability. However the focus on sustainability is still more an exception than it is standard (Langbroek R. , Onderzoeksdesign bespreking, 2009).

Some companies focusing on sustainability are:

- OVG is a project developer focusing on sustainability. It has its own sustainability team and several initiatives for sustainability including www.duurzaamgebouwd.nl Duurzaamgebouwd.nl is a platform for sustainability (OVG, 2008).
- TNT aims to enhance their activities for a better environment (TNT Post, 2008). Even though TNT is a post ordering company which causes a large amount of CO2 emissions, it wants to have a green image. TNT made a strategic CO2 reduction program to achieve this goal, it is called PlanetMe (TNT, 2008).
- Triodos Bank. The financial times awarded Triodos the title of sustainable bank of the year (Larsen, 2009).

These companies believe in the advantages of sustainability. A summary of advantages for sustainability is stated here below for the stakeholders involved in the circle of blame:

Occupiers

For occupiers, sustainable real estate is focused on wellbeing of building's users. Aspects that can be thought of are daylight, free view, air quality control. This enhances the health and wellbeing of the end users of the building. The benefits are higher productivity and lower sick leaves of employees. This can increases the total turnover of the company. On return, the end user should be willing to pay a higher rent for this higher quality of real estate.

Another advantage end users encounter within sustainable offices is lower service costs. These lower services costs should be partially paid back in a higher rent because the investor incurs costs for making the building more energy-efficient. This pay-back of service costs can be arranged in a green lease type of contract. At a later stage in this report this will be further explained.

Constructors

When a constructor is specialised in building sustainable, he would get more work and therefore increase the turnover of the company.

Developers

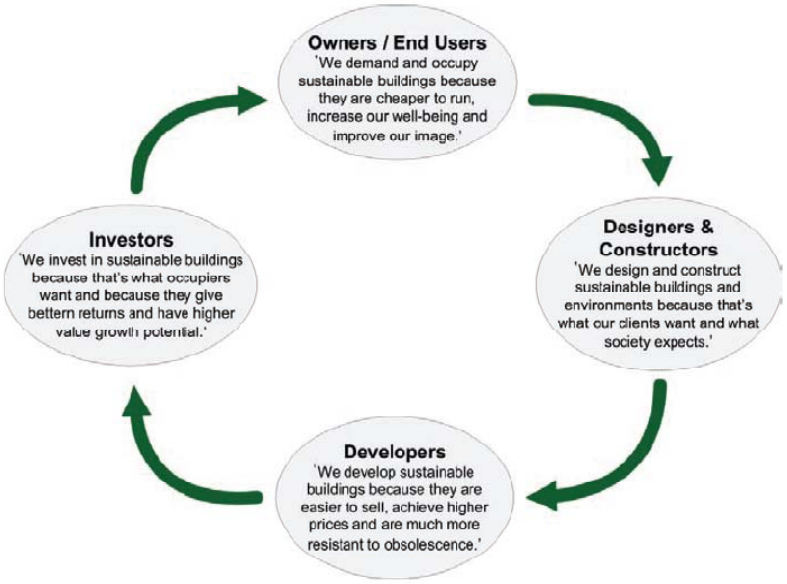
Sustainable projects are assumed to have lower risks due to the demand and therefore the buildings' let ability will increase. Another advantage is green-financing. Green-financing is a type of financing used for sustainable projects. The interest rate asked is 1,5% lower than regular loans.

Investors

When sustainable real estate will be considered as buildings with a better quality, the rent, exit value, let ability will rise and the risk and vacancy will decrease. When these advantages are acknowledged by the investors, their return will increase and the focus of their portfolio will be on sustainability.

Another important aspect for investors is the green lease type of contract. The investor can incur costs to make the building more energy-efficient. Through this the tenant will receive lower service costs. The tenants should pay this back in a higher rent through a green lease contract. At a later stage in this report this will be further explained.

If these advantages are put into the circle of blame, a figure such as the one below made by the RICS arises. They named the scheme: breaking the circle of blame. It shows how the negative aspects should be turned around into positive aspects by the stakeholders involved.



Figuur 2 Breaking the vicious circle of blame
source: RICS (2008)

1.2.5 Problem statement

The urge for sustainability is clear. The advantages for every stakeholder are known as well, but the pace for developing sustainable real estate is too slow. This section illustrates this problem using a scheme together with a textual explanation. There will be started with the problem statement, which is the following:

There is a clear willingness to pay for sustainability by all stakeholders, but the preferences of the stakeholders involved are unclear, which slows the pace of the process to realise sustainable offices.

This problem statement is based on the preceding sections as well as the figure below. The elucidation of this figure is as follows:

The current stock faces three issues. First the economic crisis makes it difficult to realise a (re)development. It is increasingly difficult to finance such a development and the risks for the stakeholders involved increased. The second issue is the high vacancy rate. The Dutch office market faces a high vacancy rate. The real estate market searches for solution to resolve this problem rather than adding new developments to the office stock. The third is that the current office stock supplies few buildings that are sustainable. But the demand for sustainable real estate is great. This lack of supply and high demand for sustainable real estate results in functional obsolescence of the current Dutch office market.
So to solve this problem of functional obsolescence, the current office stock should become sustainable. This is an opportunity to serve the demand, diminish the vacancy rate and get the real estate market going again.
But this approach of creating sustainable real estate was not going at the right pace, too slow. This slow pace is explained by the circle of blame where all stakeholders involved blame each other for not focusing on sustainable real estate. The last few years the circle of blame is partially broken, since some organisations do focus on sustainable real estate. Unfortunately this is still more an exception than it is standard.
Focusing on sustainable real estate is still more an exception than it is standard. That is because the stakeholders involved are uncertain of their preferences regarding sustainable real estate, as well as the preferences of other stakeholders. Stakeholders are uncertain of their benefits and ambitions. I would like to name this the circle of blame 2. This circle of blame 2 is shown in section 1.4.1.

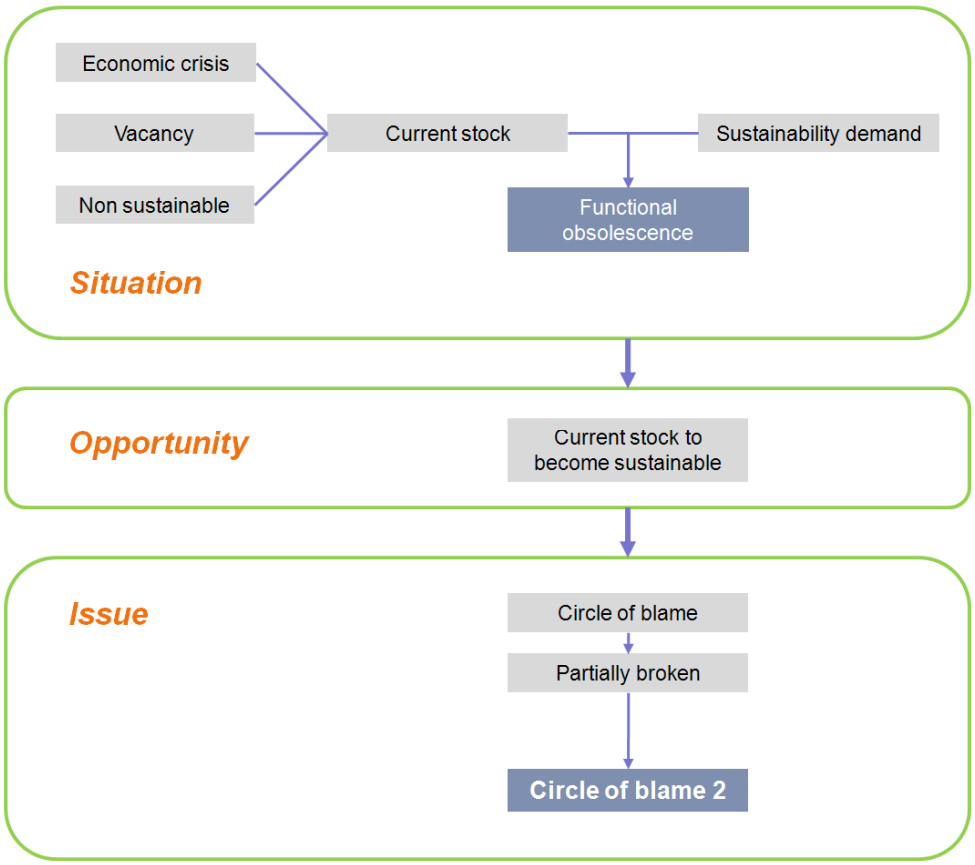


Figure 8 Problem

1.3 Stakeholders

The previous section described the problem statement of uncertain preference of all stakeholders. This section clarifies which stakeholders these are and how these are interrelated, from a financial feasibility point of view.

Cadman's circle of blame mentions four stakeholders involved: occupiers, constructors, developers and investors. In this research, the constructors and developers are combined to developer. The developer represents the organisations responsible for the realisation of the development. The stakeholders considered in this research are:

- End users (occupiers)
- Investors
- Developers (constructors and developers)

The financing stakeholder, often a bank, is excluded from this list since a financer only sets out a loan for the initial investment. For the rest he does not influence the development process.

Figure 9 shows the schematic cash flows of a building through its life-cycle. The horizontal line represents the time-line. The vertical arrows going up represent the income and the ones going down represent the costs.

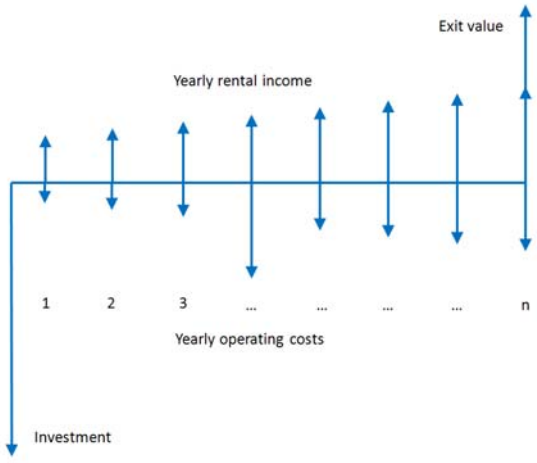


Figure 9 Cashflow scheme

The goal of a development from an investor's point of view is to receive a certain percentage return on its investment. These investments consist of the initial investment to purchase the development or building and operating costs during the life time of the building. The initial costs are made by the developer for (re)development of the building. The operating costs are determined by the design and construction of the (re)development and therefore also influenced by the developer.
The income is obtained from yearly rental income and the exit value. The rent is paid by the end user. Therefore the income of an investor is dependent on the end user. The exit value is the selling price after *x* years.

In short: The user pays the rent, the developer determines the costs and the investor is the owner who receives a return on the costs and income involved.

1.4 Objective and end product

This section discusses the objective and end product. The objective will be further explained. The end product is a brief section which states the end products.

1.4.1 Objective

The objective of this master thesis is:

To gain insight into the financial feasibility of sustainable offices, to increase the pace of realising sustainable offices, by considering the stakeholders preferences involved.

The figure below shows the current problem, circle of blame 2, on the left, and the situation when this problem is solved on the right. To come to the step from problem to solution, extra information and evidence is needed. This research searches for empirical evidence regarding the end user and developer. The investor part is mentioned throughout this master thesis, but no empirical research is conducted regarding the investor.

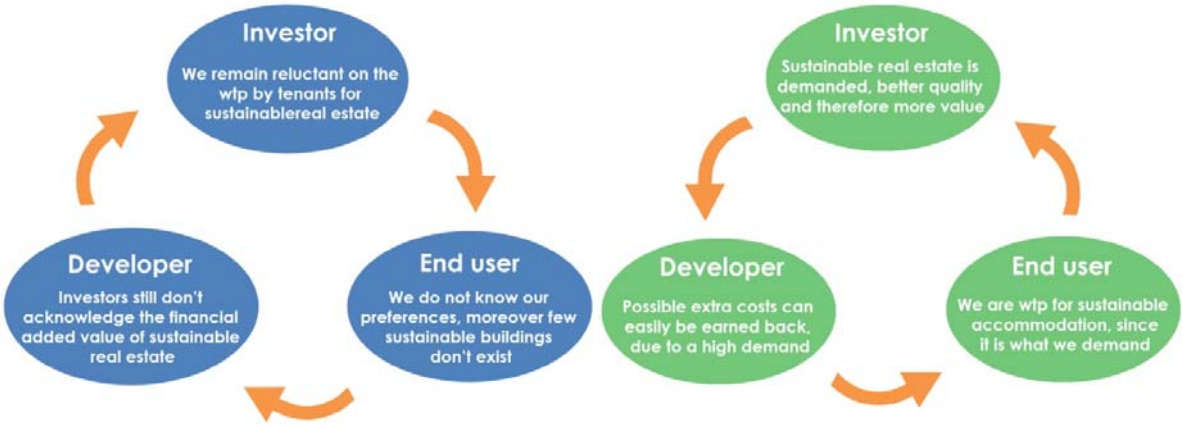


Figure 10 Circle of blame 2 vs. solution

1.4.2 End product

The scope of this master thesis consists of two research topics, this resulted in two end products as well:

1. End users - Textual and graphical results(from a survey)
2. Life-cycle cost - Calculation model and advise (from cost modelling)

The concluding end product is a recommendation to what extent sustainability is feasible for different scenarios in the Dutch office market.

1.5 Research questions

Out of the preceding problem statement, objective and end product the following research question is formulated:

To what extent are investments in sustainable offices financially feasible, considering the end user's preferences, throughout the entire life-cycle of a (re)development?

The following sub-questions are addressed:

- *Which sustainability aspects are to be considered for sustainable offices?*
- *What are the stakeholder's motives to focus on sustainability?*

1. End user

- *What are the end user's preferences?*
  - Which sustainability aspects? Label?
  - Planning?
  - Governmental attitude?
  - Importance of sustainability in choice of accomodation
- *What is the end user's willingness-to-pay?*

2. Developer

- *How to determine the life-cycle costs of the end user's preferences?*
- *How to approach the life-cycle costs of sustainability with a cost calculation model?*
- *What are the life-cycle costs of the credit daylighting?*
- *What are further implementation possibilities of BREEAM into PARAP?*

3. Investor

- *What is the added value for the investor?*

- *In what way can stakeholders act together to enhance the financial feasibility?*

1.6 Research design

As stated before it is relevant to investigate the end user's preferences, the life-cycle costs and valuation of sustainable offices, to increase the insight into the financial feasibility of sustainable offices. The chosen path for tackling these issues is addressed in this section. This section shows the research design in Figure 11, together with a textual explanation. In chapters 3 and 4, the methodology for the end user and LCC research is discussed more into detail. This section starts with a general explanation describing the process as a whole.

The research design shows three focal points:

1. User preferences (end user)
2. Life-cycle costs (developer)

(Hereafter these will be named respectively research 1,2 or 3).

1.6.1 Process

In this research the focus was on research 1 and 2. First research was done about the end user. As explained in chapter 1.2.1, these days the end user is much more important in a development, then he used to be. Therefore it is interesting to begin with investigating the preferences of the end user.
Research two tries to determine the LCC of the end user's preferences regarding sustainable real estate. Research 2 was done using a cost modelling software program. It is an explorative study which results in information on LCC and an advice for further implementation of sustainability into the model.
Both researches were done on a scientific manner. This extensive approach was chosen to be able to go into depth on the concerning subject. The consequence of this choice was that it was impossible to conduct research for the investor part. Literature study was done and recommendations are made regarding the investor.

1.6.2 Research design

The research design is shown below in Figure 11. First, elucidation is made regarding the research design.

1. End user

A questionnaire was conducted and semi-structured interviews were held to investigate the wtp of the end users of office buildings. The 163 respondents came from the database of JLL. Questions asked were diverse and varied from definition of sustainability, to wtp in rent for sustainable accommodation, to preference of green certificate. The outcome was analysed using descriptive statistics as well as none-descriptive statistics. In SPSS 16.0 the two tailed *t*-test and Kendall's W test were performed. These tests were done respectively to find significant differences and a consensus between different type of respondents.
Three of the respondents were interviewed, to decrease the bias of the research as well as to start a discussion on the findings of the questionnaire. The output from this part is used for the final conclusion as well as for the second part 2. LCC.

2. Developer

To determine the life-cycle costs of BREEAM, an explorative study was conducted. To do so, a cost calculation model was used, PARAP. The model was developed by the TU Delft as well as commercial organisations. The model determines the LCC of a newly built office building in great detail with a small amount input. Due to the detailed level of PARAP, it was impossible to implement more than one credit. The BREEAM aspects found most important

by office users were first considered to implement in PARAP. The implemented credit was day lighting from the category health and wellbeing. Health and wellbeing was the second most desired category. Energy was preferred the most and therefore would be logical to implement in PARAP. But energy is more complex and therefore would be too time-consuming to implement.
The output of this research is an advice for the PARAP group to further implement BREEAM.
Research on LCC of sustainability in this manner is done for the first time and is desired by the market. Therefore the conclusions made are very interesting. Unfortunately extra research is needed to be able to make conclusions on the total BREEAM package.

3. Investor

To determine the correct valuation of sustainable real estate, further research is needed. During this master thesis the possibilities for research on sustainable valuation were investigated. A literature study was done and recommendations are made for a follow up research on the investor part.

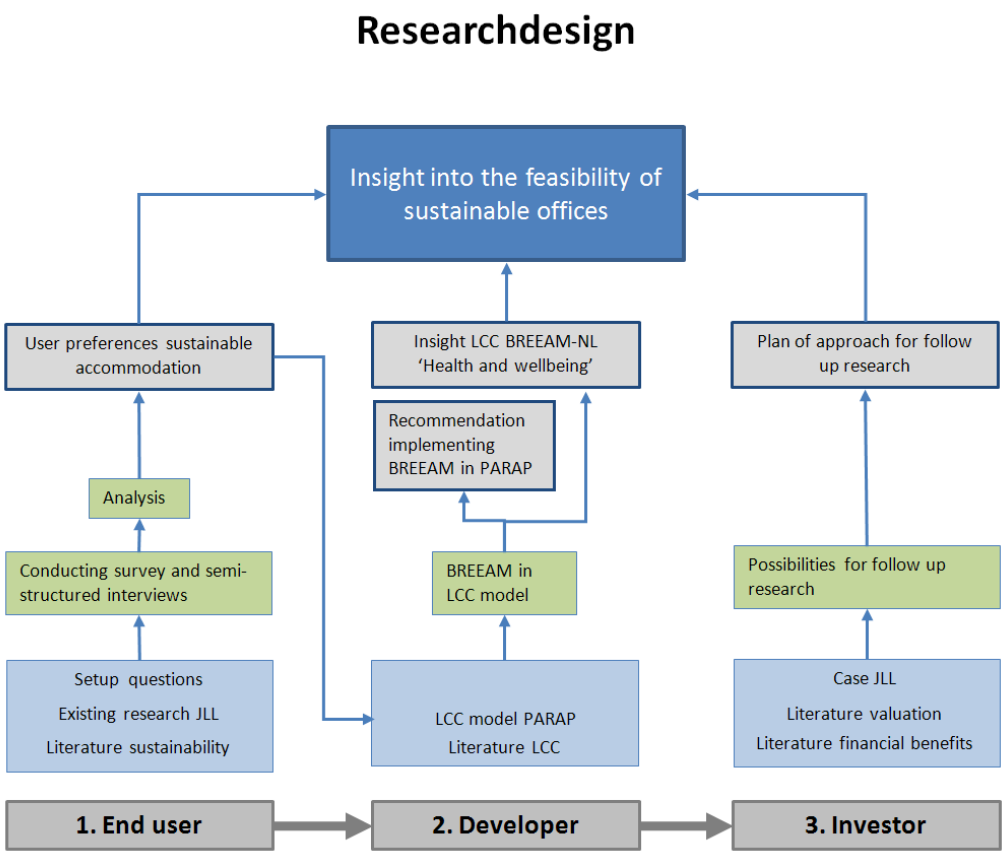


Figure 11 Research design

1.7 Demarcation

It is impossible to investigate all aspects regarding the financial feasibility of sustainable offices. The previous chapter already states some demarcation of this research regarding the research design. This section states other demarcations involved in this research.

- The office market is investigated.
- BREEAM serves as the definition for sustainability.
- For life-cycle costs of BREEAM, the credit Daylighting was investigated.
- For the end users is chosen to use stated preference as a methodology.
- Investor part is not in this research scope.

1.8 Readers guide

This section can be used as a guide to read the report. Per chapter a brief description is mentioned what the chapter is about.

1. Research setup

This chapter can be seen as the introduction. A broad range of topics are discussed such as: motive, problem, research question, objective and end product, research design, demarcation, reader's guide, scientific relevance and Jones Lang LaSalle.

2. Theoretical framework

The theoretical framework describes the literature regarding the subject of this master thesis. Subjects that come into play are:

- Sustainability
- End user
- Life-cycle cost
- Contracting

3. End users

Chapter 3 and 4 are chapters about the conducted research. Both chapters starts with the methodology used, secondly the results are addressed and finally each chapter states a summary with conclusions. The end user research investigates the user's preferences and willingness-to-pay of office users by conducting a survey and holding in-depth semi-structured interviews.

4. Developer

Research two 2.life-cycle costs investigates the life-cycle costs of sustainable offices using PARAP, a cost calculation model. It is an explorative study with some conclusions on the LCC and an advice will be given to the PARAP group for further implementation of BREEAM.

5. Conclusions and recommendations

The final chapter will discuss the conclusions from the findings and mentions recommendations for further research as well as for the practice.

1.9 TU Delft

Firstly, this section briefly states the scientific relevance of the master thesis within existing research of the TU Delft. Secondly this section mentions the graduation organisation for this master thesis.

1.9.1 Scientific relevance

This research fits to the existing research from the research program of the department of Real Estate Management (REM) and Building economics (BE) from the master track Real Estate & Housing, within the faculty of Architecture. Within this department several researches is done including:

- Koppels's PhD on Form, Finance, Function and Future. Koppels will complete his Phd at the end of 2010, beginning of 2011.
- Koppels' research on the added value of image (Koppels, 2009).
- Snoei's research about tenant preferences for sustainability in their choice of office accomodation (Snoei, 2008).
- Van den Tol's valuation method for sustainable offices (Tol, 2010).
- Koppelman's research on the financial and qualitative consequences of energy efficient measures for office buildings (Koppelman, 2010).
- Grootswagers' making existing offices sustainable (Grootswagers, 2010).

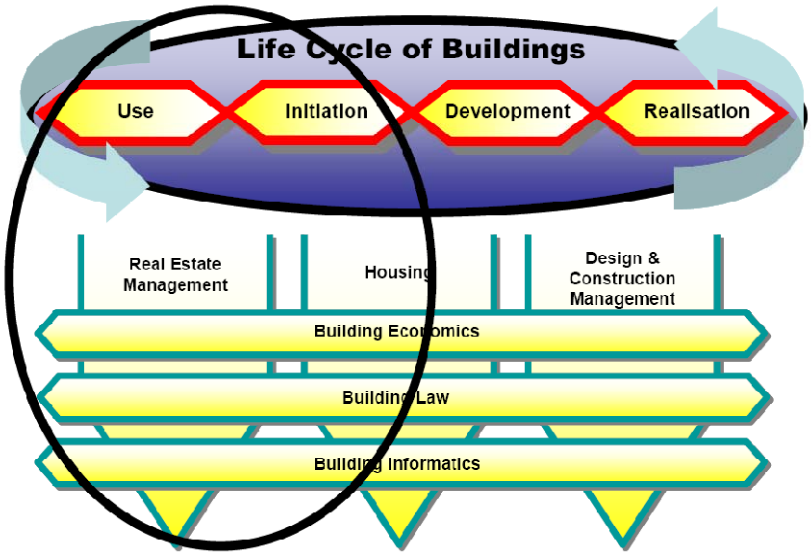


Figure 12 Position of REM and BE in relation to the other research departments of RE&H source: (van der Toorn Vrijthoff, van der Voordt, & Kooijman, 2009)

1.9.2 Graduation organisation

Primary mentor

The primary mentor for this master thesis is Drs. P.W. (Philip) Koppels. Philip is a PhD candidate at the Department of CREM and BE. His PhD is about "Form, Function, Finance and Future", which focuses on the relationship between user-value and financial-economic value of office buildings.

Secondary mentor

The secondary mentor for this master thesis is Ir. S.W. (Sjoerd) Bijleveld. Sjoerd works at the department of Design & Construction Management and is specialised in Building Economics – Cost and Quality. Sjoerd's works include cost calculation models PARAP, INKOS and AREADNE.

External Examiner

The external examiner for this master thesis is Ir. G.J. (Gerrie) Hobbelman. Gerrie is an independent examiner and therefore works at a different master track within the faculty. Gerrie works at the department of Building Technology and is specialised in Structural Mechanics.

Mentors from Jones Lang LaSalle:

Primary mentor

Ir. E. (ELsbeth) Quispel. Elsbeth is associate director, head of sustainability services NL. Since three years, Elsbeth works at JLL. Before she worked as a project manager at Tebodin B.V.

Secondary mentor

Ir. R. (Ruben) Langbroek MSRE MRICS. Ruben is associate director, head of research NL. Since two years, Ruben works at JLL. Before he worked at KFN at the department research and strategy.

1.10 Jones Lang LaSalle

The internship for the master thesis is held at Jones Lang LaSalle. JLL is a financial and professional services firm specializing in real estate services. JLL has around 30,000 employees and has offices in 60 countries. JLL has 18 different types of real estate services. The department where I recited during the internship is strategic advisory. This department is responsible for JLL's research and consultancy in the Netherlands. Typical research of JLL is:

- Randstad Office Market Outlook
- Office market quarterly update
- Office Service Charge Analysis Report
- Investors research (private and institutional)

Strategic Advisory has a broad range on consultancy. It serves municipalities, housing corporations, corporates, investors, developers on offices, retail, warehousing, public real estate and area development.

JLL focuses strongly on sustainability. Throughout the years, JLL developed several models and tools with cooperation of international colleagues to help organisations on their CSR policies. These models are:

The Third Dimension
Risk management tool for investors. It relates sustainable risk with financial performance on asset, sector and portfolio level.

Sustainability benchmarking
Measuring and comparing sustainability levels on assest and portfolio level.

Pass
Acquisition tool investors and owner/occupiers.

CSR standards
Defining CSR goals and helping to implement

Sustainable program of requirements
Implementing specific sustainable requirements into a program of requirements.

Energy management
Determining the current and future performance of a building. Implementing measurements and determining the added value impact.

Valuation sustainability
Determining the potential added value impact on asset level of sustainable measures.

In 2008 JLL did research on office users about their preferences regarding sustainable accommodation (Houtman, Quispel, & Martinus, 2008). JLL is interested in an update on this research. To do so, my end user's research would be suitable. A substantial part of JLL's research and consultancy is from the investor's point of view. Therefore more knowledge regarding costs and benefits of sustainability of this master thesis is desirable by JLL as well.

1.11 Summary

Sustainability is becoming more and more important throughout the world. Copenhagen 15 is an example where numerous countries come together to discuss the reduction of the greenhouse effect. 40% of this greenhouse effect is caused by the built environment (Bijsterveld, 2008). Therefore a lot can be done in the building sector to reduce the greenhouse effect.

To make the world more sustainable, firstly must be understood what sustainability is. Sustainability is a widely understood concept. Elkington's definition People Planet Profit is used the most: People, Planet and Profit must be in balance to come to a successful sustainable development (Elkington, 1998).

Too little sustainable real estate is arising. To change this, Dutch government and European commission set out some law and regulations to enhance the production of sustainable real estate. These are a Dutch governmental housing policy, EPC norm and Energy label.

Although several organisations focus on sustainable real estate, it still is not developing at the right pace. The problem for this is: *There is a clear willingness to pay for sustainability by all stakeholders, but the preferences of the stakeholders involved are unclear, which slows the pace of the process to realise sustainable offices.* This results in the following research question:

To what extent are investments in sustainable offices financially feasible, considering the end user's preferences, throughout the entire life-cycle of a (re)development?

To solve this problem research must be done on:

1. The end user its willingness-to-pay
2. Life-cycle Costs of a sustainable development
3. Valuation of sustainable office buildings

To determine the costs and benefits of the users' preferences, this research starts with the preferences of the end user. This was done using a survey. The second research, about the life-cycle costs, was done on the category of health and wellbeing from BREEAM. This was an explorative study regarding sustainability in a cost calculation using the model PARAP. For the investor, recommendations are made for follow up research. The research is conducted at Jones Lang LaSalle, an international real estate services firm.

Two mentors from the TU Delft and two mentors from JLL guided this master thesis.

The next chapter is the theoretical framework. This chapter will discuss the most relevant literature addressed. Topics addressed are: sustainability, end user, LCC, contracting and investor. This chapter does not draw conclusions. It is used to improve the topics addressed in this research.

Theoretical framework

2 Theoretical framework

This chapter describes the literature used for this research. Topics are addressed in the following order: sustainability, end user, life-cycle cost and contracting.

2.1 Defining sustainability

Sustainability is a widely understood term. The section *1.1.2 Definition sustainability* mentions some of the definitions commonly used since 1987. PPP is the most used definition, developed by Elkington. PPP defines sustainability as the optimisation between People, Planet and Profit. These definitions remain rather broad and do not mention actions to implement in a building to improve the level of sustainability. Literature study on the definition of sustainability is done, to determine which aspects of sustainability will be used in this research, when spoken about sustainability.

To determine the level of sustainability in building, or to realise a sustainable (re)development, several measurement tools are developed. This measurement tools are often named green labels. These tools can serve as a handhold for the definition of sustainable real estate. Literature study was done on several green labels to answer the first sub-question:

- *Which sustainability aspects are to be considered for sustainable offices?*

To answer this question a choice is made for a green label, rather than defining an own approach on which aspects sustainable offices imply. The reason for this is that the different existing models cause confusion on what sustainability implies for sustainable offices. An extra (own) approach will only increase this confusion.

