Objective valuation of sustainable office real estate.

A renewed valuation model

M.J. Deenen

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I. COLOPHON

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''The consequences of our actions are so complicated, so diverse, that predicting the future is a very difficult business indeed.''

– J.K. Rowling (1999)

II. PREFACE

''If everything was perfect, you would never learn and you would never grow.''

– Beyoncé

Beyoncé is still striving for perfection, knowing that it can never be achieved. Inspired by that reasoning, I started writing my thesis. I have started an adventure in a for me unknown area because I wanted to expand my knowledge to subjects which have always been interesting to me. Therefore, my graduation research was the perfect opportunity to go into these subjects. After reading an article about "sustainable office buildings", the lack of sustainability and the subjectivity within valuations immediately caught my attention. As a newcomer it was incomprehensible to me that sustainability was hardly incorporated in valuations and that there was claimed that the exact added value of sustainability cannot be determined. In addition, back then, in my eyes a perfect valuation should not include any subjectivity of the property appraisers.

Without the knowledge and the confidence of Alba Concepts, this report would not have been there. They gave me the opportunity to graduate on this innovative topic. In particular, I would like to thank Jim Teunizen for his guidance and sharing his vast knowledge and experience.

I also would like to thank Mrs. Dane, my first supervisor of the Eindhoven University of Technology. She gave me proper process guidance, good advices and a share of her expertise. She asked in depth questions that lifted my thesis to a higher level. Additionally, I would like to thank Mrs. Han as my second supervisor of the Eindhoven University of Technology.

The results and the conclusions of this thesis could not have been conducted without the participation of property appraisers of different companies and the expert panel. Also the people who filled in the online questionnaire have had a substantial contribution to my research. Therefore, I would like to thank all the interviewee, the respondents and the expert panel.

Finally, the most important people in my life; my boyfriend, family and friends, thank you for all the great support. You have listen to my doubts, my considerations and the complains during my thesis. This may not always have been fun. Doing leisure activities and giving me confidence, you have supported me through my graduation period.

Although I realize that valuations are no rocket science and it is difficult to fit changes, I still hope to have a meaningful contribution. This by incorporating sustainability into valuations of sustainable office buildings.

Enjoy reading,

Maud Deenen
Eindhoven, June 19th 2016

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IV. MANAGEMENT SUMMARY

In order to fulfil the needs of future generations, sustainability is globally no longer a trend but a necessity. In the past decades, the term sustainability has been increasingly seen as a potential solution for a wide range of challenges and problems. This obtains for both global and local scales across all walks of life (Eccles, Krzus, Rogers, & Serafeim, 2012). Since resources become depleted and CO2-emissions need to be reduced, the society should embrace sustainability. Real estate is responsible for a significant use of resources and account for approximately 44% of the CO2-emmision. According to requirements of the European Union the CO2-emission levels should be at least 20% less in 2020 than the emission levels in 1990 ("Europa 2020 | Europese Unie | Rijksoverheid.nl," 2015). For that reason, it is a must to make existing real estate more sustainable.

It is the building owner's liability for making the current real estate more sustainable. However, in today's system, contribution from the building owners will not be profitable. This is due to the lack of sustainability in the value of sustainable office buildings. In the current way of valuing, a conventional office building will get approximately the same value before and after applying sustainable measures. In addition, sustainable office buildings only result in perceptible benefits for a building's users and not in benefits for building owners and banks. Users prefer sustainable office buildings, because of the fact that sustainable buildings provide vast benefits in relation to increase in productivity and reduction of absenteeism (John Alker, Michelle Malanca, Chris Pottage, 2015). If sustainability would be incorporated in valuations, sustainable office buildings will get a higher value compared to unsustainable office buildings. In that way, all stakeholders will gain benefits from sustainable office buildings. First the building's users retain their benefits. Second, building owners will profit from reduced maintenance costs, a higher market rent or a strongly decreasing risk on long term vacancy and a higher residual value. Lastly, the banks will benefit from less risks by financing sustainable office buildings.

The renewed valuation model offers property appraisers a way to determine the value of sustainable office real estate in a less subjective way. By incorporation of sustainability in a valuation model, the potential benefits of sustainable buildings are going to be taken into the value of an office building. In the renewed valuation model, sustainability is expressed in four aspects; energy costs, maintenance costs, productivity and absenteeism. The renewed valuation model is built up from a DCF-model (slightly adapted), elements of sustainability and the directives.

For enclosing objectivity in the renewed valuation model, default discount rates and exit yields were set. This has been done through online questionnaires and a validating expert panel. However, valuations are no rocket science and therefore subjectivity cannot be excluded. Setting default discount rates for each different sustainable aspect, the objectivity in the renewed valuation model has been maximized.

In contrast to the literature, the market is not aware of the positive effects of sustainable buildings. Therefore, users are not willing to pay considerably more for a sustainable building. However, property appraisers have to estimate the market value of a building. The market value is the price that random a user is willing to pay for specific building on that moment.

Due to the fact that there is almost no awareness among the users, property appraisers are not in a position to include sustainability in the value of a building. Before sustainability can be incorporated in the valuations, awareness on the market has to be created. Property appraisers can contribute to this by naming the future prospects of the building in the valuation report and making the effects of sustainable buildings more obvious for users.

At this moment a transition has started. It is a matter of time until the awareness among the users is created. The period of transition is difficult to estimate. However, when a number of large corporations decide to take sustainability or the productivity and absenteeism into their office building choices, the process will accelerate.

V. SAMENVATTING

Om te voldoen aan de behoefte van de toekomstige generaties is duurzaamheid niet langer een trend maar een behoefte. Het begrip duurzaamheid wordt in toenemende mate gezien als mogelijke oplossing voor een breed scala aan uitdagingen en problemen door bijna alle lagen van de bevolking (Eccles, Krzus, Rogers, & Serafeim, 2012). Omdat natuurlijke bronnen uitgeput raken en de CO2-uitstoot moet worden verlaagd is onze samenleving genoodzaakt te verduurzamen. Vastgoed veroorzaakt een aanzienlijk deel van de uitputting van de natuurlijke bronnen en veroorzaakt ongeveer 44% van de CO2-uitstoot. Om te kunnen voldoen aan de eisen van de Europese Unie in 2020, die voorschrijven dat de CO2-uistoot met 20% verminderd moet zijn ten opzicht van 1990 is het van groot belang dat bestaand vastgoed verduurzaamd wordt ("Europa 2020 | Europese Unie | Rijksoverheid.nl," 2015).

Door het verduurzamen van bestaand kantorenvastgoed dragen gebouweigenaren bij aan het verminderen van de negatieve impact op de samenleving. Echter, het is nog niet rendabel gebleken om bestaand vastgoed te verduurzamen. Dit is te wijten aan het feit dat duurzaamheid niet wordt meegenomen in de huidige manier van het waarderen van kantoorgebouwen. Duurzame kantoorgebouwen hebben nauwelijks meerwaarde ten opzicht van niet-duurzame kantoorgebouwen. Wanneer een niet-duurzaam gebouw wordt verduurzaamd zal er slechts een kleine waardestijging waarneembaar zijn welke niet opweegt tegen de kosten van de verduurzaming. In de huidige situatie profiteren alleen de gebruikers van de voordelen die een duurzaam kantoorgebouw biedt. Gebruikers willen duurzame huisvesting omdat dit enorme voordelen met zich meebrengt zoals verhoging van de arbeidsproductiviteit en verlaging van het ziekteverzuim (John Alker, Michelle Malanca, Chris Pottage, 2015). De andere belanghebbende; banken en gebouweigenaren, profiteren daarin tegen niet van de voordelen van een duurzaam kantoorgebouw. Wanneer duurzaamheid wordt geïntegreerd in de waardering zullen duurzame kantoorgebouwen een aanzienlijk hogere waarde krijgen ten opzichte van niet-duurzame kantoorgebouwen. Daarnaast zullen alle stakeholders profiteren van de positieve effecten van een duurzaam kantoorgebouw. De gebouweigenaren zullen profiteren van lagere onderhoudskosten, een hogere markthuur of een verminderd risico op structurele leegstand en een hogere restwaarde. Door het (her)financieren van duurzame kantoorgebouwen zullen de banken profiteren van lagere risico's.

Het vernieuwde waarderingsmodel biedt taxateurs een kans om duurzaam kantorenvastgoed te waarderen op een objectieve manier. Door de integratie van duurzaamheid in de waardering zullen de positieve effecten van duurzaam kantorenvastgoed zichtbaar worden meegenomen in de waardebepaling van het gebouw. Duurzaamheid wordt in het nieuwe waarderingsmodel uitgedrukt in vier verschillende aspecten; energiekosten, onderhoudskosten, productiviteit en ziekteverzuim. Het vernieuwde waarderingsmodel bestaat uit het enigszins aangepaste standaard DCF-model, duurzaamheid als geïntegreerd onderdeel en een handleiding voor het gebruik van het vernieuwde waarderingsmodel.

Om de objectiviteit binnen het vernieuwde waarderingsmodel te waarborgen zijn er standaarden vastgesteld voor de disconteringsvoet en de exit yield. Deze zijn door middel van een online enquête en een expert panel vastgesteld. Echter, taxaties zijn geen exacte

wetenschap, er zal altijd een zekere subjectiviteit blijven bestaan binnen taxaties. Door het instellen van een standaard disconteringvoet voor ieder duurzaamheidsaspect blijft de objectiviteit op het gebied van duurzaamheid binnen het vernieuwde waarderingsmodel gewaarborgd.

In tegenstelling tot wat de literatuur voorschrijft is de markt zich niet bewust van de positieve effecten van een duurzaam gebouw. Hierdoor zijn gebruikers niet bereid meer te betalen voor een duurzaam kantoorgebouw ten opzicht van een niet-duurzaam kantoorgebouw. Een taxateur moet de marktwaarde van een gebouw bepalen. Dat wil zeggen; de prijs die een willekeurige gebruiker vandaag de dag wil betalen voor het desbetreffende gebouw. Vanwege het feit dat er nauwelijks bewustzijn is onder de gebruikers kan de taxateur de positieve effecten van een duurzaam gebouw niet meenemen in de waardering. Voordat duurzaamheid geïntegreerd kan worden in de waardering moet er bewustzijn gecreëerd worden op de markt. Taxateurs kunnen bewustzijn creëren door het toekomstperspectief van het gebouw te benoemen in het taxatierapport en het inzichtelijk maken van de positieve effecten van duurzame gebouwen aan de gebruikers.

Op dit moment begeven we ons in een transitie, het is een kwestie van tijd totdat de gebouwgebruikers zich bewust worden van de voordelen van duurzame kantoorgebouwen. Het is lastig in te schatten hoe lang dit proces zal duren. Echter, wanneer een aantal grote corporaties beslist om duurzaamheid en de productiviteit en het ziekteverzuim mee te nemen in de afwegingen voor hun huisvesting zal het proces worden versneld.

VI. ABSTRACT

What is the exact value of a building? These days sustainable buildings do not get a perceivable higher value relative to unsustainable buildings. This due to the lack of sustainability within valuations. It are only a building's users that benefit from the positive aspects of a sustainable building like the increase in productivity and decrease of absenteeism. There are no perceptible benefits for the building owners, therefore making existing real estate more sustainable is stagnating. Using the Fuzzy Delphi Method (FDM) a consensus among property appraisers about the most important physical aspects of an office building is made. The results of the FDM are included in the renewed valuation model. Sustainability is expressed in four aspects: energy costs, maintenance costs, productivity an absenteeism. Due to the incorporation of sustainability in valuations sustainable buildings will get a perceptible higher value relative to unsustainable building. In addition, all stakeholders will benefit from the positive effects of sustainable buildings.

Key words: Sustainability, valuations, sustainable offices, objective valuations, Fuzzy Delphi Method (FDM), most important criteria sustainable buildings

1. INTRODUCTION

In this introduction, first the research context will be discussed. After that, the area of the main problem will be specified in the problem definition. Next, the main research question with associated sub-questions will be elaborated on. Finally, the research design will be explained and thereafter the expected results will conclude the chapter.

1.1 RESEARCH CONTEXT

What is the value of a building? It is the responsibility of property appraisers to assign a well-founded value to a building. These days, the value of a building is often calculated using references combined with the gut feeling of the property appraiser. A gut feeling is a well-developed sense within a person; the appraiser uses this to estimate the outcome of a specific situation and act accordingly. The current way of valuing office real estate had been done so for years. Therefore, it is assumed that there is no need for a model that can objectify the sensitivity of the property appraiser. Due to that assumption, no improvements are made to the current way of valuing. It might be due to a feeling of attachment to the existing valuation method or it might be due to the opinion of property appraisers who think this way of valuing is relatively easy. Thereby, in most cases a good underpinning of the valuation is missing. In addition to that, as an important concept in the construction and real estate sector a significant variable for valuation is missing, namely sustainability. These days the question is no longer if a building is sustainable, but to what extent a building is sustainable.

Resources become depleted and CO2-emissions need to be reduced. Our society needs to become more sustainable. Therefore, there is a need for more sustainable development. In addition to this, real estate also has to become more sustainable, because the real estate sector causes significant use of resources. Sustainability has become a standard understanding in society. Approximately 44% of CO2-emissions is caused by real estate (Koolmoes, 2014). Due to this fact, making existing real estate more sustainable is a must in order to meet the requirements of the European Union in 2020. The CO2-emission levels should be at least 20% less than the emission levels in 1990. In addition, 20% of the energy has to come from renewable energy sources like wind, solar, geothermal- and bio-energy (“Europa 2020 | Europese Unie | Rijksoverheid.nl,” 2015).

‘Sustainability should outweigh more in real estate valuations’ (Schuur, 2016). This statement of the real estate director of ABN AMRO should encourage property appraisers to change their current way of valuing. Currently, sustainability is only taken into account if an energy label has positive influence on the value (C or higher). The value will increase with an x amount, all depending on the gut feeling of the property appraiser (Berkthout, 2010). In a few cases, property appraisers also take other aspects of sustainability into account, such as maintenance and facility costs. However, a sustainable building encompasses more than these aspects. Property appraisers often use references to underpin their assigned value. Though, the lack of appropriate sustainable references leads to omission of sustainability within valuations. Moreover, the exchange system of references between the property appraisers that is used for determination of valuations is not reliable, far from error-free and contamination (Have, Taxatieleer vastgoed 2, 2011).

Although the exact scope of a sustainable building is missing, tools like BREEAM and LEED are developed to measure the sustainability of a building. These tools assess buildings on aspects like energy, health & wellbeing, water, pollution, transport etc. Besides that, the impact of

sustainable building features results in benefits like an increase in productivity, reduction of absence through illness and an improved image. However, these benefits are not included in valuations despite the huge financial benefits. In addition, all tools assess buildings on other sustainable aspects, that makes the usage of these tools doubtful.

Up to now, no valuation model is developed that takes sustainability into account. A new model that includes sustainability in a uniform way and limits the objectivity within valuations, will result in benefits for all stakeholders of a sustainable building.

1.2 PROBLEM DEFINITION

During the past years sustainability has become more important. This also applies to the real estate sector. Sustainability is included in different degrees in new buildings. However, making existing real estate (more) sustainable is a very slow process. This despite the fact that there is a lot of office real estate that no longer meets the needs of the users. One of the reasons of the slow proceeding of making existing office real estate more sustainable, is that it is not profitable for the building owners to make their office buildings more sustainable. In this situation, only users gain benefits of making existing office real estate more sustainable, like increase in productivity or decrease of absenteeism. The building owners on the other hand hardly gain benefits from making their office buildings more sustainable. This is due to the value of the building; the value of a sustainable building is not considerably higher compared to the value of a conventional building. Due to this fact, making existing office real estate sustainable is stagnating. All this is due to the fact that there is a lack of sustainability within valuations. When sustainability would be included in valuations and sustainable buildings get considerably higher values relative to unsustainable buildings, it becomes profitable for building owners to invest in making their buildings more sustainable. They will benefit from

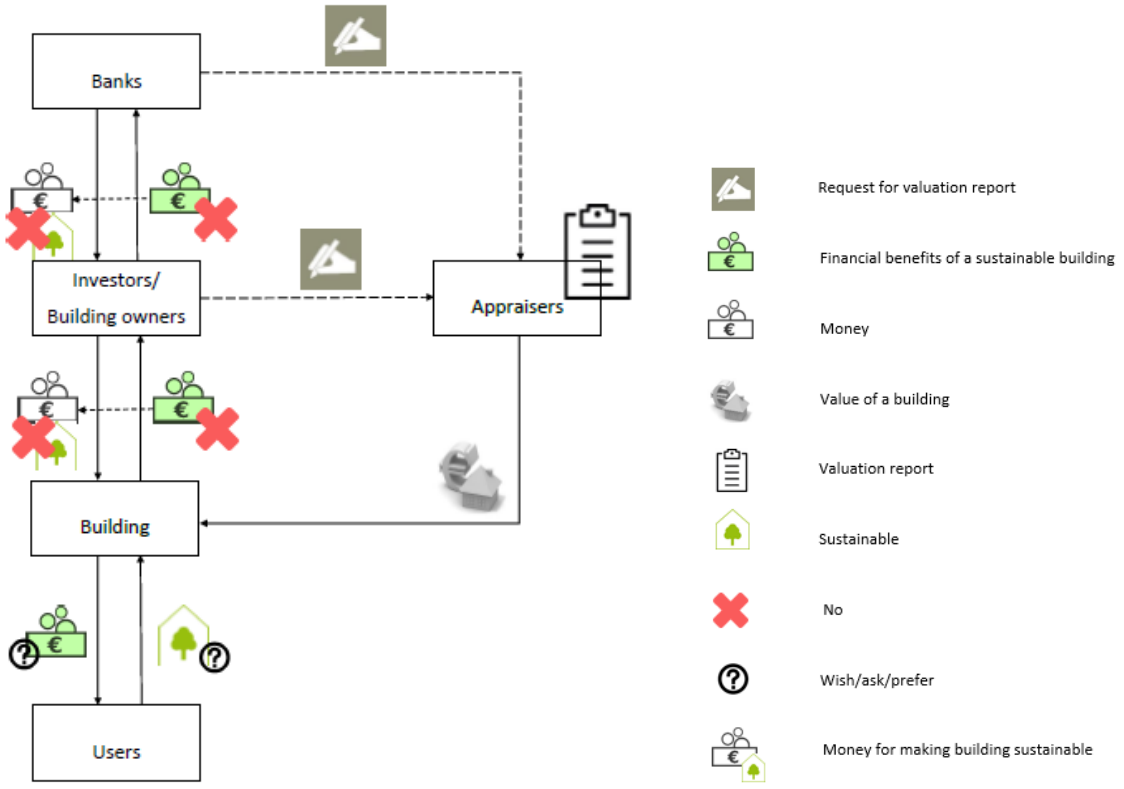

Figure 1. Overview: lack of sustainability in valuations

lower maintenance costs, lower risks or higher rental income and higher residual value. In addition, banks will refinance earlier because their risks are lower for sustainable buildings compared to unsustainable buildings. Figure 1 shows the current effects of the lack of sustainability in valuations.

1.3 RESEARCH QUESTIONS

Based on the problem definition, a valuation model that includes the different aspects of sustainability and reduces the subjectivity of property appraisers in the context of sustainability is missing. Therefore, the aim of this research is to design a renewed valuation model that includes all aspects of sustainability and reduces the subjectivity of the property appraisers. The renewed model allows property appraisers to assign a well-founded value to a sustainable office building. A value that includes the sustainability aspects of a building, which affects the behaviour of various players on the office real estate market. Investors and tenants will be pushed through financial and social benefits to prefer sustainable office buildings relative to unsustainable office building.

Derived from the problem definition and the aim of this research the next main question is formulated:

How can a renewed valuation model including directives ensure that sustainable office real estate can be valued in an objective way?

In order to answer the main question of this thesis the following sub-questions are formulated.

Current state:

1.1 According to what directives and valuation methods do property appraisers value office real estate?
1.2 How are valuations in practice actually performed?
1.3 How do property appraisers take sustainability into their valuations?
1.4 How objective is a valuation of a property appraiser?

Sustainability:

2.1 What is sustainable office real estate?
2.2 How can property appraisers assess the sustainability of office buildings?
2.3 What are the most important criteria of a sustainable office building?

Renewed model:

3.1 How could the subjectivity within valuations be limited?
3.2 How could sustainability be integrated in an existing valuation model?
3.3 How will the renewed valuation model for objective valuation of sustainable office real estate look like and how does it work in practice?

1.4 RESEARCH DESIGN

The extent of this research consists of five phases: problem definition, diagnosis, design, implementation and evaluation (see figure 2). In the first phase, the problem definition, the problem will be exposed. This phase is elaborated in the research proposal. After a clear representation of the actual problem the research can proceed to the next phase, diagnosis. This phase exists of the data collection, of which there are two kinds; data collection of primary resources (literature review and surveys) and data collection of secondary sources (expert interviews)(Kumar, 2011). A literature review will concisely summarize the findings that have been emerged from prior research on the subject. The conclusion of a literature review should represent the writers considered judgement about the prior research, how accurate and complete is the knowledge of that subject and what is missing in the existing literature (Tyler, 1999). Expert interviews are used to obtain information of the exploration of the current market, to obtain additional knowledge about the subject and as first selection step for the Fuzzy Delphi Method (FDM) (Littig & Pöchhacker, 2014). The online questionnaire is used to obtain objective numbers for the calculations of the FDM. This method can solve the fuzziness of common understanding of expert opinions for solving the group decision (Hsu, Lee, & Kreng, 2010). The outcomes of the FDM will be input for the design of the renewed valuation as the most important criteria for the incorporation of sustainability in office building valuations.

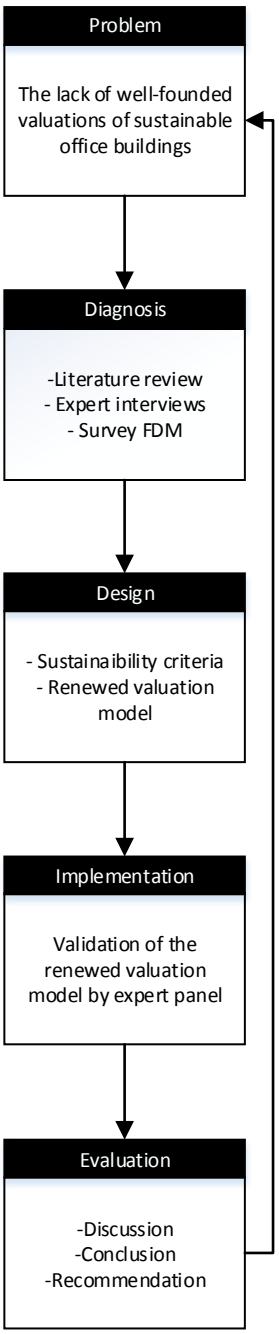

Figure 2. Research model

In phase three, design, a new valuation model will be designed based on the findings in the theoretical background, questionnaires, the expert interviews and the results of the FDM. The renewed model will have the same roots as the valuation methods used these days, only this one will provide property appraisers the opportunity to grant a well-founded value to a sustainable office building. The fourth phase is about the implementation of the renewed valuation model. The renewed valuation model will be applied on a test case to show the effects of the renewed valuation model. For the validation of the renewed valuation model an expert panel assessed the model and the results of the questionnaire. In the evaluation phase, the results of the implementation phase will be elaborated on and possible modifications to the model are suggested. Conclusions and recommendations for further research are written in the end.