Throughout the world numerous tools are developed. Examples of organisations that developed a model for its country are:

- DGBC – Dutch Green Building Council
- USGBC - United States Green Building Council
- AGBC - Australian Green Building Council
- BRE - Building Research Establishment (United Kingdom)

Within the Netherlands several labels exist. The most commonly used are considered in the literature study, which are the following:

- BREEAM-NL
- LEED
- Greencalc
- GPR gebouw
- Energy label.

The next section discusses the different labels. It shows the choice of label which is used throughout the rest of this research. In the sections following, these labels are briefly explained.

2.1.1 Green label choice

For this research one of the above mentioned measurement tools is chosen to serve as a handhold to determine the sustainability aspects that are taken in account throughout this research. Below, a table is shown that compares the labels. Furthermore is stated which one is chosen for this research. The table shows for each label which aspects it takes in account to determine the level of sustainability.

Table 3 Label comparison with aspects influencing the degree of sustainability

	BREEAM	LEED	Greencalc	GPR Gebouw	Energy label
Management	X				
Energy	X	X	X	X	X
Health & Wellbeing	X	X		X	
Transport	X		X		
Water	X	X	X	X	
Materials	X	X	X	X	
Waste	X	X		X	
Land use & ecology	X	X			
Pollution	X	X			

BREEAM is the measurement tool that is used throughout this research. BREEAN is likely to become the leading tool for The Netherlands for three reasons. Below these three arguments are stated:

- BREEAM has an international character, focused on Europe.
- BREEAM is translated to Dutch standards.
- BREEAM has the broadest scope of the labels; it also includes location aspects and car usage for instance.

The following sections show a brief description of each of these green labels.

2.1.2 BREEAM-NL

BREEAM is the abbreviation for Building Research Establishment Environmental Assessment Method. It originates from the Building Research Establishment (BRE) in 1990, situated in the UK which is similar to the Dutch Technical scientifically research department (TNO – technisch natuurwetenschappelijk onderzoek). The Dutch Green Building Council translated BREEAM to Dutch standards which resulted in the BREEAM-NL version for newly built in The Netherlands.
BREEAM-NL newly built is operational since September 2009 to test new developments on the amount of sustainability. The DGBC is working on the BREEAM-NL in use and on BREEAM-NL urban area development. These last two are not available yet.

Due to its international character, focus on Europe and translation to Dutch standards, BREEAM is likely to become the most used label in The Netherlands.

BREEAM-NL is a measurement tool to determine the score on the sustainability level of a building. It does so by looking at nine categories: Management, Health & Wellbeing, Energy, Transport, Water, Materials, Waste, Land use & Ecology and Pollution. These categories are briefly explained below.
The total BREEAM score is the weighted average of all these categories. Each category represents a certain percentage of the total certification. These percentages are *shown Figure 13 BREEAM categories' weight*. Each category has (a different amount of) credits. When a credit is achieved, points are given. The scores that can be achieved are pass (30% of the total credits), good (45%), very good (55%), excellent (70%), outstanding (85%) (DGBC, 2008).
Besides the nine categories, the score can be enhanced with 10% for innovative credits. All innovative credits are 1% addition. But according to the DGBC these credits have fierce criteria (DGBC, 2009)

Category	Weighting
Management	12%
Health & Wellbeing	15%
Energy	19%
Transport	8%
Water	6%
Materials	12.5%
Waste	7.5%
Land Use & Ecology	10%
Pollution	10%

Figure 13 BREEAM categories' weight
Source: (DGBC, 2008)

The nine BREEAM categories are:

- **Management** focuses on enhancing the performance of the user and the proper management of materials, energy and pollution during the development.
- **Health & Wellbeing** focuses on comfort. Aspects that come into play here are: natural light & lighting, quality of air, controlling the heating and sound.
- **Energy** focuses on energy efficient use of the building during its life-cycle.
- **Transport** focuses on car usage reduction. Examples of aspects are the distance of facilities to the building, supply of public transport.

- **Water** focuses on efficient use of water. Examples are usage of grey water, leak detection.
- **Material** focuses on the impact of materials used for the development and building usage on the environment. Some aspects that come into play are re-use of materials and origin of materials.
- **Waste** focuses on waste management. Aspects addressed are waste management on the construction site, use of secondary material, storage for re-usable waste and others.
- **Land Use & Ecology** focuses on the interaction between the development and the existing surroundings and plan area. Aspects addressed are stimulation of building on polluted sites, consulting future residents and neighbors, taking care of plants and animals.
- **Pollution** focuses on reducing the building's pollution. Sound pollution, light pollution, usage of cold means which cause reduction of the greenhouse effect and others are aspects addressed here.

2.1.3 LEED

Another international green label is LEED (Leadership in Energy and Environmental Design), developed by the United States Green Building Council (USGBC) and operational since 1999. LEED is based on the English BREEAM tool. Like BREEAM per category scores can be achieved from which a total score and certification is determined. The different levels of certifications are Certified, Silver, Gold and Platinum. The six categories of LEED are Sustainable sites, Water efficiency, Energy & atmosphere, Materials & resources, Indoor environmental quality and a bonus category (USGBC, 1999) (see *Figure 13 BREEAM categories' weight*). Different to BREEAM is that BREEAM is adapted to the standards of a country and LEED has the same standards worldwide.

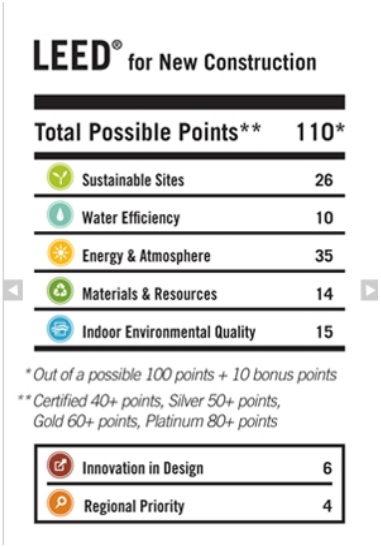
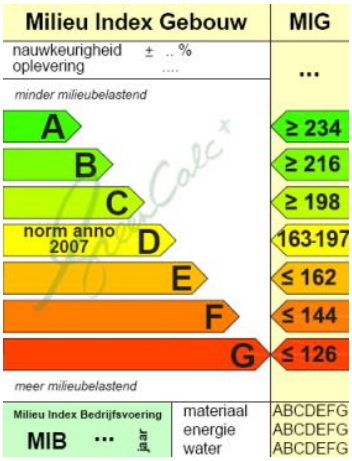


Figure 14 Leed categories
Source: (USGBC, 1999)

2.1.4 Greencalc

Greencalc is developed by Stichting SUREAC (sustainable real estate accountancy & certification). SUREAC consists of several institutions including NIBE and TU Delft. Greencalc is an assessment tool for sustainability of a building or an area. It considers all time frames of a development: initiative, built and operating time. The categories it uses are: materials, water, energy and mobility. Greencalc focuses on technical aspects of a building that influences the environment. The life cycle analysis is an important aspect in Greencalc (Haas, 2009)



The amount of sustainability is expressed with an environmental index. *Figure 15 Greencalc's environmental index* shows the index.

Figure 15 Greencalc's environmental index
Source: (naar Energieneutraal)

2.1.5 GPR gebouw

GPR gebouw is developed by the municipality of Tilburg and W/E advisors. GPR considers six categories: energy, materials, waste, water, health and living quality. For each category a score from 1 to 10 will be achieved depending on the amount of sustainability (GPR Gebouw).

Figure 16 GPR gebouw's score
Source: (GPR Gebouw)

2.1.6 Energy label

The energy label is developed by the Energy Performance Building Directive (EPBD). The EPBD is a directive of the European Parliament on energy efficiency of buildings. The guidelines of the EPBD were implemented in the member states in 2006. These guidelines were based on the Kyoto Protocol (European Parliament and Council, 2002). Since 2008 the energy label was obliged in The Netherlands to use for all buildings during a transaction. Interesting to mention is that if no energy label is used during a transaction there is no penalty. This resulted in little amount of labels used (Vastgoedmarkt, 2009).

The energy label calculates the energy efficiency of buildings. It does so by determining the relative difference between the energy consumption of a building and the allowed energy consumption. The outcomes are put into different categories varying from A (+/+++) to G.

Figure 17 Energy label source: (Senternovem, 2007)

2.2 Sustainability motives

Chapter one shows the importance of sustainable real estate and the three stakeholders (end user, investor and developer). But what is the reason stakeholders want to focus on sustainable real estate? What are their benefits? This section answers the second sub-question which is the following:

- *What are the motives, of the stakeholders involved, to focus on sustainability?*

Several researches investigated these motives. The conclusions are summarised in the figure below. The literature used for these conclusions are:

- Myers et al.'s *The relationship between sustainability and the value of office building (2007).*
- Langdon's *Costs of green revisited (2007).*
- Eichholtz' *Doing well by doing good (2008).*
- Tol's *Added value of sustainable office buildings (2010).*

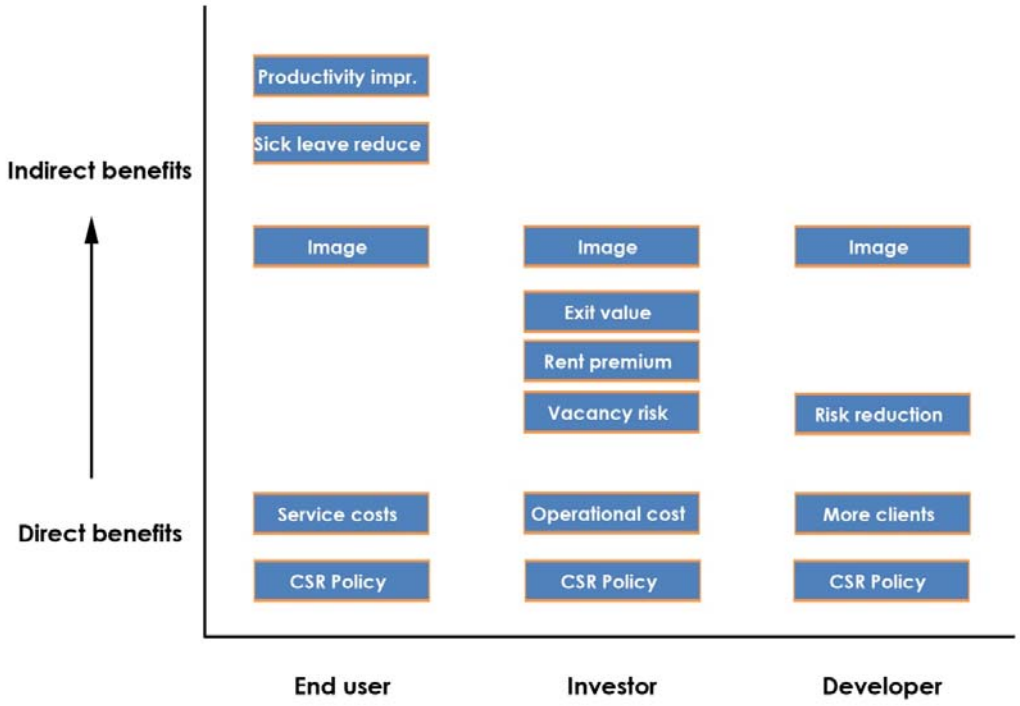


Figure 18 Stakeholder's motives

A distinction is made between direct and indirect benefits since some benefits are more complex to measure than others are. For instance, it is easier to measure the service costs savings a building has, than it is to measure the increase of employee's productivity in a sustainable building.

Some advantages account for all stakeholders and others do not. Advantages that account for all stakeholders are the image improvement and achieving their CSR policy.

The advantages for the end user that are unique compared to the other stakeholders are the productivity improvement, sick leave reduction and service costs. The first two can be achieved by a better quality of the working area. If this working area shows more daylight, has better air quality, good amenities, than it is likely that employees feel comfortable, can easily concentrate on their work. Eventually this will result in a higher productivity of the employees and a lower sick leave. Unfortunately this is difficult to measure. Therefore it is mentioned as an indirect benefit, in the scheme above.
The service costs advantage, is a reduction of service costs due to a more energy efficient building. This is direct benefit since it is easy to measure.

The advantages for the investor that are unique compared to the other stakeholders are the exit value, rent premium, vacancy risk and operational costs. The first three are shown in the middle of the scheme, between indirect and direct. The reason for this is that these advantages are easy to quantify (so more direct), but investors often do not know how, or often do not see the added value of sustainability in for example a rent premium (so more indirect). But these advantages are achieved, because a sustainable office is an office with a higher quality and therefore is worth more. This should be seen in the rent, exit value. A sustainable office is also more demanded and therefore has a low vacancy risk compared to non sustainable offices.

The advantages for the developer that are unique compared to the other stakeholders are the ‘risk reduction’ and ‘more clients’ advantages. More clients is a direct benefit. In the problem statement of chapter one is shown that opportunities are within sustainable redevelopment. Therefore more clients will be attracted when a developer is well experienced in sustainable developments. The risk reduction is more indirect, since it is plausible that a sustainable development shows lower risk due to its higher demand, but remains uncertain till the purchase is done.

2.3 End User

Previous research was conducted regarding the willingness-to-pay of end users for sustainable office buildings using different research methods. This chapter shows the most relevant conclusions drawn regarding end user's wtp which is used during this research. The research is discussed categorical, according to the research methods used. Three stated preference researches will be mentioned first and hereafter three revealed preference researches. Before all this, a table is shown which summarises the results from these researches.

Table 4 Major findings from literature research regarding the end user

	Rent premium	Green lease
Stated preferences		
Snoei (2008)		76 %
JLL (2008)	5 %	
Corenet global & JLL (2009)	3,2 %	
Revealed preferences		
Eichholtz (2008)	3 %	
Pot (2009)	1,5 - 18 %	
Heineke (2009)	3,7 %	

2.3.1 Stated preferences

Three researches are discussed here:

- Snoei's master thesis from the TU Delft in 2008: "Huisvestingsvoorkeuren kantoorgebruikers, energiezuinigheid nader beschouwd."
- JLL's "Duurzame huisvesting: een gids voor de Nederlandse kantoorgebruiker" 2008.
- Corenet Global and JLL's "Perspective on sustainability" 2009.

Snoei, "Huisvestingsvoorkeuren kantoorgebruikers, energiezuinigheid nader beschouwd." (2008)

Gerald Snoei graduated from the TU Delft in 2008. His master thesis was about the preferences of office users regarding their accommodation with the sustainability aspects in particular. He did so using two research methods. The first was a discrete choice analysis to determine the preferences of end users between different office types. The second research method was a direct survey to determine more concrete preferences of end users regarding sustainable accommodation. Both methods had 127 respondents with a response rate of 13%.

Snoei's, major finding is the wtp of office users for 76% of the savings made by energy efficiency in a higher rent. This question is asked, because investors can make the investment needed for energy-efficiency, but the tenant receives the benefits, being lower service costs. This problem is called split-incentive.
Furthermore Snoei showed a preference for reciting in energy-efficient buildings by end users (Snoei, 2008).

Jones Lang LaSalle, "Duurzame huisvesting: een gids voor de Nederlandse kantoorgebruiker." (2008)

JLL's research regarding sustainable accommodation in 2008 was twofold. The first part of the research shows the preferences of end users. This part was done using a direct survey of 135 respondents. The second part states a guideline for end users to become sustainable. This second part is less interesting for this master thesis and the results will therefore not be further elaborated on.

JLL shows four major findings.

- 2008 faces an economic crisis, but sustainability remained an urgent matter and therefore would be here to stay.
- Sustainability is expected to be more expensive than conventional buildings according to 74% of the interviewed office users.
- 74% of the respondents are willing to pay for these extra costs, more than 50% of the respondents want to pay a maximum of 5% rent premium for sustainability.
- Nearly 50% of the office users want to be accommodated sustainable within the coming five years. From this JLL concludes that in the coming five years almost 20 million square meters of sustainable office buildings are needed (Houtman, Quispel, & Martinus, 2008). However this is an interesting conclusion which gives some insight in the urgency of sustainable accommodation, it is an arguable conclusion and too quick drawn.

CoreNet Global and Jones Lang LaSalle, "*Perspectives on sustainability*" (2009).

In 2009 CoreNet Global and Jones Lang LaSalle held their third annual global survey on sustainable office accommodation. The respondents were Corporate Real Estate (CRE) executives responsible for real estate portfolios across the globe. The research does not mention the amount of respondents. This research shows the preferences of office users worldwide regarding sustainable accommodation. The major findings are shown in Figure 19.

Figure 19 Major findings of the CoreNet global research (2009) Source: (Probst, Wallbank, Hirigoyen, & Anderson, 2009)

2.3.2 Revealed preferences

Several researches determined the rent premium paid for sustainable offices by end users using a hedonic pricing method (a method of revealed preferences). The advantage of revealed preferences in comparison to stated is that revealed shows evidence instead of opinions or intentions (stated preferences). For the Dutch office market it is difficult to this type of research since data is limited. Below two Dutch researches are mentioned who tried to do so and this section starts with one from the U.S.A. where more data is available.

Eichholtz, Kok and Quigley, *"Doing well by doing good"* (2008)

This research is conducted by the University of Maastricht together with the University of Berkeley, California. The research compared buildings with a LEED or energy star label with non labelled buildings. It considers 893 labelled office buildings.

The major findings of this research are that the premium paid for sustainable office buildings is 3% (for rent), 6% (for effective rent) and 16% (for selling) (Eichholtz & Kok, 2008).

This research of Eichholtz et al. is predominately used to state that green buildings give a rent premium. Because this research used the largest sample so far it is often referred to. Since the Dutch office market is a different market, it is difficult to draw parallels.

Pot, *"Duurzame kantoorgebouwen: een studie naar het rendement voor de belegger."* (2009)

This research is conducted by the Amsterdam School of Real Estate (ASRE). It tried to do a similar research as Eichholtz et al. for the Dutch office market. It considered the rent premium of office buildings as well as other aspects determining the investor's direct return. As stated before, little data is at hand in The Netherlands for a research like this. Pot's research was able to consider 18 sustainable buildings and 63 non sustainable buildings. Pot defined sustainable offices to at least fit one of the following criteria:

- Greencalc 150
- GPR Gebouw 6
- Energylabel B
- 25% EPC improvement compared to the norm at time of construction.

Her results are not significant because of the small sample. However her findings show achieve a higher rent, varying from 1,5% to 18% for sustainable buildings (Pot, 2009).

Heineke, *"Energiezuinige kantoren: Loont het om te investeren?"* (2009)

Heineke, like Pot, did statistical research to determine the rent premium paid for sustainable offices in the Dutch office market. The major difference between his research and the one done by Pot, is that Heineke choose to go for a large dataset. He considered 267 sustainable office buildings, buildings with an energy label. This resulted in concessions on some relevant determinants for rent. Amount of floors, occupancy rate, esthetical quality, facilities and several others were left out of consideration. Furthermore he did a case study on the costs of making an office building more energy-efficient.

His major findings regarding the rent premium are that with an improvement of the energy label an average net rent premium is 3,7% will be achieved (Heineke, 2009).

2.4 Life-cycle costs

The second part of the research is about the life-cycle costs of sustainable offices. This section discusses why life-cycle approach should be considered, research regarding the costs of sustainable offices. Furthermore it discusses two existing models regarding costs and sustainability to obtain extra grip on the implementation of sustainability in a cost calculation model.

2.4.1 Why life-cycle cost approach?

Life-cycle cost approach is an approach to consider all cost of a building throughout its entire life-cycle, from development/procurement stage to eventual disposal. According to Woodward it has become essential to plan and monitor assets throughout their entire life-cycle to optimise the investment. Optimising the trade-off between all the cost factors relating to the asset during its life-cycle will give the minimum life-cycle cost of the asset (Woodward, 1998).

Within sustainability it is even more interesting to consider the life-cycle approach since for sustainability often an investment is needed, but this investment can be paid back by lower operating costs. Therefore it is interesting to determine the period of pay-back time and therefore conducting research using the life-cycle approach.

2.4.2 CBRE, "Who pays for green? The economics of sustainable buildings" (2009).

CBRE summarises different literature in its report *Does green pay off* which gives a clear overview. The literature they use for the costs of sustainability comes from (BRE, 2007), (Matthiessen & Morris, 2004) and (Langdon, 2007) (Eddington, Barren, Hitchcock, Desormeaux, & Axford, 2009). CBRE states that to come to the basic levels of certification development costs may raise to an additional 2-3% building costs. To achieve the high levels of certification construction costs between 5-7,5% extra are likely to occur(Eddington, Barren, Hitchcock, Desormeaux, & Axford, 2009). *Figure 20 Additional investment costs for sustainability*
Source: illustrates these results.

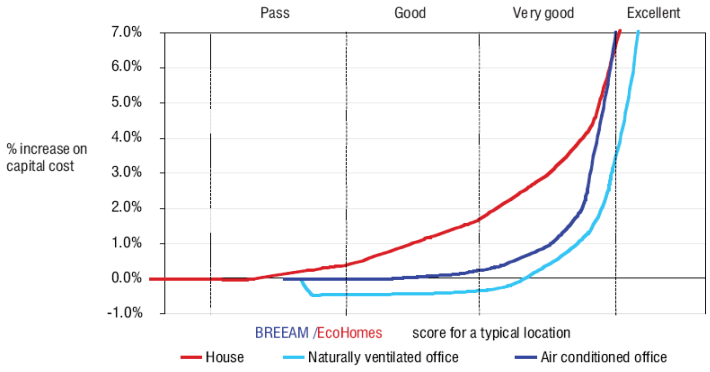


Figure 20 Additional investment costs for sustainability
Source: (BRE, 2007)

CBRE developed three scenarios to demonstrate the savings of energy consumption. The energy savings can be up to 78% of its original use. This is concluded from the figure below.

Estimates of energy consumption were generated under each of three scenarios:

SCENARIO 0	Standard three-storey building with gas fired radiators is as the building stands, with no enhancements. **597 kWh/m2/yr** **G Rating**
SCENARIO 1	Double glazing and Roof refurbishment installed to meet current regulations **526 kWh/m2/yr** **G Rating** *(-12% in energy consumption from scenario 0)*
SCENARIO 2	Enhanced Capital Allowances (ECA) qualifying heating and ventilation systems, efficient lighting and high quality maintenance **131 kWh/m2/yr** **B Rating** *(-78% in energy consumption from scenario 0)*

Figure 21 Estimates of energy savings potential
Source: (Eddington, Barren, Hitchcock, Desormeaux, & Axford, 2009)

JLL shows that the total costs of accommodating expenses are distributed according to the figure below, service costs cause 22% of the expenses. When this 22% is combined with CBRE's energy savings potential of 80%, there can be concluded that annual savings can be made up to 17% of the total yearly accommodation costs (Langbroek & Bressers, OSCAR, 2010).

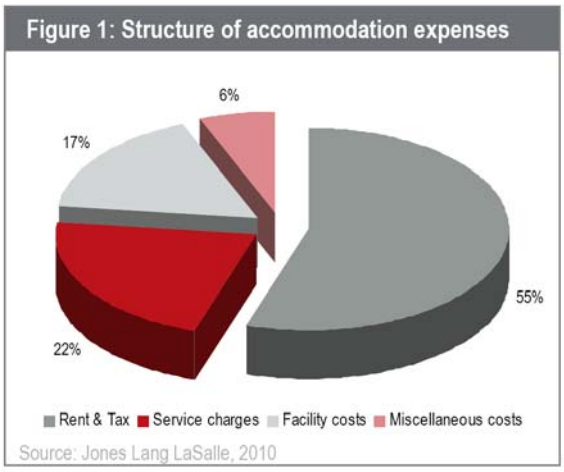


Figure 22 Structure of accomodation expenses
Source(Langbroek & Bressers, OSCAR, 2010)

Publications of The Green Building Council of Australia (GBCA) in 2008, mentions that previous research shows a decrease of operating costs of 8-9% for sustainable buildings (Browman & Wils, 2008).

These results show that extra investments that are needed for a sustainable development can be earned back by lower operating costs.

2.4.3 Brink Group, "Financial quickscan sustainability."

Brink Group is a service oriented company within the real estate market. It focuses on management, consultancy, automation of construction, accommodation and real estate. On the field of automation they claim to be the market leader within the calculation and maintenance industry.

Brink Group made a calculation model for office buildings which determines the investment costs combined with the BREEAM score. It is called the financial quickscan sustainability (FQD – Financiële Quickscan Duurzaamheid). In the end of 2009 it became operational.

The information regarding the FQD was obtained from two interviews at the Brink Group company. These interviews were held with cost advisors, Tim Hartman and Woud Jansen of Brink Group.

The website for the FQD is www.quickscanduurzaamheid.nl or www.rekenen-aan-duurzaamheid.nl. Brink Groep developed this model commissioned by the DGBC.

The model was developed by two groups. The first group consisted of four or five people took the lead in the development of the model. When extra information regarding building costs was needed, the second group, an expert panel of 10-15 costs experts from different divisions within the Brink Group could be consulted. Altogether it took Brink Group two years to develop the model.

The model is free to use. It gives a quick and detailed insight into the investment costs of a sustainable office development.

The output of the model is the investment costs for the development, a BREEAM score and a People Planet Profit (PPP) score. An example of this output is shown in the figure below. The criteria for the PPP score, is determined through an expert panel of Brink Group. Although this score is arbitrary it is an interesting score to use because PPP is often used as a definition for sustainability.

Figure 23 Output Financial quickscan sustainability Brink Groep
Source: (Brink Groep, 2009)

The process for the use of FQD is as follows:

- Firstly basic questions about building specifications are asked. Examples are: amount of square meters, type of location, type of façade, etc.
- Secondly per BREEAM category questions are asked. These questions are the BREEAM credits formulated into questions. The user of the program is to state whether he wants to achieve this credit or not.
- When all questions are answered, the model calculates the associated investment costs, BREEAM score and PPP score involved.

The model is developed using MS Excel and consists of numerous sheets. Every sheet contains different kind of information concerning costs and are linked to each other. The categories of these sheets have a logical built order: starting with the foundation, than the floors, than façade, than W-E installations, and others. From these categories, type of elements can be chosen in the model, for instance a type of floor. From this choice is calculated the needed m_2 and a cost price per m_2 is determined. So calculations are made on element level.
BREEAM uses some none building specific aspects. For these aspects a different approach for the cost calculation must be made. BREEAM's management category is such an aspect. For managerial aspects Brink determined the amount of working hours a management task involves and determines the costs by multiplying this to the hour salary needed (Hartman & Jansen, 2010). However this method is based on rough assumptions, Brink Groep made it possible to come to overall investment cost calculations for the BREEAM label.

This model is an easy-to-use model which gives detailed insight into the building costs of BREEAM, but it does not determine the operating costs. When one calculates with sustainability it is as interesting to look at the operating costs as well as to look at the building costs. In the future, Brink Group will add this to the existing model. At this stage it is unclear when this will be finished.

2.4.4 Royal Bam Group n.v., *"Greenup tool."*

The royal BAM group n.v. is a European oriented construction company. BAM is listed on the Euronext Amsterdam. Their core businesses lie in construction, real estate, infrastructure, public private partnership, installations, consultancy & engineering and facility management Bam is one of the largest construction companies in Europe with 28.000 employees(Koninklijke BAM groep nv).

The information was obtained during an interview with Sander Holm from BAM Utiliteitsbouw. Sander Holm is manager knowledge centre sustainability and responsible for the Bam Greenup Tool.

The development of the BAM Greenup tool started mid 2007. Since November 2008 the model is ready to use. It can be used to determine all the costs involved of a development at an early stage of the design. The model will be able to show the pay-back time of specific building measures. The model serves as a quickscan. The model is for internal use or can be hired by external companies. The BAM Greenup tool is a design tool.

BAM has two reasons to develop this model. The first is to improve the knowledge of the employees on sustainability and the second is to prevent failure cost of the construction. 65% of the total failure costs of a development are made in the design. Reducing these costs by using a calculation model during the design phase can be an advantage for BAM to outrace their competitors.

The process when using the model is as follows:

- A choice for a type of office building (20 possibilities) must be made
- Further specification on building dimension when needed, such as fte's and many others are possible.
- Further specification on the level of comfort, energy-efficiency and use of materials is possible.
- Another possibility is to state the amount of sustainability you want to achieve and the model will calculate the costs involved.

The output of the model is a score on either GPR gebouw, Greencalc or BREEAM depending on the user's wishes. Furthermore the output will show the investment costs as well as operating costs.

A remark must be made that although the BAM Greenup tool can calculate the costs for different green labels, at first it makes rough assumptions to come to these conclusions. When desired, it can be calculated more into detail.
Another remark is when the BREEAM score and costs will be determined, additional calculations must be made regarding the specific location. These are not predetermined in the model and will be made for each case specific.

2.4.5 Difference between FQD and BAM Greenup tool

The two models show some differences. These differences are:

- BAM determines investment costs as well as operating costs, Brink determines only investment costs.
- BAM can determine different green labels (BREEAM, Greencalc or GPR), Brink only determines BREEAM. However to determine BREEAM with the BAM Greenup tool, extra location calculations must be made.
- Brink is public accessible, BAM is for intern use only.
- Brink is ready to use for anyone, expert knowledge is not necessary.