1.5 EXPECTED RESULTS

The expected result is to have a renewed valuation model that supports property appraisers to assign well-founded values to sustainable office buildings. This model will embrace a new way of assigning value to a sustainable office building in which all aspects of sustainability will be included in an objective way. The model should provide support in the area of valuing

sustainable office real estate and the underpinning of the variables. The variables that according to the current way of value depends on the gut feeling and the credentials of the property appraisers. This new way of valuing reflects the positive effects of sustainability in the value determination of an office building, what brings many benefits for all stakeholders.

1.6 READING GUIDE

This research focuses on the design of a renewed valuation model for valuing sustainable office buildings in an objective way. This study mainly consists of three parts. The first part, chapter 3 contains the literature review. This chapter provides information about the research already done to objective valuation of sustainable buildings and attempts that have been made to incorporate sustainability within valuations. Using this chapter, the theoretical sub-questions can be answered and the need of a renewed valuation model can be confirmed. The criteria of a sustainable building provided by the literature study serve as input for the Fuzzy Delphi Method (FDM). In addition, the provided information is also used for the expert interviews to ask specific and deepening questions to the interviewee.

The second part of the thesis, chapter 4, is completely focused on the design of the renewed valuation model. This chapter answers the more practical sub-questions about valuations in practice and the questions that needed a specific research method like the FDM. Different steps have been taken before the renewed valuation model was designed. First expert interviews were held to find out how valuations are actually performed in practice and for the validation of the criteria of a sustainable building as input for the FDM. After that an online questionnaire is conducted for the application of the FDM. The results of the FDM, the most important physical criteria of a sustainable office building are used as input for the renewed valuation model. Thereafter a second online questionnaire is conducted for setting default numbers in the renewed valuation model. After the design of the renewed valuation model the model is applied on a test case.

Finally, the third part of this thesis makes conclusions. By answering sub-questions in the different parts of this study the main research question is answered in this part. Thereafter, conclusions about this study are made and recommendations for future research are given.

2 GLOSSARY

NVM	Nederlandse Vereniging van Makelaars en taxateurs
RICS	Royal Institution of Chartered Surveyors
IVS	International Valuation Standard
EVS	European Valuation Standard
ROZ/IPD	Raad voor Onroerende Zaken/ IPD vastgoedindex
NRVT	Nederlands Register Vastgoed Taxateurs
PTA	Platform Taxateurs en Accountants
DCF	Discounted Cash Flow
In-use	Tool for existing office building
BREEAM	Building Research Establishment Environmental Assessment Methodology
LEED	Leadership in Energy and Environmental Design
Property appraiser	A property appraiser estimates the value of an object and underpins this value in a valuation report
Valuation	A valuation is an appraisal of property. Usually this is for the purpose of applying for a mortgage loan. The lender can assess the basis of the valuation report or a mortgage may or may not be provided accounted for using the purchased item
Value	The usefulness or desirability of a property to users. The theoretical maximum price users will pay for a property. For example, a company wants to pay € 1,5 million for building X
Worth	An expected selling price for a property. The most probable price which will be concluded between buyer and seller. It is not a fact but an estimate based on the subjective opinion of a property appraiser. For example, a property appraiser estimates that the possible sale of building X will be € 1,4 million
Price	Actual observable exchange price in the open market. The amount for which a property is sold. For example, after negotiations between seller and company, the users paid € 1,45 million for building X

3. THEORETICAL BACKGROUND: MAIN PROBLEMS OF VALUING SUSTAINABLE OFFICE BUILDINGS

In the face of, in all probability, a sharp increase in demand for sustainable office housing, the need for a valuation model that takes sustainability into account is growing every day. It allows property appraisers to assign a well-founded value to an office building. In addition to that, it will create a push-factor for building owners to invest in a more sustainable building because of the financial benefits and the strongly decreasing risk on vacancy. Also the banks will profit by the less risks of financing a sustainable building. However, despite the increase in the demand of sustainable buildings, researchers are still looking for a suitable way to incorporate sustainability in the valuation process. This theoretical background will look at the concerns regarding the lack aspects of sustainability within valuation methods. In the following three sections, essential information of three relevant topics will be given.

The first section, sustainability, will contain information about sustainability in general and sustainability related to real estate. The second section is about valuations. Different valuation approaches will be discussed and the objectivity within valuations will be covered. To conclude this section, the link between sustainability and valuation of office real estate will be made. The third section contains market evidence. Herein, the relationship between sustainability and the price and market value become clear. Finally, a conclusion and discussion will conclude the theoretical background chapter.

3.1 SUSTAINABILITY

The concept of sustainability was originally coined in forestry, where it means never harvesting more than what the forest yields in new growth. Sustainability was based on the concern of preserving natural resources for the future. Most important for early farmers was maintaining soil fertility. A report of Club Rome predicted that many natural resources crucial to our survival would be exhausted within one or two generations (Meadows, Meadows, Randers, & Behrens, 1972). Thereafter, a reversal was made and sustainability became public in the way ones know it today. Nowadays, sustainability is about three dimensions that must be in harmony: social, economic and environmental (Kuhlman & Farrington, 2010). However, there is no specific definition for sustainability. The lack of sustainability within valuations could be caused by a missing definition of sustainability; most probably this is one of the underlying problems. To understand sustainability in general and sustainability in relation to real estate deepening is essential for understanding this underlying problem.

3.1.1 Principles of sustainability

Sustainability is no longer a trend but a need, in order to meet the needs of future generations. In the last decades, the term sustainability has been increasingly seen as a potential solution for a wide range of challenges and problems from the global to the local scale across seemingly almost all walks of life (Eccles et al., 2012). Also in the real estate sector sustainability is seen as a potential solution for problems. Sustainability is integrated into the corporate mind set as growing numbers of large companies are reporting publicly on their corporate sustainability strategies and achievements (Loi, Lam, Ngo, & Cheong, 2015). Companies show their contribution to supporting human life on earth, stable human population and continue quality in the environment and ecosystems, as it is important that all sectors reduce the negative impact on the society (Brown, Hanson, Liverman, & Merideth, 1987).

There are obviously many ways of defining sustainability. Most of the definitions either state or imply that the goal of sustainability is human survival. The contexts range from a social or cultural perspective, where quality of life is emphasized, to an economic perspective, with emphasis on a steady-state economy, to a biological perspective, where the emphasis is on the management and maintenance of ecosystems and species survival (Brown et al., 1987). Usage of different terms and definitions of sustainability from various information sources causes confusion about their usage. The meaning of some terms is sometimes slightly different from one another or either sloppy or similar (Glavič & Lukman, 2007). The Dutch dictionary defines sustainable as: overextended, little wear or decay and low environmental impact.

''duur·zaam
1. lang durend;
2. weinig aan slijtage of bederf onderhevig;
3. het milieu weinig belastend.'' (Dale, 2016)

Giving a unequivocal definition of sustainability is complex. According to research by Glavič & Lukman, who sougth to clarify the meanings and applications of 51 terms and definitions of sustainability, it is crucial to understand sustainability terms, their definitions and interconnections for better communication in the process of moving our societies toward sustainable development (Glavič & Lukman, 2007). However, they do not provide a general definition of sustainability.

One of the first definitions for sustainability is given by Brundtland, in the report 'Our Common Future (1987)' in which sustainable development is considered as the key concept. Their definition is:

''*Sustainable development is the development that satisfies the needs of the current time period without jeopardizing the ability of future generations to satisfy their needs.*''-
(Brundtland, 1987)

Thus, this definition compromises two important elements, 1) satisfying human needs and requirements and 2) intra- and intergenerational ethics (Lorenz, Trück, & Lützkendorf, 2007). Whereby, economic growth and stability is achieved by making connections between environmental protection and social equity.

3.1.2 Sustainability in relation to real estate

Sustainability in relation to real estate can be considered in many ways. First a definition of a sustainable building within this research will be given. The content of valuation guidelines concerning sustainability will be studied and tools for measuring the sustainability of a building will be discussed. Last, all sustainability criteria provided by literature will be merged into one section.

3.1.2.1 Definition of sustainable building

Partly due to the lack of a definition of sustainability, a definition of a sustainable building is also missing. Due to the fact that giving an unequivocal definition of sustainability is complex, giving an unequivocal definition of a sustainable building is even more complex. Making a link between two definitions is much easier than making a link between a definition and an unknown definition. Furthermore, when it comes to sustainable buildings, the words *green*

and *sustainable* are often used interchangeably. Although the words have a different meaning, neither one of them does have a general definition. In general green is about *not as bad as* or *notably better* (Yudelson, 2010), whereas sustainable is more about efficiency, equity and intergenerational equity based on social, economic and environmental aspects (Ciegis, Ramanauskiene, & Martinkus, 2009).

The UK Green Building Council, an organisation which campaigns for a sustainably built environment and has a diverse membership of more than 400 organisations, defines a sustainable building as:

''*A sustainable building should be one which meets peoples' needs – as a home, or a workplace for example – in ways which enhance its positive impacts and minimize its negative impacts, environmentally and socially, both locally and globally over time*'' – **UK Green Building Council (2009)**

Yudelson, a researcher who did a lot of studies to the extent of a sustainable building, describes the difference between *green* and *sustainable* buildings. He describes a green building as follows:

''*A green building is one using design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants*''- **Jerry Yudelson (2008)**

Elkington is the founder of the slogan People, Planet, Profit (PPP) who indicates that these three P's should be combined harmoniously (NVM, 2011). Therefore, he was of great importance in the history of sustainability. His definition of sustainable real estate is:

''*The social dimension for the well-being of the humanity, for the producers, users and people in the area of the real estate. The economic dimension is all about the profitability of the real estate. The last environmental dimension is about the choice of material, design, installations, waste and choice of location*''- **Elkington (2002).**

Various descriptions above reflect the confusion regarding a general definition of a sustainable building, by use of the same context but the slightly different content of the definitions. In most cases researchers write about *green* buildings, not sustainable. This is probably due to the fact that *green* is the safer option relative to sustainability. Because it is less like to put n*otably better* or *not as bad as* in a wrong context, than a general undefined word like *sustainable*.

Researchers propose, just as national and international authorities, no general definition neither of sustainability nor a sustainable building (Glavič & Lukman, 2007). According to the RICS, the world's leading professional body for qualification and standards in land, property and construction, there is no general definition of a sustainable building. On the other hand, they do provide a document which includes, expectations concerning a possible consensus for a general definition of sustainable buildings: ''*Sustainable buildings provide optimal usability for owners, tenants and others, whereby the use of natural resources and the influence on the environment will be minimized.*" (RICS, 2009).

Summarized, many definitions of sustainability or sustainable buildings are used today. However, a general definition of sustainability and related concepts is missing, due to the fact that no one seems to know what sustainability exactly includes. The magnitude of

sustainability will be omitted in this research. When a *sustainable* building is mentioned, a common definition of sustainable real estate that derives from the vision of Dutch real estate investors is meant: ''*Sustainable real estate is a building that has been built or adapted with minimum use of scarce resources such as materials, energy, water and locations, while ensuring optimal functioning in tenant satisfaction, indoor environment and health.*'' –IVBN (2009).

3.1.2.2 Sustainability in guidelines

Although none of the national or international valuation guidelines for property appraisers confer a general definition of a sustainable building, one might assume that guidelines provide a way to value a sustainable building. However, this is not the case; property appraisers of commercial real estate have to deal with different, more or less compelling standards for valuing real estate of different agencies that do not include measures for valuing sustainable buildings. These standards can be divided into four categories: 1) Scope, like ethical codes, behaviour guidelines and principals, 2) Institutes, such as IVCS, RICS, TEGoVA and the appraisal institute, 3) National legal regulations like Wet WOZ and 7:290 BW about indemnification for expropriation and 4) Standards in specific areas IPD/ROZ Vastgoedindex Nederland (TMI, 2014). Regarding dealing with sustainability within valuations the second category institutes, that includes national and international guidelines, will be explained in more detail. As all property appraisers should abide by one of these guidelines. What guideline will be used depends on the task and client.

<u>International guidelines</u>

In general, three international guidelines dominate the current market in The Netherlands; Red book (RICS), Blue book, EVS (TEGoVA) and IVS (IVCS). The authoritative appraisal standard with a global scope is the IVS. The Blue Book and the Red Book are standards with a more European-oriented application range (Berkhout; Roggeveen, 2014). This section will discuss the Blue Book and the Red Book, the global scope is incorporated in these European-oriented guidelines. Despite the lack of a general definition for sustainability, the guidelines each define a definition of a sustainable building themselves:

"*Sustainable buildings displays characteristics that minimise environmental impact through all parts of the building's life-cycle and focuses on improved health for its occupiers, optimise utility for their owners and occupiers and the wider public, whilst minimising the use of natural resources and environmental impact*" – RICS (2008)

''*A "green" or "sustainable building" uses resources such as energy, water, materials and land more efficiently than buildings constructed to existing minimum standards, producing less waste and fewer emissions and potentially offering a better internal working environment. As sustainability expects that the needs of the present should not compromise the ability of future generations to meet their own needs, green buildings should also take social, ecological and environmental issues into account. That broader definition includes external effects and the impact across generations*.''- TEGoVA (2012)

The intention of these guidelines is to offer property appraisers a support for underpinning their valuations. Both the valuation process and the product are regulated by these guidelines. Moreover, these guidelines also include ethical and behavioural guidelines, professional rules, content principles and reporting thereof.

In spite of the increasing demand for sustainable housing all over the world, these international guidelines barely include information about sustainability. The RICS, who imply that they are the ''*World's leading professional status in land, real estate, infrastructure and construction''*("RICS," 2016) included, up till a certain height, sustainability in the Red Book. Since 2016, the requirements for the substantiation became much stricter, what will result in more transparent valuations. In addition, it is mandatory to justify sustainability in the valuation report. Previously, the Red Book advised property appraisers to gather appropriate and sufficient information about the sustainability of a building. Only if this information was confirmed by market evidence, it must be included in the valuation report ("RICS-taxatiestandaarden januari 2014," 2014). Besides that, the guideline refers to a document that provides recommendations relating to the identification, evaluation and impact of sustainability issues on commercial valuations (RICS, 2009).

The other European-oriented guideline, the Blue Book, claims that the focus on environmental constraints has led to one definition of sustainability as improving the quality of human life while living within the carrying capacity of supporting eco-systems. The guidelines provide a lot of information about different sustainability issues such as green-lease, certification tools and sustainability in general. Also, the guidelines contains a checklist with factors to consider alongside the usual description of the property pertain to sustainability (TEGoVA, 2012). However, when it comes to dealing with sustainability within the calculations there is no difference between the Red Book and the Blue Book. Both do not offer property appraisers a method to take sustainability into their appraisal. It is limited to advice of the inclusion of sustainability within the valuation.

National guidelines about sustainability

Next to the international guidelines, also national guidelines may be applicable within valuations. In 2013 PTA (Platform Taxateurs en Accountants) published ''Good practices'', this document provides 28 recommendations for improving the quality of valuations. Each recommendation encompasses examples, that provide property appraisers understanding how to deal with the recommendations. In addition, each recommendation takes into account regulations within the IVS and EVS. Opposed to the international guidelines, it is noted that the degree of depth of the 'good practices' is partly dependent on the type of object, and its complexity (PTA, 2014). The PTA was repealed in January 2016 following the establishment of the Nederlands Register Vastgoed Taxateurs (NRVT). The published recommendations have been for the vast part adopted by the NRVT in its rules for affiliated property appraisers. The aim of the NRVT is a central registry for real estate property appraisers to create a uniform, objective, transparent and accountable self-regulation assessment framework for exclusive real estate property appraisers.

In short, both national and international guidelines have integrated sustainability. It prescribes that property appraisers should include sustainability in their valuation under condition of relevant market evidence. Research in the United Kingdom indicates that around half of the leading property valuation companies integrated sustainability in their valuation report (Loi et al., 2015). Relative to the need of sustainability these days, this number is far too low. Based on the need of sustainability the assumption can be made that sustainability should be integrated in 100% of the valuation reports. However, the integration of sustainability these days is limited only to the naming whether the building is sustainable and what kind of energy label it has in the valuation report. By the new regulations of the RICS a major step towards

full implementation of sustainability within valuations can be made. Nevertheless, there is still no way for incorporation of sustainability within the calculation of the value.

3.1.2.3 Measurement tools sustainability

Over the past few years, many sustainable building assessment tools are developed for measuring the sustainability performance of a building. Probably because of the lack of a general definition for a sustainable building, one univocal assessment tool is missing. All assessment tools require varying levels of sustainable features and the focus on sustainable criteria differs for each assessment tool (Sayce, Sundberg, & Clements, 2010). Tools such as BREEAM, LEED, GPR and GreenCalc+ are globally used sustainable building assessment tools. However, there is no international standard. In fact, only one aspect of sustainability is commonly accepted in the Netherlands; the energy label. Although the energy label is just one small part of sustainability, since 2008 it is mandatory to have an energy label for each transaction of an office building. The best well known national and international tools for measuring the sustainability performance of a building are briefly explained below.

BREEAM

Building Research Establishment Environmental Assessment Method (BREEAM) is a globally used integral tool for measuring the sustainability performance of new buildings, existing buildings, fields and demolition projects. BREEAM-NL is the Dutch version, derived from the international BREEAM tool. The tool is managed and develop by the Dutch Green Building Council (DGBC). The tool awards points for satisfying specified sustainable applications in the categories: management, health, energy, water, materials, waste, pollution, transport and ecology & land use. Each of these categories is weighting, the end score results in one of the five different levels: pass, good, very good, excellent or outstanding.

LEED

The Leadership in Energy and Environmental Design (LEED) rating system was developed by the U.S. Green Building Council. The rating tool can be applied to all project types, a distinction between a total of five categories is made: building design and construction, interior design and construction, building operations and maintenance, neighbourhood development and homes. Based on the number of points achieved in each of these categories, a building receives one of four LEED rating levels: Certified, Silver, Gold or Platinum.

GPR

GPR-gebouw is a national tool for measuring the sustainability performance of existing buildings, new construction and major renovation of residential and commercial construction. GPR-gebouw shows the sustainability performance of a building in five categories: energy, environment, health, quality of use and future value. Each category will be marked on a scale of 1 to 10, where 5 is the standard and 10 the maximum.

GreenCalc+

GreenCalc+ is a national tool developed by Sureac. In total three categories will be assessed in this method: material usage, water usage and energy usage. This mathematical model expresses the environmental performance of a building in a single number, the environmental index. The tool is applicable to both new and existing buildings.

Energy label

At time of rental or sale an energy label is mandatory for office buildings. Unlike all previous methods, this tool does not measure the sustainability of a building; it calculates the Energy Performance Coefficient (EPC). The EPC is a number that measures the principal energetic values of a utility function. The EPC requirement for office buildings is since 2015 reduced to 0,8.

Within The Netherlands, BREEAM, GPR gebouw and GreenCalc+ are most common, where BREEAM is the most comprehensive tool (Neimann, 2012). BREEAM is used in over 50 countries and has more than 1 million registered certifications. The tool has national variants in the form of country specific schemes, it is an international bespoke tool (Faulconbridge, 2015). The popularity is reflected in the number of applications of BREEAM within the Netherlands. The number of certifications has strongly increased from 47 certified buildings in 2013 to 503 certified buildings in February 2016 (Simons, 2013).

3.1.3 Sustainability criteria

Despite the increase in popularity of measurement tools for sustainable buildings, some comments can be made. Due to the changing market demands and the extent of sustainability, organizations are compelled to constantly adapt and improve the assessment tools. Because of this, the level assigned to a building is time-dependent. A building that meets the highest level at a certain point of time, can after a certain time no longer meet the requirements of the adapted tool. Yet, the building still has the highest certification level. Also, the scope of the tools can be discussed, for example, BREEAM does not asses criteria related to sustainable material usage in construction, recycling of raw materials or a demountable construction (Lange, 2011). This would therefore imply that these criteria do not belong to a sustainable building; the scope of sustainability is much broader than the criteria in the assessment tools. Users have a large share in rating the level of sustainability, choices and proceedings of the user have a lot of influence on the result. Discussion can arise about the fact if the user is an element of the sustainability or not (Stoer, 2013).

Unaware of what a sustainable building exactly means, a lot of different sustainable criteria are assessed and measured by different tools. Only trained experts of the organizations are allowed to assign sustainability levels to a building. Property appraisers, who have to assign a value to a building, are not able to apply these tools because of their missing expertise and the time it takes to use the tool. However, a non-certified building is not automatically unsustainable. When a building does not have a certification, property appraisers should take sustainability into their valuation as well. According to Myers, a building can have elements what make them more sustainable than others, such as the reduction of CO2 production, reduced water, gas and electricity consumption, enhanced building occupant health and comfort, but these criteria are not measurable for property appraisers (Myers, Reed, & Robinson, 2007). Until now there is no proper method for property appraisers to assess the sustainability of a building in the valuation models in order to include sustainability in value.

Attempts have been made to design valuation tools to assign a well-founded value to a sustainable building. Sayce and Ellison were the first who tried to integrate sustainability into the assessment of a building's value. Their research, with the main goal of creating an valuation tool to assess a building's value in accordance with the triple bottom line, started in

2003. After selection of sustainability categories, based on existing measurement tools, focus groups selected a total of nine sustainability categories suitable for commercial real estate (Myers et al., 2007). Policy management issues made the existing measurement tools unsuitable for property appraisers because of the complicated assessment design. The combination of the nine selected criteria resulted in a model that was applied on the commercial real estate market in the UK. Evidence of application on the market showed that sustainable buildings get a higher value relative to unsustainable buildings. Due to the integration of sustainability into valuations the impact of sustainability on property worth has become visible through five main avenues; rental growth, depreciation, cash flow, duration to let and duration to sale (Sayce & Ellison, 2006). Meins, Wallbaum & Hardziewski also attempt to integrate sustainability into the assessment of property worth but focused on the risk calculations. Flexibility & polyvalence, energy & water dependency, accessibility & mobility, safety and health & comfort are the five selected criteria through broad national discussion with experts and scientist. By the implementation of this tool to apartments in central Switzerland risks percentages were calculated and the impact of sustainability can be shown by these percentages (Meins, Wallbaum, Hardziewski, & Feige, 2010).