2.5 Valuation of sustainable real estate

Chapter one research setup clarifies the plan of approach to address the research question. The research design illustrates what must be done to answer this question. Attention must be paid to the following three aspects: 1.End user preferences, 2.LCC and 3.Investor. This chapter addresses the third aspect: 3.Investor. This chapter shows the literature study on the valuation of sustainable real estate. It will try to answer the following sub-question:

1. *What is the added value for the investor regarding sustainable real estate?*

The added value for an investor lies in its increase in return. Its return is based on several aspects:

- Rent
- Vacancy
- Lettability
- Operating costs
- Exit value

So how does sustainable real estate changes these aspects which influence the return of the investor? There is little evidence on the added value of sustainability. Therefore the investor remains reluctant for investing in sustainable real estate. Further research is needed to provide this evidence. To determine the added value for the investor several researches are done. This section describes the research of Peter van den Tol. He developed a valuation model to be able to appraise sustainable real estate.

This model is made on the base of a literature study, a case study, semi-structured interviews and an online-survey. Figure 24 shows his research design. After the interviews and literature study, Tol decided that the GIY method and DCF method are the best valuating methods to use. For these models, assumptions were revised on rent level, service costs, vacancy rate, green finance, maintenance, GIY and rent correction. An expert panel review was not done.

The model is a well structured step-by-step process to come to a new valuation model. This model makes it possible to appraise sustainable real estate. However it is a first attempt to determine the value of energy-efficient buildings. Therefore it is likely that improvements of the model should be made to enhance the assumptions.

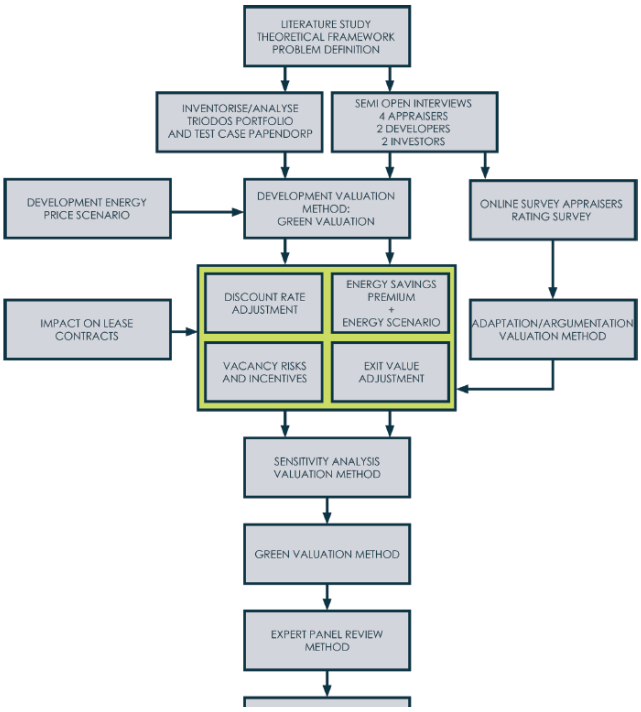


Figure 24 Tol's research design
Source: (Tol, 2010)

2.6 Lease contracts

Throughout the process of this research, it became clear that traditional lease contracts do not help the improvement of sustainability in office buildings. Traditional lease contracts cause a 'split-incentive.' When an office building is made more energy-efficient, the investor makes the costs but the tenant gets the benefits of lower service costs. This mismatch of costs and benefits is called the 'split-incentive.' To solve this problem a new type of contract has been developed: green lease. In this research, no empirical research was done. But, the insights I got during this research, made me belief that green lease is the solution for a major problem regarding sustainable real estate. Therefore a literature study on green lease is done, after the empirical research of the end user and developer. This literature study is shown below.

2.6.1 Green lease in the Netherlands

Green lease is a type of contracting in which the investor and the tenant make agreements on (for instance) the energy-savings component. The costs made by the investor which (for instance) results in lower service costs are (partially) paid back by the tenant using a higher rent (van der Bijl, 2010).

The green lease contract in The Netherlands is at the start up phase. Only a few developments used green lease. These are:

- Transport at Schiphol
  - Investor: Schiphol Real Estate
  - End user: Martinair and Transavia
- Head office TNT at Hoofddorp
  - Investor: TNT
  - End user: TNT
  - Consortium: finance Triodos and project developer OVG
- Villa Rusthoek at Baarn
  - Investor: Triodos Vastgoedfonds
  - End user: AT Osborne
- NIBE water tower at Bussum
  - Investor: unknown
  - End user: several as well as owner-occupier

The companies involved in these projects made their own green lease contract and therefore varies in its setup. The water tower just simply arranges a higher rent for the pay-back. The others are more a green lease setup where a calculation is made for the energy savings, but still differ in its detail. A standard for the green lease contract in The Netherlands is being developed by the Amsterdam School of Real Estate (ASRE), 'Duurzame deals' by van der Bijl (2010). His thesis will be finished by the end of the year.

2.6.2 Green lease abroad

Other countries already developed guidelines for this contract. These are:

- U.S.A. – Building Owners and Managers Organisation (BOMA), model green lease agreement (2008)
  (BOMA international, 2008).
- Canada – Real property association, National standard green office lease (2008) (REALpac, 2010).
- England – Better Building Partnership (BBP), green lease toolkit (2009)
  (Clarke & Bugden, 2009).
- Australia – Investa Property Group, green lease guide for commercial office tenants (2007)
  (Investa Property Group, 2007).

These models go beyond considering only the service costs. The BBP recommends that 12 aspects are considered for the setup of a green lease. Some of these are: water, energy, energy-efficiency, waste and transport.

2.6.3 Remarks regarding green lease contracts

But the use of green lease is not standard yet. Some remarks and points of attention are made why this is not standard. These are:

- **Short term investor**
  Often investors own real estate for no longer than ten years (Langbroek, 2010). This is much shorter than the life span of a building. This makes it difficult to earn back energy-efficient measures that need longer then ten years. So when a building is sold and the investment is not earned back yet, the new owner must be willing to take over the residual costs of the initial investment.
- **'New'**
  Companies tend to not like change. Companies like the way things work the way they do (Leersum, 2010). They must be convinced to change their contracting.
- **Lack of evidence**
  The circle of blame is partially broken. The reason that it is not fully broken has to do with the lack of evidence. More research must be done to show that green lease is a better solution for contracting within a sustainable (re)development than traditional contracting.
- **No standardised Dutch model**
  In The Netherlands no green lease model exists to serve as a guideline. Van der Bijl's model will be finished by the end of the year (van der Bijl, 2010). This could serve as a starting point for the Dutch office market.

On January the 2nd 2010, a Belgium vennoot of Stibbe, Rudy Nauwelaarts, gave a lecture on green leases on how to overcome some of the problems occurring with a green lease. The two major relevant ones for The Netherlands as well are discussed:

- **What if either the tenant or the landlord does not meet the agreements made?**
  Judges are not acquainted with green lease type of contracts. So it might be difficult to settle the disagreement in court. On the other hand if the contract was set up proper, Nauwelaarts think the judge will agree with whatever is written in the contract. Another option would be to make a clausal on what if some-one does not meet the agreements. Current contracts are made according to the ROZ contracting. This could serve as an example to set up one for the green lease to prevent such problems.

- **The length of contract**
  Energy savings incur a certain pay-back time. Contracts are often only 3 to 5 years. Contracts probably need to be longer to make it easier to achieve this pay-back time (Nauwelaerts, 2010).

JLL also mentions landlords and tenants are still struggling with the details of green leases. Therefore it is important to keep the definition of green lease terms flexible for parties (Jones Lang LaSalle, 2008). Every accommodation can be different. According to JLL the green lease should be flexible on the following aspects for both the end user and investor to determine their ambitions on the level of agreement:

- Hours of operation
- Tenant usage and fit-out
- Weather patterns
- Unforeseen breakdown in equipment
- Building occupancy profiles

2.7 Summary

The theoretical framework discusses six topics: defining sustainability, sustainability motives, end user, developer, investor and green lease. In the same order the topics will be summarised below.

Defining sustainability

Many definitions exist for sustainability. For this research an existing definition of sustainability is chosen. An own definition could increase the existing confusion on the sustainability definition. The level of sustainability in buildings can be measured using green certifications. The ones most used for the Netherlands are BREEAM-NL, LEED, Greencalc, GPR gebouw and the energy label. The choice was made to use BREEAM throughout this research. BREEAM is likely to become the leading measurement tool in the Netherlands for three reasons: it has the broadest scope of all tools, it is international (oriented on Europe) and translated to Dutch standards.
BREEAM, originated in the UK, measures sustainability using nine categories. BREEAM-NL became operative in the Netherlands since September 2009.

Sustainability motives

But why would stakeholders focus on sustainable real estate, what are their motives? The figure below shows these motives. Some are for all stakeholders the same, others are not. Some motives are direct benefits and others are indirect.

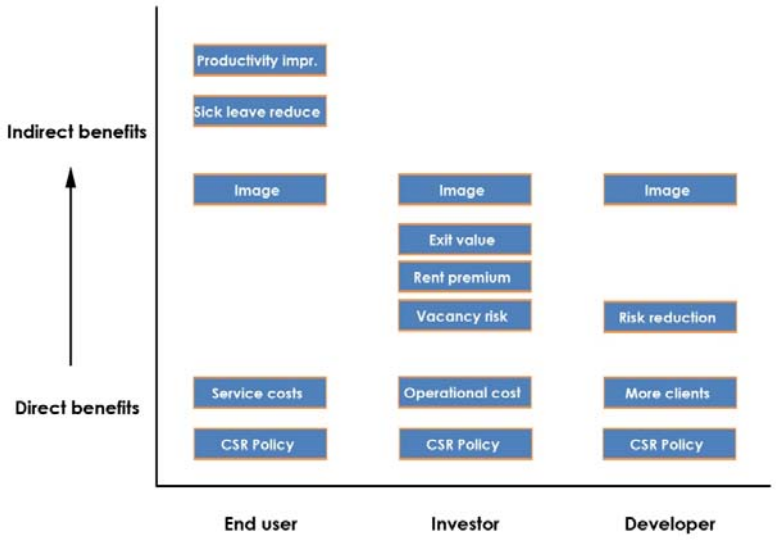


Figure 25 Stakeholder's motive

End user

For this master thesis the most relevant end user research are three stated preference researches and three revealed preference researches. The three stated are from the TU Delft (Snoei, 2008), JLL (Houtman, Quispel, & Martinus, 2008) and Corenet global (Probst, Wallbank, Hirigoyen, & Anderson, 2009). The main conclusions are visible in Table 5.

Table 5 Results from previous end user's research

	Rent premium	Green lease
Stated preferences		
Snoei (2008)		76 %
JLL (2008)	5 %	
Corenet global & JLL (2009)	3,2 %	
Revealed preferences		
Eichholtz (2008)	3 %	
Pot (2009)	1,5 - 18 %	
Heineke (2009)	3,7 %	

Developer

There is a lack on research regarding the life-cycle costs of sustainable real estate as a whole. But CBRE states a summary of existing research which gives a proper, quick overview of costs for sustainability. It mentions that basic sustainability is only 2-3% more expensive, but high end sustainability can incur 5-7,5% more investment costs.
Two Dutch firms tried to incorporate sustainability into cost calculation models. These are a good first step, but still need improvement for proper usage.

Investor

The added value is needed for the investor to be willing to invest in sustainable real estate. Literature shows that its risk-return profile improves on the following aspects: rent premium, decrease of vacancy risk, reduction of operating costs and a possible higher exit value. Tol made a revision on the appraisal model for sustainable real estate. He made it possible to quantify positive effects of sustainability in a valuation model. However his assumptions remain rather rough.

Green lease

Throughout the process of the research, the split-incentive problem seemed to be one of the major issues, the real estate market is struggling with. The solution for this can be the green lease contract. This is a contract where both investors and end users make agreement on the benefits of the service cost savings. Green lease is used in The Netherlands for a few projects.
The ASRE is developing a standard model for green lease. Other countries, Australia, Canada, The UK and The USA already have standard models for green lease for a few years. Some remarks can be appointed for the reluctance on green lease.

The next chapter discusses the end user research. First it addresses the choice of methodology, secondly the methodology and thirdly the results.


1. End user preferences

3 End users

Chapter one research setup clarifies the plan of approach to address the research question to what extent sustainable offices are feasible. The conceptual model and the research design illustrate what must be done to answer this question. Attention must be paid to the following three aspects: 1.End user preferences, 2.LCC and 3.Investor. This chapter addresses the first aspect: 1.End user preferences. This chapter tries to find out the end user's preference and willingness-to-pay regarding sustainable accommodation.

The questions that need to be answered regarding end users are the following:

1. Part one: End user

- *What are the end user's preferences?*
  - Which sustainability aspects? Label?
  - Planning?
  - Governmental attitude?
  - Importance of sustainability in choice of accomodation
- *What is the end user's willingness-to-pay?*

To answer this question, a direct customer survey was conducted and several semi-structured interviews were held. The survey resulted in 163 respondents from the database of JLL. Out of these respondents three corporate real estate managers were interviewed. The survey had a wide range of questions regarding sustainability. The preliminary results from the survey formed the basis for the interviews.

The results from this research resulted into several publications. JLL in cooperation with me made their own publication and articles were written in the *Financiële Dagblad*, de *Vastgoedmarkt* and the daily newsletter of *PropertyNL*. All these publications are added in the appendices.

This chapter is divided into three sections. The first section clarifies the methodology. The choice, a setup and type of analysis for a survey as well as interviews are discussed here. The second section deals with the results of the survey. The results of the survey will be shown and discussed in categorical manner as determined in the survey. The results of the interviews are stated hereafter. The final section contains a summary and conclusion of this chapter to give an answer to the questions mentioned above.

3.1 Methodology

Various methods to research the priorities of end users exist, but not all methods are relevant for the above-mentioned objectives. The first two sections explain step-by-step why a survey was conducted and interviews were held. The third section describes the setup for the survey and briefly for the interviews. The fourth section discusses the analysis used for the results of the survey.

3.1.1 Choice for survey

In Christoph Breidert, Michael Hahsler and Thomas Reutterer's 'A review of methods for measuring willingness-to-pay' (Breidert, Hahsler, & Reutterer, 2006), a 32-page literary review, gives a systematic overview of the different methods for measuring the willingness-to-pay. Each step of Breidert et al.'s review was followed in order to come to a choice for methodology. Breidert et al.'s findings are shown in the figure below:

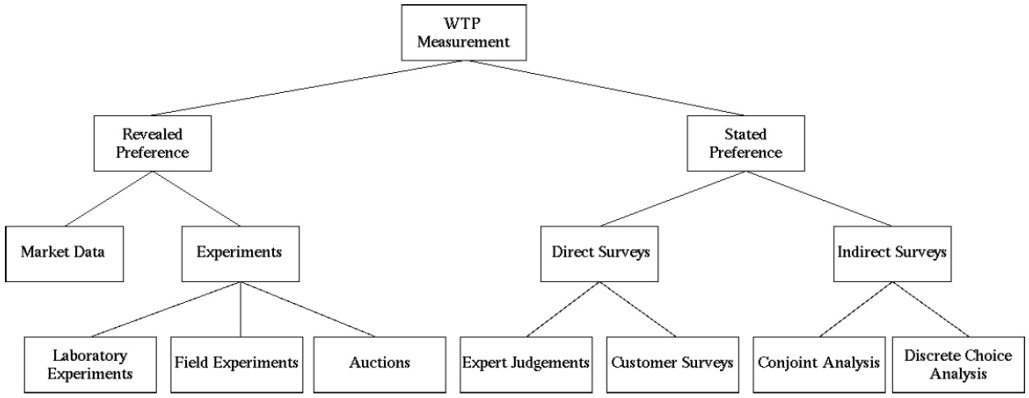


Figure 26 different methods for determining willingness-to-pay (Breidert, Hahsler, & Reutterer, 2006)

The first distinction Breidert makes is the one between either stated or revealed preference. Revealed preference is a data collection method which is based on actual or simulated price response data whereas stated preference utilizes surveying techniques (Breidert, Hahsler, & Reutterer, 2006). The data used for revealed preference can be obtained from market data or generated out of performing experiments; the data is actual price responses. Stated preference collects its data from either direct or indirect surveys. Stated preferences is not so much about actual transactions, but more about what people *state* they are willing to pay. This, of course could be biased, because what people say they are willing to pay does not automatically mean that they would actually pay this in practice as well. Therefore a revealed preference method would be the most valid one. However with revealed preferences, the needed data is not always at hand and can consume considerable time and money (Breidert, Hahsler, & Reutterer, 2006).

Revealed was the first method to be considered. This was used by Eichholtz, Kok and Quigley's 'Doing Well by Doing Good' (Eichholtz & Kok, 2008), investigating rent levels of sustainable office buildings. For this method a database containing building characteristics which influence the rent level is needed. Such a database is not at hand in The Netherlands. An option is to gather this information through personal fieldwork. This would take too much time. Therefore the choice was made for stated preferences and not revealed preferences.

Within stated preferences Breidert et al. distinguishes between direct and indirect surveys. Within direct surveys, respondents are directly asked what they are willing to pay. With indirect surveys, respondents are asked to give a ranking or rating to state their preference for a certain product. A ranking or rating of a product has the advantage that desired behaviour is reduced. An indirect survey takes more time than a direct survey, this can be a disadvantage.

The above step-by-step process of elimination led to the choice for direct surveys. The amount of time determined this choice.

The final step, according to Breidert et al., is choosing between expert judgements and customer surveys. An expert has knowledge about the consumers need and is therefore more time-efficient than interviewing customers themselves. Expert can be biased because their personal objectives might conflict with the survey's objectives. Expert judgement is best applicable within markets with little customers, since experts know what their customers are willing-to-pay (Breidert, Hahsler, & Reutterer, 2006). The Dutch office user is a large market and therefore unsuitable for Breidert et al.'s expert judgements.

The step-by-step analysis led to the direct customer survey method.

3.1.2 Choice for interviews

The outcome of a survey can be biased or difficult to interpret in the correct manner. Triangulation is used to reduce this effect. According to Jick (1979), triangulation is the use of two or more methods to check the results. Interviews as well as a survey were used in this research to obtain triangulation. The type of triangulation used here is sequential triangulation since the interviews were based on the results of the survey (Jick, 1979).

According to Earl Babbie's 'The practice of social research' (2007) Interviews can be held in three different ways. These are stated below:

- Structured interviews: the interviewer asks questions and the interviewee is to answer the questions without wandering off from the question. It leaves little room for the interviewee, but major control for the interviewer.
- Non-structured interviews: the interviewer sets guidelines for topics to discuss. The primary goal is to come to a discussion rather than answer predetermined questions. It leaves a large amount of space for the interviewee to talk about a certain topic, however, the interviewer has fewer guidelines.
- Semi-structured: the interviewer asks questions as well as allowing room to deviate from a set structure (Babbie, 2007).

Semi-structured interviews are the most suitable option since the desire was to both ask questions as well as starting a discussion. On the one hand fixed questions are asked to understand the outcome of the survey. But on the other hand topics were addressed to start a discussion about the end users' positive and negative findings on the feasibility of sustainable accommodation.

3.1.3 Setup survey and interview

After choosing the methodology used, it is essential to have a proper setup for both the survey as well as the interviews. Since the survey is more extensive than the interviews, a larger part is written about the survey. The survey was built-up according to two books, Baarda's *'Basisboek enqueteren'* (Baarda, 2007) and Sekaran's *'Research methods for business, a skill building approach'* (Sekaran, 2003).

The first section (3.1.3.1) mentions how Baarda was helpful for the setup of the survey and shows Sekaran's scheme 'Principles of survey design'. The second section (3.1.3.2) discusses Sekaran's topics from his scheme as well as the implementation of these topics in the survey. This section is built-up according to his scheme. The last section (3.1.3.3) briefly shows the setup for the semi-structured interviews.

3.1.3.1 How to make a survey

Baarda et al.'s book gives information about aspects that are relevant for surveys and serves as a step-by-step guidebook to come to a survey. The following topics are discussed:

1. What is a survey?
2. Formulating questions
3. Formulating answer alternatives
4. Finishing off the survey
5. Preparation of fieldwork
6. To take an oral survey

Sekaran illustrates the principles of the survey in the diagram 'Principles of survey design' which is shown below. This diagram shows the aspects of a survey and served as a guideline for the survey. The titles and topics of the following sections are according to this scheme.

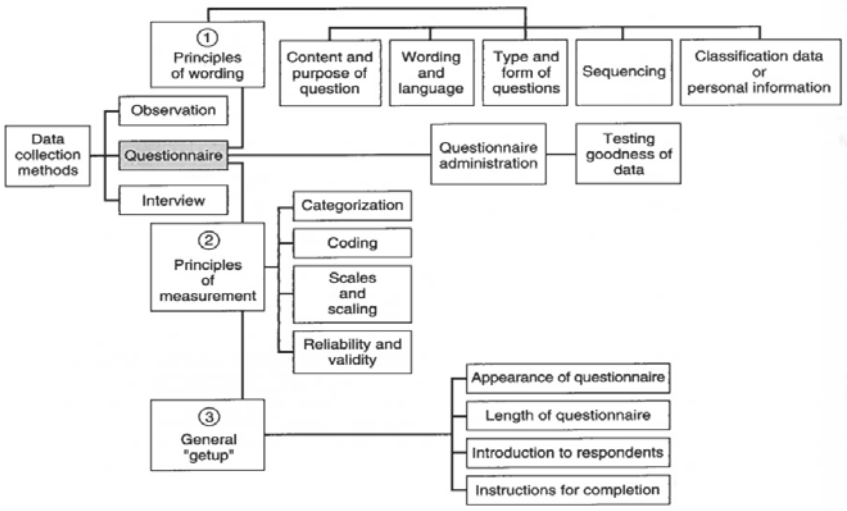


Figure 27 Principles of survey design (Sekaran, 2003).

3.1.3.2 Principles of survey design

Figure 27 Principles of survey design . is divided into three numbered aspects: 1. Principles of wording, 2. Principles of measurement, 3 General "getup". The following sections are divided in the same order to discuss the build-up of the survey used for the master thesis.

3.1.3.2.1 Principles of wording

The first step in Sekaran's scheme is the one of principles of wording which discuss the following five topics:

- Content and purpose of question
- Wording and language
- Type and form of questions
- Sequencing
- Classification data

Content and purpose of question

The content and purpose of the questions are divided into eleven categories. Briefly each category used for the survey is discussed below.

A. Origin respondent

Characteristics of the respondents are asked to receive background information. This information is necessary, to determine patterns from different types of respondents. For example the wtp for sustainability may differ between the commercial or public sector.

B. Definition sustainability

In this category general questions about sustainability are asked to enhance the 'feeling' of the respondent for sustainability before answering the rest of the survey's questions. Definition of sustainability, CSR policy, importance of sustainable accommodation and aspects that represent sustainability are topics addressed here.

C. Priorities of sustainability

A question is stated where the BREEAM categories are mentioned from which the respondents have to state their top three. Conclusions are drawn about which aspects of BREEAM the user finds important. As mentioned in the research design, chapter one research setup, the data collected in this part of the survey is used as input for the second part of the research 2. Life-cycle costs.

C1. Health & Comfort C2. Energy C3. Transport C4.Water

The questions in this category go more in depth into some of the categories of BREEAM. The questions addressed are BREEAM's categories which have direct influence on building aspects. For instance, the amount of daylight (from the health & wellbeing category) is a question in this category and a management plan for reducing the amount of energy (from the management category) is not. End users' priorities within a certain BREEAM category are concluded from this. These conclusions form the input for the LCC calculation.

D. Choice for accommodation

Two questions are asked. The first question is to find out whether users would like to focus on newly built office space or on redevelopment. The Dutch office market has a high vacancy rate, therefore real estate companies should focus more on refurbishment than on newly built. This question is to see whether users share the same point of view. The second question is to see how important sustainability is in their choice for accommodation related to the aspects that influence the choice for accommodation the most. The aspects that influence choice of accommodation the most are obtained from Neecke's master thesis (Neecke, 2007).

E. Realisation

This question determines the progress of organisations in reaching their goals for sustainable accommodation. The data obtained through this question helps to define the progress that has and has not been made in order to achieve tomorrow's sustainable world.

F. Financial aspects

Estimations of investment costs, wtp in rent for sustainability, wtp for sustainable aspects and a green lease question are asked here. This category gives information on office users' wtp for sustainable accommodation.

G. Law and regulation

This category is about the development of law and regulations for the coming five years. Two questions are asked, one about the respondents' opinion and one about their expectations. The data obtained from this category gives insight into the wishes of end users for government involvement in coming to a more sustainable built environment.

H. Advantages sustainability

Two questions are addressed in this category. The first is about which advantages are desired the most. The second is about the wtp for these advantages.

I. Sustainability certificates

BREEAM-NL recently became operational in The Netherlands. In this category questions are asked about sustainability certificates and BREEAM in particular. The user's opinion regarding the use of sustainability certificates is asked.

J. Planning

In this category the respondent is asked when they want to be accommodated in sustainable office space. The urgency for sustainable accommodation is measured in this category.

K. Finalising

Finally, the respondent is thanked for their cooperation, asked whether they would be interested in the results and if they could be contacted again for further questions regarding the survey.

Wording and Language

Aspects regarding wording and language are not too complex and often considered automatically when designing a survey. Most of these aspects will not come as a surprise. Because since it is important to use the correct wording and language in a survey, the wording and language aspects according to Baarda and Sekaran are mentioned below.

Three aspects are important regarding wording and language of a survey. The first is to be as objective as possible in a survey (Baarda, 2007). Therefore, the wording and language that is used must be well considered. If not, it is very likely that respondents will give biased answers. The second aspect that is important is that no room is left for interpretation by the respondent. The respondent must answer the question the way it is intended.
The third important aspect is that everybody understands the questions that are asked. The questions need to be well explained since respondents come from different backgrounds with different knowledge (Sekaran, 2003).
The tips below regarding wording and language were kept in mind during the design of the survey (Baarda, 2007):

- Avoid jargon & technical wording
- Clear descriptions and avoid vague wording
- Keep it simple
- No questions about more than one subject
- No directional questions, stay neutral
- Be careful with sensitive subjects, it can create resilience
- Be aware of the context in which questions are asked

Type and form of questions

Like 'wording and language,' aspects regarding 'type and form of questions' are likely to show no surprises, but useful to mention for the completeness of the survey's setup.

According to Sekaran, three types of questions can be used for a survey: open, closed and qualifying.

- Open questions are questions where a lot of space is left open for the respondent to answer.
- Closed questions are questions where the respondent must choose an answer from the list.
- Qualifying questions are questions that are asked to determine if the respondent is suitable to answer a follow up question (Sekaran, 2003). For instance if a question is asked about investment costs then only those people should answer the questions who have the knowledge about investments. Therefore a preceding question is necessary to determine whether the respondents are owner-occupiers or tenants.

Closed and qualifying questions were used in this survey. No open questions were asked because these are likely to show a wide range of answers and therefore will be more complicated to interpret.
Qualifying questions were asked in two categories, A. Origin of respondent and C. priorities of sustainability. To illustrate this, in category A. this was done for the question where respondents state whether they are a tenant or owner-occupier. The idea for this is that tenants receive questions about rent and owner-occupiers about investments.

Sequencing

Sequencing is the way the questions and the whole survey are ordered. A clear build-up of the survey is desired, this will decreases the complexity of a survey. Ordering the survey in a logical manner is helpful to achieve this clear build-up.

Classification data

The purpose of classification of the data is to get to know more about the professional and personal background of the respondents. This background information is treated in the first category of the survey.

3.1.3.2.2 Principles of measurement

The second step in Sekaran's scheme is the one of the principles of measurement which discusses the following four topics:

- Categorisation
- Coding
- Scales and scaling
- Reliability & validity

Categorisation

Categorisation is the first step in organising the data obtained from the survey. The data was obtained digitally and collected through Inquisite in MS Excel.

Coding

Coding is further organising the data for more statistical research. Two types of statistical research is done in SPSS. These are a hypothesis test for two variables and a consensus test. To do this test in SPSS, the two variables must be recoded into numbers.

Scales and scaling

The possible scales and scaling are mentioned below. This paragraph will conclude with the type of scale and scaling used for the survey.

Different kinds of scales and scaling can be used for the answers. Sekaran describes different options as listed below:

Type of scaling:

- Nominal scale: a nominal scale is one where the respondents choose an answer from a list. Eg. "How important is sustainable accommodation for your organisation." Then a number to indicate the importance are the possibility for answers.
- Ordinal scale: an ordinal scale not only categorizes the variables in such a way as to denote differences among the various categories, it also rank-orders the categories in some meaningful way. It is ordering accordance to some preference (for instance ranking). The ordinal scale does not give any indication of the magnitude of the differences among the ranks.
- Interval: it measures the magnitude of the differences in the preferences among the individuals.
- Ratio: ratio scale overcomes the disadvantage of the arbitrary origin point of the interval scale, in that it has an absolute (in contrast to an arbitrary) zero point, which is a meaningful measurement point (Sekaran, 2003).

Scale attitude:

Rating scales and ranking scales. Rating scales have several response categories and are used to elicit responses with regard to the object, event or person studied. Ranking scales make comparisons between or among objects, events or persons and elicit the preferred choices and ranking among them. Rating scales are used to measure most behavioral concepts. Ranking scales are used to make comparisons or rank the variables that have been tapped on a nominal scale (Sekaran, 2003).

- Nominal scale lends itself for dichotomous or category scale.
- Ordinal scale lends itself for ranking scales, either paired comparison, forced choice or comparative scale.
- Interval scale lends itself for the other rating scales.

Rating scales are (Sekaran, 2003):

- Dichotomous: this is a 'yes' or 'no' answer question
- Category: here there are different options given and one must be chosen. For instance, "in which sector is your organisation working?"
- Likert: how much people agree or disagree with a statement on a 5 or 7 point scale.
- Semantic differential: Bipolar adjectives are used in the answer, bad-good, ugly-beautiful.
- Numerical: This is the same as semantic differential, but then supplied with numbers.
- Itemized rating: every number has an item, very unlikely, unlikely, etc.
- Fixed or constant sum rating: state own importance by giving numbers, but the sum of answers has a fixed number.
- Staple: this measures the intensity and direction, so a '-/+' as well as a number
- Graphic rating: graphics are used to clarify the rating.
- Consensus

Ranking scales are (Sekaran, 2003):

- Paired comparison
- Forced choice
- Comparative scale

In the survey nominal scales are used to acquire characteristics about the interviewee as well as opinions on several aspects. Ordinal and interval scales are used to find out the preferences of the interviewee. The different attitudes for rating scales used are: categorized, dichotomous, and numerical scale. The ones used for ranking are forced choice and paired comparison.

Reliability & validity

According to Christiaans et al., reliability has many different meanings, the most common being reproducibility. Reproducability measures whether the data would be identical at a different time or place (Christiaans, Fraaij, de Graaff, & Hendriks, 2004).

For validity Christiaans et al. distinguishes between two types of validity, internal and external. Internal validity describes whether the measured data leads to the conclusions drawn. External validity describes whether predictions can be made from the results obtained (Christiaans, Fraaij, de Graaff, & Hendriks, 2004).

For the current survey to be reliable and valid, the sample should represent the Dutch office market to reduce biased results. Nonetheless it is rarely possible to achieve such a sample. JLL provided the database from which a sample was selected. Although this does not represent the total population, it is a sample with a wide variety of office users due to JLL's extensive contacts in this field. Therefore it is likely that this sample will represent the distribution of type of office users in The Netherlands. Section *3.2.2 A.* this amount of validity and reliability is investigated.

The people contacted for the survey are a combination of the following lists:

- Corporate Solutions newsletter: JLL publishes a newsletter which is sent out to its corporate contacts.
- JLL's End user research of 2008: a similar research was done. Please note that it is uncertain whether these contacts still work at the same company and have a function as a real estate representative. Therefore it was uncertain how many contacts from this list were still representative.
- Email sent to JLL's employees (The Netherlands) to add contacts working in the following departments: Agency, Investor Property Management and Project-Development & Services.
- Facility managers of TU Delft: ten facility managers of various faculties found on the university website were added.

608 people received the survey and 163 respondents filled in the survey. This is a 27% response rate. The process is further discussed in 3.2.1 Process of survey.

3.1.3.2.3 General "getup"

The final step in Sekaran's setup for a survey is the general "getup". According to Sekaran, surveys must be appealing to the respondents to achieve a high response rate (Sekaran, 2003). This can effectively be achieved by paying attention to the following four topics:

- Appearance of survey
- Length of survey
- Introduction to respondents
- Instructions for completion

Appearance of survey

Respondents usually decide in a split second whether or not they fill in the survey. The layout of a survey can influence the response rate. The figure below shows the layout of the survey attempting to appeal to the respondents and creating a higher response rate.

Figure 28 Layout Survey

Length of survey

The length of a survey influences whether a respondent completes the survey (Sekaran, 2003). A survey sent by email to a list of customers should take no longer than ten minutes (Christiaans, Fraaij, de Graaff, & Hendriks, 2004). This survey took around eight minutes to complete. The reason for being rather long is because many topics were addressed very much into detail for this research.

Introduction to respondents

The introduction of the survey determines the respondents' 'go or no go'. The introduction should be clear, brief and complete. See the appendix for the introduction of the survey.

Instructions for completion

The survey itself must be clear for the respondent throughout the process. This can be explained in the introduction or during the survey. The advantage of doing this during the introduction is that the process of the survey is clear right from the start. The disadvantage is that the introduction might become too long. In this survey it was possible to mention the instruction in the introduction without comprising the introduction to be clear and brief. Therefore the instructions were mentioned in the introduction.

3.1.3.3 Setup Interview

This section gives a brief setup for the interviews and names the people that were interviewed.

3.1.3.3.1 Type of questions

The preliminary results of the survey served as a guideline for the interviews and were converted into questions. The semi-structured interviews were based on these questions.
Some of the topics addressed were:

- Pitfalls and catalysts for sustainable real estate
- Financial aspects
- Green labels
- Government

The setup for the semi-structured interviews are shown in the appendix.

3.1.3.3.2 Interviewee

During the survey, the respondents were asked whether they could be contacted for further information. 54 respondents (out of 163) showed interest. 90 respondents showed interest in only the results of the survey.
Out of the 54 respondents the following people were interviewed:

- F. Kerstens, *Senior portfolio manager real estate* ABN AMRO Bank
- L. van Leersum, *Director Real Estate EMEA* Royal Philips Electronics
- F. Verwaaijen, *Managing director* TNT Real Estate

3.1.4 Survey analysis

Different methods can be used to analyse a survey. This section states which methods were used for this survey. Firstly descriptive statistics are mentioned and statistical analysis hereafter.

3.1.4.1 Descriptive statistics

Descriptive statistics form the basis for analysing results of the survey. Descriptive analysis show simple results ordered in different manners. Most of the results are shown in a graphical manner (Trochim, 2006). The three descriptive methods used are:

- Directly visualising the answer: for some questions it is less interesting or even impossible to do statistical research on the outcome. The conclusions from these questions will be directly drawn from the answers. This is less scientifically justified, but it does show a tendency of the preferences of the end users.
- Box plot: in some cases box plots are a possibility to gain insight in the distribution of the answer. A box plot is a Box-whisker diagram which shows the median, spread and interquartile range of scores in one graph (Field, 2005). In the figure below an example is shown. The box plots were made using SPSS 16.0.

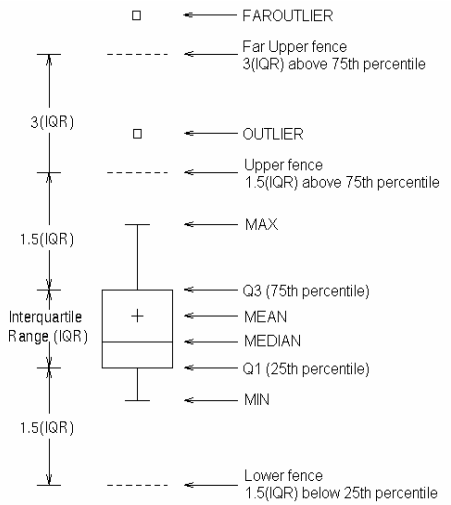


Figure 29 Example of a box plot
Source: (SAS Instiitute Inc., 2010)

- Interviews: the in-depth interviews serve as a support for the outcome of the survey. The interviewee's opinion is connected to the outcome of the survey and vice versa to come to less biased answers.

3.1.4.2 None-descriptive statistics

For some questions of the survey it is possible to look at the difference between certain groups using statistical analysis. This is done for the groups: commercial sector vs. public sector, large sized firms vs. other sizes and tenants vs. owner-occupiers. The tests done are the independent two tailed *t*-test and the Kendall's W test. Both are briefly explained below.

- Independent two tailed *t*-test: with this test two means are compared. It determines the chance whether one group answers different from another group (Field, 2005). To explain for which questions this can be done, an example is used. Several questions are as follow "*how important do you find … (give a number from 1-10, 1 being most important and 10 the least)"* These 'numbering' questions can be analysed using the two tailed *t*-test to see whether there is a significant difference between different groups of respondents. This was done utilizing the independent *t*-test. This test was done in the statistical computer software program SPSS 16.0.

- Kendall's W: kendall's W test determines whether there is a consensus in the way the respondents rank the question. In other words, whether people give the same order of ranking (Schmidt, 1997). Several ranking questions that can be analysed using the Kendall's W test are as follow *"in which order do you find the following aspects of …. Important (rank these answers from 1 to ….)".*This test was done in the statistical program of SPSS 16.0.

Kendall's W	Interpretation	Confidence in Ranks
.1	Very week agreement	None
.3	Weak agreement	Low
.5	Moderate agreement	Fair
.7	Strong agreement	High
.9	Unusually strong agreement	Very high
W = 1	Complete agreement	Very high

Figure 30 Amount of consensus for Kendall's W score.
Source: (Schmidt, 1997)

3.2 Results

This section discusses the results in the same categorical manner the survey was conducted. The first category addressed is about the organisation, the second about sustainability in general and after these questions, more specific ones are addressed about preferences, ambitions and willingness to pay regarding sustainability. Per category a table is shown in which shows the addressed topics. The categories are:

A. Sample descriptive
B. Definition sustainability
C. BREEAM categories
D. Choice for accommodation
E. Ambitions
F. Financial
G. Legislation
H. Advantages
I. Energy label & sustainability certificates
J. Planning
K. Further contact

The representativeness of the sample, was checked using Bak's 'Kantoren in cijfers 2009' (Bak, 2010). The questions B3, B4, C1, C2 and D1 were suitable to do statistical research. Box plots and two tailed *t*-test were done. This statistical research was done for different sectors, sizes of organizations and rental/ownership.. Question B4 was suitable for a Kendall's W test. B3, C1, C2 and D1 were suitable for a two tailed *t*-test. Only the relevant results are shown.

For the other results counts the same, not all results are shown only the relevant results. These results are analysed using graphs, relatively simple calculations and literature. It will be mentioned how many respondents answered the question, when other than the total 163 respondents answered the question.

In the appendices a scheme is shown of all the questions added with information such as why the question is asked, to which sub question it is linked and its answering bandwidth.

Before all this, a brief overview of the survey's process is given.

3.2.1 Process of survey

A pilot study was done using the draft version of the survey to enhance the quality of the survey. People that undertook this pilot version are Koppels from the TU Delft, Langbroek and Quispel as well as two other employees from JLL, my parents, girlfriend and two fellow graduates from the TU Delft. The comments of this wide variety of people resulted in a final version of the survey suitable for every kind of office user.

The final survey was sent by e-mail with a guiding letter. The goal of the guiding letter was to increase the response rate. The email was made attractive, concise as well as fully informational. To create an attractive letter, every respondent was addressed personally using mail merge of ms word through ms outlook.

Table 6 Process of response

Guiding e-mail	Amount
Same day	21
1 day after	23
2 days after	12
3 days after	5
1st reminder	
same day	29
1 day after	34
2 days after	13
3 days after	5
2nd reminder	
same day	11
1 day after	6
2 days after	2
3 days after	1
Later	1
Total	**163**

In the first section of the guiding letter, the goal was explained, in the second why the survey is important for the respondent, in the third the effort needed and benefits for the respondent, in the fourth my research explained and the link towards the survey. The full email can be seen in the appendices.

Two reminders were sent 4 working days after its predecessor, being the previous reminder or initial invitation. These emails were sent out at 11:30 hour, so the respondent was likely to read it right before or after lunch. This time of the day is the biggest chance respondents have a spare moment they could use to fill in the survey.

Although expected, it was interesting to see that more respondents participate in the survey shortly after the email (reminder). Table 3 Response process show this process.

A response rate of 27% was achieved. If you compare this to Table 7, it becomes clear that this is a good response rate. The table predicts a response rate of 15-30% since the survey held was medium sized and only a little incentive was given, the results of the survey. The survey was made and administered using Inquisite. The results were interpreted in MS Excel and SPSS 16.0.

Table 7 Typical response rate for respondents
Source: (PeoplePulse, 2010)

Survey Type	Response Rates With invite incentive:	Response Rates With NO invite incentive:
Post-service Client Survey (short length*)	55-75% (with 1 follow-up)	40-60% (with 1 follow-up)
Post-service Candidate Survey (short length)	60-80%	40-60%
General Client Satisfaction Surveys: (medium length**)	15-30% (with 1 follow-up)	Less than 10% (with 1 follow-up)

Short Length surveys consist of up to 12 questions
* Medium length surveys consist of 12-25 questions

3.2.2 A. Sample distribution

This is a general category. The goal is to know the respondent's origin.

Table 8 Questions A. Organisation specifications

A. Classification data & personal information
A1. Type of sector
A2. Position within organisation
A3. Rent / ownership
A4. Office activity
A5. Amount of m2 in building
A6. Type of clients
A7. Amount of establishments
A8. Size of organisation

Some of the results from this category could be combined with other categories. For instance the sector and their wtp: "which sector is more willing to pay for sustainability? Public or private?" This is done for the following groups of respondents:

- Type of sector: public vs. private (A1. Type of sector)
- Size of organisation: small, medium, large (A8. Size of organisation)
- Type of lease contract: Rent vs. ownership (A3. Rent/ownership)

Fout! Verwijzingsbron niet gevonden. shows how many respondents each group contains. For commercial and public sector a box contains the name undefined, because for some sectors it is unclear whether these are public or commercial.

Rent/ownership is also used as a qualifying question. To give an example: if the respondent is a tenant and no owner-occupier, he will receive questions about rent prices and none about investment costs because it is assumed that a tenant has more knowledge on rent prices that he would on investment costs. The share of tenant or owner-occupiers in the survey is shown in Table 9.

Table 9 Respondent's distribution

Dividence	Count	Percentage
Large	90	55%
Medium	48	29%
Small	23	14%
Tenant	91	56%
Owner-occupier	41	25%
Both	31	19%
Commercial	104	64%
Public	37	23%
Undefined	22	13%

A1: Type of sector

Question: *In what sector is your organisation operational?*

The population of the survey is compared to DTZ's take up per sector of the past ten years (DTZ, 2010). A relative comparison is made and shown in the figure below. It becomes clear that the survey's population is very representative for the actual distribution of office users in the Netherlands which makes the conclusions more credible.

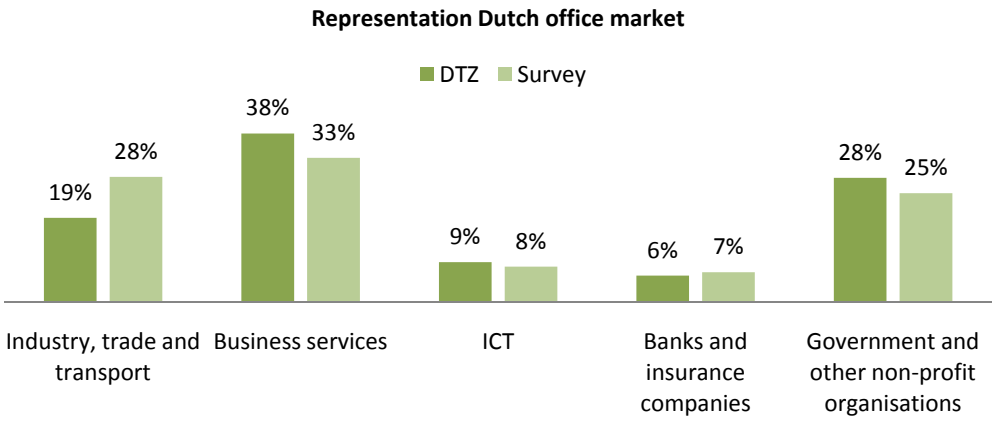


Figure 31 Distribution of respondents and DTZ's office users distribution

A2: Position within organisation

Question: *what is your position within the organisation?*

These results show whether the respondents have a decision making position within their organisation. For this survey to be credible, it is important that the respondents are decision makers. Out of the 163 respondents, 141 respondents are either Real Estate managers or members of the board of directors. So 86% of the respondents are decision makers and therefore respondents have substantial influence on the accommodation of its organisation.

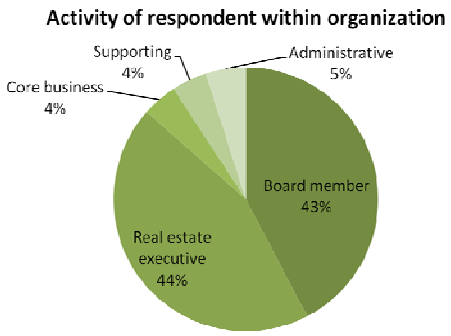


Figure 32 Activity of respondent within organization

3.2.3 B. Definition sustainability

This category is twofold. On the one hand it serves as an introduction of sustainability where topics addressed are about the definition of sustainability, such as: aspects that represent sustainability and CSR policies. Those questions should enhance the respondent's feeling for sustainability and will help finishing the survey.
On the other hand a question (B3.) is asked about the importance of sustainable accommodation. This question is a more detailed question where statistical analysis is possible. The two tailed *t*-test is performed for several groups of respondents.

Table 10 Questions B. Definition sustainability

B. Definition sustainability
B1. Presence of 'MVO' policy
B2. Definition of sustainability
B3. Importance of sustainable accommodation
B4. Aspects that represent sustainability

B3. Importance of sustainable accommodation

Question: *How important is sustainable housing for your organisation in general? (Rate your answer from a 1 to 10 scale.)*

For various groups the means were determined to see how the preferences were sorted for different groups. These means show that small and medium sized companies find sustainable accommodation less important than large sized companies.

Means:
All respondents: 7,3
Small sized companies: 7,1
Medium sized companies: 7,0
Large sized companies: 7,5

The two tailed *t*-test was performed to determine if this difference is significant. Out of this test is shown that large sized companies find sustainable accommodation significantly more important than the other respondents. Table 11 shows the output obtained from SPSS to determine this conclusion. Underneath the table will be explained how this conclusion is drawn.

Table 11 Output two tailed *t*-test size of companies

Group Statistics

	A_Num...	N	Mean	Std. Deviation	Std. Error Mean
B_Belangrijk_duurzame_huisvesting	Groot	90	7,54	1,256	,132
	Andere	73	7,08	1,605	,188

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
B_Belangrijk_duurzame_huisvesting	Equal variances assumed	1,256	,264	2,063	161	,041	,462	,224	,020	,905
	Equal variances not assumed			2,011	134,422	,046	,462	,230	,008	,917

An independent sample *t*-test is performed. In the first, smaller, table of the two, you see this is done for 'groot' vs. 'andere' (large sized companies vs. other sized companies). The H0 zero hypothesis is that large sized companies consider sustainability as important as the

other respondents. H1 one hypothesis is that large sized companies consider differently important than other sized companies.
The larger table of the two shows that levene's test, Sig is 0.264 > 0.05. Therefore 'equal variances are assumed'. In this row, the 'Sig. (2-tailed)' is 0.041 < 0.05 and therefore H0 is rejected. In other words large organisations consider sustainable housing significantly more important than other sized organisations.

For other differences to be significant, the amount of respondents and differences must be larger.

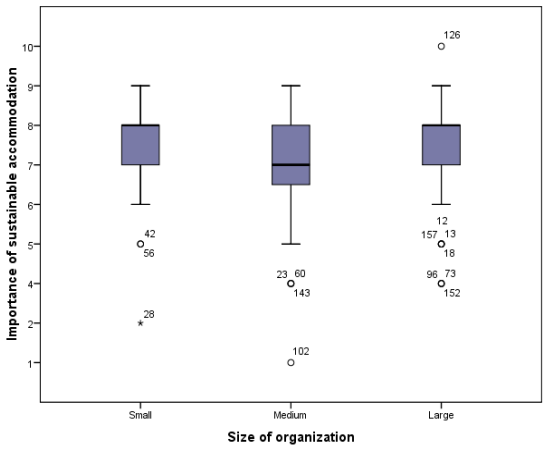


Figure 33 Boxplots for question B3

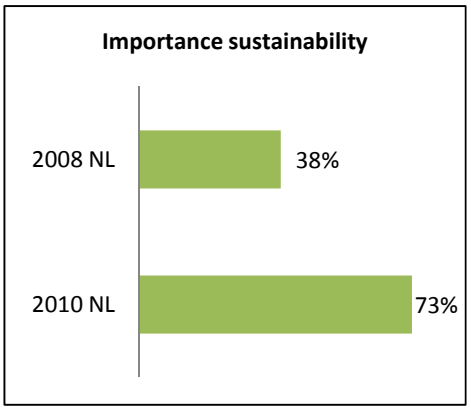


Figure 34 Organisations that consider sustainable real estate to be an important topic

B4. Aspects that represent sustainability

Question: *In what way represent the following aspects sustainability in general the most and least? (An order of ranking from 1 to 9 must be given. No aspect can have the same ranking number as another one.)*

For these answer the Kendall's W test was performed to determine the amount of consensus between the respondents. Table 12 shows the results. The amount of consensus is Kendall's W 0,230. This means a very weak to weak consensus. For different sectors or different sizes of companies the results are negligibly different. This means that people give a different order of ranking to which aspects characterize sustainability the most.

Two interesting points to mention are: Energy ranks number 1 (mean rank is 2,09) by far and 'users comfort' scores the lowest (mean rank is 5,93). A reason that user comfort scores low on this question is because it was about sustainability in general and not real estate specific. Although it still was not expected that user comfort would not be ranked the lowest by users since this is an aspect directly reflecting on them.

Table 12 Output Kendall W regarding aspects representing sustainability according to end users

Kendall's W Test

Ranks

	Mean Rank
B_Energie	2,09
B_Water	4,53
B_Materiaal	4,86
B_Flexibiliteit	5,71
B_Levensduur	4,14
B_Gebruikscomfort	5,93
B_Afvalreductie	4,45
B_Vervuilingsreductie	4,29

Test Statistics

N	163
Kendall's W[a]	,230
Chi-Square	262,278
df	7
Asymp. Sig.	,000

a. Kendall's Coefficient of Concordance

3.2.4 C. BREEAM categories

This category discusses the BREEAM categories.

Table 13 Questions C. Priorities of sustainability

C. Priorities of sustainability
C1. Importance of sustainability aspects for accomodation

First the preference for the different BREEAM categories is asked. This question serves also as a qualifying one. If a certain category is stated to be in the top three (respondents could fill in one, two or three categories), another question about the credits from this category is asked. The categories which have follow up question are the BREEAM categories that imply building specifications: C1.Health & wellbeing, C2.Energy, C3Water and C4.Transport.

The output of this question serves as input for the second part of the research *2. Life-cycle Costs (LCC)*. In this second part some building interventions will be tested in PARAP. The building interventions that will be tested will be those of BREEAM that are found most important by the office users.

C1. Importance of sustainability aspects for accommodation

Question: *Which aspects of sustainability are most important for your housing? (State your top three out of the following aspects)*

The results from the respondents' top three of BREEAM are compared to the weight BREEAM sets to the specific category. This comparison is shown in *Figure 35 BREEAM categories preferences by respondents vs. BREEAM.* The results show a very similar outcome. However, energy is found more important by users. This is not surprising because energy is the most discussed aspect of sustainability. Land use & ecology as well as pollution are found to be less important by users than BREEAM. This can possibly be explained by the fact that other categories of BREEAM are every day encountered by office users and land use & ecology and pollution are not.

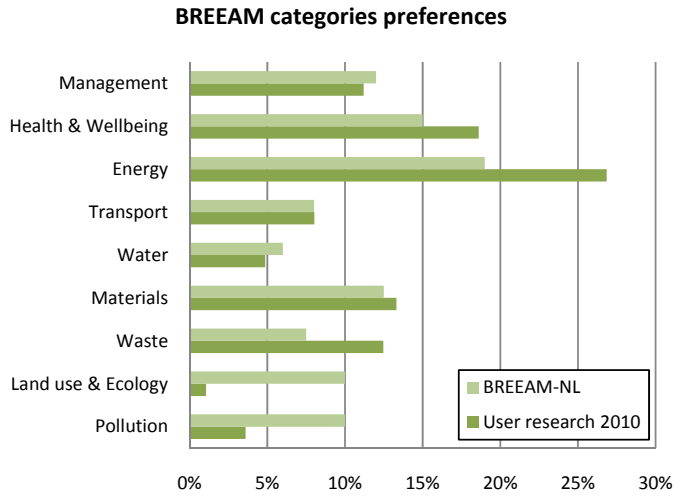


Figure 35 BREEAM categories preferences by respondents vs. BREEAM

Another conclusion drawn from this figure is that energy and health & wellbeing are found most important by the respondents. Therefore these categories are investigated further in by looking at the questions and answers about these two specific categories.

Question: *Within health & comfort, which aspects would you like to see realised? (State the importance of the following aspects, 1 is least important – 5 is most important.)*

C1. Health & Comfort
C1.1. Daylight
C1.2. Free view
C1.3. Sun blinds individually adjustable
C1.4. Type of lighting
C1.5. Lighting individually adjustable
C1.6. Natural ventilation
C1.7. Internal air quality
C1.8. Temperature adjustable per area/individual
C1.9 Sound noise reduction due to good sound insulation

Question: *Within energy, which aspects would you like to see realised? (State the importance of the following aspects, 1 is least important – 5 is most important.)*

C2. Energy
C2.1. Submeasurements, per area
C2.2. Application of sustainable energy
C2.3. Energy efficient external lighting
C2.4. Energy efficient elevators and escalators
C2.5. Energy efficient installations
C2.6. Improved heat insulation

It would be interesting to see significant differences within the two categories of energy and health & wellbeing. But within these questions not all respondents filled in these questions, so the sample of respondents becomes smaller. Below there is a table shown how many of the respondents filled in Energy or Health & Wellbeing. To keep the data sample as large as possible, there only has been looked at large companies compared to the others regarding the energy aspect.

Table 14 Amount of respondents for question C1&C2

Dividence	Count	Percentage
Health & comfort	88	54%
Energy	127	78%

There are no significant differences using the two tailed *t*-test using SPSS. The differences of the averages scores are rather small. For large organizations compared to the other organizations, this is shown in the table below.

Table 15 Average scores for large organisations and other organisations on energy aspects

Energy aspects	Other organizations	Large organizations
Sub measurement	3,11	3,2
Sustainable energy	4,01	3,99
External lighting	3,79	3,71
Elevators & stairs	3,34	3,46
Installations	4,38	4,36
Heat insulation	4,13	4,19

3.2.5 D. Choice for accommodation

In this category, two questions were asked. The first one is about the importance of sustainability in the choice for an accommodation in comparison to other aspects that influence the choice for accommodation. The second is about the focus of office users on sustainable accommodation regarding newly built or refurbishment?

Table 16 Questions D. Choice for accommodation

D. Choice of accommodation
D1. Importance building and location aspects
D2. What accommodation to sustainabilize

D1. Importance building and location aspects

Questions: *How important are the following location and building aspect in your choice for accommodation? (rate the importance from 1 to 5.)*

The results are compared with the Neecke's master thesis 'Klantenbinding bij kantoorhuurders' (customer's loyalty of office users) (Neecke, 2007). She uses research from the NVB (NVB, 2002) and from Twynstra and Gudde (Twynstra Gudde Management Consultants, 2004) to determine which aspects influence office users the most in their choice for accommodation.

The results of this master thesis, shown in *Figure 36 Average rating on aspects which influence the choice for accommodation the most*, are very similar to Neecke's research. This makes the results from this research less biased. This supports that sustainability is among the top influencers in the choice for an accommodation.

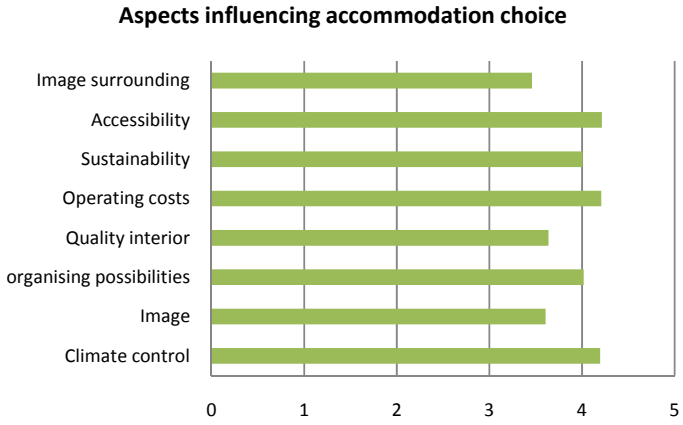


Figure 36 Average rating on aspects which influence the choice for accommodation the most

D2. What accommodation to become sustainable

Question: *if you choose for sustainable accommodation, how do you want to you're your accommodation sustainable?*

Investors want to focus on redevelopment instead of newly built due to the high vacancy the Dutch office market copes with (IVBN, 2009). It would be interesting to know whether office users share this opinion. The result from this question is that 51% focuses on existing real estate but does not want to relocate. Office users like to refurbish their current housing, they do not want to move. When they want to move, they will do so using newly built.

3.2.6 E. Ambitions

This category addresses two questions regarding the realisation of the goals set by the organisations of the respondents. The first question is about the planning for achieving the sustainability goals. The second question addresses how these goals will be achieved in the coming five years.

Table 17 Questions E. Realisation

E. Realisation
E1. Realisation of goals so far
E2. Realisation of goals in the coming five years

90% Of the respondent state to have ambitions regarding sustainable accommodation. Out of the respondents with an ambition, 45% is right on track at this moment and still have to make a big effort to achieve their goals. 9% states to have (nearly) achieved their goals. In five years time 18% of the respondents with an ambition will at least nearly have reached their goals. These results are shown in the pie charts below. The major difference between the two charts is that in five years time two groups have increased: the group who nearly finished their ambitions as well as the group that is right on track, but still has a lot to do regarding sustainable accommodation. This means that the next five years the demand for sustainable real estate will increase even more.