Both attempts, of Sayce and Ellison and Meins et al. proved successful through the implementation on the market. Nevertheless, the models do not meet today's office occupier's requirements. Due to the changing market in which sustainability is becoming increasingly important and the increasingly stringent requirements of users, these tools became out-dated and no longer applicable to the current market.

In addition to these tools, Lorenz and Lützkendorf studied the financial aspects of sustainable property valuation. Therefore, sustainability criteria set by Sayce an Ellison formed the basis. Each of the criteria is linked to financial worth, see table 1 (Lorenz & Lützkendorf, 2008).

Sustainability criteria	Conduit
Building adaptability	Risk premium, cash flow, rental growth, depreciation
Accessibility	Rental growth, depreciation
Building quality	Rental growth, cash flow, depreciation
Energy efficiency	Rental growth, risk premium, cash flow, depreciation
Pollutants	Rental growth, risk premium, cash flow, depreciation
Contextual fit	Rental growth
Waste and water	Rental growth, cash flow, depreciation
Occupier satisfaction	Risk premium
Occupier impact	Risk premium

Table 1. Sustainability linked to financial worth

Many studies have been done to consider integrating sustainability in the property valuation process. In 2011 Lorenz and Lützkendorf provide an overview of the various publications and research efforts undertaken to integrate sustainability considerations into the property valuation process. According to the conclusion of the study, there are three types of sustainability criteria that influence value. Firstly, sustainability criteria that have measurable impact on the value like energy-efficiency, pollution, waste and transport features. In this research called the factual criteria. The second type of criteria is likely to have an impact on the value such as comfort, health aspects and building materials. Because of the insufficient database no conclusions can be granted to the magnitude of this impact. In this study called the plausible criteria. Last the criteria that are not likely to have direct impact on the value.

Criteria like environmental impact, cultural quality or contribution to biodiversity preservation probably do not affect the value of a building. These criteria will be disregarded in this study. However they may have an indirect effect on the property value by creating an image and reputation for the building owner or tenants(Lorenz & Lützkendorf, 2011). However, the effect of these criteria cannot be calculated.

3.1.3.1 Factual criteria

According to previous research and available assessment tools, two types of lists that provide sustainability criteria that have measurable impact on the value can be distinguished. First, the criteria of the assessment tools for measuring the performance of sustainable buildings. By the scope of this research, tools only applicable for ''in-use'' buildings will be included in this study. Other tools also include, for example, the design process. The associated criteria are not relevant for this research because property appraisers assign value to existing buildings. LEED, BREEAM, GPR-gebouw and the energy label provide a tool for buildings ''in-use''(Vree, 2010). The certification tools are used in many countries around the world but the tools are adapted to the specific market in the Netherlands (Neimann, 2012).

The second, and last type of list is the criteria provided by the literature. Sayce, Ellison and Meins et al. conducted extensive research to the most important criteria for measuring the sustainability of a building. Others like Lorenz & Lützkendorf, Warren & Myers, Fuerst & McAllister, and Reed & Wilkinson and more, all referred to these criteria in their research to the relation between sustainability and property valuation.

C	LEED	BREEAM	GPR gebouw	Sayce and Ellison	Meins et al.
1.	Energy and atmosphere	Energy	Energy	Energy efficiency	Flexibility and polyvalence
2.	Indoor environmental quality	Well- being and health	Well- being and health	Occupier	Energy and water dependency
3.	Water efficiency	Water	User quality	Waste and water	Accessibility and mobility
4.	Location and transportation	Transport	Future value	Accessibility	Safety/ security
5.	Sustainable sites	Waste	Environment	Climate control	Health and comfort
6.	Materials and resources	Materials		Contextual fit	
7.	Innovation	Land use and ecology		Adaptability	
8.	Regional priority	Pollution		Pollutants	
9.		Management			

Table 2. Overview sustainability categories

Table 2 shows an overview of the sustainability categories composed of the several lists discussed. The different lists show some similarities, energy and health can be marked as most important categories because of their appearance in each list.

By merging all lists of sustainability criteria, a long list of sustainability criteria can be created. Appendix 1 shows the list, BREEAM, LEED and Sayce & Ellison are included. GPR-gebouw could not be included because the literature does not provide substantive criteria. In against it, the literature did provide criteria set by Meins et al. but these were residential specific what made them not usable for this study focused on office buildings.

The criteria by Sayce & Ellison only includes physical features of a building. Due to this fact it is obvious that these tools are specially develop for property appraiser's use. LEED and BREEAM include company specific and social criteria, that cannot be perceived by property appraisers.

Further research needs to be done to select the most important criteria of a sustainable building for property appraisers' use.

3.1.3.2 Plausible criteria

In addition to the factual criteria, plausible criteria like comfort, health and building materials are also important for the assessment of the sustainability of a building. Despite the fact that these criteria cannot be assessed by property appraisers, they impact the value of a building. Moreover, plausible criteria are affected by factual criteria.

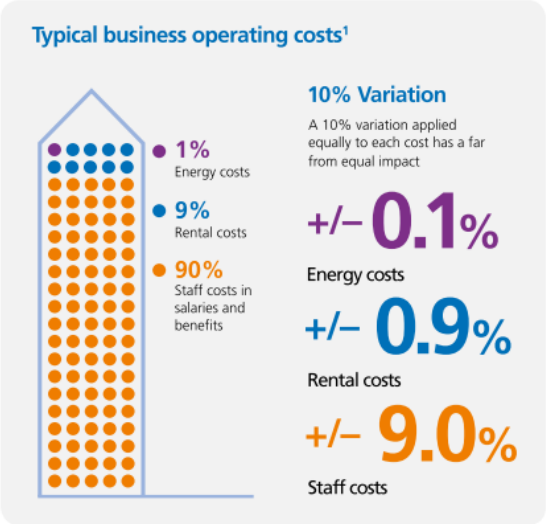

Figure 3. Business operating costs (John Alker, Michelle Malanca, Chris Pottage, 2015)

A few years ago, it was already concluded that sustainable office buildings result in benefits for the users (Paumgartten, 2003). 10% of the total costs for a company are the business operating costs. 9% hereof are rental costs and 1% energy costs. Against it, staff costs, including salaries and benefits, typically account for 90% of a business' operating costs (figure 3). It follows that productivity of the staff should be a major concern for any organisation (DGBC, 2015). Due to this fact, saving on business operating costs can be done best by saving on staff costs. Saving on energy costs and rental costs is a bonus but relative to the staff costs is a very small amount. Saving on staff costs can be done by firing employees; however, a better and much friendlier option is sustainable office housing. Overwhelming evidence claims that the health, well-being and productivity of its users is effected by the design of an office (John Alker, Michelle Malanca, Chris Pottage, 2015). Sustainable design features (factual criteria) result in reduced illness symptoms, reduced absenteeism and significantly increases of measured productivity of the workforce. A sustainable building with natural lighting, thermal comfort, air quality, worker-controlled temperature and ventilation will provide better performance relative to a conventional building (Lützkendorf & Lorenz, 2005).

Due to this, tenants will pay higher rent if the building's performance reduces absenteeism and increase productivity (CBRE, 2007). Because of the fact that 1% increase in productivity can nearly offset a company's entire annual energy costs, tenants are willing to pay higher rents. Market participants are becoming more aware of the benefits and risks associated with the ownership and occupation of property (Lützkendorf & Lorenz, 2005). This affects the office building choices of companies; herein sustainability with associated benefits plays an increasingly important role.

Investors can respond to the changing of the evolving tenant demand for sustainable housing flow (Bozorgi, 2015). Investment in sustainable real estate could, also for investors, lead to financial benefits in several distinct ways. A lower risk premium, reduced operational costs and lower holding costs are the most important. Operational costs should be reduced due to energy and other utility savings and reduction of holding costs due to lower vacancy rates and higher tenant retention (Fuerst & McAllister, 2011).

Nevertheless, the financial impact of the benefits of sustainable office housing (e.g. reduce absenteeism and increase productivity) is hard to assess. This is partly because the lack of evidence of outperforming similar buildings and partly because it may simply be hidden (P Eichholtz, Kok, & Quigley, 2010).

Discussion section 3.1 Sustainability

Due to the increasingly growing urge to sustain our world in order to meet the needs of future generations, sustainability has become important in the real estate sector. The need for sustainable buildings is growing. The sustainability level of a building can be measured by tools like BREEAM and LEED. Nevertheless, one unequivocal measurement tool is missing. All measurement tools require varying levels of sustainable features; the focus on sustainable criteria differs for each assessment tool, what makes the use of them doubtful. In addition, these tools are not applicable for property appraisers. Property appraisers are not able to assess the sustainability of a building and take sustainability into the valuation. This results in only users benefitting from the sustainable features of a building. Sustainable buildings bring a lot benefits for its users like increase in productivity and decrease of absenteeism. If the property appraisers are able to assess sustainability and take this into an existing valuation method, sustainable buildings will get a premium value relative to unsustainable buildings what results in benefits for all involved stakeholders.

By this section sub- question 1.1 can be answered partly and sub- questions 2.1 and 2.2 can be fully answered. Sub question 1.1 will be answered in the discussion of section 3.2.

2.1 What is sustainable office real estate?

There is not one fixed definition for sustainable office real estate. In this research a common definition of sustainable real estate that derives from the vision of Dutch real estate investors is used: ''*Sustainable real estate is a building that has been built or adapted with minimum use of scarce resources such as materials, energy, water and locations, while ensuring optimal functioning in tenant satisfaction, indoor environment and health.*'' –IVBN (2009).

2.2 How can property appraisers assess the sustainability of office building?

To date, there is no appropriate way for property appraisers to assess the sustainability of a building. This could be due to the missing definition for a sustainable building. Tools like BREEAM and LEED measure the sustainability of a building and assign a sustainability level to it. However, by the lack of a definition all these tools assess on other aspects that makes the use doubtful. Therefore, a suitable uniform way for property appraisers to assess the sustainability of a building that can be taken into the value is still missing.

3.2 VALUATIONS

A valuation is an estimation of a property appraiser that takes the current market and building specifications of the relevant object into account. The assigned value is the value that the property appraiser thinks the market is willing to pay for that specific building. One would think that a sustainable building would get a premium value relative to an unsustainable building because of the increasing demand for sustainable office housing. Due to the fact that sustainability is still not incorporated in valuations, the premium value of a sustainable building is barely noticeable. This is despite the fact that sustainability is a need and the demand for sustainable office housing has strongly increased. For incorporation of sustainability in valuations, basic knowledge is needed. First, different kinds of valuation approaches are explained of which the most important methods for this research will be explained in detail. Thereafter, the objectivity within valuations will be discussed because of the on-going discussions of subjectivity and uncertainty within valuations. Finally, the link between valuations and sustainable office buildings will be made.

3.2.1 Valuation methods

Assigning value to a building is done by using one or more valuation methods. Valuation methods are calculations in a more or less regular pattern, with the aim to underpin the value of a building mathematically as well as possible. The use of a specific valuation method depends on specific properties of the building and the available data (Ten Have, Berkhout, & van Arnhem, 2011). Substantially, four valuation approaches can be distinguished; the comparative approach, cost approach, income approach and the legal approach (Ten Have et al., 2011). Each approach can be used by multiple methods. Table 3 shows an overview of the four approaches with associated methods.

Valuations	Comparative approach	Cost approach	Income approach	Legal provisions
1	Comparative method	Cubic metre method	BAR –method	7:290 BW
2	Rental value method	Building element cost method	NAR –method	Wet WOZ
3	Capitalization method	Retrospective method	DCF –method	
4	Multi- regression method	Depreciated replacement cost method	Turnover rent method	
5		Residual value method	Gross operating profit method	

Table 3. Overview valuation methods

Comparative approach

In this approach, the value of an object is derived from a number of similar objects, of which a recent transaction price is known. Based on a given unit or account, differences and similarities between the valuation object and reference objects will be analysed. By comparing realized transactions a market value will emerge (Ten Have et al., 2011). Nevertheless, each valuation should consider market changes and property appraisers should take the cases that have affected the transaction prices into account. Comparative method, rental value method, capitalization method and the multi-regression method are the four methods of the comparative approach.

Cost approach

The basis of this approach method is the production costs plus the value of the land and possible corrected deprecation. This method is often used when there is not sufficient market data available. In general, the cost approach is applied to less common real estate objects. Also, this method serves as a control calculation for other valuation methods beyond the cost

approach (Ten Have et al., 2011). The cost approach includes cubic metre method, building element cost method, retrospective method, depreciated replacement cost method and the residual value method.

Income approach

The income approach is by far the most used approach for valuations of properties. In total this valuation approach counts five valuation methods. The most well-known methods are the BAR-, NAR- and DCF-method. The assumption is made that the real estate object constitutes a self-class income; these revenues are converted into a capitalization amount. It is calculated what amount can be invested in order to obtain a certain return. The BAR-, NAR- and DCF-method will be explained in further detail because of their importance for this research.

BAR-Method

The BAR is used for determining the private sale in rented state. If there are no current rental agreements the property appraisers can calculate with a fiction provision. Originally the BAR-method is a simple method in which the BAR-yield is central. BAR-yield is the estimated gross investment results, expressed as a percentage that could be achieved during the first year of operating of an investment in a real estate object.

For valuation with the BAR-method the next formula is used:

$$W = \frac{Hp}{Y_{bar}} - kk$$

Y_{bar} = yield bar
W = value
Hp = rental income
kk = legal transactions

NAR-Method

The NAR-method calculates the value of a property based on a net rental income. The gross income is adjusted with the expenses made in exploitation. The calculation method is as follows:

$$W = \left(\frac{Ha - Ke}{Y_{nar}} -/+ CW * Kc\right) - kk$$

W = value
Ha = alteration rent
Ke = operating costs
Y_{nar} = yield nar
CW = present value
Kc = capital corrections
kk = legal transactions

The formula has many similarities with the formula of the BAR-method. However, this formula is enhanced with operating costs and capital corrections to the value. These two changes

affect the yield; instead of calculating with the BAR-yield, the NAR-method will calculate with the NAR-yield.

DCF-Method

This method consists of discounting future cash flow deriving from a property in the case of a valuation, while assessing the worth in discounting future cash flows deriving from an investment. The cash flow is discounted at a proper discount rate (D'Amato & Kauko, 2012). In short, the calculations are based on forecasted future income and costs, that still assume that the outcome of the calculation is true. Within this method there can be more details incorporated on the revenues than the BAR- or the NAR-method.

The present value can be calculated by the following formula:

$$PV = \frac{CF1}{(1 + Y_{dcf})^1} + \frac{CF2}{(1 + Y_{dcf})^2} + \cdots + \frac{CF_t}{(1 + Y_{dcf})^n}$$

n = number of terms
Y_{dcf} = yield dcf
CF_t = cash flow in period t
t = 1….n
PV = present value (contante waarde)

Legal provisions

Only two legal provisions for valuation are determined by the Dutch government. First, the 7:290 BW method, this method is used for legal rent for residential real estate and industrial premises. Second the wet WOZ; this provision provides that all property annually will be valued by the municipalities in the Netherlands. The municipality will value all property with the WOZ method to determine the basis for various taxes and fees. Both the 7:290 BW and WOZ methods are not relevant to this research, so they will not be further discussed.

''It is important to know that valuation methods are just underpinnings of a valuation and are not a valuation on themselves.'' - (Ten Have et al., 2011).

3.2.2 Objectivity within valuations

''Valuation is not a fact; it is an estimate'' (RICS). A valuation of the market value is an estimate of the expected price that will be paid. It reflects the general expectations of the market movements, therefore demand and supply are essential for pricing. Due to the subjectivity of the property appraiser, basically all valuations are inaccurate and therewith in principle always subjective. The subjectivity arises by the estimation, based on the opinion of a property appraiser. By the characteristics of the real estate market like heterogeneity, slow changes in stock and immobility, the market is less efficient. By the lack of continuous pricing, prices respond slow to new information (Schekkerman, 2004). Valuations are based on transactions in the past, also known as references that do not include recent movements on the market. Nevertheless, valuations are used like facts. As long as the valuation is well underpinned and transparent, no one complains about the subjectivity within the valuations. Therefore, it is important that property appraisers make reports of the uncertainties and how they dealt with it by setting the price. Uncertainty within valuations is caused by a combination of the

estimation of value drivers and the overall market. Hereby, the uncertainty increases in predicting the future market. This gives a plurality of the estimate and thus uncertain variables. The more complex the property, the more variables (Schekkerman, 2004).

During the past years, a lot of research has been done into the liability, objectivity and uncertainty in valuations. The discussion of uncertainty and objectivity of valuations has been on-going for several years. These discussions lead to the formation of committees by the RICS. The aim of these committees is to give recommendations of how to limit the uncertainty within valuations. First, in 1994, the Mallinson Report gave recommendations about the limitation of uncertainty. One of the principal tenets was that property appraisers should expand not just the details of the property, but also from the valuation itself, its dynamics, its relativities and its uncertainties (Mallinson & French, 2000). Also the Carsberg committee gave recommendations (2000). Their main conclusion was the aim to establish an acceptable method "by which uncertainty could be expressed in a manner that will be helpful and will not confuse users of the valuation. RICS should also seek to agree with appropriate representative bodies of those commissioning and using third party valuations the circumstances and format in which the property appraiser would convey uncertainty." (Stasiak, 2013).

French and Gabrielli provide several research points in regards to uncertainty in valuations. According to them, there are two types of uncertainty; normal uncertainty and abnormal uncertainty. The first, normal uncertainty, is a universal and unsurprising fact of property valuation. Abnormal uncertainty might occur when there is a significant concern about market conditions such as times of financial turmoil. Wherever the property appraiser considers that the uncertainty may be greater than normal, the property appraiser should refer in a report to specific circumstances. In addition to the two types of uncertainty, French and Gabrielli tried to identify the characteristics of uncertainty of the inputs involved in the DCF model. The DCF model incorporates many uncertain variables; this increases the need for analysis of the input. Not only the range of the uncertainty between variables need to be considered but also the inter-relationship of the variables (French & Gabrielli, 2004). Other studies have also been done within this context. However, so far, the expression of uncertainty in valuations is still not standardised. The RICS should offer a range of standards to adapt to all valuation requirements (Joslin, 2005).

However, the issue of uncertainty in valuations is still outstanding. Despite of the new guideline of the RICS (2016), that commits to better underpin valuations, a standardisation of how to deal with uncertainty in valuations is still missing. Even though research has exposed the problems, the right solution has still not been found.

3.2.3 Valuation of a sustainable building

These days, sustainability and sustainability tools are important terms in the real estate market. Nevertheless, property appraisers are identifying the relationship between sustainability and the market value, but there is still a lack of sustainability in the valuation process (Warren-myers, 2013a). According to Warren, Biener & Myers there are three barriers that we have to overcome before sustainability can fully be incorporated in the valuation processes. Firstly, the property appraisers need to understand what sustainability means. Their knowledge must be very extensive, from the concept of sustainability to the understanding of the rating tools and certifications. Property appraisers also need to be able to identify the sustainable attributes of a building that would affect the market value. Overall,

it is strongly recommended to further support skills and education of property appraisers, in order to better the valuation profession and the ability to accurately assess the market value of property now and into the future (Warren, Bienert, & Myers, 2009). The knowledge of property appraisers may be doubted. The limited knowledge and practice of property appraisers results in an uncertain relationship between sustainability and market value (Warren-myers, 2013b).

Many released publications provide information about the relation between sustainability and property valuation. Lorenz and Lützkendorf combined these publications and made general conclusion: ''All of the reviewed publications agree on the need to take action, enhance awareness and debate, and provide guidance on the topic of sustainability for valuation professionals'' (Lorenz & Lützkendorf, 2011). Despite of this conclusion, until now no guidance for integration of sustainability in valuations is provided.

The literature provides three suggestions that can solve the issue of incorporate sustainability into the valuation process:

- direct adjustment of single valuation-input parameters such as gross or net rents, risk premiums etc.;
- lump-sum adjustments on the preliminary valuation results;
- calculation of sustainability-correction factor to adjust the preliminary valuation result.

Another suggestion is to extend or widen the standard content of the valuation process to include sustainability. These extensions are, first, the including of a sensitivity analysis to show the impact of likely developments and changing conditions on the estimated market value. Second, risk documentation to outline the sustainability related risks and opportunities and third, separate section on sustainability within the valuation report to explain the basic relationships between sustainability issues, risk and property value. As well as the adjustments made to account for sustainability in determining the value of the subject property (Lorenz & Lützkendorf, 2011). Unclear is how sustainability should be measured for the incorporation in the valuation process. Despite the devised solutions, these are not yet implemented in the valuations.

Sayce et al. (2007), Sayce et al (2007), Boyd (2005) and De Francesco (2008) all explore the use of DCF-method to reflect sustainability features (Sayce et al., 2010). The DCF-method is seen as the most suitable method for implementation of sustainability because this is the only method to show the impact of contributions of the property appraisers and to incorporate sustainability investments in the future in a transparent way (Tervoort, 2010). Because of the many input parameters, the influence of sustainability may affect different parameters. The only way to show this properly is in a DCF-model.

The BAR-, NAR- method is less suitable for implementing sustainability, because this method only consists of a few variables in which the effects of sustainability cannot be transparently reflected in. Whenever sustainability is incorporated in the BAR-, NAR-method it is recommended to use relevant reference transactions to underpin the valuation. The sustainable characteristics of the references should be taken into account in order to prevent comparing characteristics that are not the same (Tervoort, 2010). Because of the non-transparent market not all details of transactions are published, what makes it hard to

compare sustainable characteristics. Also, the lack of proper and sufficient references makes it hard to find proper references.

Although the benefits of sustainable buildings are clear to all stakeholders, sustainability is still not implemented in valuation methods despite the benefits for building owners such as, higher rental income and strongly increasing market value (Myers et al., 2007). Studies show that the occupancy rate of offices with higher energy labels is higher, that brings in a bigger cash flow, what results in a beneficial BAR (Kok & Jennen, 2011). The increase of the productivity and the less absences through illness results in financial benefits for the occupiers of the sustainable building. In addition, sustainable housing creates a better image to the company (Honing & Marquard, 2014).

The overall conclusion about implementing sustainability in the valuation process is that the focus needs to be on the technical and functional qualities and performance of a building (Lorenz & Lützkendorf, 2011). Research done into the implementation of sustainability in valuations only provide suggestions for how to incorporate sustainability in valuations or what valuation method is most suitable for incorporation. However, how sustainability should be measured or what weight sustainability will have, it is not specified in the suggestions.