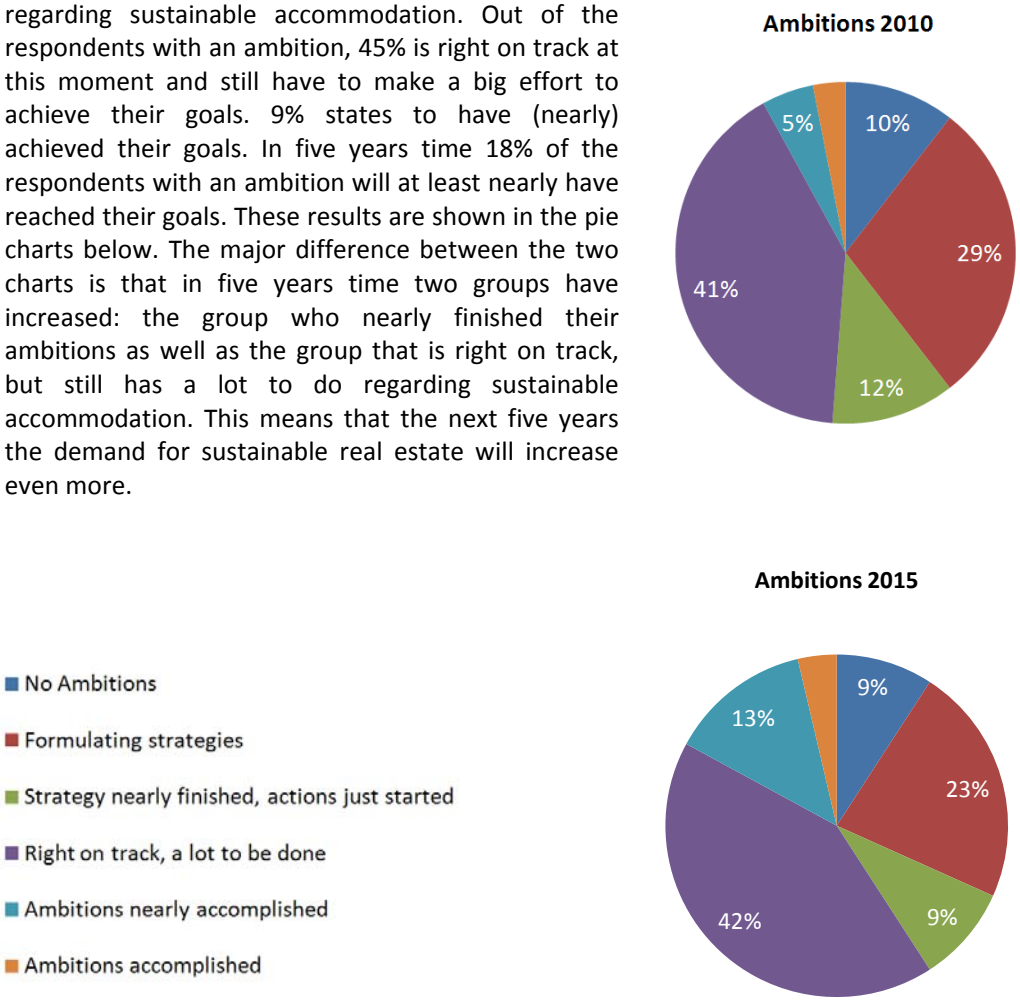


Figure 37 Progress of ambition from 2010 - 2015

3.2.7 F. Financial

This category addresses four questions regarding financial aspects of sustainability. The first question was directed at owner-occupiers about the estimation of realisation costs. The second question was directed at tenants about the willingness to pay for a rent premium when advantages are obtained. The third is a question for tenants about the willingness for a green lease type of contract. The fourth and last question looks at the wtp for the BREEAM categories individually. The first three questions are categorical ones, the fourth is a ranking one.

Table 18 Questions F. Financial aspects

F. Financial aspects
F1. Estimation realisation cost sustainable building
F2. WTP for sustainability in rent (without service costs)
F3. Green lease
F4. WTP for which sustainable aspects

F1. Estimation realisation costs of sustainable buildings (72 respondents)

Question: *What is your estimation on realisation costs for sustainable offices in comparison to traditional buildings?*

The results of this question are compared to JLL's end user research of 2008. This comparison shows a similar tendency: sustainability is considered to be more expensive than conventional buildings to realise. This year's respondents estimate sustainability even more expensive. This might be explained by the fact that people are now more aware of all aspects involved in sustainable real estate. These results are shown in the figure below.

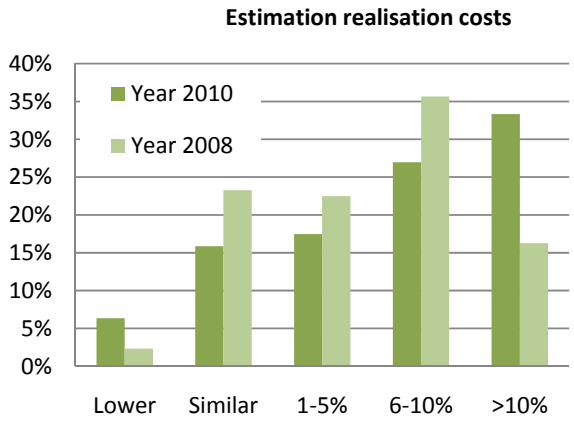


Figure 38 Realisation costs estimation by owner-occupiers

F2. WTP for sustainability in rent (without service costs) (122 respondents)

Question: *are you willing to pay a premium in rent for sustainable accommodation? Achievable advantages are higher productivity employees, lower sick leaves and image improvement. (Advantages regarding service costs are not considered here.)*

Respondents were able to fill in a range (0%, 1-2%, 3-5%, 6-9% and >9%). From the results an average was calculated. The conclusion is that respondents are willing to pay 6% premium in rent. Due to the research method used it is difficult to state that all end users are willing to pay exactly 6%, however end users are willing to pay more for sustainability. This result supports Kok's outcome of 3% premium (Eichholtz & Kok, 2008)and Triodos' outcome of 5% rent premium. Triodos performed a case study from which they conclude that sustainable buildings generate a 5% higher rent value (Berkhout, 2010).

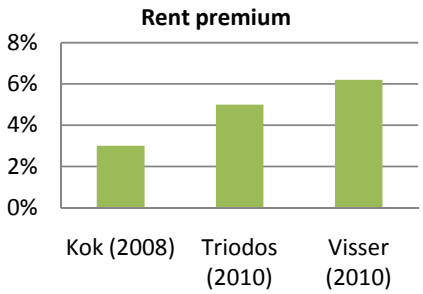


Figure 39 Rent premium end users are willing to pay

F3. Green lease (122 respondents)

Question: *A sustainable building uses less energy and water than a conventional building. What part of these savings in service costs are you willing to pay-back through a higher rent?*

Respondents were able to fill in a range (0-30%, 30-45%, 45-60%, 60-75%, 75-90% and 90-100%) From the results an average was calculated. The conclusion is that the respondents are willing to pay 32% of the savings in a higher rent. Snoei's 'huisvestingsvoorkeuren kantoorgebruikers' (accommodation preferences of office users) concluded a willingness to pay of 70% out of a similar survey in 2008 (Snoei, 2008).

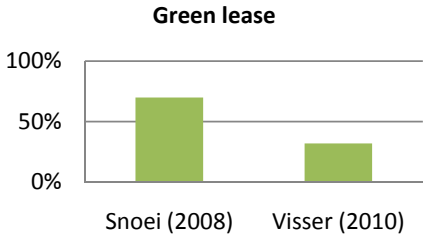


Figure 40 Percentage of service costs savings end users are willing to pay-back in a higher rent.

It would be interesting to see how the results from F2. And F3 relate to each other. They both measure percentages, but relate to different aspects. To be able to make a comparison, a fictive building is used. The fictive building comes out of PARAP with its default input. For explanation on PARAP I would like to refer to the chapter 4. Output from PARAP, such as size and service costs are used for the comparison. Additional information on average rent level is obtained from JLL and energy savings potential from CBRE (see chapter 2). The total rent per year can now easily be determined. The total rent per year is multiplied by the rent premium end users are willing to pay (see previous page), to determine the additional profit investors can get from the rent premium. This is € 45.801,- The total service costs per year are multiplied by the savings potential to determine the annual service costs savings (€ 26.400,-). This annual savings are multiplied by the percentage end users are willing-to-pay back in a green lease, to determine the additional profit the investor can get from energy-savings. This is € 8.448,-

Table 19 Comparison between the wtp of end users for green lease and rent premium

Input		Quantity	Source
Full-time equivalent		200	PARAP
Lettable floor area (m2)		5089	PARAP
Average rent/m2/year	€	150	JLL
Total rent per year	€	763.350	
Total service costs per year	€	66.000	PARAP
Average energy savings potential		40%	CBRE

Annual service costs savings	€	26.400

WTP End users	
Green lease	32%
Rent premium	6%

Additional profit investor		
Service costs	€	8.448
Rent	€	45.801

This would mean that end users are willing-to-pay over 5 times more for other advantages than energy-savings. Therefore it suggests that end users are by far more willing to pay for either image advantages or productivity and sick leave advantages.

F4. Willingness to pay for sustainable aspects

Questions: *for which aspects of sustainability are you most willing to pay in a higher rent?*
This is a ranking question where respondents were not obliged to fill in all answers. This was done not to force the respondent. It is very likely that for some aspects of sustainability, the respondents are not willing to pay. Forcing respondents to rank all aspects could create biased results. However for a Kendall's W test it is imperative that all answers are filled in and therefore it was impossible to perform this test.

The top three and the bottom three in combination with the amount of times aspects were filled in was considered. The top three respondents state energy (57% of respondents) and health & wellbeing (49% of the respondents) as most important. The third most favorable

one is water where only 20% of the respondents rate it in their top three. The least favorite aspects of BREEAM to pay for are by far management and land use.

When these results are compared to the question of C1. BREEAM categories, it shows the same tendency. This means that end users are willing to pay for the same BREEAM aspects they find important. This sounds logical, but can be seen as a control question if end users will pay for what they define as important.
However one category differs: Management is found to be reasonably important but not so favorable to pay for.

3.2.8 G. Legislation

This category states two questions about legislation. The first is on what end users expect to happen. The second is on what end users think should happen. The results are shown in *Figure 41 the respondents' opinions and expectations on legislation.*

Table 20 Questions G. Legislation

G. Legislation
G1. Expectation development law coming years
G2. Opinion development law coming years

96% of the respondents say that they want the government to take actions for a more sustainable office market. So office users say they feel the need for the government to guide this process. This can be put on to the contrary of what the IVBN (Dutch real estate investor institute) states. The IVBN pleads for less intervention by the government (on redevelopment) they consider becoming sustainable a task for market parties and not a task of the government (IVBN, 2009).
The figure below shows a lot of similarities between respondents' expectation and to what they want. But a remarkable conclusion is that the respondents (90%) do not expect, and do not want the single intervention the government is working on to implement. This intervention is, *'fines for not using energy labels during a transaction'* (Vastgoedmarkt, 2009). A reason for this could be the way of asking the question since there asked about fines and fines are usually not popular.
Legislation most preferred by end users are the obligation of sustainability certificates for newly built (54%). Three other popular legislation possibilities are: sharpen the EPC for newly built (43%), put tax on non energy efficient buildings (42%) and setting more & higher subsidies available (42%).

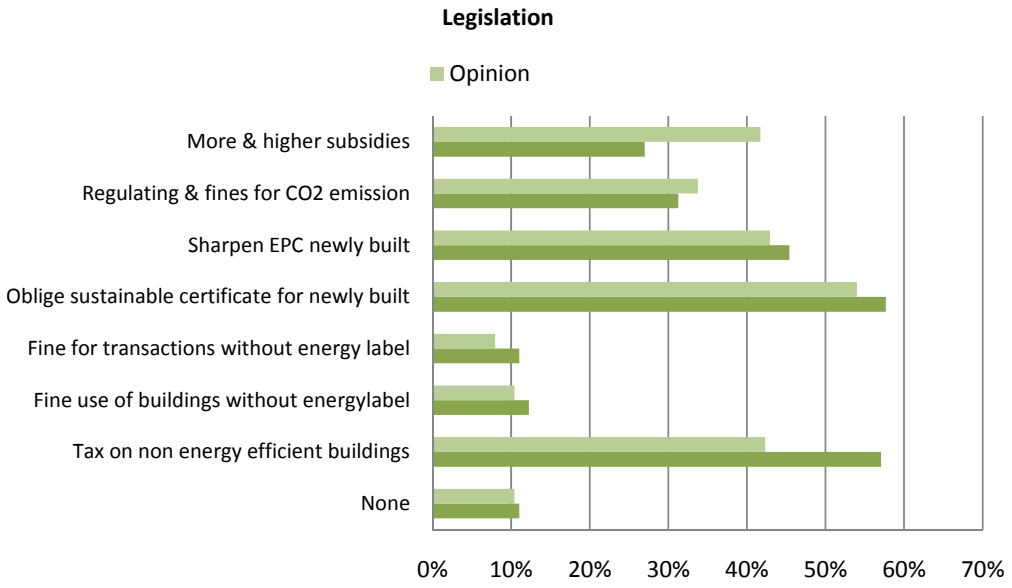


Figure 41 the respondents' opinions and expectations on legislation

3.2.9 H. Advantages

In this category three questions were asked. The first is a ranking question for preferences of advantages. The second and third are questions about the willingness to pay for the positive impact realised by a sustainable accommodation.

Table 21 Questions H. advantages of sustainability

H. Advantages sustainability
H1. Which aspects most positive impact on accomodation
H2. WTP for this positive impact in rent
H3. WTP for this positive impact in investment

H1. Which aspects most positive impact on accommodation

Question: *Which aspects will have most positive impact on your accommodation?*

As stated above, the first question is a ranking question. Respondents were not obliged to fill in all answers. This is because some answers do not count as an advantage for the respondents. Forcing the respondent to fill in all answers would result in a biased answer. But during the analysis it became clear that for a Kendall's W calculation, it is imperative to have filled in all answers and this is impossible. The analysis was done in the same way as F4. This was done for rent, ownership and all the respondents.

The conclusion from this is that the advantages most preferred by office users are: first maintenance cost, second image, third service costs and fourth productivity of employees. Only looking at owner-occupiers, economic lifespan expansion is considered the most favorable together with maintenance costs. Accessibility is by far the least favorable one.

H2. WTP for the positive impact in rent (122 respondents)

Question: *How much are you prepared to pay for this positive impact in rent?*

This is a control question. It is similar to question F2. These questions were as follows:

- F. Financial aspects: are you prepared to pay a premium in rent for a sustainable office building?
- H. Advantages: how much are you prepared to pay for this positive impact in a rent premium?

The results from both questions are visualized in the figure below. What can be concluded is that the results, are rather similar. Between 80-85% of the respondents are willing to pay a premium in rent for sustainability. Around 85% of these respondents are willing to pay up to 5% of premium. This enhances the reliability of the survey since the respondents answer two times in the same way.

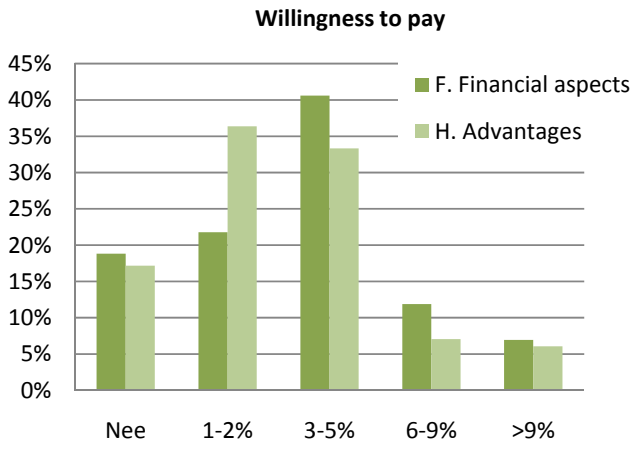


Figure 42 Control graph regarding wtp

H3. WTP for the positive impact in investment (72 respondents)

Question: *How much are you prepared to pay for this positive impact in investment?*

This question was directed at owner-occupiers. The results are compared with H2. and F1. Estimation realization costs. 80-85% of the respondents (both tenants and owner-occupiers) are willing to pay a premium for sustainability. Owner-occupiers tend to be more willing to pay. This might be because image advantages are more visible for owner-occupiers than tenants. Out of the comparison with the estimation for realisation costs, it becomes clear that owner-occupiers expect a sustainable development to be more expensive than they are willing to pay for it. This could explain the reluctance of building sustainable offices.

3.2.10 I. Energy label & sustainability certification

Two questions are asked regarding energy labels and sustainability certificates. The first question is a qualifying question on their interest for a green certificate. If answered yes, a follow up question arises on the willingness to pay for a certificate. The second question is about the preference for what sustainability label.

Table 22 Questions I. sustainability certificates

I. Sustainability certificate
I1. Willingness for a sustainable certification
I2. Choice of sustainable certificates

I1. Willingness for a sustainable certification

Question: *Would you like to have a sustainable certificate when housed sustainable? (163 respondents) Are you willing to pay for a sustainable certificate? (138 respondents)*

The majority of the respondents have a positive stand on a sustainability certification if their accommodation is sustainable. Corenet's global survey from 2009, concludes that 90% of the end users find energy labels or sustainability certificates important (Probst, Wallbank, Hirigoyen, & Anderson, 2009). This is a similar outcome to the 85% from this research. However the respondents state it is the responsibility of the investor to pay for this, since nearly 70% is not willing to pay or only a small part for the certification.

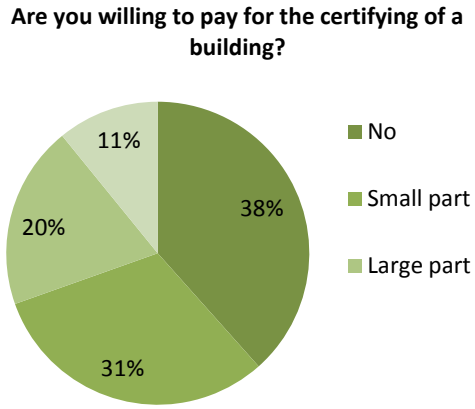


Figure 43 Wtp for a certification

I2. Choice of sustainable certification

Question: *Which sustainable certificate do you prefer?*

The results are shown in the figure below. Almost half of the respondents are not familiar with the existing labels and certificates. Office users being unfamiliarity for green certificates might be an explanation for the reluctance to sustainable real estate, people do not know what sustainable is. But when a respondent is familiar, the preference for a label lies within BREEAM first.

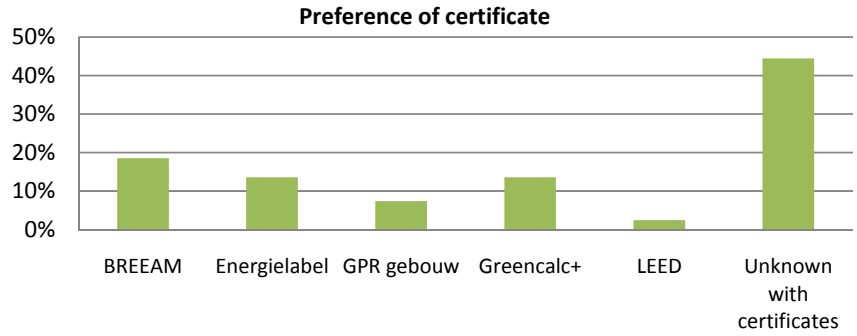


Figure 44 Preference of the respondent for an energy label or sustainability certificate

3.2.11 J. Planning

This category only addresses one question. It is about when the respondents plan to be housed sustainable.

Table 23 Question J. Planning

J. Planning
J1. When must accommodation be sustainable

This same question was asked two years ago within JLL's research. The results from 2010 and from 2008 are shown in the figure below. In 2008 organisations planned to take a shorter time for their real estate to be sustainable. Two reasons can be appointed for this phenomenon. The first is that people became more aware of what sustainability is and know it is not a process that can easily be achieved within a few years. The other reason is the economic crisis. Organisations have become more precautious to invest in 'unknown' territory and therefore are reluctant to be the 'first'.

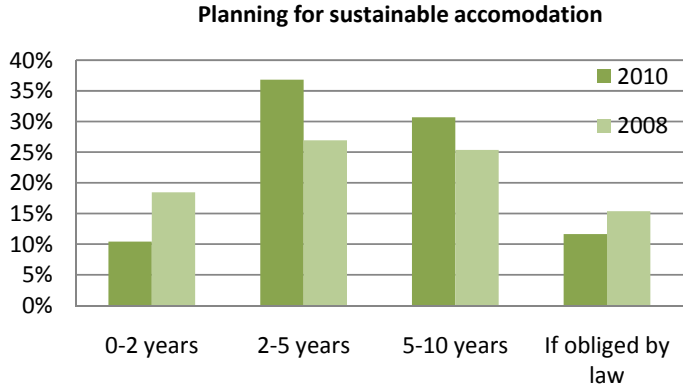


Figure 45 time span when organisations want their real estate to be sustainable

3.2.12 K. Further contact

This category addresses two questions. The first question was about whether the respondent would be interested in the results of the survey and the second whether he could be contacted again regarding the survey. It is interesting to see that 60% of the respondents were interested in the results of the research and 33% is willing to be contacted again. This last question was required for the semi-structured interview. The survey was kept as anonymous as possible to prevent social desired answers.

3.2.13 Results in-depth interviews

The results obtained from the interviews support the outcomes of the survey. So the qualitative data supports the quantitative data. These results are implemented into 3.3 Summary & conclusions. Below a brief summary is given for each interview.

F. Kerstens, ABN Amro Bank:

The integration of ABN Amro and Fortis has its effect on the bank's real estate. This re-organisation caused the disposal of some of its real estate. In the coming years, 150 offices and banks need to be disposed. And the effect of the credit crisis made ABN Amro to focuse on cost reduction. For its real estate, ABN will do so by arranging their office accommodation more efficiently, using 'het nieuwe werken' (the new office concept). Their goal is to go from 1,1 workplace/FTE to 0,7 workplace/FTE. This can be seen as an aspect of sustainability: when less space is used, less material and energy is used.

Sustainability in general is considered when moving to a new accommodation, but not considered for its current housing. But their focus remains on disposal rather then sustainability.

F. Verwaaijen, TNT Real Estate:

Flip Verwaaijen is one of the pioneers for sustainable real estate in The Netherlands. Verwaaijen's focus during the interview regarding sustainability was on the total costs of ownership. In my research I refer to this as the life-cycle costs. Verwaaijen's opinion is that if one wants to become sustainable, total costs of ownerships as collaboration between tenant and investor during initiative, build and operation of the building is the way people need to look at sustainability.
The costs of a sustainable building should be the same or lower than in a traditional one. What this means is that although the investment costs are higher, these extra costs can be earned back through lower service costs. This pleads for a green lease type of contract. In its Dutch headquarter TNT realised this type of contract together with the Triodos bank. Within this contract, the tenant as well as the investor has responsibilities to achieve the lower service costs involved in a sustainable building. The tenant would be responsible for the service costs influenced by him and the same kind of responsibility would be for the investor.

L. van Leersum, Philips:

At the moment of the interview, Philips was working on a policy regarding sustainability and its accommodation which can be used worldwide and meets it's own sustainability principles.

"To help fulfil its EcoVision targets, Philips participates in the Global Green Building Council and helped establishing the Dutch Green Building Council. Philips also signed the "Manifesto for Energy Efficiency in Buildings" initiated by the World Business Council for Sustainable Development (WBCSD)." (Leersum, 2010)

Although logical it is interesting to mention that Philips' sustainability policy is predominately focused on energy-efficiency which is one of its core businesses. This shows that the definition of sustainability is differently interpreted by different types of organisations.

3.3 Summary & conclusions

Sub-questions regarding the end user were investigated in this chapter and will be answered in this section. The questions are the following:

1. End user

- *What are the end user's preferences?*
  - Which sustainability aspects? Label?
  - Planning?
  - Governmental attitude?
  - Importance of sustainability in choice of accommodation
- *What is the end user's willingness-to-pay?*

To come to answers to the above mentioned questions a survey was conducted (163 respondents, 27% response rate) and three semi-structured in-depth interviews were held. The setup of the survey was made according to Baarda's book *'Basisboek enqueteren'* and Sekaran's book *'Research methods for business, a skill building approach'*. A wide range of questions was asked, some were general about sustainability and others were detailed. The analysis of the survey was done using descriptive statistics as well as hypothesis and consensus testing the Kendall's W and the two tailed *t*-test are done respectively to measure the consensus and to test hypothesis. The survey's sample is obtained from JLL's database.

This direct customer survey is made as valid, reliable and unbiased as possible. This is done using eight measurements:

- Anonymity of the survey to prevent social desired answers.
- The survey started with general questions which serve as information on the subject to enhance the respondent's expertise on sustainability which could be useful for the other questions.
- The sample represents the Dutch office market. This was checked with the distribution of the transactions from the past ten years done by DTZ (DTZ, 2010).
- 86% of the respondents are decision makers and therefore have influence on the accommodation of their organisation.
- Two control questions are asked. These are questions which ask the same answer but use a different question. This is done to see if respondents answer consistently. The conclusion is that the respondents did answer the same.
- Semi-structured in-depth interviews were held to support the outcome of the survey.
- Statistic research was used to support the results obtained from the survey.
- Results of the survey were compared to previous research.

The results are discussed in the following order: firstly more in general about the importance of sustainability, the end user's ambition and their planning. Secondly brief about newly built vs. redevelopment. Thirdly about sustainable aspects, certificates and advantages of sustainability. Fourthly about financial aspects and there will be concluded with results regarding the government.

Sustainability is becoming increasingly important. Over 70% of the respondents find sustainable accommodation to be important. Globally this was already 70% in 2009 (Probst, Wallbank, Hirigoyen, & Anderson, 2009). But in the Netherlands only 38% of the Dutch office users stated sustainability to be important in 2008 (Houtman, Quispel, & Martinus, 2008). For large organisations, this is significantly more. This is likely to be because for large companies public exposure is more important than it is for small companies. Sustainability can positively contribute to this public exposure. Leon van Leersum, director real estate Philips EMEA, states that sustainability is an opportunity to improve the image of an organisation. For listed companies even more since this can (positively) influence its share on the stock exchange (Leersum, 2010).

Although sustainability is more important, the planning of office users to be accommodated sustainable is longer then it was in 2008. In 2008 21% of the respondents stated to be accommodated sustainable within two years (Houtman, Quispel, & Martinus, 2008) In 2010 this is only 11% of the office users. There are probably two reasons that caused this phenomenon:

- The process of accommodating sustainable. End users are more aware of the effort that needs to be made to be accommodated sustainable.
- The economic crisis. End users are more careful with their assets. Consolidating is more likely than investing. Frank Kerstens, senior portfolio manager of ABN AMRO, states it as follows: "These days people are more likely to fill up the holes they have in their socks, rather than buying new socks." Two years ago, before the crisis it was the other way around (Kerstens, 2010).

Although end users plan longer to make their accommodation sustainable, the demand for sustainable real estate is likely to increase in the coming five years. The end users that implement their ambitions increase from 45% in 2010 to 55% in 2015. When this demand increases a different focus for real estate developers and especially real estate consultants is needed to fit the demands of office users.

Whether end users want this new demand to arise in newly built or redevelopment is interesting to find. The Dutch office market faces a 13,2% vacancy (Fokkema, Schepman, Hofmann, van der Veen, Shishegar, & Blokland, 2010) and the IVBN pleads for a strong focus on redevelopment instead of newly built (IVBN, 2009) to not further increase the vacancy rate. But do office users like to achieve their sustainability ambitions in redevelopment or newly built? Most users (51%) like to focus on the real estate they recite in, probably because moving is an effort. But when office users decide to move, they would like to move to newly built. So to satisfy both the investor and end user, real estate consultants and developers should focus on current housing.
When moving, how important is sustainability in their choice of accommodation compared to other criteria such as location? Sustainability is among the aspects that influence the choice of accommodation the most. It is difficult to state how much this influence is, but Neecke's master thesis at the TU Delft, *'Klantenbing bij kantoorhuurders'* showed similar results (Neecke, 2007).

A question was asked about the end user's preference of aspects within the term of sustainability. The most preferred BREEAM categories are Energy and Health & Wellbeing These two categories: Energy and Health & Wellbeing are further investigated in the second part of the research 'life-cycle costs'.

Is a green label such as BREEAM desirable and who should pay for this? 85% of the respondents want a green certificate. CoreNet concluded this is 90% worldwide (Probst, Wallbank, Hirigoyen, & Anderson, 2009). But end users are not so familiar with these labels since nearly half (44%) does not know what the labels imply. BREEAM is slightly the most preferred one.
70% of the office users are not willing to pay or only a small part for the certification. So according to them, it is the responsibility of the investor to pay for this. This does not seem too surprising, but the certification of a building can be a substantial part of the investment. This is because all BREEAM aspects needed to be checked which costs a lot of time. Now it is interesting to see that office users are not willing to pay for this certification.

Both soft and hard advantages were stated to be important. Verwaaijen however says that soft advantages are nonsense; he states that a higher productivity will be achieved by good management and not by better sustainability (Verwaaijen, 2010). But van Leersum says to recognize the soft advantages, but they are not possible to quantify for the business case. But the image advantage can be quantified to some extent. When a corporate is sustainable, this attracts confidence of the shareholders and results in the increase in value of the shares on a stock exchange (Leersum, 2010).

Respondents assume realisation costs for sustainable real estate is higher than traditional real estate. However if advantages such as lower sick leaves or image improvement are obtained, office users state to be willing to pay a 6% rent premium. JLL's 2008 survey determined this was 3,4% (Leersum, 2010). Kok concluded that a rent premium of 3% is paid for sustainable buildings in the USA (Eichholtz & Kok, 2008) and Triodos concluded from a case study the rent can be 5% higher (Berkhout, 2010). These days it seems end users become more willing to pay for sustainable office.

When a building is made more energy-efficient, the service costs will be lower. To do so, the investor must incur costs. Traditionally, the benefits of lower service costs are obtained by the tenant and not the investor. A new type of contract should be used, green lease. This is a contract where the user pays some of its savings back in a higher rent. From this research is concluded that respondents are willing to pay an average of 32% of these savings. Snoei concluded this would be 70% (Snoei, 2008). It is remarkable that in 2010 end users are less wtp for a green lease contract then they were in 2008. According to Flip Verwaaijen, national director TNT real estate, this is a good model because everybody must benefit to have a successful sustainable development. But tenants often look too little at their service costs (Verwaaijen, 2010). When everybody must benefit, a logical spread would be if the end user pays 50% of his savings in a higher rent. But this research shows this is only 32%. This 32% might give some problems during implementation of this model in practice.