Discussion section 3.2 Valuations

There are several different valuation methods that can be used for calculating the value of an office building. However, none of these methods includes sustainability aspects or ensure objectivity within the valuation. The DCF method appears most suitable for incorporating sustainability, because this method is the most transparent method in which the sustainability aspects can be processed transparently. To limit the subjectivity within valuations it is important that incorporation of sustainability should be done as objectively as possible. Literature provides different options for incorporation of sustainability in valuation methods, nevertheless more detailed research is needed to show which one of the options is most suitable.

With the information of this section, sub- question 1.1 can be answered.

1.1 According to what directives and valuation methods do property appraisers value commercial real estate?

There are two kinds of guidelines property appraisers should abide to; the national and the international. These guidelines include many rules with the intention to offer property appraisers a support for underpinning their valuations. Rules are defined for the valuation process and product. Moreover, the guidelines also include ethical and behavioural guidelines, professional rules, content principles and reporting thereof.

In general, there are four valuation approaches with associated valuation methods. Therefore, the DCF and the NAR –method are the most often applied methods for valuing commercial real estate.

3.3 MARKET EVIDENCE

Market evidence plays a crucial role in making office buildings more sustainable. In general, people will not invest in more sustainable buildings when there is no system in place that proves that sustainable buildings truly have financial benefits relative to conventional buildings. From this fact the conclusion can be made that if there is overwhelming market evidence, the majority will invest in more sustainable buildings, knowing that the demand for sustainable buildings increases. Market evidence on the effect of sustainability on the price is provided in this section. Also, the market evidence of sustainability of the market value will be discussed in which the most important aspect is the need of the building users.

3.3.1 Effect sustainability on price[1]

Factual criteria

Past transaction prices provide a lot of useful and important information. The premium that sustainable buildings get relative to unsustainable buildings is some of this important information. Much research is done to the effect of different sustainability aspects and the effect from labels and certifications on the transaction prices. Firstly, the effect of sustainability aspects will be discussed, after that the effect from sustainability certificates on the transaction price will be explained.

The residential real estate market differs from the commercial real estate market, there is good comparability of houses against poor comparability of commercial real estate. The findings from the impact of energy labels on residential real estate are essential. The energy label influences the prices and selling time of residential real estate. Homes that have been labelled as more energy efficient get a premium rent relative to ''standard'' homes. Besides that, the sale time of energy efficient homes is six days shorter relative to ''standard'' homes (Brounen & Kok, 2011).

Despite the poor comparability of office buildings, the effect of energy labels on office buildings is studied. Transactions of the past provide evidence that more energy efficient office buildings achieve a premium of 6.5% higher rent compared to similar non-energy efficient office buildings. Accessibility, another aspect of sustainability, also affects the rent. Tenants are willing to pay a premium for office buildings with many facilities in the direct vicinity compared to offices at mono-functional locations (Kok & Jennen, 2012).

Next, the effect of sustainability certificates on transaction prices will be discussed. Evidence from different countries all over the world provide different premiums for sustainable certified office buildings. Evidence from the UK shows that BREEAM-certified buildings are leased for 21% more compared to unsustainable buildings. Sustainable buildings also transacts for about 2% more per net square meter relative to unsustainable buildings (Chegut, Kok, & Eichholtz, 2011). In the United States, LEED and Energy Star are the most common certificates. The Energy Star certificate only measures the energy performance of a building and can be compared with the energy label in The Netherlands. The different studies done to the effect of these two certificates on the transaction prices all show different results. Energy Star certification will generate over 3% per square foot, the difference in effective rent is estimated to be about 6%. In against it, no effects of LEED certification on transaction prices are found (Eichholtz, Kok, & Quigley, 2010). At the time of research, the conclusion can be made that

[1] Actual observable exchange price in the open market.

energy efficient buildings seem to be more important for tenants than sustainable buildings. One year later, the same research to the effect of LEED and Energy Star on transactions prices was done. Oddly enough, the outcomes of this research differed. LEED certified buildings resulted in a rental premium of approximately 5% over non-certified buildings and Energy Star certified buildings resulted in a rental premium of 4% (Fuerst & McAllister, 2011).

For all that, hard evidence on the effect of energy efficient on transactions prices contains just one part of sustainability, energy. Evidence on sustainability certificates differs, the relationship between sustainability and the price is harder to make because of the lack of evidence (Warren-myers, 2013a).

Plausible criteria

In contrast to the evidence of the factual criteria on the transaction prices, it is hard to prove the plausible criteria empirically. Good comfort and health of a building results in advantages for users such as increase in productivity and decrease of absenteeism. Although hard to quantify and often neglected, these advantages can be of significant value to a buildings' users (Reichardt, Fuerst, Rottke, & Zietz, 2012).

Therefore, much research has been undertaken in this field. In most of the studies a clear link is identified between certain building aspects (factual criteria) and comfort and health of users. The increase in productivity for example; different studies link different building aspects to productivity: increase in productivity can be achieved by 23% better lighting, 11% better ventilation and 3% by individual temperature control, what will result in an increase up to 18% of productivity (The U.S. Green Building Council, 2013); re-locating from a conventional building to a sustainable building can result in an increase of 2 -10% of the productivity of the employees (Lorenz & Lützkendorf, 2008); as result of better air quality productivity improvements of 8 -11% can be reached (John Alker, Michelle Malanca, Chris Pottage, 2015); According to Koolmoes the productivity of employees improves when; employees can control daylight (86%), much daylight at workplace (85%), employees can control temperature (82%), unobstructed view out (80%), opening windows for ventilation (74%) and relax area near workspace (63%) (Koolmoes, 2014). Many different building features influence the productivity of users, all these aspects together that optimises the increase in productivity.

Feige et al. studied all existing literature to the links between certain building aspects and the comfort and health of the users. Temperature, outdoor air supply, noise level, light, office size, ventilation, personal control and daylight are all building aspects that are linked to comfort and health. The comfort and health of a building can be determined by the productivity, performance and absenteeism of the users. For example, doubling the outdoor air supply results in 10% reduction of illness and increasing of the noise level will result in 3% decrease of the performance rate (Feige, Wallbaum, Janser, & Windlinger, 2013). These are just some examples; much more research has been done to the effect of certain building aspects to the comfort and health of users.

It is proven that health and comfort aspects affect the productivity and absenteeism of users. Nevertheless, these benefits are not taken into account by valuing an office building. It is difficult to determine the exact effects of health and comfort on the price of an office building.

3.3.2 Effect sustainability on market value[2]

Factual criteria

In order to determine a proper market value, the property appraisers should gain knowledge of the market. To set the market value property appraisers have to make estimations of what will happen in the future and what tenants are prepared to pay for a specific building. Therefore, the market value strongly depends on the demand side. Users are willing to pay a premium of an average of 4,2% more for a sustainable building relative to a conventional building (Koolmoes, 2014).

To determine the impact of sustainability on the market value of a building, it is important to determine the indicators and performance that have impact on the building's value (Myers et al., 2007). According to Lützkendorf & Lorenz the link between sustainability and market value is in the classification of the buildings. Two types of categories can be distinguished; first the economic, environmental and social aspects, and secondly aspects related to the fulfilment of user's and occupant's needs (Lützkendorf & Lorenz, 2005). In other words, first the factual criteria of a building and second the plausible criteria. Due to the fact that users are willing to pay more for sustainable buildings, it is important to know which sustainable features are most important the user's choices for an office building.

In 2002 a survey was conducted among tenants about their housing choices and the importance of sustainability categories. Results show that transport and mobility are the most import category for housing choices (22.1%), thereafter economy and work (21.5%), community benefits (20%), resource use (17.5%) and buildings and land use (18.9%) are most important (Hemphill, McGreal, & Berry, 2002). Over the years user's preferences change, therefore aforementioned results are no longer relevant to the current market. Jones Lang LaSalle (JLL) conducted the same research among users of office buildings in 2008, 2010 and 2013. In this research the nine categories of BREEAM formed the base and the importance of these nine categories in users office building choices was asked. Results slightly differ each year; the most recent research showed that health & well-being is the most important category for housing choices. In against, in 2010 energy was the most important category for users. In addition, respondents were asked to give concrete measurable sustainable criteria important to their housing choices. Daylight access for visual comfort, better internal air quality and ability to measure and modify energy consumption are most mentioned, and so most important criteria. Flexible lay-out possibilities and good public transport in immediate surroundings are also important criteria for housing choices (Jones Lang LaSalle, 2013).

According to research conducted by Jones Lang LaSalle, two-third of the respondents are willing to pay between 1 to 5% on top of their regular rental price for sustainable benefits, 8 to 12% of the respondents are even willing to pay over 5% more (Jones Lang LaSalle, 2013). One year later, more extensive research had been done to premium rents for sustainable housing. Results show that 6 % of the respondents (housing decision makers) are willing to pay higher rent for sustainable housing. 24% of the respondents are prepared to pay 2-4% over a rental price for a conventional building. 12% are prepared to pay 4-6% more, 7% are prepared to pay 6-8% more and 8% are even willing to pay over 8 % for sustainable housing (Koolmoes, 2014). Overall, the market clearly needs sustainable housing in order to meet the

[2] An estimate of the price that would be achieved if the property were to be sold in the (open) market.

demand of two thirds of the users. Even the users are willing to pay more for sustainable housing from 1 to more than 8% over conventional buildings.

Nevertheless, property appraisers should know that sustainability is just one housing choice criteria; the most important housing criteria for users are flexibility, location, cost, marketing and many more (Mason-Jones, R. and Towill, 2012).

Plausible criteria

Although sustainability is not one of the primary housing choice criteria, 38% of the users designated sustainability as important housing criteria. Yet, companies increasingly choose sustainable housing. Sustainable housing not only ensures increase in productivity and a reduction in absenteeism but also a good image. Propagating a sustainable image is increasingly important in the market positioning of companies (Stoer, 2013).

The choice for sustainable housing varies for each company and depends on company's motives and goals. In 77% of the cases increasing productivity is mentioned as important. 68% has indicated sustainable housing because of the improved image for the company. Therefore, increasing productivity and an improved image are two important factors that add value to an office building. In total, 86% claim to have the ambition to be more sustainable, with the aim of contribution to society or increase of the productivity of the employees (Koolmoes, 2014).

Thus, the market value of office buildings that increase productivity or improve the image of companies by their sustainability will be higher compared to conventional buildings. Users are willing to pay a premium for sustainable buildings because of, not only the financial but also the social benefits of a sustainable office building.

Conclusion section 3.3 Market evidence

The market provides hard evidence of the premium prices energy efficient buildings get relative to non-energy efficient buildings. In against it, the relationship between sustainability and price is harder to make because of the differences and the lack of evidence. The effect of plausible criteria, like comfort and health, is even harder to provide. It is sure that health and comfort aspects affect the productivity and absenteeism of users. Nevertheless, hard evidence is lacking. It is difficult to determine the exact effects of health and comfort on the price of a building. If the effects could be measured these could be taken into account for the valuation of a building.

Prior research shows that tenants are willing to pay more for sustainable office buildings because of the gaining benefits, like an increase in productivity and the decrease of absenteeism. Despite of the changing office building preferences of the recent years, the health and well-being of a building's users seems most important for the housing choice. Tenants prefer a sustainable building relative to an unsustainable building because of social and financial benefits. Nevertheless, property appraisers should know that sustainability is just one housing choice criteria. The most important housing criteria for users are flexibility, location, cost, marketing and many more.

3.4 Conclusion and discussion

Literature provides a lot of information about sustainability in general and sustainability in relation to real estate. Likewise, much research has been done into the main focus of this study. The most important problem is the lack of integration of sustainability in valuations for defining the value of sustainable office buildings. Valuation methods do not include any sustainability aspects and the guidelines do not provide how to take sustainability into valuation methods. One of the underlying problems could be the lack of the ability for property appraisers to assess the sustainability of office buildings. If property appraisers cannot assess the sustainability it is hard to take the right factor or amount into the valuation. Another important problem is the subjectivity within valuations; valuations should be more objective for better incorporation of sustainability.

BREEAM, LEED and other certification tools are often used these days to measure the sustainability of an office building. Through the magnitude of the tool and the application time, these tools are not usable for property appraisers. Besides that, the tools focus on both the physical building aspects and the company specific aspects. This makes the tool not applicable for vacant buildings and thus, not applicable for property appraisers. Many researchers attempt to find a solution and create a model for property appraiser's use; what means a tool that assesses the physical features of a building not company specific. The aim of these models was the ability for the property appraiser to measure the sustainability of a building and take this into the valuation. However, by the changing market, changing demand and the chancing extent of sustainability these models are outdated and no longer useful. These days, more research is done to the extent of sustainability, market demand and users requirements. This offers an opportunity to create a model that can be used by property appraisers for assessing the sustainability of a building in addition to the other aspects.

Whenever property appraisers have the ability to assess the sustainability of a building, the assessment has to be taken into the valuation. The currently used valuation methods do not take sustainability into account. Literature provides different options of incorporation of sustainability in the calculation of the valuation methods. Although, valuation is no rocket science, deciding which of the provided options is best is hard to say. In addition to the different options, research has been done into the most suitable valuation method for incorporation of sustainability. According to different researchers the DCF-method seems to be most appropriate method. Nevertheless, the link between incorporation of the different options into the DCF-method is not made in the literature. In this thesis the link will be made; sustainability will be incorporated in the DCF-model.

Another important problem outside the sustainability issue is the subjectivity within valuations. Uncertainty and subjectivity in valuations arise by different predictions and estimations made by property appraisers. Different studies conclude that there should be an acceptable method that regulates dealing and reducing the uncertainty and subjectivity in valuation. Until now, no attempts have been done to reduce subjectivity within valuations.

The magnitude of these problems is much broader than The Netherlands; all over the world these problems are recognized and research is done. Appendix 2 shows the research done in other countries. In general, the same researchers in each country published multiple studies about the same subject with new findings.

In short, according to the literature the valuation market is dealing with three important problems that have not been solved yet; a lack of sustainability in the valuations, a way for property appraisers to assess the sustainability of a building and the subjectivity within valuations. This offers an opportunity to create a model that is capable of solving all these problems. First, a way of assessing the sustainability for property appraisers should be developed. After that, the outcomes of this model could be implemented in the DCF method, that decreases the subjectivity within valuations because of calculation with set amounts.

Discussion

When property appraisers assess sustainability they are only able to assess the physical sustainability features of a building. This is because the sustainability of a vacant building should also be able to be assessed and company specific criteria are not measurable for property appraisers because of their complexity. Discussion can arise about the scope of sustainability; can the sustainability be assessed by only physical criteria? This research assumes that it is possible; otherwise sustainability can only be taken into account if a building has a sustainability certificate.

The understanding *objective* can also be discussed. According to the dictionary objective is without being influenced by personal preference, unprejudiced, uninhibited. It is difficult to judge when a valuation is objective. A valuation will always include some uncertainty and subjectivity. Both, uncertainty and subjectivity of a valuation can be limited. When the subjectivity is limited to a minimum the valuation will be objective.

4. RENEWED VALUATION MODEL FOR SUSTAINABLE OFFICE BUILDINGS

Sustainability is an important understanding in the real estate sector and sustainability is increasingly relevant for all stakeholders in this sector (Piet Eichholtz, Kok, & Quigley, 2015). Within a few years sustainability will be the standard. This can be inferred from the fact that more and more rules and general guidelines are drafted related to sustainability and the increasing demand for sustainable real estate (Steinmaier, 2014). The prediction is that in the future users will not rent a building that does not meet the 'standard' sustainable features, the government already started with this (Rijksoverheid, 2010). Office buildings that do not meet the standard compliant sustainability features will be repealed by the government and financers, what compels building owners to invest in a (more) sustainable building within a few years (IVVD, 2014). Despite the increase of standardization of sustainability in the office real estate, it is remarkable that there is still a lack of a model for integrating sustainability issues into the valuation of office buildings. The theoretical background describes the main problems of valuation of sustainable office buildings. It includes gathering essential information about three main problems: (1) the lack of a way for property appraisers to assess the sustainability of an office building, (2) the lack of sustainability in valuation methods and (3) subjectivity within valuations (figure 4). To get insight into the current way of valuing, interviews were conducted with several property appraisers. The focus of these interviews was on valuations of sustainable office buildings. All property appraisers were asked to fill in a questionnaire about the most important criteria of a sustainable office building. The results of the interviews are used as input for the application of the Fuzzy Delphi Method (FDM). In order to find out the most important criteria of a sustainable office building the FDM was applied. To understand the most important criteria of a sustainable building and making them assessable, the criteria were linked to the four most important aspects that are affected by sustainability. These aspects reflect the benefits that can be gained by sustainable office buildings. In order to design the renewed valuation model a questionnaire and an expert panel were conducted. To ensure less subjectivity within the renewed valuation model the questionnaire was used to set default discount rates and exit yields that can be taken in the renewed valuation model. The results of the questionnaire were validated by the expert panel. Due to the expert panel the amounts of the default discount rates were adopted. In order to understand the importance of implementation of sustainability within valuations the renewed valuation model was applied on a test case.

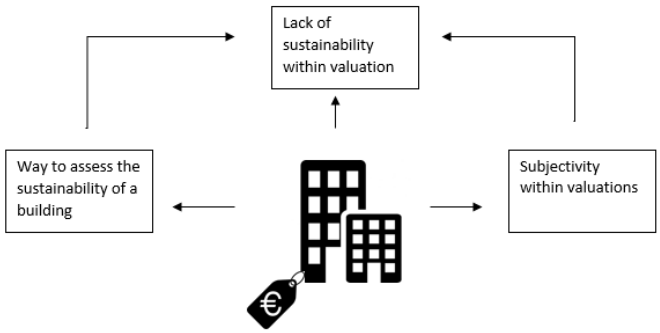

Figure 4. Three main problems of valuing sustainable office real estate

4.1 EXPERT INTERVIEWS

After clarification of the problems of valuing sustainable office real estate, it is essential to gain information about the current way of valuing. As well, the encountered problems by property appraisers and the intercourse of property appraisers of sustainability within valuations are essential for the development of a new valuation model. The knowledge of the experts, in this case the property appraisers, is gathered by half-standardized structured interviews. In total 7 property appraisers of the bigger leading valuation companies in the Netherlands are interviewed (Savills, Colliers International, MVGM, CBRE, NAI Netherlands, Scherrenberg taxaties and Troostwijk). The experience of all interviewed property appraisers differs within years and projects.

4.1.1 Interview structure

Due to the essence of the gathered information it is important to conduct structured interviews. Four levels of structuring interviews are emerged, the first level requires that the exact same questions need to be asked to each candidate in the exact same order. The second level requires that primarily the same questions be asked but allows more flexibility for discussion of interesting lines. The third level only covers topics, no questions and the fourth level is unstructured (Campion, Palmer, & Campion, 1997). For the interviews in this research the second level was applied. The same questions are asked to all property appraisers but, there was plenty room for discussion.

To obtain all the essential information needed for supporting the design of the new valuation model and to answer sub-questions, the next questions were submitted to all experts:

- What do you think of the current way of valuing and what improvements can be made?
- How does 'your company'[3] deal with sustainability within valuations?
- What is the general method within 'your company' and how is sustainability implemented in this model?
- Besides to the general guidelines, does 'your company' have an additional document for handling sustainability within valuations?
- How is sustainability included in the valuation when the building has a BREEAM certificate and how is it included when the building does not have a certificate?
- Do you think the sustainability of an office building can be assessed by only physical aspects of a building?
- What percentage of a valuation is fixed and what percentage is attributable to the gut feeling of the property appraiser?
- What do you think of the subjectivity within valuations, should this be more regulated?
- Whose role is it to introduce a new model, method or standard on the market that decrease the subjectivity within valuations?
- Would a model that takes sustainability into account and decreases the percentage of gut feeling within a valuation be an improvement for the office real estate market?
- Would a model like this be accepted by the market?

[3] Where 'Your company' is mentioned the company name of the respective company has been named in the interview.

In response to these questions discussions were raised and in-depth questions were asked. In the end all the property appraisers answered these questions.

4.1.2 Findings expert interviews

The findings of the expert interviews are of major importance for this research. Prior to the development of a new valuation model, it is essential to gain insight into the actual way of valuing. Property appraisers are the future users of the renewed valuation model hence, for them it should be a manageable model. Therefore, in total seven experts of leading valuation companies in the Netherlands were interviewed (Savills, Colliers International, MVGM, CBRE, Troostwijk, NAI Netherlands and Scherrenberg taxaties). The interviews were really interesting and many statements were made; however, this section only includes the main findings of the interviews important to this research. For privacy reasons, no names of experts are mentioned in this section.

Current way of valuing

All experts generally reacted the same way to the question what they think of the current way of valuing and possible improvements. The general consensus was that there will always be room for improvement. Nevertheless, all agreed that in the past major improvements have been made. In the last years, the profession of property appraisers has become more and more professional by standardisations and education. Previously, each property appraiser valued based on different definitions and without substantiation of the value. A valuation report consisted of only a few pages; nowadays they are entire books, something what will only increase in the future. Due to standardization in recent years, definitions are generalized and substantiation is required. Since January 1st, 2016 the NRVT provides guidelines for all valuation reports. These guidelines commit to a substantiation of the calculations and the final value. Another commitment by the new guideline is the plausibility control, what means that each valuation must be considered by two pairs of eyes. Property appraiser X said: '' At this moment the NRVT is full of rules we have to comply, what we all not like because we are pushed into selection lists. Nevertheless, I do think the NRVT is good. The NRVT arrange a lot of things, also for the future that are good for the appraisal world and valuations in general.'' Most property appraisers indicated that standardization of valuations is fair but it must remain within its limits. However, one of the property appraisers proposed a general mathematical model with the remark that this probably would be too much of standardization.

Sustainability within valuations

Sustainability within valuations is a tricky topic for property appraisers. Not all answered the question directly but did face the extent of sustainability. All interviews revealed that the extent of sustainability is questionable. For answering complicated sustainability issues, a description of a sustainable building is necessary. Listed buildings, like impressive canal houses, are very popular and also sustainable because of their long lifespan. This also applies for large industrial buildings on brownfields. Back then, the construction of these buildings was not sustainable at all; heavy concrete floors were required to carry heavy industrial machines. However, these buildings are still there and are now used for other purposes. These types of buildings are also sustainable because of their long lifespan. However, the majority of interviewees implied that a sustainable building is a building that fulfils the BREEAM standards.

Ultimately, the replies of experts on how they deal with sustainability within valuations do not vary that much. Valuation reports include a sustainability section; only the content is limited to name the energy label and optionally a certification. One of the experts proposed to include improvements of the property in terms of sustainability in this section to show the potential of the property. These improvements will be determined by a short sustainability quick scan on the building. Another said to provide a model in the valuation report that includes sustainability aspects like proximity to public transport, building year etc. Each aspect gets a qualification; in the end the property appraiser can judge the sustainability level of the building. All property appraisers agreed on the fact that the incorporation of sustainability in the valuation report depends on the task of the client. If the client specifically asks for sustainability, the section is more extended.

Before knowing how sustainability is taken into the calculation, it is essential to know what valuation methods property appraisers use to underpin their valuations. All property appraisers indicated to work with the BAR-, and NAR-method and the DCF-method, in which the DCF-method is often used as a check or in case of special buildings. One of the property appraisers said: ''Frankly, it is true that the DCF is calculated in such way that it comes out on the BAR/NAR. Only if you notice a large difference between those two something is wrong.'' Several property appraisers emphasized that the calculation methods only serve as underpinning the value. In addition to that, the inputs for the BAR-, and NAR-method are almost always based on references. Even in the crisis, when almost no suitable references were available for property appraisers to base their input numbers on, they assessed values to a building based on transactions prices of the past. This occurred even though these transactions prices were out-dated.

''Sustainability is reflected in valuations, only it is almost impossible to filter out.'' The answers to the question of how sustainability is, or could be implemented in valuation methods, differ for each property appraiser. In general the property appraisers agreed with each other on the aspects that should reflect sustainability. Rental income, operating costs and the exit yield or the capitalization factor are the three most important aspects for reflecting sustainability. Rental income, due to the lower energy costs, will make tenants open to paying more rent. This aspect is named by all property appraisers. The operating costs could be lower when the building is very low in maintenance. Last, the capitalization factor or the exit yield (depends on the valuation method) could be lower because the lower risk for vacancy. A few remarks have been made on these aspects. The non-transparency of the capitalization factor will be increased by the incorporating sustainability; it will be unclear what percentage is attributable to references based on the building and what to sustainability. This is due to the fact that sustainable buildings are often new buildings, what makes them unsuitable as a reference for renovated sustainable buildings. Also some remarks were made in regard to the maintenance costs, that are not per definition lower for a sustainable building. High tech installations may even entail higher maintenance costs. One of the property appraisers also noticed the re-letting time as important because this will be lower in relation to an unsustainable building. How large the impact of sustainability is on these aspects is not clear. Often the increase of the rental income is based on the gut feeling of the property appraiser. Due to the lack of suitable sustainable references, the rental income cannot only be based on these references.

Nevertheless, sustainability is not literal reflected in the calculation model. However, what is most important for estimating the value of a sustainable building, what does the market want to pay for this building? Property appraisers have to estimate the market value and what changes will arise on the market in the coming years. A sustainable building with energy label A++ and BREEAM excellent certification in the polder can have a much lower value than an energy G label building near to the station in the Randstad. This implies what all property appraisers emphasize; the location of a building is and will always be the most important aspect of a building.

The impact of certifications like BREEAM on the market value is barely notable according to all interviewees. In practice, no commercial real estate buildings are one on one comparable to each other; commercial real estate is heterogeneous. If, theoretically, two office buildings are identical and at the same location, the building with the BREEAM certificate will have a higher market value. However, in practice, there are no identical buildings. Due to that fact no research proves strong evidence that a BREEAM certificated building gets higher rent per square meter relative to a non-certified building. There are many aspects that play important roles in setting the market value next to sustainability, where the housing market is easier because they are seen as homogenous products. Next to that, the importance of BREEAM certifications also depends on the type of user and type of location. ''There are companies renting a building and say I want to rent that building but I want the building upgraded to BREEAM excellent, this is a condition of the lease. ''Mostly these are the bigger companies with the aim for a green image. In against it, smaller companies or companies who do not want a green image do not add value to a BREEAM label and will not even think about it. They want a building that fits the company, fulfils their needs and has a good location. It will take time before the benefits of sustainability are fully integrated in the market and also smaller companies prefer to rent sustainable buildings.

If the sustainability of a building can be assessed by only the physical criteria of a building is still questionable. According to some experts it would be practical if there is a checklist that provides aspects of a sustainable building. However, not all property appraisers have sufficient technical knowledge to assess all aspects. For example, aspects like the difference between sound absorbing ceiling panels or standard ceiling panels and LED lighting or normal lighting. It appears that the skillsets of some property appraisers fall short, that makes it impossible to work with a checklist before training these experts. In addition, these days property appraisers already check aspects of the building that are covered by sustainability like, re-use of the property, functionality footprint and maintenance costs. However, in order to claim that a building is sustainable tenants often wants evidence in form of a label.

Subjectivity within valuations

Subjectivity within valuations is a tricky topic. Looking at a valuation, the percentage of property appraisers depending on a gut feeling cannot be pinpointed. To set a value to a building property appraisers have to make a lot of estimations; all these estimations are based on references and the knowledge and experience, in other words the gut feeling of the property appraiser. Thereby, the worse the market, the less references so the more gut feeling of the property appraiser. Since January a lot changed in the guidelines concerning valuations. The requirements for the substantiation have become much stricter, what should result in more transparency. Nevertheless, there will always be a part that can be assigned to the gut

feeling of the property appraiser. Expert Y said: ''When I walk around, I have a feeling for the value that always starts with the rental value of standard real estate. I do think it will largely be driven by transactions of similar properties and similar location but there will always be a bit of subjectivity of the property appraiser.'' It is always an estimation of the property appraiser, some will see the building positive, and the other will see it more negative. Valuations are no rocket science, they are estimations depending on the gut feeling and the experience of the property appraiser. Each property appraiser has his or her own opinion, so each property appraiser will add another value to the same building. Due to this fact, there will always be some subjectivity within valuations.

When more transparent data of transactions of the past become available on the market the subjectivity can be limited according to most experts. When the data of transactions of the past are more transparent they are more useful as reference because the provide more information about the sale and the building. However, this will also result in a smaller acceptance of the margin of error. The housing market is already enormously transparent because of a lot of available reference material. ''At the time that office references become better, I mean transparent and sharp in their substantiation. You will see that the market will adopt more. Therefore, there is especially a huge need for transparency.'' Nevertheless, most of the property appraisers do not think this will happen at short notice.

Where some experts suggested a model for limiting the subjectivity or dealing with sustainability, others think that all kinds of new standardizations are unnecessary because of the already existing guidelines and models that standardize sufficiently. Standardization of sustainability in the calculation models would be a good idea according to one of the experts. ''It simply should have a place in the value, a proper and decent place where it really plays a part. But sustainability will never be the primary driver of the value of a building.'' Another claimed that the calculation models should be standardized. According to most of the experts the technology in the future ensures that a valuation will take less time by a proper database of references and building features. Valuations will be more automated. Nevertheless, they all agreed on the fact that a property appraiser is, and always will be needed to assign a value to a building. In addition, a property appraiser should always visit the building before he can give a well-founded value. This means that a well-founded valuation can never be done only by computer.

Discussion section 4.1 Expert interviews

Before changes can be made, it is important to know how valuations are performed in practice these days. By interviewing 7 property appraisers who are daily involved in valuations, a proper impression of valuations in practice can be outlined. By these expert interviews sub-questions 1.2, 1.3 and 1.4 can be answered.

Based on the expert interviews, some conclusions can be derived for the use of valuation methods and the perception of sustainability by property appraisers. In the last years, many improvements in valuations have been made by stricter and more standardizations. The complexity is within the lack of a definition of a sustainable building, this is also indicated by the property appraisers. This makes it difficult to assign value to a sustainable building. The most important conclusion of the interviews is that sustainability is not included in the value of a building except extreme sustainable office buildings. Sustainability it limited to mentioning the energy label or the sustainable certification in the valuation report. In the interviews property appraisers agreed on the variables that should reflect sustainability; rental income, operating costs and the exit yield or the capitalization factor. Besides, valuations are no rocket science. Property appraisers have to make a lot of estimations to assign a value to a building. All these estimations are based on references and their knowledge and experience; in other words, the gut feeling of the appraiser.

1.2 How are valuations in practice actually performed?

During the last years, many improvements have been made in the valuation process by standardisations and education. By regulations of the RICS and the NRVT a fair substantiation of the value is mandatory since 2016. Nevertheless, several property appraisers do not fully implemented the new standardisations yet. In addition, most property appraisers think that standardizations will only increase and will become more stringent in the coming years. What will not always contribute to a better valuation. The interviewees also indicate that references are very important for assigning a value to a building. Actually all values are based on references, although this is not correct because there is calculated with outdated data.

1.3 How do property appraisers take sustainability into their valuations?

The only way how the majority of the property appraisers take sustainability into their valuation is by naming the energy label or the sustainability certification in the valuation report. Remarkable is that all property appraisers agreed on the fact that sustainability should be taken into the value of a building and it can be reflected in different variables of the DCF-model. However, by the lack of suitable references property appraisers drop the sustainability aspect or add an amount based on the gut feeling.

1.4 How objective is the valuation of a property appraiser?

What exact percentage of a valuation is based on the gut feeling of a property appraiser is impossible to pinpoint. Nevertheless, all property appraisers admit that a lot of estimations have to be made for setting the value of a building. All these estimations are based on references and the knowledge and experience, in other words the gut feeling of the property appraiser. Valuations are estimations that depend on the gut feeling with guarantees of the property appraiser. Due to this fact, there will always be some subjectivity within valuations.

4.2 FUZZY DELPHI METHOD (FDM)

Sustainability should be incorporated in the valuations methods. Therefore, there is a need to find out the most important physical aspects of sustainability in the context of valuation of office buildings. In order to do that the Fuzzy Delphi Method (FDM) is used because this method enables achieving consensus among the experts about the physical criteria of a sustainable office building. The outcomes of this method show a ranking of the most important criteria of a sustainable office building and will be input for the renewed valuation model as most important criteria of a sustainable office building. In order to understand the FDM, general knowledge about the method is necessary. First, some general information and the steps of the FDM are provided. The first step of the application of the FDM is the data collection; by literature, expert interviews and online questionnaires the criteria for the application of the FDM were selected. Thereafter the application of the FDM is explained in detail. Next, the results of the application of the FDM are elaborated. Based on the outcomes of the questionnaire the most important criteria of a sustainable office building were selected.

4.2.1 FDM in general

The Fuzzy Delphi Method (FDM) is an analytical method based on the Delphi Method. The Delphi method is a type of collective decision-making method with several rounds. Expert's opinions are asked in the form of anonymous written questionnaires. The purpose is to achieve a consensus among the experts on the evaluated subject. The Fuzzy Delphi Method proposed by Ishikawa et al., 1993 is a combination of the traditional Delphi Method and the Fuzzy Theory. The FDM takes into consideration the fuzzy concepts in opinions of experts about a specific subject. The human perception and feelings are vague, to describe the feelings more precisely the FDM can be applied (Lin & Chuang, 2012). The Fuzzy Delphi method is preferred over the traditional Delphi Method; this is mainly because the questions and answers from the Fuzzy Delphi method tend to have certain fuzziness. This also applies to the subject of sustainable valuation; both the questions and answers have some vagueness (Ho, Hsiao-Lin, & Wang, 2008). For example, there might be differences in the expert's interpretation of the concept of a sustainable building. Due to the advantage of a limited number of questionnaires and the limited time frame, the FDM is very appropriate for this research. This method also takes into account the fuzziness that confronts every survey process, assuring that there is no misinterpretation of an expert's prime opinion, thus it genuinely reports their responses. In this way the efficiency and quality of questionnaires are improved (Glumac, Blokhuis, Han, Smeets, & Schaefer, 2010).

The FDM includes the following steps, that will be explained in more detail in section 4.2.3 Application FDM:

1. *Validate predefined list of the attributes;*
   This step explains in detail how the data collection as input for the Fuzzy Delphi Method is done. The result of this step is a list with criteria that had to be assessed by experts.

2. *Collect opinions of experts;*
   In the second step the evaluation score of each alternate criteria will be found, given by each expert by using linguistic variables in questionnaires.

3. *Set up triangular fuzzy number;*
   This steps contains of the calculation for the evaluation value of triangular fuzzy number of each alternate factor given by experts and to find out the significance triangular fuzzy number of the alternate factor.

4. *Defuzzification;*
   The unique triangular numbers will be turned into single real numbers using the simple centre of gravity method.

5. *Screen evaluation indexes*
   In the end, a selection of proper factors can be made from numerous factors by setting a threshold α. The principle of screening is as follows:

   if $s_j \geq \alpha$, then No. j factor is the evaluation index.
   if $s_j < \alpha$, then delete No. j factor.

4.2.2 Data collection

The data collection required for the application of the FDM is gathered by the theoretical background and a validation questionnaire. The theoretical background provides a list of sustainability criteria of office buildings composed by researchers and certificate organizations. By a thorough selection, a shortlist of physical sustainable criteria is compiled as input data for the application of the FDM. The full list consists of 290 sustainable criteria (appendix 1). This are too many criteria for the application of the FDM. In 4 different steps a selection is made to a total of 25 criteria as input for the FDM. Figure 5 shows the selection steps with the number of associated criteria.

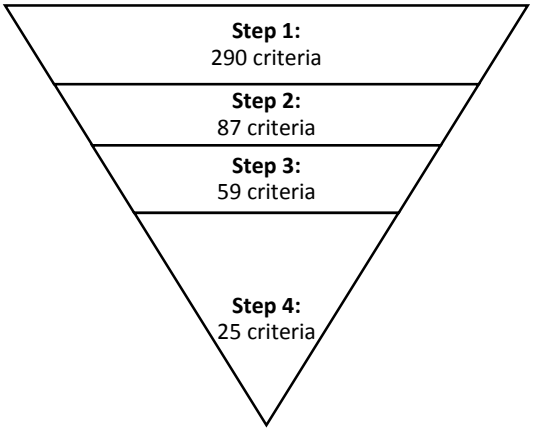

Figure 5. Selection steps criteria FDM

The extracted list from the theoretical background includes several dual criteria, this is due to the use of different lists that contains overlapping criteria. First, the overlapping criteria are combined into one criterion. After that, only the physical criteria are selected; the other criteria will not be used because the final model has to be applicable for all property appraisers, in which no additional knowledge has to be gained. In addition, the model must be applicable for occupied and vacant office buildings. Therefore all company specific criteria should be rejected from the list such as actual traffic information, maintenance policy and purchase of interior. Criteria like percentage of recycled water, lighting level and NOx emission are deleted from the list because of the immeasurability of the property appraiser. After selection step 1, there are 87 remaining physical criteria of an office building (see appendix 3).

The list with 87 criteria is used as input for the first step of the FDM; validate predefined list of the attributes. To narrow down the number of criteria as input for the FDM, different selection steps are conducted. First, five property appraisers gave their opinion about the list through an interview. Thereafter, 20 experts of different stakeholder groups were approached through an online questionnaire. In the final selection step an email is sent to over 400 property appraisers with the request to fill in an online questionnaire about the most

important physical criteria of sustainable office buildings. In the next section the validation of the predefined list and the application of the FDM is explained in more detail.

4.2.3 Application FDM

The Fuzzy Delphi Method can solve the fuzziness in common understanding of expert's opinions. As for the selection of fuzzy membership functions, previous research was usually based on the triangular fuzzy number, trapezoidal fuzzy number and Gaussian fuzzy number (Hsu et al., 2010). Due to the simple mathematical operations and the computational efficiency the triangular membership function is applied in this research. Although other functions like the trapezoidal or Gaussian may contain more information, this information is superfluous in this research to select the most important criteria of a sustainable office building. To know the common understanding of the group decision the geometric mean model of Klir & Yuan, 1995 is used because of the simplicity of the problem.

The following steps explain in detail how the application of the FDM was conducted:

1. *Validate predefined list of the attributes;*

For the relevance of this research the criteria have to be validated by experts. Validation of the criteria is needed because different groups of stakeholders may have different opinions about the importance of the sustainable criteria. Therefore, the 87 remaining criteria were represented in a questionnaire to 5 property appraisers; selection step 2. Each property appraiser was asked to tick the most important criteria for each category and to add missing criteria. There were no limitations regarding the amount of criteria to tick. The questionnaire was presented during interviews, what allowed property appraisers to explain their opinions about the list and to underpin their choices. One of the findings was that most property appraisers ticked the same criteria and also that most of them added one or two missing criteria in the overall list. The interviews revealed that in general property appraisers have a common opinion, the general criteria are more important than the more specific criteria. For example, it is not important if the ventilation of the building is natural or mechanical, just the type of ventilation is important. Likewise, renewable energy sources are often ticked, what kind of renewable energy source is applied are not considered as important by property appraisers.

Based on the results of the questionnaire and the related interviews the list was adapted. It also indicated that the depth of the building is important. The related number (15 to 18 meters) on the other hand is not relevant, because it depends on other aspects of the building. The ability to add missing criteria resulted in a total of 12 added criteria by the property appraisers. Some of these criteria are acoustics, collective use of cars and actual energy consumption per square meter. Other criteria such as user experience and reducing paper usage are company specific and therefore not applicable to this research. After the interviews the list was adjusted. Criteria like the burglar system have been removed because none of the property appraisers ticked these. In support of this choice property appraisers said that the burglar system has nothing to do with the physical sustainability of a building. More criteria similar to the burglar system have been deleted from the list. After selection step 2, the list consists of 54 criteria.

In the third selection step, other stakeholders, outside of the property appraisers, need to verify the list of criteria. For this, the remaining criteria with associated descriptions are presented in an online survey to 3 other stakeholder groups. In total the criteria have been validated by 15 experts of four different stakeholder groups; property appraisers, building users, government and professors. Each group has a different purpose for the validation of the criteria. Property appraisers are the primary target group for the model. Property appraisers will use the model for assessing value to a building and it is therefore important to know their opinion. The second stakeholder group consists of building users; the demand side. The real estate market is a demand market, what means that buildings have to fulfil the requirements of users or else they will host in another building. It is therefore important to know what criteria of sustainable buildings are significant to them. The government is the third validation group. By using a new valuation model that includes sustainability, the value of a building will have positive effects on the investment value. Hereby real estate becomes more interesting to banks and financers of real estate. Due to the lack of proper sustainable references, positive financial effects of sustainable buildings are not visible these days. By a new way of valuing sustainable office real estate, the positive effects will contribute to the goals of the government, such as the energy agreement or to re-use materials and the CO2-emission goal in 2020. Finally, the group of professors, they can give further insight into the latest knowledge about sustainability in relation to office real estate.

The online questionnaire was completed by 10 respondents. In total 15 respondents, including the property appraisers, validated the sustainable criteria. The original intention was to have 20 respondents, five of each stakeholder group. Due to limited research time, the decision was made to close the survey after more than 3.5 weeks. Nevertheless, all stakeholder groups are represented. In total 5 property appraisers, 5 government employees, 3 professors and 2 building users validated the criteria.

Before the start of the criteria selection process, a target number of 25 -30 criteria was set because the overall size of the model must remain within its limits. After validation, a total of 25 sustainability criteria were selected. All criteria ticked by the half (7) or more of the respondents were selected for the application of the FDM. Appendix 4 shows an overview of the criteria and how often they were ticked. After thoroughly studying the rejected criteria, it can be concluded that no important criteria for this research are rejected within these selection steps. Table 4 shows an overview of the 25 selected criteria with corresponding description as input for the FDM.

2. *Collect opinions of experts;*

By means of an online questionnaire the opinions of the experts are gathered. Section 4.2.4 explains in more details how the questionnaire is conducted. Each expert gave an evaluation score of every criteria by using a seven-point Likert scale. The seven-point Likert scale is preferred over the five-point Likert scale because of the extended number of choices, this generates more specific results. Over seven options will result in a too complicated task for the experts. The triangular fuzzy numbers of the seven-point Likert scale are shown in table 5.

Extremely unimportant	Very unimportant	Unimportant	Moderately important	Important	Very important	Extremely important
(0, 0, 0.1)	(0, 0.1, 0.3)	(0.1, 0.3, 0.5)	(0.3, 0.5, 0.75)	(0.5, 0.75, 0.9)	(0.75, 0.9, 1)	(0.9, 1, 1)

Table 4. Seven-point Likert scale

3. *Set up triangular fuzzy number;*

After the selection of an appropriate fuzzy spectrum, experts' opinions can be collected. Afterwards the experts' opinions should be aggregated and the fuzzy number for each criteria can be calculated. The geometric mean model by Klir & Yuan, 1995 will be used to find out the common understanding of the group decision. First, the evaluation value of a single criteria by a single expert is expressed as triangular fuzzy number $\widetilde{w}ij = (a_{ij}, b_{ij}, c_{ij})$, where factor j element given by factor i expert of n experts where $i = 1,2,\ldots.n$, $j = 1,2,\ldots.m$.

Then the fuzzy weighting $\widetilde{w}j$ of j is $\widetilde{w}j = (a_j + b_j + c_j)$, j = 1,2,…m. Where:

$$a_j = \min_i \{a_{ij}\}, \quad b_j = \frac{1}{n}\sum_{i=1}^{n} b_{ij}, \quad c_j = \max_i \{c_{ij}\}$$

4. *Defuzzification;*

After the aggregation of the opinions and the calculated fuzzy numbers, the fuzzy numbers should be defuzzified. Defuzzification is the process of converting fuzzy numbers into crisp numbers, single real numbers. There are several methods for defuzzification. The simple centre of gravity method (Klir & Yuan, 1995) will be used to defuzzify the fuzzy weight $\widetilde{w}j$ of each criteria to definite value s_j.

$$s_j = \frac{(a_j + b_j + c_j)}{3}, \text{ where } j = 1,2,\ldots..,m$$

5. *Screen evaluation indexes*

In the end, a selection of proper factors can be made from numerous factors by setting a threshold α. The threshold is typically 0.7 but it varies based on the researcher's opinion in different studies (Habibi, Jahantigh, & Sarafrazi, 2015).
The principle of screening is as follows:

if $s_j \geq \alpha$, then No. j factor is the evaluation index.
if $s_j < \alpha$, then delete No. j factor.

The results of the application of the FDM are discussed in section 4.2.3.