When both the wtp of end user for the rent premium and green lease are compared, some calculations on a fictive building are needed. The results for this are shown in Table 24. These are based on literature review, PARAP and results from the survey. The result is that end users seem to be over 5 times more willing-to-pay for a rent premium, excluding the service cost advantages. This would mean that end user are, by far more willing-to-pay for advantages such as image improvement and productivity increase of employees, than they would be for energy-savings.

Table 24 Comparison between the end users wtp for rent premium and green lease

Input	Quantity	Source
Full-time equivalent	200	PARAP
Lettable floor area (m2)	5089	PARAP
Average rent/m2/year	€ 150	JLL
Total rent per year	€ 763.350	
Total service costs per year	€ 66.000	PARAP
Average energy savings potential	40%	CBRE

Annual service costs savings	€ 26.400

WTP End users	
Green lease	32%
Rent premium	6%

Additional profit investor	
Service costs	€ 8.448
Rent	€ 45.801

What would be the best role for the government on speeding up the process of sustainable real estate? The IVBN wants less involvement by the government and considers it the responsibility of the market parties (IVBN, 2009), but 90% of the respondents want the government to be active in their policy to come to a more sustainable environment. Van Leersum also states that some intervention, policy making and regulations are needed from the government (Leersum, 2010).
Governmental policies are often made for four years. After four years elections are held and new policies will be made. But policies that are longer than four years could enhance the reduction of risk for real estate parties and could enhance the pace of sustainable real estate.

The next chapter will elaborate on the life-cycle costs research. The built up is as follows: first the methodology will be discussed, second the results and finally the conclusion will be mentioned.

Table 25 Key figures on rent premium and green lease compared to previous researches

	Rent premium	Green lease
Stated preferences		
Visser (2010)	6 %	32 %
Snoei (2008)		76 %
JLL (2008)	5 %	
Corenet global & JLL (2009)	3,2 %	
Revealed preferences		
Eichholtz (2008)	3 %	
Pot (2009)	1,5 - 18 %	
Heineke (2009)	3,7 %	
Case study		
Berkhout (2010)	5 %	

Table 26 Key figures from the survey compared to previous research

	Visser (2010)			JLL (2008)	Corenet (2009)
	2010	2015			
Importance of sustainable accomodation			70 %	38 %	70 %
Within two years accomodated sustainable			11 %	21 %	
Implementing sustainability ambitions	45 %	55 %			
Becoming sustainable in current accomodation			51 %		
Desire for a green label			85 %		90 %
Don not want to pay for a green label			70 %		
Desire for governmental intervention			90 %		

Developer

4 Developer

Chapter one research setup clarifies the plan of approach to address the research question to what extent sustainable offices are feasible. The conceptual model and the research design illustrate what must be done to answer this question. Attention must be paid to the following three aspects: 1.End user preferences, 2.LCC and 3.Investor. This chapter addresses the second aspect: 2.Life-cycle costs. This chapter shows the results of the explorative study for the life-cycle costs of sustainable offices

The questions that need to be answered regarding life-cycle costs are the following:

2. Developer

- *How to determine the life-cycle costs of the end user's preferences?*
- *How to approach the life-cycle costs of sustainability with a cost calculation model?*
- *What are the life-cycle costs of the credit daylighting?*
- *What are further implementation possibilities of BREEAM into PARAP?*

To answer these questions, modelling was performed using the cost calculation model PARAP designed by the Center for People and Buildings (CfPB) together with the TU Delft. BREEAM was used to implement sustainability into life-cycle costing. Out of part one: end users research it became clear that from BREEAM's nine categories, energy and health & wellbeing are considered most important by office users. Due to the amount of detail used in PARAP and BREEAM, only one credit of BREEAM, daylighting, could be implemented into PARAP. For this aspect cost calculations was done. For the categories of BREEAM more generally, an advice is given for the PARAP group to use for further implementation of BREEAM into PARAP.

This chapter is divided into four sections. The first section deals with the methodology used. It discuss the choice for cost modelling, the credit daylighting, the cost calculation model PARAP and it shows the process of this part of the research. The second section will address the results of the LCC according to the process followed. The third gives the advice for the PARAP group on how to further implement BREEAM in the model. The last section will state the summary and conclusions on this second part of the research: life-cycle costs.

4.1 Methodology

Before mentioning the results, it is useful to understand the setup and the process for the research. This section addresses the choice for cost modelling, the choice for the BREEAM credit daylighting, PARAP the model used is explained and the process that was followed using schemes.

4.1.1 Cost modelling

Within this research is tried to get more grasp on the feasibility of sustainable real estate. By doing so, it is important to look at the costs. An inception to determining the life-cycle costs of BREEAM was done by cost modelling using PARAP. The reason to choose for modelling was that this research tried to find an answer applicable to all situations, a generic answer.

In a model variables are determined and assumptions are made. With this information the model comes to an answer. So a model will be specific for a certain situation, depending on the values of the variables. So cost modelling does not show a generic result, but you can easily obtain results for each situation.

In this case, these variables and assumptions are made regarding building specifications. All buildings differ on a certain level, buildings are unique. This difference can be on location, façade, size, year, state of maintenance, architecture, facilities and many others. All these factors influence the cost and price of a building. In a cost calculation model these price variables can either be changed by the user of the model or are made assumptions on by the designers of the model.

4.1.2 Credit daylighting

The initial plan was to implement all BREEAM categories into PARAP. After interviews with the Royal BAM Group and Brink Groep about their cost calculation models including sustainability, it became clear that this would be too much work. The choice had to be made for either all categories in general or one category more into depth. The choice was made for one category more into depth to be able to draw more straight forward conclusions. If it was kept more general, the conclusions drawn on both the lcc as well as the implementation possibilities would also be more general.

The choice was made to investigate the category of Health & Wellbeing. Health & Wellbeing together with Energy is most preferred by users according to the first part of the research: end users. Because of two reasons the choice was made on Health & Wellbeing and not on Energy. The first is that up till know, only little amounts of research are conducted on health & wellbeing, so any result would be interesting. The second reason is that energy is complex. To illustrate: Stephan Grootswagers' master thesis on the pay-back time of energy-efficient buildings was solely on energy, but still limited due to its complexity and many aspects involved as he mentions in his conclusion (Grootswagers, 2010).

During the modelling process, it became clear that even the category of Health & Wellbeing would be too grant to implement in the model of PARAP. The credit HEA1 Daylighting was first to be implemented since this credit has criteria that could be determined without minor advice from specific technical experts.

Implementing this credit into detail in parap made it impossible to implement other credits as well due to the limited time available. Within this category it was possible to keep it more

general and doing research on all credits of the category, but then the desired detailed level for PARAP could not be achieved.

4.1.3 PARAP model

This second research is done using PARAP. PARAP is a calculation model to gain insight into the investment costs as well as operating costs for a building in the early stages of a development. It operates within Microsoft Excel 2003. PARAP has been developed by the collaboration between the Rijksgebouwendienst (State building services), TU Delft, TNO-Bouw, Deens Raadgevende Ingenieurs B.V., KD/Consultants B.V. and Willem Meijer Consultancy. PARAP stands for 'paraplu' (umbrella) and used here as metaphor because PARAP combines different areas of knowledge (Gerritse, Pullen, Le Roux, & Bijleveld, 2008).
The PARAP instrument generates a reference building which, with its organizational, building and location characteristics, that complies with the values implemented by the user of the program. From this input, PARAP will calculate, on element level, the build and operating costs of the building (Gerritse, Pullen, Le Roux, & Bijleveld, 2008).

4.1.3.1 Front PARAP

This section addresses the aspect that need to be understood to use the program as a user and not as a cost modelling expert.

The model has a layered structure and works with minimal input of the user to get started with the model. The minimal input of the reference building is (Bijleveld, et al., 2008):

- Amount of fte (number)
- Zip code
- Type of location (A,B or C)
- Type building (Head office, secondary office)
- Amount of floors (number)
- Basement (yes/no)

This input can be extended with variables in use. Examples for this are:

- Interest
- Inflation
- Price index
- Gross Initial Yield
- Electricity price
- Gas price

From the input, the model makes assumptions to come to a program of requirements and many other aspects in detail to generate a fictive building. Most of these assumptions are transparent and adjustable by the user of the program. In this way, the building can precisely be adjusted to the wishes of the user. Variants can be made to compare with one another. (Bijleveld, et al., 2008).

The output is specified in investment costs and operating costs. For both types of costs a sheet in excel is made. The output is visualised in two small boxes specified for large costs (see Figure 46, Figure 47 and Figure 48). If more detailed information is needed, the 'plusses' left of the large costs can be ticked and specific costs are shown of this specific category.

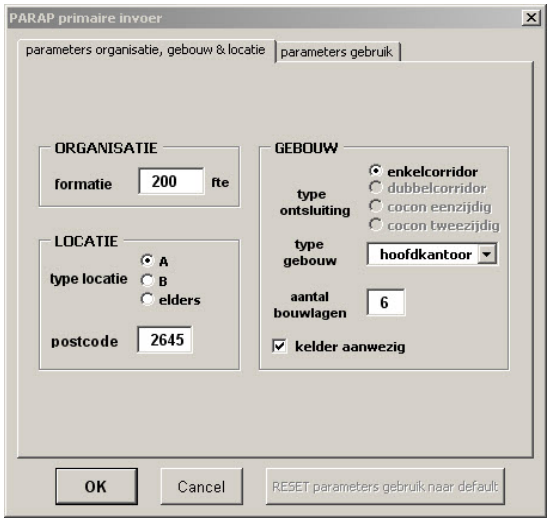


Figure 46 Example for primary input source: (Bijleveld, et al., 2008)

INVESTERING	totaal
grond	€ 6.450.000
bouwkundig werk	€ 8.173.000
installaties	€ 3.475.000
vaste inrichting	€ 347.000
terrein	€ 91.000
algemene uitvoeringskosten (AUK)	€ -
losse inrichting en bedrijfsinstallaties	€ 1.403.000
bijkomende kosten	€ 7.636.000
totaal	€ 27.500.000

Figure 47 Example of output of investment costs source: (Bijleveld, et al., 2008)

GEBRUIKSKOSTEN	totaal gebouw-gebonden
vaste kosten	€ 1,519,000
energiekosten en water	€ 78,000
onderhoudskosten	€ 250,000
administratieve beheerskosten	€ -
specifieke bedrijfskosten	€ 123,000
totaal	€ 1,970,000

Figure 48 48Example of output of operating costs Source: (Bijleveld, et al., 2008)

4.1.3.2 Back PARAP

This section addresses the aspect that need to be understood to do cost modelling regarding PARAP. The section discusses the setup of the model.

The model PARAP works with 7 hidden workbooks and 1 that is visible. The visible workbook is described in the preceding section and contains the input and the output. The hidden workbooks do all the calculations needed to come from the input to the output. *Figure 49 Operating principles* show the relationship between all workbooks. These hidden workbooks are not visible for the users of the program.

The seven workbooks are:

- DemonstratieIO

DemonstratieIO can be seen as the collector of all workbooks. The variables used for calculations are given a name according to the PARAP rules. In the IO workbook all these variables are stated with correct name and the corresponding value. When another workbook desires the value of a variable this can be obtained from the DemonstratieIO. PARAP uses many variables, the IO workbook has 1678 rows. In almost every row a variable is presented.

- Gebouwmodel (building model)

Gebouwmodel determines the dimensions of the building using the input from the workbook interface. The amount and dimensions of each type of room, traffic area, elevators, stairs, facilities, parking places, etc. are determined here.

- Installaties (installations)

All calculations regarding the installations are made in this workbook. It uses the comfort demands and climate control chosen. The calculations are rather detailed since fire alarms, sockets and many others are taken in account. The calculations are made on amount, dimensions, investment costs, maintenance, operating costs, energy needed, etc.

- Bouwkundig (building specific).

The Bouwkundig workbook determines the building costs on element level. It determines the construction period as well. This workbook has more than 100 sheets. Each sheet contains a construction activity in which the dimensions are described and the price mentioned to arrange this activity.

- MOBGeoData2

MOBGeoData2 uses the zip code from the input to determine the height of the ground water en the depth of the solid ground layer needed for the foundation.

- Begroting (budget)

This workbook comes to a detailed estimation of the costs of all elements regarding total investment, maintenance and cleaning.

- Exploitatie (operation)

Depending on the chosen management form it calculates the operating costs according to the chosen operating period or consideration period.

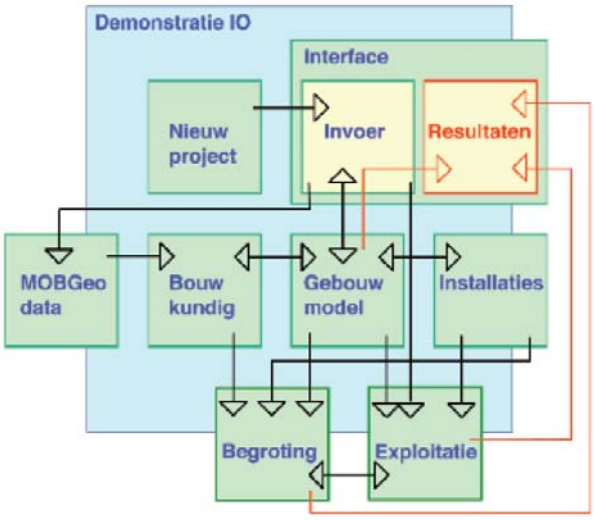


Figure 49 Operating principles
Source: (Bijleveld, et al., 2008)

For more information regarding the PARAP model I would like ro refer Bijleveld et al.'s Manual 'Parap-levensduurkostenmodel, besluitvormingondersteunend instrument voor huisvesting en kantooororganisaties.'

4.1.4 Process

The process for the second part: life-cycle costs will be discussed here according to *Figure 50 Research design part two LCC*. Below the process is described step-by-step in order of the green frameworks from the research design.

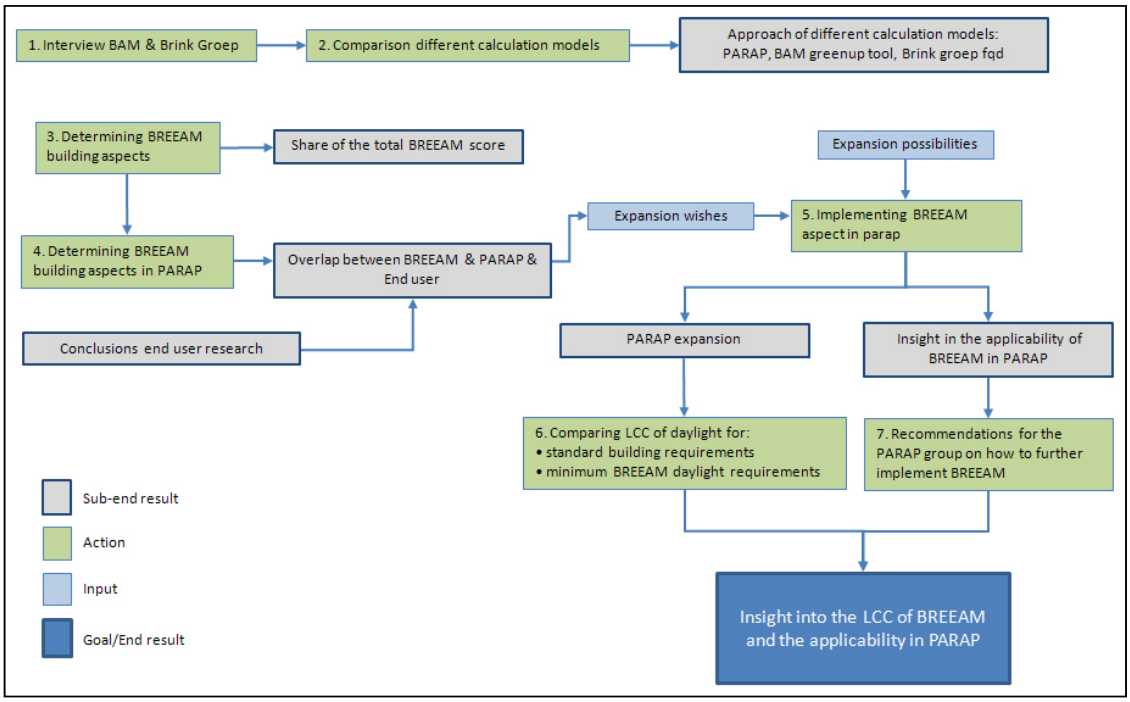


Figure 50 Research design part two LCC

1. **Interview Royal BAM Group & Brink Groep**

Before the start of the modelling process, fieldwork was done on existing models to acquire knowledge on the way this is done. Two companies have made a model to determine the costs of sustainable real estate. These are the Royal BAM Group & Brink Group. The models they made are discussed in detail in *2.4 Life-cycle costs* and briefly in this chapter in section 4.2.1

2. **Comparison different calculation models**

The BAM Greenup tool and Brink Groep's FQD were compared with PARAP. The results from this comparison can be read in section 4.2.1. This was done to overcome possible pitfalls while implementing BREEAM into PARAP.

3. **Determining BREEAM building aspects**

PARAP emphasises on the building itself. A relatively small part of location aspects are taken into account. The BREEAM aspects directly influencing building specifications were listed to determine which aspects could relatively easy be implemented into PARAP. The result of this list is shown in section *4.2*.

4. **Determining BREEAM building aspects in PARAP**

The list of building aspects that is determined in *3. Determinig BREEAM building aspects* were compared with PARAP to check overlap. Overlap would be useful and is done to see whether credits might already be implicitly implemented in PARAP. The overlap is combined with the end user's wishes. Now can be determined which criteria need implementation in PARAP and that is how PARAP needs to be expanded.

5. **Implementing BREEAM aspect in PARAP**

Combined was how PARAP needed to be expanded and how PARAP could be expanded. This resulted into modelling credit HEA1 Daylighting into PARAP. This modelling resulted in an expansion of PARAP and insight on how to further implement BREEAM in PARAP.

6. **Comparing LCC of daylighting**

The initial goal of this part of the research was to determine the LCC of BREEAM. In the end this could only be done for the credit HEA1.daylighting. The minimum of PARAP, which takes in account the bouwbesluit (building regulations) and NEN-norms (Dutch standards) but still obtaining the credit of daylighting was compared to the standard generated building of PARAP. This shows little difference.

7. **Recommendations for PARAP group**

After this modelling, knowledge is obtained on both BREEAM as well as PARAP. For the PARAP group a recommendation was made to help the PARAP group on further implementing BREEAM into PARAP. This recommendation is stated in *4.3 Advice.*

After the step-by-step process as described above, conclusions can be drawn on the LCC of BREEAM and its applicability in PARAP.

4.2 Results

The results will be discussed step-by-step according to *Figure 50 Research design part two LCC*which is similar to the elaboration on the process.

4.2.1 Interview Royal BAM Group & Brink Groep

The first step is the interviews with BAM and Brink Groep to gather some knowledge on existing models. The information gathered for the models of BAM and Brink Group are shown in section *2.4 Life-cycle costs.* It serves as a theoretical support for the modelling that was done. Briefly is mentioned here what these models are about.

BAM Greenup tool:

BAM's model is for intern use only. The model can be used for BREEAM, Greencalc or GPR gebouw. When chosen for BREEAM some location aspects must be added for the specific project. It makes cost calculations for both investment costs as well as operating costs.

Brink Group's Financial Quickscan sustainability (FQD):

The FQD is free accessible to use. It determines the investment costs for BREEAM. Brink groep developed the model commissioned by the DGBC.

4.2.2 Comparison different calculation models

The second step is a comparison between the existing models to enhance the plan of approach and determine possible pitfalls. The comparison made between the different models is discussed in section *2.4 Life-cycle costs*. Since this comparison is a result as well, the comparison is briefly mentioned here as well. The major differences are:

- FQD only determines for BREEAM, BAM for Greencalc and GPR as well.
- FQD only determines investment costs, BAM operating costs as well.
- FQD can be used by every one, BAM is only for internal use.
- Both models needed many working hours of specialists with different expertise.

4.2.3 Determining BREEAM building aspects

The third step is determining which BREEAM credits would be suitable to implement into PARAP. From BREEAM is determined which credits would be relatively easy to implement in PARAP. The criterion for this was, that the credits had to influence the building specifications directly, since PARAP determines the LCC costs caused by the building specifications. The result is shown in *Table 27 BREEAM aspects that directly influence building specifications.* There can be seen that some categories are excluded from this table. This is because these categories do not fit the criterion of directly influencing the building specifications. These categories are: Management, Materials, Waste, Land use & Ecology and Pollution. Reason why each category is excluded is stated below:

- Management: management is more about the managerial plan for the use of the building. For instance an evacuation plan or managing the safety of the construction site.
- Materials: at first sight it might seems strange that this category is excluded. But this category includes aspects such as impact on the environment by the type of material, origin of material, design, re use of existing materials. It will not be possible to implement these aspects in PARAP or an extensive extension must be made to choose other materials with the specific character as well in the model.
- Waste: waste is mainly about aspects such as waste management.

- Land use & Ecology: this category discusses aspects such as soil pollution and the preservation of animals and plants on the site in their habitat.
- Pollution: mostly discuss aspects such as air pollution.

Out of the categories, not all credits could be applied due to similar reasons as mentioned above for the excluded categories. So although categories are building specific, not all its credits are building specific. The share of BREEAM credits that could relatively easy be implemented in PARAP is 42%. Several tables were made to determine for each credit if it could be be implemented relatively easy. One table is shown on the next page. The others are in the appendices.

Table 27 BREEAM aspects that directly influence building specifications

Building specifications of BREEAM				
	BREEAM Weight	Total credits	Building related credits	Total building percentage
Health & wellbeing	15%	14	11	12%
Energy	19%	31	29	18%
Transport	8%	12	12	8%
Water	6%	11	9	5%
End total	**48%**	**68**	**61**	**42%**

4.2.4 Determining BREEAM building aspects in PARAP

The fourth step is determining which aspects of BREEAM already exist in PARAP, this could be direct or indirect. An example of the existence of a credit in PARAP indirect would be that the dimensions of the buildings are determined using the input of the amount of fulltime equivalent (fte). At first this does not imply any BREEAM credits. However different dimensions can have its influences on certain BREEAM credits such as HEA1.'Daylighting'. The dimensions of certain rooms can change and therefore the amount of daylight into the specific room.

Interesting is that some aspects of certain credits were already in PARAP. These are four credits of Health & Wellbeing and three of the category transport. The credits from health & wellbeing are direct and indirect and these are: daylighting, free view, natural ventilation. Credits from the transport category are indirectly in the model. These are facilities in the area, accessibility by public transport. These are indirect since the zip code is input and this location influences those credits. However the information needed for those credits is not yet in PARAP.

Table 28 shows that 6% of all BREEAM credits were already partially in PARAP. That means that implementing all BREEAM credits in PARAP will still be quite some effort. An inventory was made on all BREEAM credits. This inventory is shown on the next page.

Table 28 BREEAM credits in PARAP before research

Current credits of BREEAM in PARAP		
	Credits	%
Health & wellbeing	4	4%
Energy	0	0%
Transport	3	2%
Water	0	0%
End total	**7**	**6%**

SCHEMA. Los printen en erbij plaatsen.

4.2.5 Implementing BREEAM aspect in PARAP

The fifth step is the actual implementation of HEA1. Daylighting into PARAP. The credit HEA1 Daylighting consists of several criteria. Below these are discussed for each criteria. The Dutch Green Building Council (DGBC) states the criteria for each credit in their judgement guidelines (Dutch Green Building Council, 2009). The requirements for daylighting are:

e) An average daylighting factor higher than the minimum value of 2%.
f) A uniformity ratio of at least 0.4 or a minimum point daylighting factor of at least 0.8% (spaces with glazed roofs, such as atria, must achieve a uniformity ratio of at least 0.7 or a minimum point daylighting factor of at least 1.4%).
g) A view of sky from desk height (0.7 m) is achieved.
h) The room depth criterion $d/w+d/H_w < 2/(1-R_a)$ is satisfied.

Where:
d = room depth
w = room width
H_w = window head height from floor level
R_a = average reflectance of surfaces in the rear half of the room.
To achieve the daylighting credit requirements A and B or A, C and D need to be met for all the occupied rooms and/or areas (Dutch Green Building Council, 2009)

The occupied rooms in PARAP are the offices, meeting rooms, suctorial/resting rooms and canteen. For all these rooms the calculations are made using the hidden workbooks. For the addition of BREEAM a new workbook is made and added to the existing hidden workbooks. Each sheet within this new BREEAM workbook represents one of the criteria of daylighting, a,b,c or d.

Below the criteria from the BRL and the way it is implemented is described. The expanded PARAP model can be looked up from the added CD in the appendices. For any definitions regarding BREEAM that are not explained here, I would like to refer to BRL BREEAM or the CD.

4.2.5.1 A. Daylighting factor

For the criterion daylighting factor the following formula is used where the daylighting factor (DF_{av}) at least needs to be 2%:

Equation 1 Formula criterion for daylighting factor
Source: (Dutch Green Building Council, 2009)

$$DF_{AV} = \frac{A_{raam} \cdot T_{raam} \cdot \gamma}{A_{schil} \cdot \left(1 - R_{AV}{}^{2}\right)}$$

Where:

DF_{AV}	= average daylight factor
A_{raam}	= window area of the enclosure in m2
A_{schil}	= shell area of the enclosure (floor, ceiling, walls including windows) in m2
T_{raam}	= transmission factor of window (LTA) in %
Hemelzichthoek	= View of sky angle (taking into account overhangs and obstacles) in degrees (°)
R_{AV}	= average reflectivity factor of the shell (excluding the windows)

Below is described for the variables of the formula how these are determined using PARAP input and output as well as literature:

- $DF_{av}$is the average daylighting factor that needs to be determined.
- A_{raam} is the surface of the windows in the specific room. This is calculated from the percentage of open façade combined with the dimensions of the specific room. The dimensions can be found using the DemonstratieIO and Gebouwmodel workbook. The open façade is a variable that can be changed by the user of PARAP and is obtained from the DemonstratieIO workbook.
- A_{schil} is the surface of the floor, ceiling and all walls including the windows. These surfaces were obtained from the dimensions of the different rooms. These are obtained from the DemonstratieIO and Gebouwmodel workbook.
- T_{raam} is the transmission factor of the window. The transmission factor differs per type of glass. Through consultation with the second mentor of this master thesis from the TU Delft Bijleveld, the choice was made on standard double glazed filled with gas glass. The transmission factor of this type of glass is 81% according to Pilkington (Pilkington, 2006). The type of glass can not be changed and therefore this variable is a fixed value.
- Hemelzichthoek is the angle from which the clear sky can be seen. It is plausible that the view towards the sky can be partially blocked. Therefore an average of obstacles must be stated, this is determined as a small, medium or large amount of obstacles. This average amount of obstacles must be an addition in the input of PARAP from which the users of the program can check a box of either *'amper, redelijk, veel belemmering'* (small, medium, large) amount of obstacles. In the software program autocad, assumptions are made to determine the angle corresponding with the type of obstacle. These angles are respectively 80, 60 and 45 degrees. These values of the degrees are needed as input into the average daylight formula.
- R_{av} is the reflection factor of the room excluding the windows. For this criterion an addition must be made in the input of PARAP as well where the user of the program can choose light, medium or dark finishing of the room. According to van Cruchten findings assumptions were made for the reflection factor (Cruchtenvan, 2003). In PARAP assumptions are made for the finishing and different options are possible to choose from. However all these options do not determine the colour of finishing which determines the reflectance the most.

4.2.5.2 B. Uniformity ratio or Point daylight factor

To achieve criterium 'B' either a uniformity ratio or a point daylight factor must be achieved. Both are determined using a computer simulation. According to the BRL the uniformity ratio and point daylight factor are defined as follows:

Uniformity ratio: *The ratio between the minimum illuminance (of daylight) on the work surface in an occupied space (or minimum daylight factor) and the average illuminance (of daylight on the same work surface (or average daylight factor)* (Dutch Green Building Council, 2009).

Point daylight factor: *The point daylight factor is the ratio of the illuminance (of daylight) at a specific point on the work surface in an enclosure to the simultaneous unobstructed outdoor illuminance on a horizontal surface, assuming an overcast sky (Commission Internationale de l'Eclairage)* (Dutch Green Building Council, 2009).

Using computer programs would be time consuming and costly while not necessary since criterion *b* can be replaced by *c* and *d*. Therefore the choice was made to not work with the uniformity ratio and point daylight factor in this research. Examples of software programs for this criterion are:

- VABI, recommended by Holm from BAM (Holm, 2010).
- IES – VE toolkits, recommended by Dansen from DGBC (Dansen, 2010).

4.2.5.3 C. Sky view

The criterion for 'C' a view of the sky from the desk (0,7m) must be achieved. Within the PARAP model and the daylighting credit this is dependent on three aspects.
The first is the amount of obstruction caused by trees, buildings and other aspects. This amount of obstruction is a variable in the formula for criterion 'A' *average daylight factor* as well. The second aspect is the depth of the room (lgz). This is determined in the input of PARAP. From the DemonstratieIO this value is obtained. The lgz value is restricted from 3,6m to 7,2m. The third aspect is the type of façade which determines the type of windows and therefore the dimensions of the window and its place in the facade. This is determined in the input of PARAP. Specifications for the type of façade can be obtained from the DemonstratieIO workbook and the Bouwkundig workbook.
To determine the visibility of the sky from the desk, a cross-section in Autocad was made of the office building that is generated by PARAP. The figure below shows this cross-section.