Category	Code	Criteria	Description
Well-being and health	C1	Daylight	Work places have sufficient daylight
	C2	Type of building ventilation	Ventilation strategy: natural supply, natural supply and mechanical extraction or mechanical supply and mechanical extraction
	C3	Ventilation, influence by users	Ventilation can be influenced by users. By opening a window or adjusting the air flow rate
	C4	Noise exposure	Possible exposure to noise from outside. By for example, insufficient insulation in the walls
	C5	Acoustics	Acoustic measures such as an absorbent ceiling and absorbing walls
	C6	Functional	Functionality installations
Energy	C7	CO2 – emission	CO2 emissions from asset
	C8	Access to local renewable energy sources	Attendance local renewable sources, provide x percent of the total energy consumption of the asset
	C9	Actual energy consumption per square meter	Energy consumption per square meter
Transport	C10	Facilities for cyclists	Presence of adequate lighting bike racks, adequate changing rooms and adequate shower facilities
	C11	Proximity to public transport	Nearby public transport with regular schedule
	C12	Near basics	Walking distance to ATM, supermarket, mailbox, lunchroom, etc.
Water	C13	Metering water consumption	Water consumption measurement e.g. by building, floor or per user
	C14	Using collected rainwater and grey water	Use collected rainwater and grey water. E.g., toilet flushing, car washing, clothes washing, irrigation, green etc.
	C15	Separate sewer system for rainwater	Separate sewer connection for rainwater
Materials	C16	Environmental impact materials of the building	Environmental Performance coefficient of materials
	C17	Recycling	Materials of the building are recyclable, waste materials may be converted to a new product
	C18	Ecological materials	Application ecological materials in the building
	C19	Re-usability	Materials of the building are reusable
Waste	C20	Facilities for separated waste	There is enough space on the property for the separation of different waste streams
Land use and ecology	C21	Type of landscape on the plot	Landscape present on the plot e.g. forest, meadow, lake, pond, river, grassland, cultivated, paved, etc.
Pollution	C22	Discharges to surface waters	The user is in possession of a permit for the discharge of surface water
	C23	Cooling with CFK's or HCFK's	Presence refrigeration equipment containing CFC's or HCFC's or other substances that deplete the ozone layer
Adaptability	C24	Property is adaptable across use	Building layout is easy to adapt to new functional use
	C25	Accessibility, reserve capacity and wiring/pipes/ building services	In case of repair the wiring / piping etc. are easily accessible for mechanic

Table 5. Selected criteria for the application of FDM

4.2.4 Questionnaire design 1: FDM

A questionnaire is conducted to determine the importance for each of the 25 selected criteria. To rate the criteria, experts were asked to estimate the importance of previously agreed criteria. The seven-point Likert scale is used to ask the expert's opinion of each criteria. This one is preferred over other methods because of the simplicity of the choice options. It had to be easy and it should be finished within a limited amount of time for experts to estimate the importance of criteria to limit a change or stop halfway through. Because of this the min max method was not appropriate for this research. The seven-point Likert scale contains seven evaluation scores; extremely unimportant, very unimportant, unimportant, moderately important, important, very important and extremely important. In addition to this, it is asked which of the 25 sustainable criteria have influence on aspects like energy savings, productivity, absenteeism, maintenance costs and market rental. An overview of the entire questionnaire can be found in appendix 5.

The questionnaire has been set up in the BergSystem of the TUE University and was distributed by the KPE newsletter. KPE is a qualitative, innovative and reliable trainer for all organizations and employees in the construction and real estate industry. Hereby, the questionnaire reached many experts within the construction and real estate sector. In addition to that, 409 emails were sent to property appraisers of office real estate.

It is recommended that each of the homogeneous expert groups should have 10-15 participants for more reliable results (P. Schmidt & Strauss, 1975; R. Schmidt, Lyytinen, Keil, & Cule, 2001). Therefore, sufficient participants within one expert group completed the questionnaire. In this research the choice was made to submit the questionnaire to one expert group, the property appraisers; because property appraisers are the main target group for the renewed valuation model. If they were to disagree with the model, they would nog apply the model in practice.

4.2.5 Results FDM

As stated in previous sections, the FDM was applied to analyse the expert's opinion of the most important physical criteria of sustainable buildings. In total 70 respondents filled in the online questionnaire, this results in a response rate of 17%. Table 6 represents the average opinions of all 70 respondents. Based on the equations noted in section 4.2.3, calculations are performed. In order to select the most important criteria a threshold of 0,7 is set. The mean of all defuzzified numbers is 0,69, therefore a threshold of 0,7 seems most appropriate for this research. In table 6 column a, b and c are the fuzzy numbers of each criterion and column S provide the defuzzified number for each criterion. Defuzzified criteria with a mean above the threshold of 0,7 were accepted, the remaining criteria were rejected. After the application of the FDM, 12 of the total 25 criteria remain. Table 7 represents the 12 remaining criteria with corresponding ranking.

Among the in initial 9 categories, the category well-being and health seems most important for assessing the physical features of a sustainable building because it contains most of the criteria. A comprehensive selection process resulted in twelve important criteria for the assessment of a sustainable building in 4 categories: well-being and health, energy, transport and adaptability. The other 5 categories are omitted because no criteria have been selected within these categories. The category well-being and health is, as mentioned before, indicated

		Fuzzy numbers W= (a,b,c)			Defuzzified number S	
Code	**Criteria**	**a**	**b**	**c**	**S**	**Result**
C1	Daylight	0,76	0,90	0,97	0,88	Accepted
C2	Noise exposure	0,62	0,80	0,91	0,78	Accepted
C3	Type of building ventilation	0,64	0,82	0,93	0,79	Accepted
C4	Ventilation, influence by users	0,57	0,75	0,89	0,74	Accepted
C5	Acoustics	0,60	0,79	0,91	0,77	Accepted
C6	Functional	0,64	0,82	0,93	0,80	Accepted
C7	CO2- emission	0,47	0,66	0,83	0,65	Rejected
C8	Access to a local renewable energy source	0,53	0,73	0,88	0,71	Accepted
C9	Actual consumption per square meter	0,61	0,79	0,91	0,77	Accepted
C10	Facilities for cyclists	0,41	0,61	0,79	0,60	Rejected
C11	Proximity to public transport (OV)	0,64	0,81	0,93	0,79	Accepted
C12	Near basics	0,53	0,73	0,87	0,71	Accepted
C13	Metering water consumption	0,33	0,54	0,73	0,54	Rejected
C14	Using collected rainwater and grey water	0,36	0,58	0,77	0,57	Rejected
C15	Separate sewer system for rainwater	0,37	0,58	0,76	0,57	Rejected
C16	Environmental impact materials of the building	0,46	0,66	0,83	0,65	Rejected
C17	Recycling	0,39	0,60	0,79	0,60	Rejected
C18	Ecological materials	0,49	0,68	0,84	0,67	Rejected
C19	Re-usability	0,48	0,68	0,84	0,67	Rejected
C20	Facilities for separated waste	0,41	0,62	0,80	0,61	Rejected
C21	Type of landscape on the plot	0,36	0,56	0,74	0,55	Rejected
C22	Discharges to surface waters	0,41	0,62	0,79	0,61	Rejected
C23	Cooling with CFK's or HCFK's	0,49	0,69	0,85	0,68	Rejected
C24	Property is adaptable across use	0,65	0,83	0,93	0,80	Accepted
C25	Accessibility, reserve capacity and wiring/pipes/building services	0,51	0,72	0,88	0,70	Accepted

Table 6. Results Fuzzy Delphi Method

as the most important category. Followed by the categories energy, transport and adaptability, that are all equally important. All criteria of the well-being and health category are accepted, that comprises half of the selected criteria. One, of the in total 12 criteria, is significantly more important than the others; C1-daylight. This is corresponding to the obtained information of the theoretical background. Daylight is important for the comfort and health of a building's users and influence the productivity and the absenteeism. Despite daylight is significantly more important than other criteria, more selected and not mentioned criteria are important for the comfort and health of a building. These will be explained in more detail in section 4.3.2.

In against it, the three selected criteria with the lowest weight (access to local renewable energy sources, near basics and accessibility, reserve capacity and wiring/pipes/building services) do not influence the aspects productivity and absenteeism. Nevertheless, they do influence two other aspects of sustainability, energy costs and maintenance costs. The aspects of sustainability will be explained later in this section.

Surprisingly, criterion C7- CO2-emission is not selected as one of the 12 most important criteria for the assessment of a sustainable building. In despite of the requirements of the

European Union for 2020 to reduce the CO2-emission level with at least 20% compared to 1990 ("Europa 2020 | Europese Unie | Rijksoverheid.nl," 2015). Another noteworthy fact is that no criteria of the category materials are selected as most important for the assessment of sustainable office buildings, despite the increasing popularity of recycling, re-usability and environmental impact of materials. The environmental impact of materials influences the comfort and health of the users (Feige et al., 2013). Moreover, re-usability, ecological materials and recycling contributes to the reduction of the ecological footprint for future generations. The fact that these criteria are not selected as one of the 12 most important criteria can have several causes. One of the issues regarding the interviews and the theoretical background is the lack of a general definition for sustainability and a sustainable building. A result could be that it is difficult for property appraisers to decide what sustainable materials exactly are. In principle, concrete is not a sustainable material, however when a concrete construction is standing for more than 100 years, it is sustainable.

The other rejected categories water, waste, land use and ecology and pollution are less remarkable. In sustainable measurement tools like BREEAM the weights of these criteria are lower relative to well-being and health, energy and materials. Besides, it has become clear from interviews that these categories are less important in practice.

Category	Code	Criteria	S_j	Ranking
Well- being and health	C1	Daylight	0,88	1
	C2	Noise exposure	0,78	6
	C3	Type of building ventilation	0,79	4
	C4	Ventilation, influence by users	0,74	9
	C5	Acoustics	0,77	8
	C6	Functional	0,80	3
Energy	C8	Access to a local renewable energy source	0,71	10
	C9	Actual consumption per square meter	0,77	7
Transport	C11	Proximity to public transport (OV)	0,79	5
	C12	Near basics	0,71	11
Adaptability	C24	Property is adaptable across use	0,80	2
	C25	Accessibility, reserve capacity and wiring/pipes/building services	0,70	12

Table 7. Most important criteria sustainable office building

Next to the importance of all 25 criteria, the respondents filled in which of the 25 sustainability criteria have influence on four aspects of sustainability: energy costs, productivity, absenteeism and maintenance costs. According to the literature these aspects are all influenced by sustainability. Literature claims that a sustainable building will reduce energy costs and absenteeism and that the productivity will increase by influences of sustainability. Moreover, sustainability will also influence the maintenance costs. All these aspects together influence the market rent and therefore the final value of a sustainable building.

If more than half of the property appraisers indicated that a specific criterion has influence on a specific aspect of sustainability the link is made. Table 8 shows an overview of the links between criteria and the sustainability aspects. The 6 selected criteria of the category well-being and health influence almost every aspect. In against it, the selected criteria of transport

and adaptability only influence one aspect each. The criteria that influence the maintenance and energy costs are obvious because of the installations and energy related scope. However, the criterion 'functional' is not linked to maintenance costs. While one might think that the functionality of installations is also important for the maintenance costs. This might be due to the criterion description, that does not make a direct link between functionality and installations. According to the theoretical background productivity and absenteeism are both influenced by the functionality of installations within an office building. However, only productivity is influenced by the criterion 'functional'.

The most important criterion *daylight* influence in total 3 of the 4 aspects. However, there are two criteria that influence all 4 aspects; type of building ventilation and ventilation, influence by users. Though, according to the results of the FDM, the influence of daylight on these aspects is more important because of the higher rank. An overview of total clicks for each criterion on each aspect is given in appendix 6.

	Maintenance costs	Energy costs	Productivity	Absenteeism
Daylight		X	X	X
Noise exposure			X	X
Type of building ventilation	X	X	X	X
Ventilation, influence by users	X	X	X	X
Acoustics			X	X
Functional			X	
Access to local renewable energy source	X	X		
Actual consumption per square meter		X		
Proximity to public transport				
Near basics				
Property is adaptable across use				
Accessibility, reserve capacity and wiring/pipes/building services	X			

Table 8. Links criteria and aspects

Discussion section 4.2 Fuzzy Delphi Method

The Fuzzy Delphi method is used to identify the most important physical features of a sustainable building. By different selection steps 25 criteria of sustainable building features were selected for the application of the FDM. After the application of the FDM twelve important criteria for assessing a sustainable building remain. Criterion C1- Daylight is significantly more important than the others, the importance corresponds with the literature. Daylight influences the comfort and health of a buildings' users. However, literature provide more criteria that are also important for the comfort and health of the users. The selected criteria influence sustainable aspects; market rent, maintenance costs, energy costs, productivity and absenteeism. Figure 7 provides an overview of the links between the criteria and these aspects according to the respondents. Using this section sub- question 2.3 can be answered.

2.3 What are the most important criteria of a sustainable office building?

The twelve selected criteria by the FDM can be regarded as most important criteria for the assessment of a sustainable office building. Table 7 shows the twelve selected criteria of the FDM with their ranking. The results of the research method correspond with the literature. However, according to the literature more criteria are important for a sustainable building. Nevertheless, the outcomes of this research provide twelve criteria most important for assessing the sustainability of an office building that all influences aspects within the valuation.

4.3 RENEWED VALUATION MODEL

This section first describes the second questionnaire design for the qualitative part of this study. Secondly, the results of the questionnaire will be presented. Thereafter, the renewed valuation model for the valuation of sustainable office buildings will be discussed. To conclude, the test case for the implementation of the model is presented.

4.3.1 Questionnaire design 2: Qualitative

For optimization of the renewed valuation model that includes sustainability, a second questionnaire is conducted. By means of propositions the opinions of property appraisers were probed in terms of the integration of sustainability in valuations. According to the results of the interviews conclusions are drawn. Although the interviewees are only a small part of the target group. In order to make general statements about the opinion of property appraisers about the implementation of sustainability in valuations, propositions were presented in an online questionnaire. To obtain the opinion of property appraisers about the implementation of sustainability expressed in absenteeism and productivity a proposition was presented. Each of the statements had four choice options: strongly agree, agree, disagree, and strongly disagree. A conscious choice was made for four choices, because this will avoid that most of the respondents will pick the middle option. Due to the emergence of this topic, many property appraisers have no opinion about this topic and will therefore pick the middle option. However, sustainability plays a role for almost five years in the real estate market. Due to these statements property appraisers were forced to think carefully about their answers and adopt a position concerning this popular topic.

After four statements, seven questions about the amount of different variables of the DCF-method were represented to the property appraisers. The first question is a more general question about the application of different valuation methods within valuation of office real estate. This question gives insight into the current use of the DCF-method in relation to other available valuation methods among the property appraisers.

To ensure objectivity within the renewed valuation model default variables could be set. By setting default variables property appraisers need to apply less gut feeling for the determination of the value of a sustainable office building. Setting a default discount rate for each sustainability aspect and an exit yield for a sustainable building, the renewed valuation model will be less subjective relative to the standard valuation models. The discount rate is the percentage at which future cash flows are discounted to the present. The exit yield is the ratio between the final rent and the value at the end of the exploitation. Small changes of these percentages have a major impact on the value, therefore by setting default percentages will result in objectivity within valuations. The four following questions were asked to give a range to the discount rates of the four sustainable aspects of sustainability as a result of the Fuzzy Delphi Method (FDM); maintenance costs, energy costs, productivity and absenteeism. The discount rate is the calculation percentage that is used to make future cash flows to the present value. The last two questions were about the increase or decrease of the exit yield in case of a sustainable building and in case of an energy neutral building. The exit yield is the ratio between the final rental and the value of a building at the end of the exploitation; the residual value. These questions were asked set default amounts in order to ensure objectivity of the four aspects of sustainability within the renewed valuation model. The entire questionnaire can be found in appendix 7.

The results of the questionnaire were presented to the expert panel. The expert panel judged whether the results outline a clear picture of the market and whether the results are in line with their opinions.

For setting up this questionnaire the BergSystem of the university is used. The questionnaire was sent through the KPE newsletter and an email is sent to 409 property appraisers. The objective was to get as many respondents as possible for the credibility of the research. However, it should be kept in mind that there is a limited number of office property appraisers in the Netherlands.

4.3.2 Results questionnaire part 2

Together with the FDM part, this qualitative part of the online questionnaire was sent to 409 property appraisers of commercial real estate. In total, 88 respondents filled in the online questionnaire, this results in a response rate of 21,5%. The survey remained open for three weeks and in that period two reminders were sent. Questionnaire part 2 basically consisted of two parts, the propositions and the questions. In total four propositions were presented to the property appraisers.

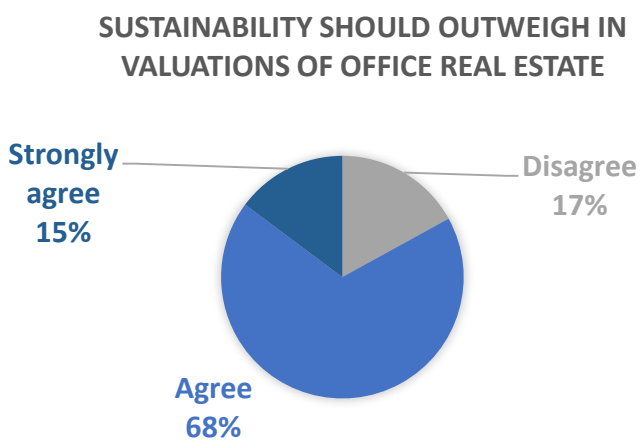

Figure 6. Proposition 1

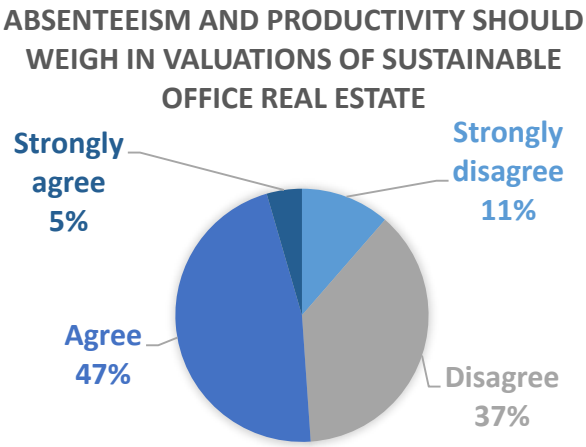

Figure 7. Proposition 2

The result of the first proposition ''Sustainability should outweigh in valuations of office real estate'' (figure 6) clearly shows that the vast majority of property appraisers agrees with this proposition. According to this fact, a change in the valuation process is needed to outweigh the sustainability within valuations. However, the result of this proposition does not show how sustainability should outweigh in valuations of office real estate and why this is not done yet. One would think that when the vast majority believes that sustainability should outweigh in valuations of office real estate, someone should take action. According to the outcomes of proposition 2 (figure 7), slightly more than half of the property appraisers think that absenteeism and productivity should weigh in valuations. Taking these aspects into the valuation is a way of incorporating sustainability in the valuation process, this will be explained in more detail in section 4.3.3.2. However, slightly less than half of the property appraisers think that productivity and absenteeism should not be included in valuations. This implies that based on the results of proposition 1, there is a reasonably large group who think that sustainability should outweigh on another way than the incorporation of absenteeism and productivity within valuations. Remark: nowhere is mentioned that sustainability can be seen as the absenteeism and the productivity of a buildings' users. It was to the property appraisers whether or not to make this link.

It is remarkable that the results of proposition 3 ''Image should weigh in valuations of sustainable office real estate'' (figure 8) shows that two-third of the property appraisers think that image should weigh in valuations of sustainable office buildings. The remarkable about this is that the productivity and absenteeism can be calculated to a certain extent; these aspects can be proven. In against it, the image is hard to calculate and cannot be pinpoint. Therefore, image is not taken into the renewed valuation model. Nevertheless, it is important to know that the majority of the property appraisers think that it is rather important to take image into the value of a building than productivity and absenteeism.

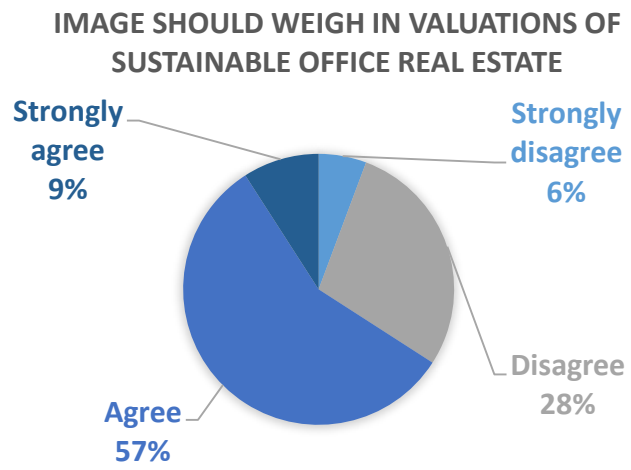

Figure 8. Proposition 3

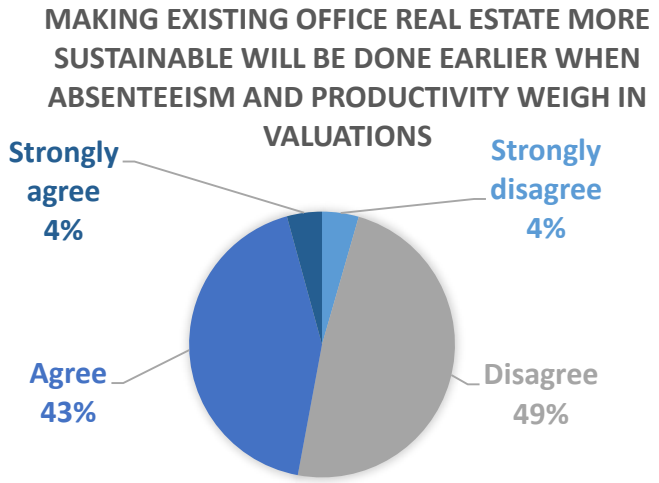

Figure 9. Proposition 4

Proposition 4 (figure 9) shows that slightly less than half of the property appraisers think that making existing office real estate more sustainable will be done earlier when absenteeism and productivity weigh in valuations. The disunity of this outcome can be explained by several reasons; if property appraisers disagree with the proposition that productivity and absenteeism should weigh in office real estate they will, in all probability also disagree with this proposition. It would be therefore that they do not agree with the statement because they think sustainability should be incorporated into valuations on a different way. It is also possible that the respondents think that incorporation of sustainability in valuations will not contribute in making existing office real estate sustainable.

The results of all propositions only provide opinions of property appraisers, they provide no information about the mind-set of the respondents. By means of the expert panel the mind-set of property appraisers and the results of these propositions were discussed in more detail.

The second part of the questionnaire consisted of seven questions. The first question was about the valuation methods that property appraisers apply to valuations in practice. In addition to the given valuation methods, the respondents had the opportunity to fill in other methods with associated percentages. The sum of the total percentages that could be filled in this question was 100%. However, several respondents gave answers over 100%. Due to this, the outcomes are difficult to compare. Outcomes show that property appraisers always apply two or more methods for the valuation of one object. The mean of each valuation method show the average of the percentages filled in by the property appraisers. The method with the highest mean, is the most commonly used method according to the respondents. It appears that the NAR-method is most often used with an average of 58,4%. Thereafter, the DCF-method is most used with an average of 50,14%, the comparative method with 47% and the BAR-method with an average of 40,13%. In total, 31 property appraisers indicated to value

100% of the valuations with the NAR-method, 27 with the DCF-method, 24 with the comparative method and 21 with the BAR-method. However, by the incorrect answering of this question no judgements can be made by the application of the valuation methods in practice. The incorrectly answers make it inconvenient to draw firm conclusions out of the results. Appendix 8 shows an overview with the results of this question.

The subsequent four questions were about the discount rates of the energy savings, maintenance costs, productivity and absenteeism. Figure 10 shows an overview of the outcomes of these questions. As defined in section 3.2.1, the discount rate is the percentage at which future cash flows are discounted to the present. The higher this percentage, the harder to estimate the value and therefore the higher risk. In other words, values that can be properly estimated have a lower discount rate than values that are difficult to predict. The results show an average discount rate of 8,04% for energy savings and an average of 8,16% for the maintenance costs. These numbers are close to each other. However, small differences in the discount rate have major impact on the final value. The average result for the discount rate of productivity is 7,7% and for absenteeism 7,54%. Due to the higher discount rates for energy savings and maintenance costs the conclusion can be made that property appraisers think that it is harder to estimate the energy savings and the maintenance costs relative to the absenteeism and productivity.

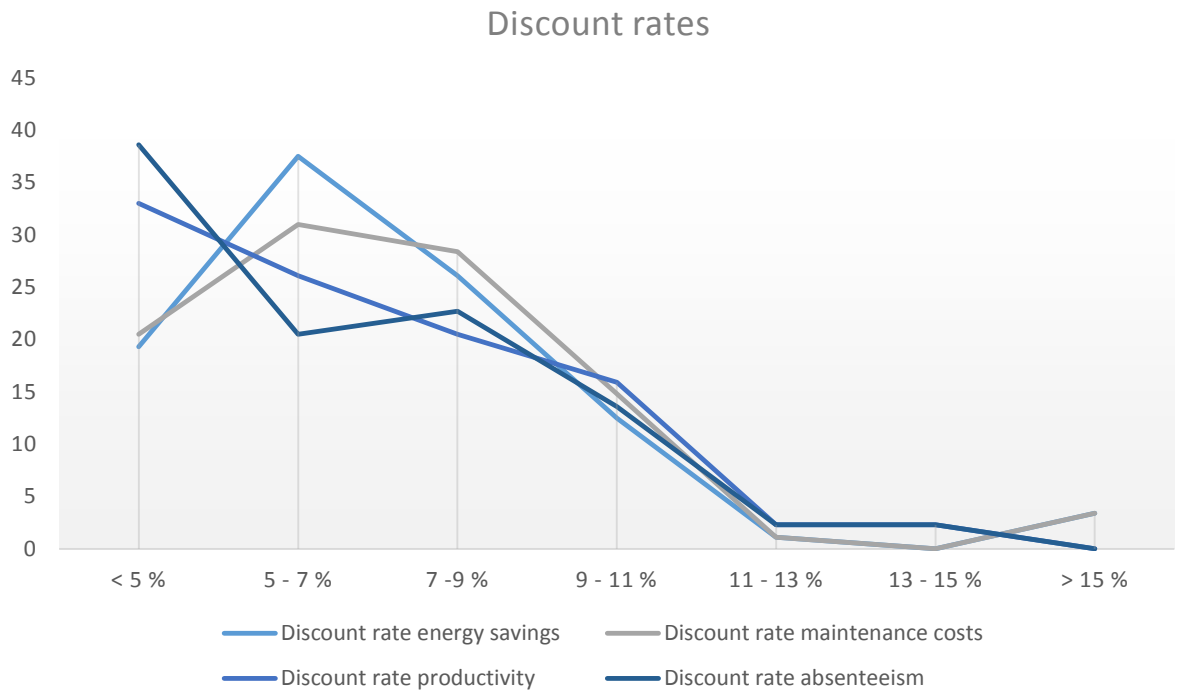

Figure 10. Discount rates

It is quite remarkable that the energy savings and the maintenance costs got the highest discount rates. Predicting the energy usages and the maintenance costs are, compared to absenteeism and productivity, relatively easy. In fact, these days property appraisers already estimate the maintenance costs and energy usage. In addition to that, for certain sustainable measures the exact energy savings can be calculated like, from normal lighting to energy efficient lighting. This also applies for the increase or decrease of the maintenance costs,

maintenance costs can be predetermined very well by multi-year maintenance plans. Due to these facts, the results of the questionnaire for the discount rates are doubtful. The outcomes can be clarified; it could due to questioning, maybe the question was not clear to the respondents or it could be that the respondents do not exactly know what the discount rate implies. According to the outcomes of the first question, that claims that the DCF-method is applied in half of the valuations, one may assume that property appraisers do know what the purpose of the discount rate is.

The final two questions of the questionnaire were about the exit yield of a sustainable and an energy neutral building. The exit yield is the ratio between the final rent and the value of a building at the end of the exploitation. The exit yield is used at the end of the duration in order to determine the residual value. In the questions, the standard exit yield was set as 10% for a conventional building. The higher the exit yield, the lower the residual value. The results show that the average exit yield of a sustainable building and an energy neutral are both 11,61%. According to these outcomes, the respondents think that a sustainable or energy neutral building has a lower residual value than a conventional building.

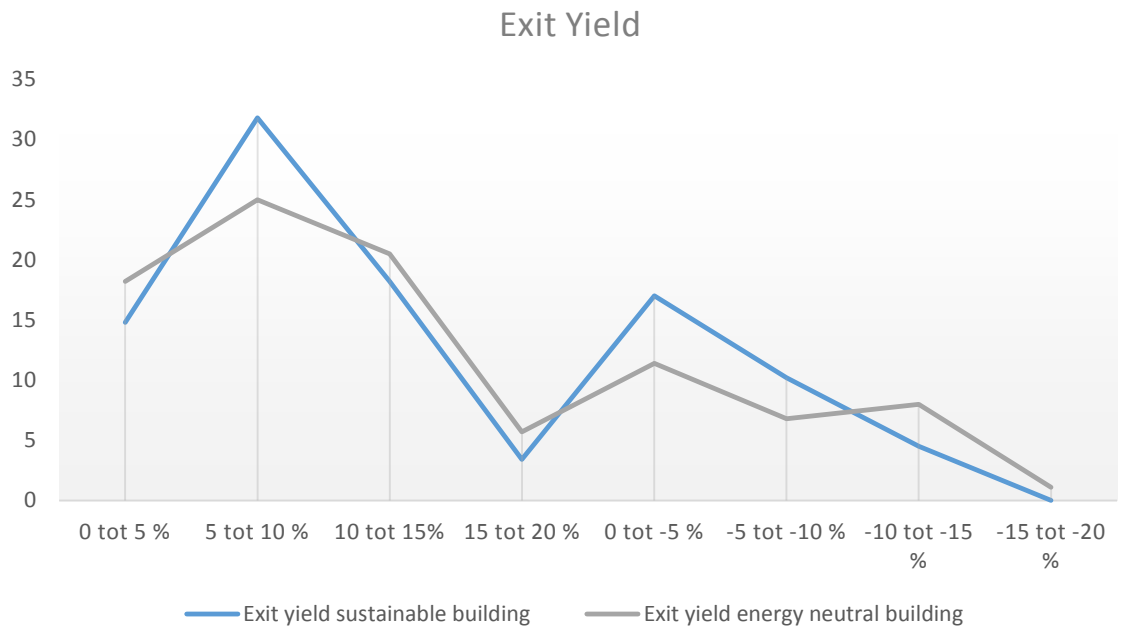

Figure 11. Exit yields

For the exit yield the same finding is made as for the discount rate. The question was not clear to the respondents or the respondents do not exactly know what the exit yield implies. In all probability the respondents do not understand the exit yield and the discount rate. As apparent from the interviews, property appraisers use in the majority of cases references for determining the amounts. In addition to that, there is literally said that the DCF-model, including with discount rates and exit yield, is calculated in such way that it comes out on the BAR-, NAR-model value. Due to this fact, the assumption can be made that the respondents do not all understand the use of the discount rate and the exit yield within the DCF-method. According to the results of proposition 1 property appraisers think that sustainable buildings should have a lower value than conventional buildings. However, the interviews indicate that

property appraisers think that the value of sustainable building should be higher compared to the value of an unsustainable building. An overview of the results of the questionnaire for the discount rates and exit yield is given in appendix 9.

4.3.3 Valuation model

The obtained information from the theoretical background, the Fuzzy Delphi Method, the expert interviews and the questionnaire will all contribute to the renewed valuation model. Literature claims that the DCF-method is the most suitable and transparent method for implementation of sustainability (Tervoort, 2010). Therefore, the renewed valuation model will be based on the DCF-model. The valuation model composes of the slightly adapted standard DCF-model combined with an added part for the sustainability. Due to the results of the FDM, sustainability will be incorporated in the renewed valuation model in form of four aspects: energy savings, maintenance costs, increase in productivity and decrease of absenteeism. Sustainable buildings result in savings on these four aspects that can be calculated and included in the cash flow of the renewed valuation model. The discount rates and exit yields as results of the online questionnaire are set as default amounts in the renewed valuation model to ensure objectivity within the sustainability part of the model. It is essential to have prior knowledge of the standard DCF-method for the understanding of the renewed valuation model. First, this section elaborates the standard DCF-model and the application of it in practice. After that, the scope of sustainability for the added part is explained and the renewed valuation model is discussed. For ensuring objectivity in the renewed valuation model, the results obtained from the second questionnaire are processed in the renewed valuation model. Finally, the renewed valuation model is applied on a test case.

4.3.3.1 Existing DCF-method

These days, property appraisers assign value to a building based on references and using the BAR-, NAR-, and the DCF-method. Due to the fact that the DCF-method is most suitable for the incorporation of sustainability the BAR-method is omitted in this section. The DCF-method consists of discounting future cash flow deriving from a real estate object in the case of a valuation, in which the cash flow is discounted at a proper discount rate. This transparent method has several advantages relative to other valuation methods like, the cash flows are displayed clearly and risks can be explicitly indicated. The cash flows will be estimated for a period of 10 to 15 years, all estimations for input variables have to be made for this time period. Many estimations for input variables have to be made to determine the present value of a building. Table 9 gives an overview of these input variables.

One of the main input variables is the discount rate (VastgoedCert, 2014). The discount rate is the percentage at which future cash flows are discounted at the present. The level of this rate depends on many factors and can vary significantly. A small change in the percentage has a great influence on the final outcome of the DCF-model. In principle the discount rate is based on the minimum rate of return requirement of the purchaser and consists of a risk-free rate and a surcharge on the risk. Nevertheless, it is the task of the property appraiser to outline a realistic future scenario and to apply an appropriate discount rate of the market (Hordijk, Worms, & Bert, 2015).

Input variables DCF	
Discount rate	*Percentage at which cash flows are discounted*
Operating costs	*Average operating costs, estimated by the property appraisers*
Increase operating costs	*Percentage of the nominal increase of the operating costs of the object*
Costs- to- buyer	*Transfer tax, notary fees and brokerage commission rates (typically around 7%)*
Rent indexation	*Percentage of annual increase of the contract of the object in line with inflation*
Rental growth	*Percentage of nominal market rent increase of the object*
Market rent for divestment	*Forecasted market rent for divestment*
Market efficiency at disposal	*A term that the assumed gross market return (exit yield) is indicated, as it applies to the end of the period*
Incidental costs	*Costs like renovation, vacancy, rent- free period etc. These should be incorporated in the year they occur*

Table 9. Input variables DCF- method (VastgoedCert, 2014)

In most cases the value of the input variables is based on references. However, these estimations are not always clear or comparable to market transactions, also known as references. In addition to that, transaction prices are often out-dated. Transactions made at this time will perhaps become public within three months. The current market can be changed relative to the market three months ago, what results in lagging behind the market by using these references. It is the responsibility of the property appraisers to have sufficient market knowledge to set proper input variables. The knowledge and the expertise of the property appraisers, in other words the gut feeling of the property appraisers and the references determine the final value for the input variables of the DCF-model.

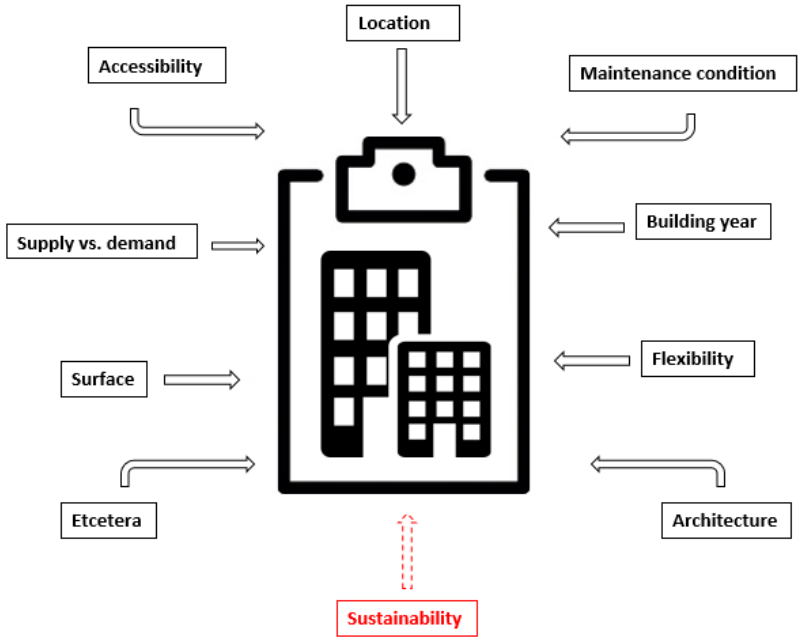

Figure 12. Lack of sustainability in valuations

Different building aspects are important for the determination of the value of the input variables. Aspects like location, accessibility, flexibility and supply versus demand in the

specific region all contribute to the final input value. However, one important aspect is missing in the determination of these values; sustainability (figure 12). The effect of sustainability should, in response to the increasingly growing importance, be made clear within the valuation. Although sustainability will never be the most important factor for determining the value, sustainability has a major influence on the cash flows and therefore on the present value.

4.3.3.2 Sustainability

Before the impact of sustainability on the value of a building can be charted, it is of essential importance to know what a sustainable building contains in despite of the lack of a definition for a sustainable building. These days, many people consider a sustainable building a sustainable certified building. Nevertheless, these certificates are not taken into account in determining the value of a sustainable office building. This could be due to the fact that all tools measure different building features and calculate with different weights to determine the sustainable performance of a building. The final levels of the sustainability performance differ for each tool. In addition to that, the sustainability levels cannot be translated into a number for incorporating the sustainability in the valuation of an office building. Therefore, there must be devised another way to implement sustainability within the value of a sustainable office building. Sustainable aspects must be translated into numbers for the incorporation of sustainability in valuations.

The results of the FDM show that most important sustainable building criteria influence four aspects: energy costs, maintenance costs, productivity and absenteeism. These aspects can be expressed in numbers, therefore these aspects could be incorporated in the determination of the value of a sustainable office building. In the standard DCF-model, used for determining the value of conventional office buildings, energy costs and maintenance costs are already included. However, a sustainable building creates savings on these two aspects. The other two aspects, absenteeism and productivity are not included in the standard DCF-model. To incorporate sustainability in the standard DCF-model, the sustainability of an office building will be expressed in energy savings, maintenance costs, decrease of absenteeism and increase in productivity.

As mentioned before, the energy costs and the rental costs of an office building are only a small part of the total operating costs. The biggest costs of the total operating costs are the staff costs (90%). Taking into account the four aspects of sustainability, this means that the biggest savings of an unsustainable building relative to a sustainable building can be made on the productivity and the absenteeism of a building's users. The literature confirms that a sustainable office building offers a healthy and comfortable work environment for the users (Honing & Marquard, 2014). The health and comfort of users can be expressed in the absenteeism and productivity.

There is no general definition of a healthy building. Nevertheless, healthy buildings focus on the people in the building (Cobouw, 2015). By focussing on the people in the building the productivity will increase and the absenteeism will decrease. According to Thomas Mueller, chairman of the Canada Green Building Council (CGBC), the most important aspect for users is health: ''Green buildings are only fun for geeks. We geeks see energy efficiency, non-toxic wood and cradle-to-cradle carpets. Most people are not interested in this. They want to be

able to work in a building that is healthy for them, where they can be productive wherever there is daylight, where there is fresh air an good food.''(Cobouw, 2015). With this statement the chairman of CGBC claims that building features are not important, only the effects of the buildings features on the users are important. This partly correspondents with the outcomes of the FDM. The results show that daylight, acoustics and ventilation are most important criteria of a sustainable office building that influence the productivity and absenteeism of a buildings' users. Looking to a sustainable office building through the eyes of a buildings' user, comfort and health are most important and have the highest value to them. Table 10 shows an overview of the building criteria with associated effects on productivity and absenteeism.

Influence aspects indoor climate	Productivity	Absenteeism
Temperature	Ideal temperature: 20 – 25 °C, every degree below or above: productivity decrease with 2%	Uncomfortable temperature levels is linked with respiratory complaints which lead to employee absenteeism
Air quality	Better air quality show productivity improvements of 8 -11%	Poor ventilation is linked with respiratory complaints which lead to employee absenteeism
Acoustics	24 working days per year, the loss per employee by poor acoustics	Unfavourable acoustics can lead to absenteeism
Daylight	46 min. more sleep each night by a workplace with plenty of daylight	View and daylight account statistically significant 6,5% of the variation for the absenteeism
View	View helps to relax and refocus the eyes	View and daylight account statistically significant 6,5% of the variation for the absenteeism
Outdoor air	Increase outdoor clean air results in 6% performance improvement	Doubling outdoor air supply reduce 10% of illness
Personal influence	Personal influence of the indoor climate increase productivity with 6%	Sustainable design features like worker-controlled temperature and ventilation reduce absenteeism
Interior	A variety of workplaces and a pleasant look and feel contribute to productivity	

Table 10. Effects of buildings aspects on productivity and absenteeism (Feige et al., 2013)

There are a lot of building criteria that influence the productivity and the absenteeism of a building's users. Not only the indoor climate of a building but also the interior, the location and the look & feel of building influence the productivity and absenteeism of the users (DGBC, 2015). Moreover, reducing the ecological footprint is associated with a healthy building. Productivity and absenteeism of users is also influenced by building materials. A healthy building consists of appropriate materials, not harmful for present and future generations.

Despite the fact that the biggest savings can be made by reducing the staff costs, savings can also be made on the energy and maintenance costs of sustainable office buildings relative to unsustainable office buildings. Sustainable buildings ensure reduction of energy costs by the use of renewable energy sources and energy efficient installations. In despite of the discussion if a sustainable office buildings reduce the maintenance costs or increases the maintenance costs, it is the task of the property appraisers to make an estimation about the maintenance costs. Green Building Council Australia concluded that a sustainable building has 8-9% lower maintenance in contrast to a conventional building (Tervoort, 2010). The lower maintenance costs are a result of the fact that a sustainable office building is young and preserved new techniques, whereby the maintenance costs are relatively lower in the coming years than office buildings with older techniques. Nevertheless, it is the task of the property appraisers to make an estimation of the increase or decrease of the maintenance costs.

4.3.3.3 Renewed valuation model

The aim of the renewed valuation model is to calculate a well-founded value of a sustainable office building. Due to the fact that in the standard DCF-model a sustainability factor is missing, a conventional office building is valued in the same way as a sustainable office building. When a conventional office building will get sustainable measures the value of the office building will hardly differ before and after the sustainable measures. When sustainability will be incorporated in the valuations, sustainable buildings will get a higher value relative to unsustainable buildings. The results of the FDM are incorporated in the form of the four aspects of sustainability: energy savings, maintenance costs, decrease of absenteeism and increase in productivity. For ensuring the objectivity within the renewed valuation model the outcomes of the questionnaire and the expert panel are set at default discount rates and exit yield.

The renewed valuation model consists of the slightly adapted standard DCF-model, an added part for sustainability and a manual for the use of the renewed valuation model. This model is an excel table in which property appraisers can fill in amounts to calculate the value of a sustainable office building. The use of the renewed valuation model is limited; only when an existing office building integrates sustainable measures, when a sustainable office building can be compared with a similar unsustainable office building or when a company moves from a conventional office building to a similar sustainable office building this model is useful. In the first mentioned application of the renewed valuation model sustainable measures for conventional office buildings means, measures that will generate savings on one of the four aspects of sustainability. Such as, replacing normal lighting to energy efficient lighting or replacing wooden frames with aluminium frames. The second mentioned application of the renewed valuation model is tricky because it is difficult to find a similar unsustainable office building for a certified sustainable office building. In addition, the behaviour of two different users will be compared, this is not a fair comparison because every user has their own behaviour that will influence the savings due to sustainability. Therefore, in this case, the use of the renewed valuation model is not recommended. The last application, moving from a conventional office building to a sustainable office building, means moving from an unsustainable office building to a building of which the sustainability has been established by a sustainability certificate. In this case, it is the same company that moves from an unsustainable office building to a sustainable office building, therefore there are no differences in behaviour. In other words, the application of the renewed valuation model is most useful for changes in current situations. If there are no changes, no savings can be made by means of the four aspects of sustainability and therefore no value can be added to the office building.

For the application of the renewed valuation model when a conventional office building will be renovated into a sustainable office building or when a company moves from a conventional office building to a sustainable office building, the property appraisers have to make estimations of the four aspects of sustainability. For this, the property appraisers have to estimate the amounts of energy savings, the amount of maintenance cost, the percentage of increase in productivity and the percentage of decrease of absenteeism. The estimated amounts can be entered in the renewed valuation model. Using general building information and specific operating data, the savings for each aspect of sustainability can be calculated. When a conventional office building will be renovated or when a company moves from a

conventional office building to a sustainable office building, more changes occur than only the sustainable features. Because of this, not all savings are attributable to the four aspects of sustainability, but for example also to the flexible working. This is especially true for the productivity and absenteeism. Therefore, a damping factor is used in the renewed valuation model. The damping factor determines what part of the savings by changes is attributable to the sustainable features. The amount of this factor is adaptable to the judgement of the property appraiser.

One office building will be more sustainable than the other, this means that the amounts of all four aspects varies for each sustainable office building. Therefore, the manual will give guidelines. Using these guidelines property appraisers are able to estimate proper percentages for the increase in productivity and decrease of absenteeism.