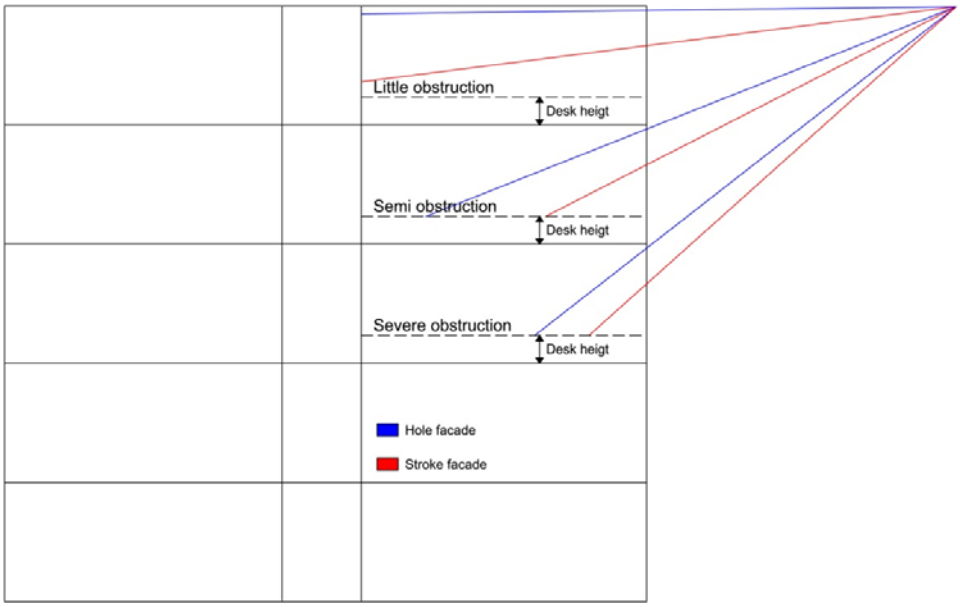


Figure 51 Cross-section for determining sky view

This cross-section visualises the maximum depth from which the sky still can be seen incorporating the three aspects. The different floors are used for the amount of obstruction. The blue line shows the range from which the sky still can be seen for the hole façade. The red line is the same, but then for the stroke façade. For both facades the line differs due to the location of the windows in the façade. The distance from the façade to where the lines hit the 'desk height', is the maximum depth a room can have from where the sky is still visible. For the location of the desk the middle of the room is chosen. This of course is influenced by the depth of the room. The results can be seen in *Table 29 Maximum facade depth in combination with obstruction and type of facade*.

In this table an example is shown as well: the choice is on a strokes façade with semi obstruction. This means that the distance from façade to corridor must not exceed 5.1 meters when desired to achieve the criterion *C.Sky view.*

Table 29 Maximum facade depth in combination with obstruction and type of facade

Range lgz1 (min:3,6 max: 7,2)

Borders (lgz1)	Strokes facade	Holes facade	Type obstruction
Barely obstruction	20,6	100	0
Semi obstruction	5,1	11,1	1
Severe obstruction	2,9	5,7	0
Type of facade	**1**	**0**	

4.2.5.4 D. Room depth

For the criterion room depth, the following formula is used:

Equation 2 room depth criterion
source: (Dutch Green Building Council, 2009)

$$d/w+d/H_w< 2/(1-R_a)$$

Where:
d = room depth
w = room width
H_w = window head height from floor level
R_a = average reflectance of surfaces in the rear half of the room.

This can easily be derived to:

Equation 3 derived room depth formula

$$(1-R_a) * (d/w + d/H_w) < 2$$

Equation 3 derived room depth formula is used to implement the room depth criterion into PARAP. Below is described for the variables of the formula how these are determined using PARAP input and output as well as literature:

- d: In PARAP the room depths are the same for all occupied rooms and can easily be obtained from the DemonstratieIO workbook, this is the variable lgz.
- w: The room width differs per room type which can be obtained from the hidden workbooks DemonstratieIO and Gebouwmodel.
- H_w: Two options are available for the window height. These are determined by the type of chosen façade in the input. The dimensions of these windows per façade type can be obtained in the Bouwkundig workbook.
- R_a: The R_a differs negligible from the R_a of the entire room. The differences varies but is around 0,3%. So for this value the R_{av} of the average daylight factor is used.

4.2.6 Comparing LCC of daylighting

The sixth step is investigating the influence the credit daylighting has on the LCC. Since only one credit was implemented during this research it is impossible to draw conclusions on the LCC of BREEAM. However conclusions can be drawn on the LCC of daylighting and on the applicability of BREEAM. The applicability will be shown in the next section, *4.3 Advice*. This section discusses the LCC of the credit daylighting. First a list is given of the PARAP aspects that influence the achieving of the daylight credit. Hereafter three variants are compared. Two of them achieve the credit and one, with the standard values of PARAP does not achieve the credit.

After implementation of the credit daylighting, it became clear that for the standard values of PARAP the daylighting credit is not achieved. Therefore a comparison was made between the standard input of PARAP and the minimum requirements to achieve the credit daylighting to determine the extra LCC needed for daylighting. The results can be seen below.

The aspects of PARAP that influence the credit daylighting are stated below per criterion of daylighting with its restriction and/or technical implications:

A. Average daylighting factor:
- Percentage of open façade: the PARAP restriction is 30%-53%. All values within this range serve criterion A.
- Dimensions of rooms: there are no PARAP restrictions for the area of a room. A variation was made on the dimensions for the offices since offices are by far most represented in PARAP. For these a variation was made between $10m^2$ and $30m^2$. PARAP's default value is $20m^2$. All values within this range serve criterion A.

B. Uniformity ratio or Point daylight factor:
- These criteria are not further discussed for this research since a computer model is needed to do so.

C. Sky view from desk:
- This criterion depends on three variables: type of façade, amount of obstacles and depth of room. Type of façade has most influence on achieving this credit. Therefore is varied with the type of façade. For the other two variables, the mean value is assumed. For these values, the hole façade achieves this criterion and the strokes façade does not. The reason the façade has a lot of influence on achieving the credit is due to the way the windows are placed. Windows of the stroke façade are situated substantially lower on the façade.

D. Room depth criterion:
- Façade depth: the range of PARAP for façade depth is 3.6m – 7.2m. For all these values this criterion is achieved.
- Width: For all reasonable width assumptions the criterion is achieved. The tested minimum is 3m. Any larger width makes it easier to achieve
- Type of façade. For both types of facade this criterion is achieved.

The three variants made are:

1. Standard values of PARAP and therefore not achieving the credit daylighting. Criterion *'C' Sky view from desk* is not met.
2. Standard values of PARAP with a change of façade from strokes (standard) to holes. This automatically changes the amount of open façade from 30% to 20%. Now the second variant still does not achieve the credit daylight. Criterion *'C' Sky view from desk* is met, but criterion *'A' Average daylighting* is not met.
3. Standard values of PARAP with a change of façade from strokes (standard) to holes and a change of open façade from 20% to 30%. Now the daylight criteria are met and the credit is achieved.

Figure 52 and Figure 53 show the results the LCC of the three variants. Comparing the LCC between variant 1 and 2 is less useful since both variants do not achieve the credit. The variants compared are variant 1 and 3; respectively the variant with PARAP's standard values and the variant achieving the credit. The LCC difference between variant 1 and 3 are:

- Investment costs of variant 3 is € 100.000,- higher which is less than 0,5% increase of the total investment costs. 0,5% cost rise is not so much. However if all 70 credits would cost 0,5% extra, then a BREEAM very good label would cost 20% extra and a BREEAM outstanding label would be 30% extra. However this conclusion can not be drawn at this stage.
- Operating costs are € 38.000,- per year higher which is 2,5% increase of the yearly operating costs. A similar conclusion as done with investment costs cannot be made because many BREEAM credits are an extra investment and less operational costs. Energy consumption is the major aspect which influences this.

4.2.7 Recommendations for PARAP group

The seventh and last step is an advice for the PARAP group to further implement BREEAM in PARAP. The recommendations for the PARAP group will be discussed in next section.

BASISGEGEVENS		1	2	3
formatie	200	200	200	200
type ontsluiting	enkel corridor	enkel corridor	enkel corridor	enkel corridor
type gebouw	hoofdkantoor	hoofdkantoor	hoofdkantoor	hoofdkantoor
aantal bouwlagen	6	6	6	6
kelder aanwezig	ja	ja	ja	ja
type locatie	A	A	A	A
postcode	2645	2645	2645	2645

INVESTERING	totaal	totaal	totaal	totaal
grond	€ 6,450,000	€ 6,450,000	€ 6,450,000	€ 6,450,000
bouwkundig werk	€ 8,288,000	€ 8,177,000	€ 8,285,000	€ 8,288,000
fundering	€ 373,000	€ 373,000	€ 373,000	€ 373,000
skelet	€ 1,130,000	€ 1,130,000	€ 1,130,000	€ 1,130,000
daken	€ 86,000	€ 86,000	€ 86,000	€ 86,000
gevel	€ 2,813,000	€ 2,718,000	€ 2,795,000	€ 2,813,000
buitenwandafbouwconstructies	€ 535,000	€ 535,000	€ 583,000	€ 535,000
buitenwandopeningen	€ 450,000	€ 355,000	€ 384,000	€ 450,000
buitenwandafwerkingen	€ 1,828,000	€ 1,828,000	€ 1,828,000	€ 1,828,000
binnenwanden	€ 1,326,000	€ 1,326,000	€ 1,341,000	€ 1,326,000
binnenwandafbouwconstructies	€ 148,000	€ 148,000	€ 148,000	€ 148,000
binnenwandopeningen	€ 720,000	€ 720,000	€ 720,000	€ 720,000
binnenwandafwerkingen	€ 458,000	€ 458,000	€ 473,000	€ 458,000
vloeren	€ 206,000	€ 206,000	€ 206,000	€ 206,000
trappen en hellingen	€ 113,000	€ 113,000	€ 113,000	€ 113,000
plafonds	€ 63,000	€ 63,000	€ 63,000	€ 63,000
AUK	€ 2,178,000	€ 2,162,000	€ 2,178,000	€ 2,178,000
geheel gebouw	€ 355,000	€ 355,000	€ 355,000	€ 355,000
project/bouwplaatsinrichting	€ 112,000	€ 112,000	€ 112,000	€ 112,000
project/bouwplaatsinrichting en uitvoering	€ 671,000	€ 671,000	€ 671,000	€ 671,000
toeslag	€ 1,040,000	€ 1,024,000	€ 1,040,000	€ 1,040,000
installaties	€ 3,475,000	€ 3,475,000	€ 3,477,000	€ 3,475,000
werktuigbouwkundig	€ 2,400,000	€ 2,400,000	€ 2,402,000	€ 2,400,000
warmte-opwekking	€ 107,000	€ 107,000	€ 109,000	€ 107,000
afvoeren	€ 43,000	€ 43,000	€ 43,000	€ 43,000
water	€ 89,000	€ 89,000	€ 89,000	€ 89,000
gassen	€ 46,000	€ 46,000	€ 46,000	€ 46,000
koude-opwekking en distributie	€ 938,000	€ 938,000	€ 938,000	€ 938,000
warmtedistributie	€ 270,000	€ 270,000	€ 270,000	€ 270,000
luchtbehandeling	€ 590,000	€ 590,000	€ 590,000	€ 590,000
regeling klimaat en sanitair	€ 317,000	€ 317,000	€ 317,000	€ 317,000
elektrotechnisch	€ 861,000	€ 861,000	€ 861,000	€ 861,000
lift en transport	€ 214,000	€ 214,000	€ 214,000	€ 214,000
vaste inrichting	€ 347,000	€ 347,000	€ 347,000	€ 347,000
terrein	€ 91,000	€ 91,000	€ 91,000	€ 91,000
algemene uitvoeringskosten (AUK)	€ -	€ -	€ -	€ -
losse inrichting en bedrijfsinstallaties	€ 1,403,000	€ 1,403,000	€ 1,403,000	€ 1,403,000
bijkomende kosten	€ 8,668,000	€ 8,604,000	€ 8,668,000	€ 8,668,000
totaal	€ 28,700,000	€ 28,600,000	€ 28,700,000	€ 28,700,000

Figure 52 Investment costs of the three variants

BASISGEGEVENS		1	2	3
dubbeltellingen onderhoud meerekenen?	nee	nee	nee	nee

GEBRUIKSKOSTEN	totaal gebouw-gebonden	totaal gebouw-gebonden	totaal gebouw-gebonden	totaal gebouw-gebonden
vaste kosten	€ 1,216,000	€ 1,208,000	€ 1,217,000	€ 1,216,000
rente	€ 743,000	€ 738,000	€ 743,000	€ 743,000
vervangingsreserve	€ 424,000	€ 421,000	€ 425,000	€ 424,000
erfpachtcanon	€ -	€ -	€ -	€ -
huur	€ -	€ -	€ -	€ -
huurderving	€ -	€ -	€ -	€ -
belastingen & heffingen	€ 31,000	€ 31,000	€ 31,000	€ 31,000
verzekeringskosten	€ 18,000	€ 18,000	€ 18,000	€ 18,000
energiekosten en water	€ 66,000	€ 66,000	€ 67,000	€ 66,000
electriciteit	€ 39,000	€ 39,000	€ 39,000	€ 39,000
brandstoffen	€ 24,000	€ 24,000	€ 25,000	€ 24,000
stadsverwarming	€ -	€ -	€ -	€ -
overige energiebronnen	€ -	€ -	€ -	€ -
water	€ 3,000	€ 3,000	€ 3,000	€ 3,000
overige gebruikskosten (ICT)	€ -	€ -	€ -	€ -
onderhoudskosten	€ 208,000	€ 178,000	€ 198,000	€ 208,000
technisch onderhoud bouwkundig	€ 45,000	€ 17,000	€ 36,000	€ 45,000
technisch onderhoud installaties	€ 42,000	€ 42,000	€ 42,000	€ 42,000
mutatieonderhoud	€ -	€ -	€ -	€ -
schoonmaakonderhoud	€ 121,000	€ 119,000	€ 120,000	€ 121,000
overig: interieur en ICT	€ -	€ -	€ -	€ -
administratieve beheerskosten	€ -	€ -	€ -	€ -
specifieke bedrijfskosten	€ 109,000	€ 109,000	€ 109,000	€ 109,000
totaal	€ 1,599,000	€ 1,561,000	€ 1,591,000	€ 1,599,000

Figure 53 Operating costs of the three variants

4.3 Advice

This section discusses possibilities and possible pitfalls of implementing the nine BREEAM categories in PARAP. First the distinction between building specific and non building specific categories will be made, because building specific categories are likely to be easier for detailed implementation. Hereafter the categories will be discussed in the same order BREEAM does. This order is: Management, Health & Wellbeing, Energy, Transport, Water, Materials, Waste, Land use & Ecology and Pollution.

4.3.1 (Non) building specific BREEAM categories

As stated in preceding sections some categories are building specific and some are non building specific. The non building specific categories are more about managerial plans than actual building aspects. Building specific categories are categories directly influencing the dimensions of the building. The non building specific categories are likely to be more difficult to implement into detail since the PARAP model is predominately focused on the building itself. The figures below show which BREEAM categories are building specific and which are not.

Table 30 BREEAM's building specific categories

Building specific BREEAM categories
Health & Wellbeing
Energy
Transport
Water

Table 31 BREEAM's non building specific categories

Non building specific BREEAM categories
Management
Materials
Waste
Land use & Ecology
Pollution

4.3.2 Advice per BREEAM category

This section discusses ways to implement BREEAM in PARAP for each BREEAM category. The first category addressed is the management category.

Management

Table 32 Credits of BREEAM category management shows the management credits. Although not surprising, these credits are predominately about managerial aspects. Managerial aspects are difficult to quantify and the LCC seem difficult to determine. Brink Group determines these costs by looking at the amount of working hours a certain activity costs and combines it with the salary needed for such an activity. This would be the best way for the PARAP group to determine these costs as well. However the operating costs will be more difficult to determine than the investment costs. For instance, It is difficult to determine the effect on the maintenance costs of a design which causes easy maintenance (credit 11). Rough assumptions must be made to do so or the expertise of a facility manager might be useful to make better detailed estimations on maintenance costs.

The salary costs used in the model now are:

- Loon_b uurloon bouwkundig
- Loon_m uurloon metaalconstructies
- Loon_s uurloon schoonmaakwerkzaamheden
- Loon_t uurloon tapijtwerkzaamheden

Additional salary costs must be made. These can be consultant salary or supervision salary costs.

Table 32 Credits of BREEAM category management

12% Management (Man)		
Credits	Name of credit	Toelichting
2	1. Commissioning	of installations
2	2. Construction site and surroundings	responsible management of and influence on the surroundings
4/7	3. Construction site impacts	management regarding environmentally conscious use of materials, energy use and reduction of pollution
1	4. User guide	manual efficient use of the building regarding user and non technical management
2	12. Life cycle costing	LCC analysis to optimis design, development, maintenance en management
3/6	13. Combined credits (Man 6 - Man 11)	minimum 2 credits, maximum 3 credits
2	6. Consultation (combined credit)	involvement in design of stakeholders
2	7. Shared facilities (combined credit)	shared facilities for local community
1	8. Security (combined credit)	implementing consultation of security in design
1	9. Publication of building information (combined credit)	publishing design and built process that positively influence the environment
1	10. Development as a learning resource	building and landscape provide a learning rescource for visitor and user
1	11. Ease of maintenance (combined credit)	design where the building and installations are easily maintained

Implementing management into the current PARAP can be quite conflicting, because PARAP is a detailed calculation model and to determine the management's LCC rough assumptions will be made.

Health & Wellbeing

Table 33 Credits of BREEAM category Health & Wellbeing shows health & wellbeing's credits. This is a typical building specific category. Examples of these credits are the amount of daylight entering the workspace, free view outside, natural ventilation or thermal comfort. Aspects that influence these credits are adjustable window, size of window, regulated heating and many other criteria.

These credits can be implemented into PARAP with little difficulties. Most of the credits are influenced by the building specifications PARAP calculates. Some aspects need more attention such as the credit 9.volatile compounds or 8.internal air quality. For these another calculation must be done, respectively amount of emission of materials and the amount of clean air that passes through the building.

Table 33 Credits of BREEAM category Health & Wellbeing

15% Health & Wellbeing		
Credits	Name of credit	Explanation
1	1. Daylighting	compliance to visual comfort
1	2. Free view	enough' free view
1	3. Glare control	using glare control due to reflection, adjustable by user
1	4. High frequency lighting	high frequency ballasts are installed in all fluorescent lighting
1	5. Internal and External Lighting Levels	compliance to visual comfort and preventing hindrance due to different lighting levels
1	6. Lichting zones and controls	in every relevant room light adjustable by user
1	7. Natural ventilation	windows can be opened by user for natural ventilation
2	8. Internal air quality	supply of clean air, secluding internal air pollution
1	9. Volatile organis compounds	use of materials that have low emissions of harmful volatile organic compounds
2	10. Thermal comfort	dynamic thermal building simulation in design phase
1	11. Thermal zoning	adjustability of temperature by user
1	13. Acoustic performance	acoustic comfort by sound isolation prevention of noise hindrance inside the building

Energy

Table 34 Credits of BREEAM category Energy shows the energy credits. Two credits are difficult to implement, not much trouble is expected. The difficult credits are:

- 1.Reduction of CO2 emission

On the choices made for the type of building, the hidden workbook *installaties* (installations) calculates all requirements regarding installations and calculates the costs involved. In this workbook an additional EPC calculation must be made where the building it's EPC is compared to the required EPC to determine the amount of CO2 reduction which is needed for this credit. This does not sound to difficult, since PARAP shows detailed information. However to optimise this credit, additional energy-efficient measures should be implemented into PARAP. To be able to do this in the best way, a study must be made on which aspects to incorporate and which not. This can be time consuming. So the EPC calculation is not the problem, but which energy-efficient measures to take in account will be.

- 5.Use of renewable energy

A problem with this credit is that there is little known on the use of renewable energy since is quite young and still improving rapidly. However there are several options: ground source heat pump (GSHP) in Dutch WKO, combined heat and power (CHP) in Dutch WKK or for instance solar cells on the rooftop. Another problem is that the possibilities of renewable energy are very much location dependent. It can be possible that a building has a lot of space for a GSHP and another building with the same zip code has no space. Therefore this credit will be very complex to implement in PARAP.

The other credits are mainly about energy efficient devices or a managerial plan. Additions must be made to PARAP, but these are not too difficult. Examples are a energy-efficient lift or sub-metering of the energy use.

Table 34 Credits of BREEAM category Energy

19% Energy		
Credits	**Name of credit**	**Explanation**
1 - 15	1. Reduction of CO2 emissions	EP-improvement is relative difference between EPC of building and EPC requirements. EP-improvement = {1-(Qpres;tot/Qpres;toel)} * 100%
2	2. Sub-metering of energy uses	measuring of energy use in relevant zones and substantial groups
1	4. Energy-efficient external lighting	energy-efficient exterior lighting, without detriment of social safety
3/6	5. Use of renewable energy	feasibility study for renewable energy + implementation of possibilities + 10%-20% reduction CO2
1	6. Building fabric performance & avoidance of air infiltration	design and construction of loading/unloading areas to minimize heat/cold loss
4	7. Energy-efficient refrigerated and frozen storage	Energy label A, heat recovery and cold buffering is used, energy efficient for cold storage
2	8. Energy-efficient lifts	
1	9. Energy-efficient escalators and travelators	
2	10. Assurance of thermal quality of building shell	Heat loss measurement to check: design = realisation

Transport

Table 35 Credits BREEAM category Transport shows the transport credits. This category is more non building specific. Therefore credits will be complex to implement. The credits that will not be difficult to implement will be: 3.Cyclist facilities and 7.Travel information point. Credits 1,2,4 and 5 are more complex due to the following reasons:

- 1.Provision of public transport, 2.Proximity of amenities and 5.Travel plan and parking policy

These credits depend on either the facilities that are close by the location of the building or the parking policy of the municipality is. This kind of information must be added to the information PARAP uses at the moment. It might be an idea to start with the four biggest Dutch cities. But still that is a lot of work.

- 4.Pedestrian and cycling safety

This credit is very much dependent on how the accessibility of the building is situated in the design. I am not sure on how to implement this credit and will therefore make no further recommendations for this credit.

Table 35 Credits BREEAM category Transport

8% Transport		
Credits	Name of credit	Explanation
2	1. Provision of public transport	distance to public transport and provision of public transport
1	2. Proximity to amenities	several amenities within 500 meters (supermarket and others)
2	3. Cyclist facilities	covered or lockable bycicle storage, shower, changing room and lockers
2	4. Pedestrian and cyclist safety	good and safe access to the site
3	5. Travel plan and parking policy	stimulating public transport
1	7. Travel information point	including up to date travel information
1	8. Deliveries and manoeuvring	loading/unloading spaces are adequate for manoeuvre and does not cause hindrance

Water

Table 36 Credits BREEAM category water shows the water credits. This credit is building specific. This category will not show much difficulty for implementing in PARAP. Most of the credits will be additions for the workbook of installations. Some research must be done for the use of grey water systems.

Table 36 Credits BREEAM category water

6% Water		
Credits	Name of credit	Explanation
3	1. Waterconsumption	Minimise consumption of potable water
1	2. Watermeter	monitoring water usage
1	3. Major leak detection	reduce consequences of leakage due to detection
1	4. Sanitary supply shut off	reduce risk of minor leaks
2	5. Water recycling	grey water and rain water for toilets to reduce the use of water
1	6. Irrigationsystems	reduce drinking water for green aminities
2	7. Vehicle wash	washing of vehicles uses grey water

Materials

Table 37 Credits BREEAM category materials shows the materials credits. This category is non building specific. This might seem odd, since this category is about materials and a building is made of material. But apart from the first credit, the costs these credits imply are difficult to determine using PARAP. Activities of these credits are: re-use of the previous building on the site, the source of the used materials and design protection for vulnerable parts.

The first credit is about the impact on the environment caused by the materials used. For this an existing formula can be implemented into PARAP. Formula's can be obtained from the BRL in combination with Greencalc or GPR gebouw. This formula is the LCA method (levenscyclus analyse), which is a life-cycle analysis of the impact of the material through its life-time on the environment. The LCA method is a method to determine the impact of products and human activity on the environment. Using the LCA method, the entire life-cycle of a product or activity is considered (RIVM, 2010). The LCA method is used in many countries. In the nineties of the 20th century, the International Organisation for Standardization (ISO) developed a standard for the LCA, ISO14040.

All the credits incorporating re-use or the origin of the material are not so much relevant for PARAP. For this a study must be made to be able to make rough assumption on the costs this implies and to be able to implement in PARAP.

Table 37 Credits BREEAM category materials

12.5% Materials		
Credits	Name of credit	Explanation
6	1. Materials specification	environmental impact of materials during life cycle of building
1	3. Reuse of building facade	a certain percentage is the minimum
1	4. Reuse of building structure	a certain percentage is the minimum
4	5. Responsible sourcing of materials	evidence of 80% of materials with responsible sourcing
1	7. Designing for robustness	protection for vulnerable parts of the building reducing detoriation

Waste

Table 38 Credits BREEAM category waste shows the waste credits. This category is a diverse category. It has two managerial credits, two building specific credits and one credit concerning recycling. The two managerial credits (1 and 6) can be implemented on the same way the category of management should be done. The two building credits are about recycling. One is about waste storage of recyclable materials, credit 3. This one would be not so difficult to implement. Extra workspace should be added into the hidden workbooks 'gebouwmodel' and 'bouwkundig'. Credit 2 is about recycled materials used for construction. This is complex to implement in PARAP and similar to credit 3 and 4 of the material category.

Table 38 Credits BREEAM category waste

7.50% Waste		
Credits	Name of credit	Explanation
3	1. waste management on the construction site	amount, recycle, management
1	2. recycled aggregates	recycled materials used for construction
1	3. recycable waste storage	during use of building
1	5. Compost	does not count for office buildings
1	6. Finishing elements	in collaboration with tenant, reduction waste of materials

Land use & Ecology

Table 39 Credits BREEAM category land use & ecology shows the land use & ecology credits. This is a non building specific category. The first two credits are about the type of soil the building will be constructed on. The information must be added to the information of the zip code. Information needed would be: amount of ecological and landscape value. This should be done on a similar way, this should be done for some credits of the transport category. The other credits are managerial credits and should be implemented on the way the management category is implemented. Credit 3.Existing wildlife at the construction site might be complex because taking in account of the existing wildlife during the construction can cause extra building costs. But this differs per project since the wildlife and buildings differ per project. So it will be difficult to determine the amount of these extra costs in a model.

Table 39 Credits BREEAM category land use & ecology

10% Land use & Ecology		
Credits	Name of credit	Explanation
5	1. Re use of land	construction on land with low ecological and landscape value
2	2. Contaminated land	stimulating build on contaminated land to encourage cleaning
1	3. Existing wildlife at the construction site	to protect and conserve the existing wildlife during construction
2	4. Plants and animals as co-users of the plan area	to protect and conserve the plants and animals during use of the building
1	6. Long-term sustainable co-use by animals and plants	management plan to conserve wildlife and plants written by en ecologist
1	8. Local wildlife partnerships	to encourage the use of local knowledge on the flora and fauna

Pollution

Table 40 Credits BREEAM shows the pollution credits. This category is focused on the pollution of the building caused by emissions. Most of the credits are achieved by using type of materials and gasses. For this some technical research is needed. It might by wise to make a choice whether these credits are standard or a choice in the interface for the user of the program. If this will be a choice for the user, the choice might be too technical for the user to choose from.

Table 40 Credits BREEAM category pollution

10% Pollution		
Credits	**Name of credit**	**Explanation**
1	1. Refrigerant GWP - building services	refrigerant with GWP < 5
2	2. Preventing refrigerant leakes	no refrigerants, automatic disclosure when leaking
1	3. Refrigerant GWP - Cold storage	refrigerants with GWP < 5
3	4. NOx emmissions from heating sources	reduction air pollution
3	5. Protecting buildings from floods	preventing measures for damage risks
1	6. Minimising watercourse from floods	sustainable drainage systems
1	7. Reduction of night time light pollution	lighting in appropriate areas, upward lighting minimised, reducing light pollution
1	8. Noise attenuation	diminishing the possibility of nuisance for neighbouring buildings

4.3.3 Overall advice

For offices, BREEAM consists of 70 credits. This explorative study showed that implementing one credit into PARAP can be a lot of work. Brink Group took two years with ten people to implement the 70 credits in a model which only incorporates investment cost. Before implementing BREEAM it is wise to make a concise planning on how much time it takes and how much time is available. It might be wise to start with those categories that have the most output. That would be categories with most influence on the costs and BREEAM score. This section will end with an advice for the choice of categories to start with implementing.

PARAP is characterised by the simplicity of the input and output (in the visible workbooks). Little input is needed, to make a detailed life-cycle cost calculation of a development. A choice must be made on the visualisation of BREEAM in the visible workbooks of PARAP, without jeopardising the clarity.

It would be wise to implement BREEAM into the interface workbook the same way it is already organised. It is organised as follows: the interface has several frameworks such as ‘basisgegevens,’ ‘organisatie,’ ‘gebouw’ and ‘locatie’. These frameworks have different subjects, for instance organisation has ‘aantal werkplekken,’ ‘vaste werkplekken’ and ‘functioneel nuttig oppervlak.’ These subjects are further specified into aspects. ‘Functioneel nuttig oppervlak’ has for instance the aspects ‘kantoorruimte’ and ‘ondersteunende ruimte’ and others. These aspects are further specified in the hidden workbooks from which calculations are made. The clarity remains because on all different levels of categories, subjects and aspects assumptions are made and therefore semi-hidden for the user. When desired these semi-hidden assumptions can be made visible by clicking on the ‘plus’ and changed by the user.
BREEAM should be added in the same way. So BREEAM is a category, all the BREEAM categories are subjects and all credits are aspects. Standard a sustainability level must be chosen in the input, and then the PARAP model should make assumptions to achieve the desired level. When the user wants to achieve certain credits or BREEAM categories, he can manually change this.

A large part of the BREEAM categories can be implemented into PARAP. But for some credits this is more difficult. To be able to implement all credits some decisions must be made on how to cope with these credits.

- **Energy-efficiency expert**
  Energy-efficiency is an important aspect for sustainability. It would be useful to use some-one who is an expert on this field to implement all aspects incorporating energy-efficiency in PARAP.
- **Facility manager**
  A facility manager will have the knowledge on maintenance costs and type of maintenance needed for certain aspects that must be added. Examples are: easy maintenance by design, energy-efficient lifts, water saving systems, and others.
- **Zip code information**
  Several location aspects must be taken in account. The information needed can be added to the information used for the zip code. But this is a lot of work. A plan must be made up for this problem. An idea would be to hire students who will gather the information needed.
- **Managerial costs**
  A choice must be made whether rough assumptions will be made for the estimation of managerial costs or another approach will be undertaken. Rough assumption will make it a lot easier to determine, but that is not characteristic for PARAP.
- **Plan of approach for strange credits**
  Some credits are not easy to implement. These must be gathered in a list and made a plan of approach on how to handle with these for implementation. Examples of these credits are: ENE5.Renewable energy, TRA4.Pedestrian safety, MAT7.Robust design, MAT5.Origin of materials, MAT3,4.Re-use of materials, HEA13.Acoustic performance, and others.

Some general predictions on the costs of BREEAM are stated below:

- **Managerial costs**
  A substantial bit of the credits of BREEAM are not directly related to building aspects, but more about the management of the building or the construction site. Therefore the management hours will intensify quite some bit and therefore these costs as well due to the extra man hours needed.
- **Quality of installations, materials, devices and elements**
  Another substantial part is about the quality of the elements. Examples are: origin of materials, individual sensors, leak detection, renewable energy, energy-efficient, installation for grey water and others. These are additional building elements and will increase the cost. However with technology improvements these aspects will be become less expensive.
- **Location aspects**
  Credits that are influenced by the location and not so much the building must be tried to add to the zip code which is entered in the input. These credits are:
  - *ENE 5 Renewable energy*
    Is influenced by the location on the possibility of implementation and on the complexity of implementation which can differ per site.
  - *TRA 1 Provision of public transport and TRA 2 Proximity to amenities*
    The height of the ground price is also determined by the amount of public transport and amenities in the area.

- *LE 1 Re-use of land*
  The costs are influenced by the location on the amount of construction that is at the site and therefore amount of replacement that is needed
- *LE 2 Contaminated land*
  Building on contaminated land can cause quite some extra costs which are usually avoided.
- *LE 3, LE 4 and LE 6 about wildlife and plants.*
  The amount of work and therefore costs to keep the wildlife and plants during the whole life-cycle of the building conserved depends very much on the site.

- **Certifying costs**
  An addition to the costs is the costs of the actual certification. Certifying a building causes a lot of working hour because BREEAM has many credits and all need to be checked. This must be done during the initiation phase as well as during the delivery to come to a BREEAM certificate. These costs for large sized buildings can be budgeted as € 50.000,- (Quispel, 2010). When BREEAM would be implemented in PARAP this could reduce the certifying costs during the initiation phase.

The above cost aspects should be taken in account while implementing BREEAM into PARAP. But where to start? The energy category will show most impact and therefore is most interesting looking at. Energy is most interesting due to the following reasons:

- Energy influences the investment costs largely, depending on the type of chosen installations.
- Energy determines the service costs and therefore also has influence during operating time
- Energy has the most percentages in BREEAM 21%
- Society often considers energy-efficient as a definition for sustainability. Therefore companies often focus solely on energy.

Before the PARAP group starts with implementing energy in PARAP I would recommend to start with a brief and concise feasibility study on the implementation of BREEAM due to the fact that BREEAM consists of so many different aspects. This feasibility study should be focused on the following aspects:

- Amount of man hour needed/available for implemented
- What categories will be started with
- What level of detail will be implemented
- Possibility to implement all details
- How to handle with rough assumptions in a detailed model
- Fields of knowledge needed
- Plan of action

4.4 Summary and conclusions

Four sub-questions are mentioned regarding the life-cycle costs of end users. This last section of the lcc research addresses each question step-by-step.

1. How to determine the life-cycle costs of the end user's preferences?

The first part of this master thesis is done to determine the end user's preferences regarding sustainability. It became clear that categories Energy and Health & Wellbeing, where the most preferred ones by end users. To determine the life-cycle costs of the end user's preferences, the choice was made to investigate the category Health & Wellbeing, credit HEA1 Daylighting. This choice was made, because energy would be too time-consuming to investigate in a calculation model. Another reason to choose for HEA1 is that this credit is directly building related and therefore likely to be relatively easy to implement in PARAP. PARAP is the cost calculation model used. A cost calculation model was chosen to make results applicable for many situations. The reason no other credits were implemented was due to the time-consuming process of the detailed implementation of a credit into this model.
PARAP is a life-cycle cost modelling software program, operating in MS Excel on an element level. It uses 8 workbooks, one visible for the user and 7 hidden for the calculations that need to be made. Little input is needed for cost calculations on life-cycle costs using PARAP.

The figure below shows the process how the lcc approach was addressed in this research. This figure is explained by addressing sub-question 2 on the following page.

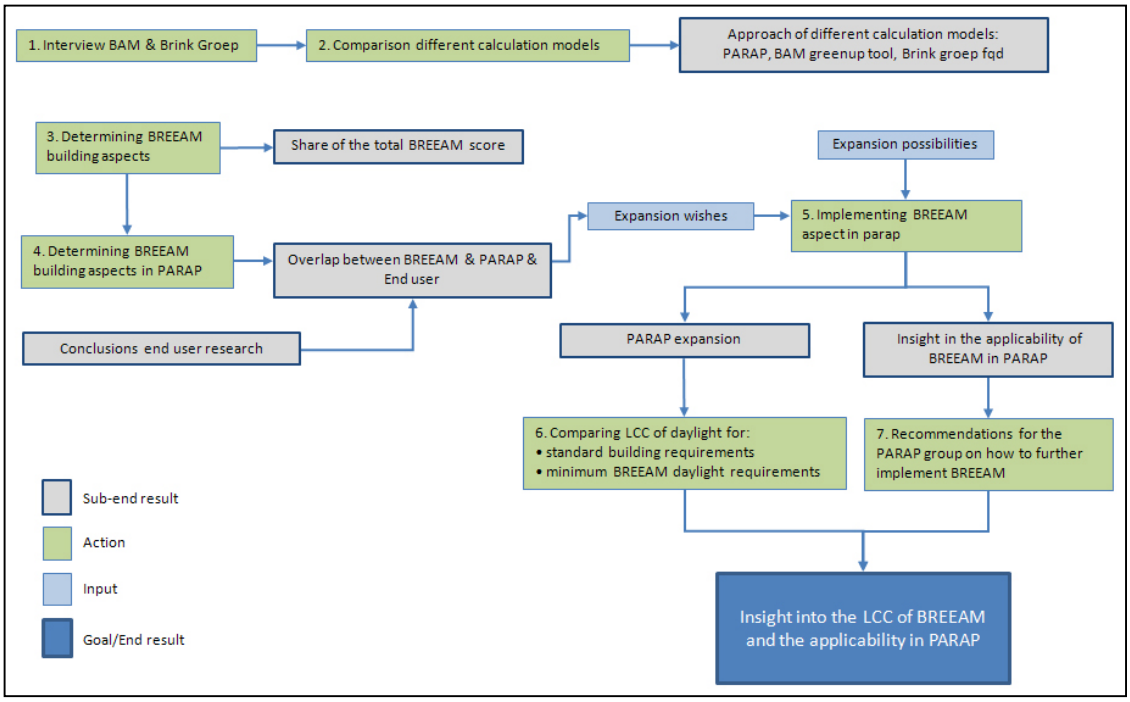


Figure 54 Research design part two LCC

2. *How to approach the life-cycle costs of sustainability with a cost calculation model?*

This question will be answered by briefly describing the process. This process can also be seen in Figure 54. Within the first and second step existing models were investigated to understand the build up of these models. Two models were examined, one from the Brink Groep and one for the Royal BAM. The third and fourth step determines which BREEAM aspects are building specific and in what way these are already in PARAP. 42% of BREEAM credits are building specific. 6% of BREEAM credits are partially already in PARAP.
For the implementation of HEA1 in PARAP an extra workbook is added. The criteria to achieve this credit are obtained from the DGBC. The data needed for these criteria are obtained from calculations made by PARAP and through own literature study.
So an addition to the cost calculation model of PARAP is made to determine the lcc of (a) BREEAM (credit).

3. *What are the life-cycle costs of the credit daylighting?*

Using the standard input of PARAP, the credit daylighting is not achieved. Investigated is the lcc corresponding with the minimal requirements to achieve the daylighting credit compared to PARAP's standard input. The three variants used to do so are:

1. Standard PARAP input (credit is not achieved)
2. Change type of façade (credit is not achieved)
3. Change type of façade and percentage open façade (credit is achieved)

The lcc needed to achieve the credit HEA1, from variant 1 to variant 3 is:

- Investment costs increase of: € 100.000,- which is a relatively rise of 0,5%.
- Operating costs increase of: € 38.000,- per year which is a relatively rise of 2,5%.

To achieve the daylighting credit both investment costs as well as operating costs rise. This is because the type of façade and percentage of open façade are changed. These are both influencers on the operating costs. An increase of window surface results in extra heating to compensate for the heat loss through the window. However lcc predictions for all BREEAM credits is not possible at this stage, a successful first attempt is made to show the possibility of BREEAM in PARAP.

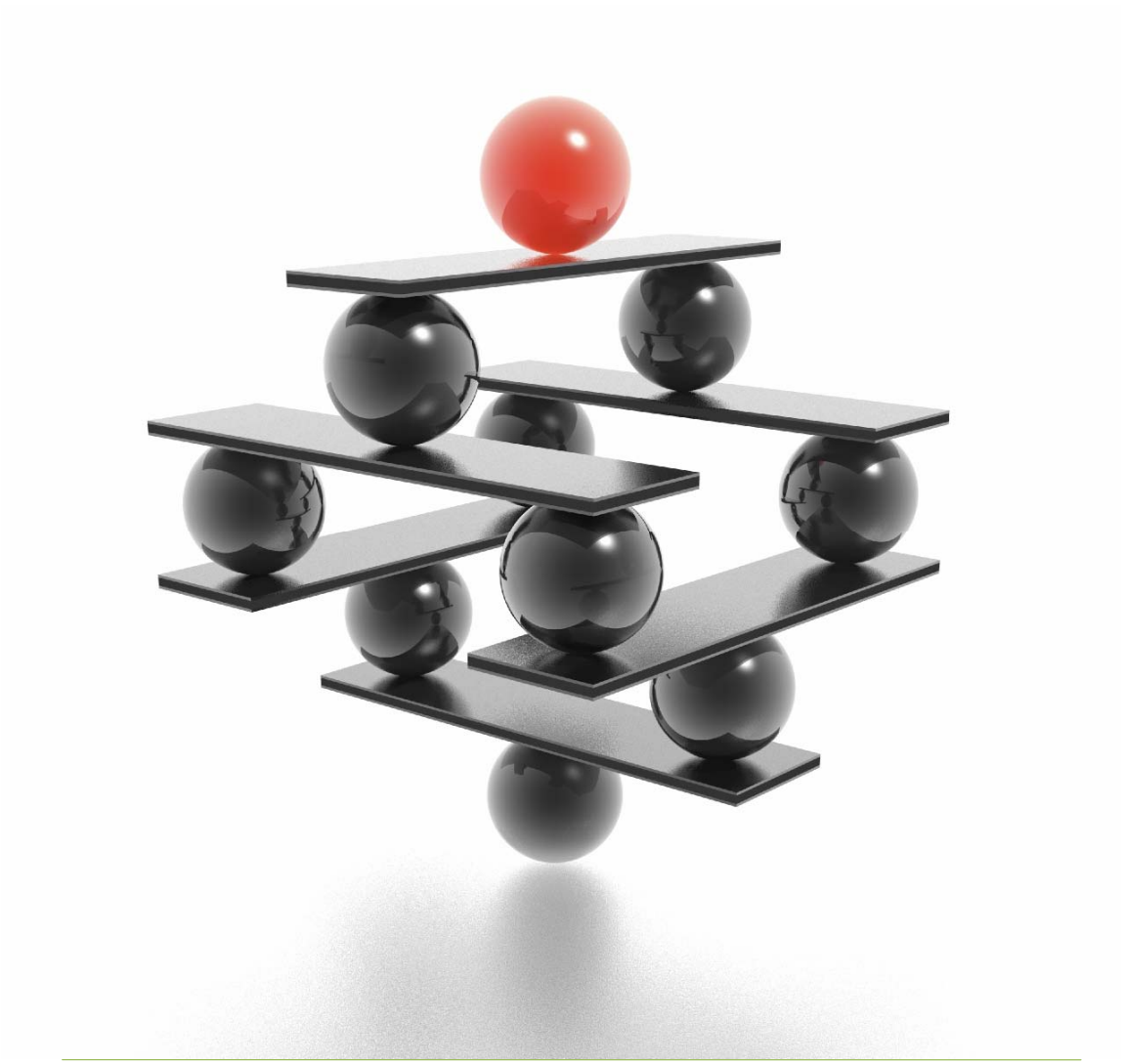
4. *What are further implementation possibilities of BREEAM into PARAP?*

The result of a credit fully implemented in PARAP, showed that it is possible to implement a sustainability tool in PARAP. Further implementation is possible. But implementing all BREEAM credits into a detailed cost calculation model such as PARAP, will cause an extensive amount of work. However for most BREEAM credits the only problem will be the time available. Some general remarks are made in this paragraph to serve as a handhold for further implementation of BREEAM into PARAP:

- **Planning**
  A study must be made on the time needed to implement the BREEAM categories as well as to determine the time available to do so.
- **Rough assumptions**
  For some aspects it is complex to make detailed assumptions and relatively easy to make rough assumptions. An example for this would be managerial aspects. Rough assumptions are however not characteristic for the level of detail PARAP uses. The PARAP group must decide on how to cope with this mismatch of level of detail.
- **Complicated credits**
  For some credits it is complex to determine its characteristics. These are mentioned in *4.3.3 Overall advice*. If these are desired to implement, for each credit a plan of approach must be made to implement them in PARAP.
- **Certifying costs**
  Little is known about the certifying costs because there is little experience using BREEAM labels. But these costs seem to be substantial and therefore important to take in account in PARAP as well. The reason for these high costs is that BREEAM consists of 70 credits and each credit needs to be checked. This checking, costs a lot time and therefore money. To give an impression: for a new development JLL is working on of 17.000m_2, the developer preliminary budgets € 45.000,- (Quispel, 2010). When BREEAM would be implemented in PARAP, this could reduce the certifying costs during the initiation phase.
- **Expanding expertise**
  Some extra expertise can be useful on the fields of energy-efficiency for renewable energy and other sustainability aspects such as water & materials and BREEAM certification.

The next chapter, chapter 5, discusses the conclusions and recommendations from this research.

Conclusions & Recommendations



5 Conclusions & recommendations

This final chapter addresses the conclusions and recommendations regarding the conducted research. Firstly the conclusions are mentioned, secondly recommendations are stated. Recommendations made are for both theory and practice. Concluding, some methodological remarks will be made.

5.1 Conclusions

For this research a general research question and several sub-questions are stated in chapter 1. The answers to the sub-questions are discussed in the conclusions of the corresponding chapters which are: chapters 2, 3 and 4. The general research question is answered in this chapter which is as follows:

To what extent are investments in sustainable offices financially feasible, considering the end user's wishes, throughout the entire life-cycle of a (re)development?

To come to an answer, the preferences of all three stakeholders, involved in a (re)development, should be considered. These are the end users, the developer and the investor. The preferences and wtp of the stakeholders remains unclear, which resulted in the circle of blame 2. This research tries to give more insight into the preferences of the stakeholders, to increase the pace of realising sustainable offices.

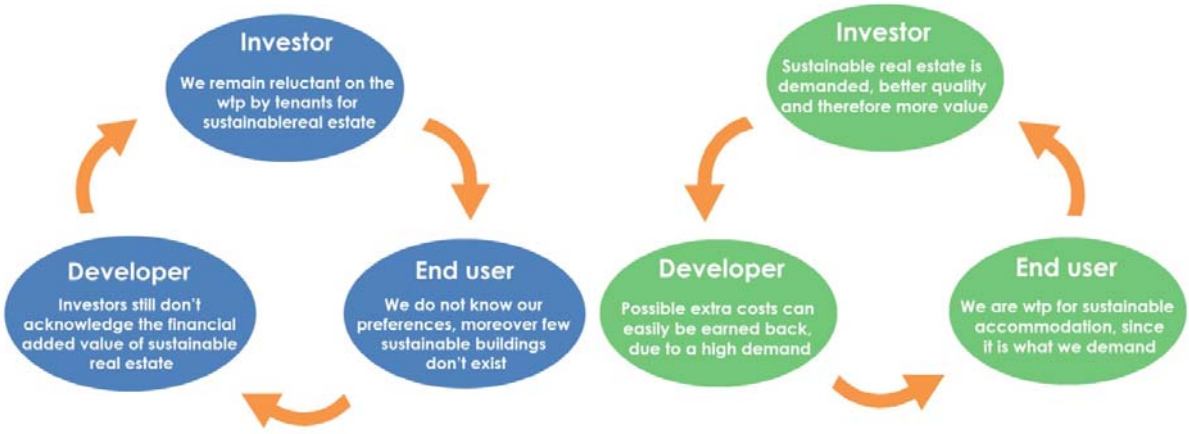


Figure 55 Circle of blame 2 on the left vs. solution on the right

This research shows empirical results regarding the end user and developer. These are shown below. Hereafter some situations for owner-occupier and owner-tenant are discussed, to illustrate the financial feasibility of sustainable offices.

1. End user

The first part of the research is an analysis of the willingness-to-pay by end users for sustainable office accommodation. In 2010 the planning of end users to be housed sustainable is longer than it was in 2008. This can be explained by the economic crisis and increased knowledge on the implementation of sustainability. But sustainable accommodation still has become increasingly important. Two years ago, only 38% of the Dutch office users stated sustainable accommodation to be important, in 2010 this is 70%. This is likely to result in an increase in demand for sustainable offices. According to the survey's results, this increase will continue in the coming five years. In 2010 45% of the end users implement their ambitions for sustainable accommodation, 55% of the respondents think they are in 2015. Besides this demand, the end user seems to be willing to pay. If advantages such as improvement of productivity or image improvement are obtained, the end user is willing to pay a rent premium of 6%. But to solve the split-incentive, end users state they are only willing-to-pay 32% of their service costs savings back to the investor in a rent premium. This could result in some difficulties to implement the green lease type of contract.

Table 41 Results on rent premium and green lease willingness-to-pay by end users

	Rent premium	Green lease
Stated preferences		
Visser (2010)	6 %	32 %
Snoei (2008)		76 %
JLL (2008)	5 %	
Corenet global & JLL (2009)	3,2 %	
Revealed preferences		
Eichholtz (2008)	3 %	
Pot (2009)	1,5 - 18 %	
Heineke (2009)	3,7 %	
Case study		
Berkhout (2010)	5 %	

To compare the wtp of end users on rent premium and green lease, calculations using a fictive building are made. Table 24 shows the results. Input for the comparison comes from literature review, PARAP and results from the survey. End users seem to be over 5 times more willing-to-pay for a rent premium, excluding the service cost advantages. This would mean that end users are, by far more willing-to-pay for advantages such as image improvement and productivity increase of employees, than they would be for energy-savings.

Table 42 Comparison between the end users wtp for rent premium and green lease

Input		Quantity	Source
Full-time equivalent		200	PARAP
Lettable floor area (m2)		5089	PARAP
Average rent/m2/year	€	150	JLL
Total rent per year	€	763.350	
Total service costs per year	€	66.000	PARAP
Average energy savings potential		40%	CBRE

Annual service costs savings	€	26.400

WTP End users	
Green lease	32%
Rent premium	6%

Additional profit investor		
Service costs	€	8.448
Rent	€	45.801

2. Developer

The second part of the research was an explorative study on the life-cycle costs of sustainable offices. It tries to give more insight into the total costs of sustainable offices. The sustainability label BREEAM and the cost calculation model PARAP were used to do so. Both are detailed methods, incorporating many aspects. Implementing all BREEAM aspects into PARAP would be too time-consuming. In this research one BREEAM credit, HEA1 Daylighting, is implemented and an advice for further implementation is given. The credit daylight shows an increase in investment costs of 0,5% and in operating costs of 2,5%.

This research is a first attempt to incorporate BREEAM in a life-cycle approach. It shows that it is possible to implement BREEAM into PARAP. However it will be an extensive work to implement all credits. To do so, recommendations are made for the PARAP group for further implementation.

Like this research, many researches show that the investment costs for sustainable (re)development is higher than non-sustainable (re)development. The exact height depends on the level of sustainability. These extra costs must be earned back by the investor, to be willing to invest in sustainable offices.

3. Investor

According to this research, the investor can get a rent premium of 6% to earn back possible additional investments. However, investors remain reluctant on the recognition of the financial added value of sustainable real estate. According to investors, there is not enough evidence for the added value of sustainable real estate. Investors consider sustainable real estate as a risk. Investors want to minimise their risk-return profile and therefore remain reluctant to invest in sustainable real estate.

Below situations are discussed to give extra grasp on the financial feasibility of sustainable offices. The situations are from an owner-occupier and owner-tenant perspective. For both perspective the 'quick-wins', energy-efficiency and green labels are discussed.

- **Quick-wins**
  Quick-wins symbolise actions that can be done to serve the tenant's wishes, using little effort to improve the level of sustainability of an office building. Quick-wins show few problems in the financial feasibility and are easy to achieve. Examples of such actions are automatic light switches and decreasing the temperature of the central heated spaces by a half degree Celsius. Actions as such positively influence the level of sustainability. Most of the actions reduce the service costs as well. However these actions are a first step for a sustainable building, and no ambitious sustainability levels will be achieved in this way. Out of the survey it becomes clear that tenants often want a higher level of sustainability. Quick-wins show negligible difference for owner-occupiers and owner-tenants.
- **Energy-efficiency**
  Achieving a high energy-efficient building is often considered to be well sustainable by end users. In an office building where the owner (investor) is the user as well, it is less complex to reach a high level of energy-efficiency. The reason is that all advantages are fully for the same stakeholder. These are image improvement, service costs reduction and possible higher exit value. The benefits of lower service costs are directly earned back by the owner-occupier. For an owner-tenant situation this is more complex. When a building is rented out, there is a problem for increasing the level of energy-efficiency, the split-incentive. The investor makes costs for energy-efficiency and the tenant (end user) obtains the benefits of lower service costs. To solve this problem, a new type of contract has been developed, the green lease. This is an agreement between tenant and investor where both parties make arrangements on the share of benefits of lower service costs for both parties. During the research it became clear that green lease is a concrete solution for a large problem regarding sustainable real estate. The survey showed however, that tenants would only be willing to pay back 32% of these savings. Efforts should be made to show end user that it should be a fair share between both the end user and investor. This can enhance the process of green lease implementation in the real estate market.

- **Green labels**
  The survey from this research shows that 85% of the office users want a green label, when they recite in a sustainable building. It also shows that demand for sustainable offices is likely to increase in the coming years, therefore the demand for green labels as well. Green labels incorporate many aspects. Energy savings cause direct quantifiable benefits. Advantages obtained from other sustainability aspects are less directly quantifiable. Examples are: higher productivity, lower sick leave of the employee and image improvement. This research shows end users are willing-to-pay a rent premium of 6% for a sustainable office. It even shows that end user tend to be, by far (5 times), more willing to pay for other advantages than energy-savings. But investors remain somewhat reluctant to pay for this added value. To change this, extra research or evidence is needed to convince investors. Owner-occupiers often want to show off with their building and consider the benefits of image improvement rather large. In such situations, the financial feasibility is less important, not unimportant, but less. In an owner-tenant situation it is more complex. But with the increase of demand by the end user, investor should not wait for evidence to come. This research showed Green lease is a first step to address the split-incentive. Moreover green lease can also be used to address other sustainability aspects. To achieve high sustainability levels, probably concise agreements should be made. Throughout this research it became increasingly clear that collaboration is needed from both the investor as well as end user to achieve a high level of sustainability.

5.2 Recommendations

In this section, firstly recommendations are made for additional research and secondly recommendations for the practice are mentioned.

5.2.1 Research

Follow up research recommendations are mentioned here in the same order that was used throughout this master thesis: end user, developer and investor.

- Interesting for further investigation is the rent premium tenants are willing to pay for sustainable offices using a hedonic pricing method. This type of research will show extra evidence for the investor that end users are willing-to-pay a rent premium. A research like this one is successfully performed for the U.S.A. (EichholtzPiet & KokNils, 2008) and is tried less successful for The Netherlands, due to the availability of data (Heineke, 2009)(Pot, 2009).

- For the life-cycle cost a follow up research would be very useful. At the moment, the investment costs as well as the operating costs of sustainable offices are still relatively unclear. This research conducted an explorative study on implementing BREEAM in PARAP. Further implementation would be useful. Chapter 4 gives several recommendations on how to do so.

- For the investor three follow up researches are mentioned:
    - Pay-back time of measures for energy-efficiency. Grootswagers (2010) did research on the pay-back time for energy-efficient measures. When a building is made energy-efficient, this can be earned back by lower service costs. The question is when the benefits outrun the costs. After this point the lower service costs are purely extra return. For the investor it would be interesting to know when this point is achieved. At the moment, this type of research is interesting for the owner-occupier and not for the investor with a tenant. The reason for this is the problem of the split-incentive.

    - Split-incentive. To solve the split-incentive a green lease type of contract is developed. Van der Bijl developed a Dutch model based on the ROZ-IPD. Further research for The Netherlands could help to provide evidence for real estate firms to use the green lease contract. Research can be done on further development of guidelines for such a contract. Another possibility is to study the process on how to implement green lease into practice.

    - The fourth and last type of research is the revision of the valuation method. To be able to incorporate all the advantages in the value for the investor, a new valuation model must be developed. Van den Tol (2010) made such a model. Additions should be made to enhance to assumptions made. This model can be examined by conducting a case study.

5.2.2 Practice

Besides recommendations for follow up research, some recommendations can be made for the practice. Firstly, two recommendations are made for all parties involved. Secondly two advices are mentioned for real estate firms in particular. Finally a recommendation is given for the government.

- **Definition of sustainability**
  Sustainability is a widely understood definition. This should not be seen as a complication, but as a playfield for all organisations to determine their own definition and ambitions for sustainability. This is a good thing, because organisations have different priorities and can achieve sustainability in their own way. To give an example, a company such as Philips, will probably focus more on the lighting and energy-efficiency. But a company which is focused on reducing its size, due to the economic crisis, will focus on using less space. Both companies contribute to a more sustainable world and both achieve their goals.
- **Create future benefits now**
  Several years ago people thought sustainability would be a hype. But sustainability remained a 'hot topic', even during the economic crisis. This resulted that sustainability is now considered to be here to stay and is even predicted to be standard in the future. But than it is remarkable sustainable real estate is not evolving at the pace it should be. However, companies focusing on sustainable real estate now, will still be one of the front runners and therefore create future benefits. Companies that do not do so, will face an obliged adaptation in the future, due to increased law and regulation. But they will not receive the benefits since these are standard by that time.
- **Real estate advisory firms**
  What actions can real estate advisory firms such as Jones Lang LaSalle do, to come to a more sustainable world and therefore be a front runner?
  - Translating CSR policy into program of requirements. Many organisations have their own CSR policy. This is the ambition of the organisation for sustainability in general. This can incur many aspects and not directly relate to real estate. It is the task of the real estate advisory firms to translate these into a concise program of requirements to help the client to achieve its sustainability ambitions.
  - Green lease is the type of contract which can help the financial feasibility of sustainable (re)development. Real estate advisory firms can make parties realise, the importance of green lease and how to use it.
  - Added value. Real estate advisory firms are in the position to led the real estate market know that sustainability is an increase in quality and therefore in value. They can do so by publications, research and scenario development of the possibilities.
- **Clear policy government**
  To speed up the pace for sustainable real estate, the government should make a clear, long lasting policy. But the government often changes its policy. This results in confusion by commercial parties. Commercial parties do not know where their focus must be. A possible step the government could take is to say the following: *"In ten years time we want the real estate of firms to use X CO2 less compared to 2010. When this is achieved the company receives a subsidy if not a fine."* But organisations must remain free in their choice on how they will achieve these regulations. The Dutch government remains reluctant for this type of policy. But other countries, such as the U.K. and Germany, already have such policies. Maybe the Dutch government can learn from these existing policies.

5.3 Methodology remarks

This section makes some small remarks regarding the used methodology.

- **Survey**
  Surveys can be useful to measure a tendency since this method costs relatively little time. The problem with surveys is that surveys measure opinions rather than evidence. Therefore it is difficult to draw concrete conclusions.
- **Modelling**
  An advantage of modelling is that the level of detail can be chosen by the researcher depending on his wishes and time available. With modelling, it is usually possible to obtain generic results. However, qualitative aspects are rather difficult to implement in a model.
- **Investor**
  Research on the investor remains difficult to make generic, since real estate appraisal is often based on appraisers' opinions and therefore are subjective.
- **Situation dependent**
  Results from research on real estate in general are often not generic, since every building is unique. This makes it difficult to come to generic conclusions.

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