When the property appraisers made estimations for the four aspects of sustainability, the financial benefits for each aspect can be calculated. The calculated savings are taken into the future cash flow. By the discount rates the future cash flows are discounted to the present value. The discount rates obtained from the online questionnaire and the expert panel, are filled in as default percentage in the renewed valuation model for ensuring objectivity. Due to the fact that the results of the questionnaire are doubtful because the majority of the respondents does not understand the DCF-model, the default discount rates are adopted by the expert panel. This will be explained in the next section. Each of the four aspects of sustainability has its own discount rate. Property appraisers can deviate from these standard discount rates, under the condition of a well-founded underpinned reason in the valuation report. This also applies for the exit yield, the results of the online questionnaire and the expert panel are used as standard exit yield for a sustainable office building. Property appraisers may derogate with reservation to proper underpinning in the valuation report. By setting standard discount rates and exit yields the objectivity within the sustainability part of the renewed valuation model will be ensured. It is necessary to set these discount rates because of the lack of suitable sustainable references. Often property appraisers base their discount rates and exit yield on references. However, as mentioned before there are not sufficient suitable references for comparison of sustainable buildings. By using this renewed valuation model, the added value of sustainable buildings will be proved and references can be made for valuation of sustainable buildings.

In addition, when the model will be applied and therefore sustainability is incorporated in valuations, benefits for all stakeholders will become visible. Property appraisers are instructed to value a sustainable office building and take sustainability into account in their valuation whereby the value of a sustainable building will have added value relative to an unsustainable building. Due to this, investors are open to invest more in a sustainable building because; they gain higher market rent, will have less maintenance costs and they have lower risks on structural vacancy. In addition, banks are willing to finance more for making sustainable buildings more sustainable because of reduced risks and higher rate of returns. Finally, the users who already benefit from sustainable buildings will still profit from the benefits of a sustainable building like increase in productivity and decrease of absenteeism.

In short, by application of the renewed valuation model all stakeholders will gain benefits out of a sustainable building. Figure 13 shows an overview of the results after incorporating sustainability in valuations of sustainable office buildings.

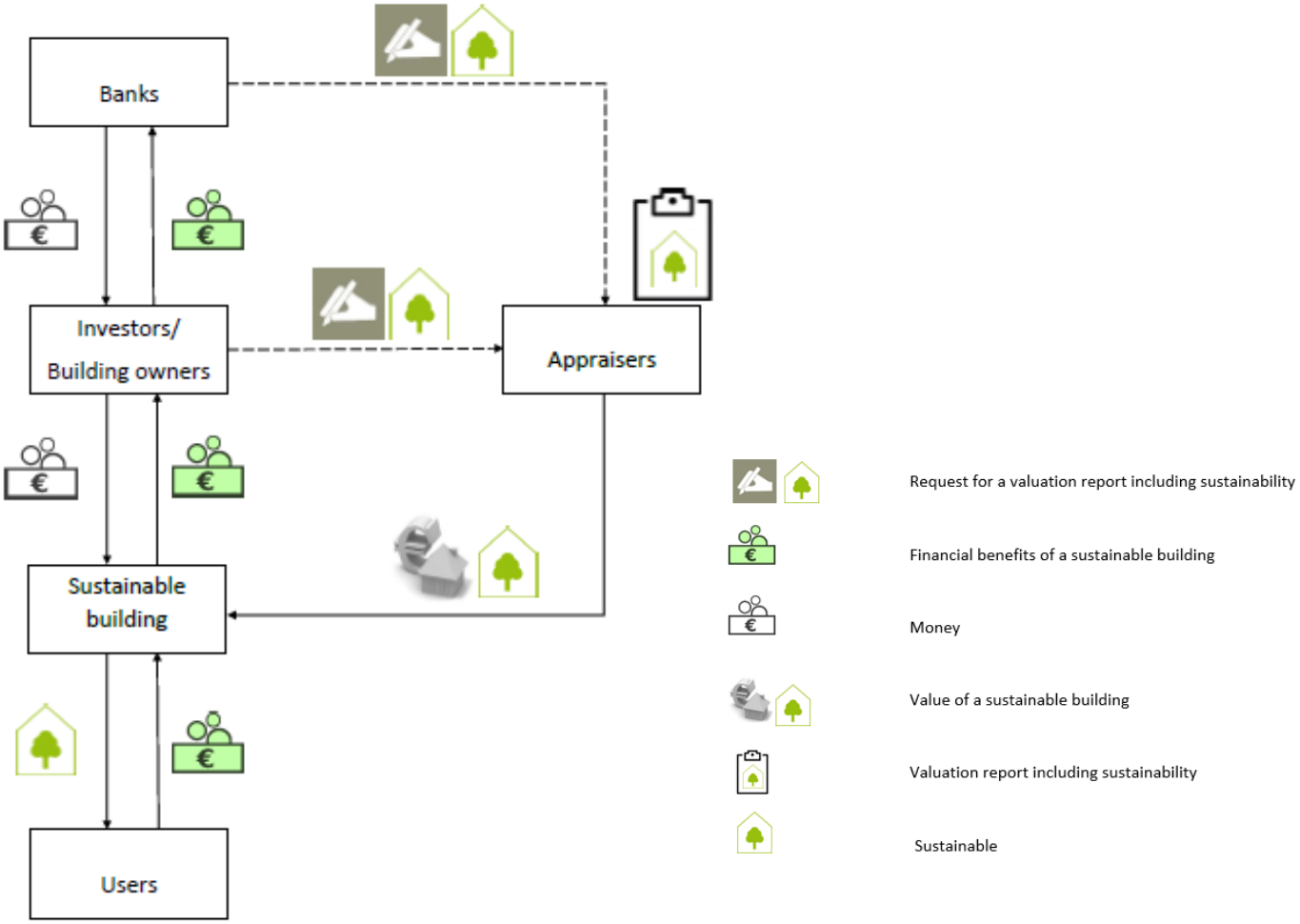

Figure 13. Effects of sustainable valuation

4.3.4 Expert panel

In order to validate the renewed valuation model, 4 property appraisers with affection to sustainability and valuations formed an expert panel. The aim of the expert panel was; to validate the renewed valuation model, to discuss the outcomes of the propositions and to clarify the remarkable outcomes of the discount rates and exit yields. The expert panel had the ability to make corrections in the outcomes of the questionnaire as means for validating statements and views of property appraisers (Flick, 2009).

First, the following propositions were presented to the experts:

- Sustainability should outweigh in valuations of office real estate.
- Absenteeism and productivity should weigh in valuations of sustainable office real estate.
- Image should weigh in valuations of sustainable office real estate.
- Making existing office real estate more sustainable will be done earlier when absenteeism and productivity weigh in valuations.

For each proposition the experts gave their opinions. Thereafter the results of the online questionnaire were represented to the experts and they had the opportunity to comment the outcomes. A more detailed overview of the results of the expert panel can be found in appendix 12. For each proposition the following conclusions were made by the expert panel:

1. Sustainability should outweigh in valuations of office real estate

The market value is the price that users are willing to pay a for specific building today. Currently users are not aware of the benefits that sustainable buildings bring. Due to this, users are not willing to pay more for a sustainable building. Therefore property appraisers cannot take sustainability into the value of a building. What property appraisers can do is creating awareness among users by naming the future prospects of the building in the valuation report. Contrary to the users, banks start thinking about this subject. They observe deteriorating risks profiles. By entering conversations with building owners who have a finance at their organization, they will think together for possibilities to make buildings sustainable for refinancing. However, it boils down to only when the users create awareness and see the benefits of sustainable buildings, property appraisers can include sustainability in the value of a building.

2. Absenteeism and productivity should weigh in valuations of sustainable office real estate

According the expert panel productivity and absenteeism should certainly weigh in valuations. However, the market is not yet aware of the impact of sustainability on absenteeism and productivity. This is why property appraisers cannot take these aspects into the valuation. Users should weigh productivity and absenteeism in their office building choices. However, these aspects are even further from the user's mind-set than sustainability. Research proves that sustainable buildings have positive impact on the productivity and absenteeism, although the users have to believe these facts. When users believe the facts and take these aspects into their considerations for their choices of a business accommodation, property appraisers can take these sustainability aspects in the valuations. Therefore, it is remarkable that half of the property appraisers who filled in the online questionnaire agreed on the proposition.

Stated by the expert panel a side note must be made in the difference between small-medium enterprises (SMEs) and corporates. Where the choices of SME users are mainly based on emotions, the corporate users pay much attention to conscious office housing choices.

3. Image should weigh in valuations of sustainable office real estate

Image already weighs in valuations according to the expert panel. Image includes a lot of factors, one of these factors is sustainability. For image in general, users are willing to pay more because parties want to be distinctive. For a sustainable image users are not willing to pay more, the sustainability of a building is entwined in the general image. A sustainable building is more attractive than an old building with energy label G. Still, one-third of the respondents of the online questionnaire disagreed with the proposition. This could be due to the vagueness of the concept 'image'. Some respondents will have interpreted image as sustainable image, other respondents as image in general.

4. Making existing office real estate more sustainable will be done earlier when absenteeism and productivity weigh in valuations

The expert panel states that the proposition should be: making existing office real estate more sustainable will be done earlier when users take absenteeism and productivity into account in their housing choices. When users realize the effects of sustainable buildings on absenteeism and productivity, different office housing choices would be made and absenteeism and productivity could be taken into the valuations.

After the propositions, the results of the online questionnaire for the discount rates and exit yields were discussed. Experts gave their opinion about suitable discount rates and exit yield for the different aspects and tried to clarify the results of the online questionnaire. Due to the extensive expertise of the expert panel about valuations and sustainability, the expert panel had the opportunity to adapt the results of the online questionnaire. By the market knowledge, years of experience in valuations and sustainable innovative ideas this expert panel perfectly fits the subject of this research.

Discount rates

According to the expert panel it is difficult to give an amount for the discount rates of each sustainability aspect because no standard discount rate is given. Nevertheless, in general, the lower the discount rate, the greater the guarantees. In a few years conditions for the decrease of the absenteeism and the increase in productivity will be guaranteed. However, despite the fact of evidence that sustainable buildings have positive effects on; energy cost, maintenance costs, absenteeism and productivity, when the market is not aware of these benefits, sustainability cannot be taken into the valuations.

Some general conclusions were made by the expert panel out of the results of the online questionnaire. It is remarkable that energy and maintenance costs be lowered at a higher discount rate even they are much more specific than productivity and absenteeism. The discount rate for maintenance costs is alarmingly high because a multi-year maintenance budget is made for each building, the guarantees are very high. This means that the discount rate should be low, about 2%. In against it, the guarantees in productivity and absenteeism are really low, what means that the discount rate should be very high.

By the expertise of the expert panel, the conclusion can be made that respondents in all probability do not understand what they are completed. Therefore, they are likely filled in the middle of the bandwidth. The course of the graph should actually be reversed.

Exit yield

The expert panel claimed; the more sustainable the building, the lower the exit yield should be. An energy-neutral building should have an exit yield lower than a sustainable building because it is more future-proof. The results show that the respondents do not understand the exit yield. The standard exit yield for a conventional building is set at 10%, a sustainable building should have a lower exit yield because sustainable buildings have a higher value relative to unsustainable buildings. However, the results of the questionnaire show an average exit yield of 11,6%. Based on these results the respondents suggest that a sustainable building should have a lower value relative to an unsustainable building.

Despite the fact that 50,14% of the respondents claimed to use the DCF-model, the results of the online questionnaire for setting the discount rates and exit yield do not support this and therefore the default discount rates for energy costs, productivity and absenteeism are adapted to more credible percentages. The adapted percentage according to the opinion of the expert panel are explained in the next section.

Damping factor

At this moment the damping factor for absenteeism is 0% because the market is not aware of the benefits that can be gained by sustainable buildings. The damping factor for productivity is 5% since the productivity is considered by some users. When these aspects are adopted by the market, the damping factors will increase.

At this moment there is a transition, it is a matter of time until the awareness is created among the users. It is difficult to estimate how long this process will take. However, when a number of large corporations decides to take productivity and absenteeism in their office housing choices the process will be accelerated. Currently it is not profitable for building owners to make existing office real estate more sustainable because sustainability is not included in the valuation. When sustainability will be included in valuations, it will be profitable for building owners to make existing office buildings more sustainable. The spread of the result of the proposition of the online questionnaire is probably caused by different interpretations by the respondents.

The results of the online questionnaire show that property appraisers do not understand the DCF-method, this is confirmed by the expert panel. Despite the fact that 50,14% of the respondents claimed to use the DCF-method. Nevertheless, the DFC-model is used as standard for the renewed valuation model because this is the only model that makes clear all the cash flows of a building. Other valuation methods like the NAR- and BAR-method are not transparent and only use a few variables for the determination of the value of a building. Incorporation of sustainability within the variables of other valuation methods cannot be done on a clear and transparent way. The fact that the majority of the property appraisers does not understand the DCF-method may be caused by the fact the majority of the property appraisers use the BAR-method to determine the value of a building. The DCF-method is used as a check for the BAR- or NAR-method. In which the DCF-method is filled in on a way that the outcome of the DCF-model is the same as the outcome of the BAR-, or NAR-method (according to the expert interviews).

4.3.5 Test case

For the creditability of the model, the renewed valuation model is tested on an existing building. The test case building is located on a business park in Amsterdam and comprises approximately 2.200 m2 lettable floor area. The building year is; built after 1990 and no renovations have been done since. If no sustainable measures will be taken, there is an expected structural vacancy of 15% within 10 years and the residual value of the building will decrease. Appendix 10 provides an overview of the building with associated building information. This test case contains a building owner-tenant situation, the building owner needs to sustain the building for preventing structural vacancy. Therefore, the market rent will not increase after sustainable measures. However, the residual value of the building after sustainable measures will be higher after operating time, this is a great benefit for the building

owner. The tenants will profit from the decrease of absenteeism and increase in productivity after sustainable measures. When the building owner takes no sustainable measures the tenants will probably rent other sustainable buildings after the expiry of the lease.

To clarify the difference in value of a sustainable and an unsustainable building, the renewed valuation model is applied on the same building before and after sustainable measures. For calculating the value of an unsustainable building the renewed valuation can be used, wherein the added part for sustainability is zero. By doing this the renewed valuation model will be used as a standard DCF-model. First, the test case building is valued as an unsustainable building, the building has a value of € 2.885.000. The value of the unsustainable building will be the same calculated with the renewed valuation model whether with a standard valuation method, under the condition that the value is determined by the same property appraiser (see figure 14). Secondly, the value of the same building is calculated after the incorporation of sustainable measures and assuming that users created some awareness for sustainable buildings. Sustainability is incorporated in the renewed valuation model in the four aspects that resulted out of the FDM. Due to the sustainable measures of the building the productivity will increase, the absenteeism will decrease and the energy and the maintenance costs will be lower. The discount rates used for each aspect are based on the results of the questionnaire and the expert panel. As a result of the questionnaire a discount rate of 8% is used for the energy savings. This because of a small discussion concerning the future of energy prices, some claimed that these will only go down while other claimed that these cannot be predicted. The expert panel agreed on the fact that the maintenance costs are a guarantee, therefore the discount rate is set at 2%. According to the expert panel the graph of the discount rates should have been the other way and the productivity and absenteeism have a very low guarantee. Therefore, the discount rates for these aspects are set at 13%. The damping factors for absenteeism and productivity are both set on 30% because the assumption is made that little awareness is created among the users. Due to the sustainable measures the expected structural vacancy within 10 years is reduced to 5%. The final value after the application of the sustainable measures is € 7.315.000. This results in an added present value of € 4.430.000. In addition to that, the residual value of the building increased with approximately 5.5 million after the sustainable measures.

If the value of the test case building should be determined after sustainable measures in the way property appraisers value office buildings these days, the assumption can be made that the value would be determined with the BAR-method based on references. Based on the following assumptions, the value of the test case building after sustainable measures can be determined by the BAR-method: legal transaction costs of 6,5%, a BAR-yield for an unsustainable building of 9,5% and a rental income of € 268.200. The percentage of the legal transaction costs and the rental income are the same as in the renewed valuation model. Therefore, only the assumption for the BAR-yield is estimated. The assumption is based on the value of the unsustainable test case building calculated with the DCF-model (€ 2.885.000) and the average BAR-yield for office buildings on other locations in the West of The Netherlands (DTZ Zadelhoff, 2015). The BAR-yield for an unsustainable building is 9,5%. Based on the gut feeling, the property appraiser will reduce this percentage because of the sustainability. According to the average BAR-yield for office buildings on other locations in the West of The Netherlands the lowest BAR-yield is 6,5%. Therefore, this percentage (6,5%) is used to calculate the value of the test case building after sustainable measures. According to these assumptions the maximum value of the building after sustainable measures is €

4.125.000. The difference in calculating the value of the building after sustainable measures with the renewed valuation model or the valuation method currently used by property appraisers is € 3.190.000. Figure 14 gives an overview of the differences in value. However, because no property appraiser actually determined a value to the building after sustainable measures, no guarantees can be given to the difference in the value. Appendix 11 shows the renewed valuation model applied on the test case building before and after the sustainable measures.

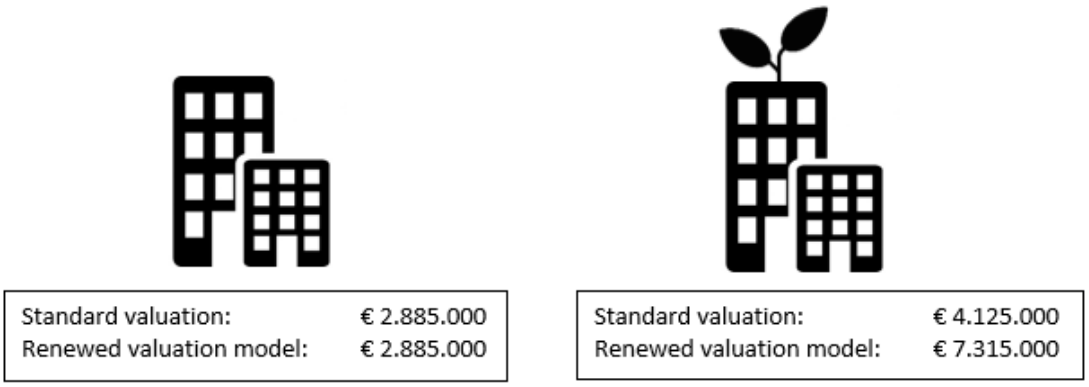

Figure 14. Value differences sustainable and unsustainable building

Discussion section 4.3 Renewed valuation model

By the lack of awareness among the users for the effects of sustainable buildings, property appraisers cannot take sustainability into the valuations because they have to determine the market value. This does not correspond with the literature, according to the literature users are aware of the benefits of sustainable buildings and they prefer sustainable office buildings because of the benefits like increase in productivity. In this ideal situation the renewed valuation model can be applied. However, the awareness of users should be created before the renewed valuation model can be used. The main aim of the renewed valuation model is to calculate well-founded values of sustainable office buildings. These days a conventional office building is valued in the same way as a sustainable office building. However, when awareness among the users is created the renewed valuation model gives insight into the added value of a sustainable building relative to an unsustainable building. Using the online questionnaire and the expert panel, an exit yield and discount rates are set to ensure less subjectivity within the renewed valuation model. The test case proves that if the market is aware of the effects of sustainable office buildings and property appraisers can take sustainability take into the valuations, sustainable buildings have a high added value relative to unsustainable buildings. According to the expert panel, the conclusion can be made that the majority of the property appraisers do not understand the DCF-method.

Sub- questions 3.1 and 3.2 can be answered using the information obtained from this section.

3.1 How could the subjectivity within valuations be limited?

By stricter and more standardizations, the subjectivity within valuations can be limited. However, property appraisers argue that standardizations should remain within its limits. The subjectivity within the renewed valuation model is limited to a certain extent by setting default percentages for the discount rates and exit yield. The default percentages are set by a combination of the results from the online questionnaire and the expert panel. However, if property appraisers have a well-founded reason to deviate of these percentages this should be properly substantiated in the valuation report.

3.2 How could sustainability be integrated in an existing valuation model?

The lack of one unequivocal measurement tool results in different sustainability levels which cannot be assessed for integration in an existing valuation model. However, the effects of sustainable buildings can be expressed in four aspects; energy costs, maintenance costs, productivity and absenteeism. The savings that can be made on these four aspects can be taken into the valuation. The amount can be integrated in the cash flow and against a proper discount rate the present value can be calculated.

5 CONCLUSION AND RECOMMENDATIONS

In this final chapter of this graduation thesis most important findings of the research are explained concisely. This thesis offers added value to the existing way of valuing sustainable office real estate by providing a renewed valuation model for valuations of sustainable office real estate. The first section gives a short conclusion and describes the scientific and societal relevance. Within this section the main question of this thesis has been answered. The final, second section, establishes recommendations for future research and a reflection on this research.

5.1 CONCLUSION

The main aim of this research was the design of a renewed valuation model for the valuation of sustainable real estate in an objective way. Using the Fuzzy Delphi Method (FDM) the most important physical criteria of a sustainable office building are established and incorporated in the renewed valuation model expressed in four aspects: energy costs, maintenance costs, productivity and absenteeism.

Using the obtained information of this study, the main research question can be answered:

''How can a renewed valuation model including directives ensure that sustainable office real estate can be valued in an objective way?''

Property appraisers have to estimate the market value of a building. The market value is an estimation of the price that users are willing to pay today a for specific building. Currently users are not aware of the benefits that sustainable buildings bring. Due to this, users are not willing to pay more for a sustainable building. This means that it is not possible for appraisers to include sustainability in the value of a building. However, when awareness on the market is created, sustainability can be included in the valuation.

Assuming that the awareness among the users will be created within a few years, the renewed valuation model offers property appraisers a way to value sustainable office real estate in an objective way. By the use of default discount rates and exit yields, the objectivity within the renewed valuation model can be ensured to a certain extent. However, valuations are no rocket science, there will always be some subjectivity within valuations. When the renewed valuation model is used, sustainable buildings create savings for the building owners and users on four aspects; energy costs, maintenance costs, productivity and absenteeism. These savings are reflected in the cash flow of the model. In addition, the renewed valuation model also includes guidelines to assist property appraisers with the application of the renewed valuation model. The guidelines include standards of how property appraisers should deal with sustainability within valuations.

5.2 RELEVANCE

This section will first describe the scientific relevance of this research and second the societal relevance of this research. In the scientific relevance the main research question is answered using all obtained information of this research.

5.2.1 Scientific relevance

During the past years al lot of research is done to valuations of sustainable office real estate. David Lorenz and Thomas Lützkendorf provide a systematic overview of various publications and international research efforts undertaken to integrate sustainability considerations into the property valuation process. They concluded that changes are required for the integration of sustainability within the valuation process and that these should be supported by action, that could be undertaken by the professional and valuation-standard-setting bodies and organisations within the valuation world (Lorenz & Lützkendorf, 2011). This article provides different options for incorporation of sustainability in the existing valuation models. However, a way of how sustainability should be assessed by property appraisers is missing. There are measurement tools for appraisers to measure the sustainability of a building such as BREEAM and LEED. Despite of that, there is no uniform way to assess the outcomes of these tools and take these into account in setting a value of a sustainable building. In addition to that, all measurement tools result in other, incomparable levels what makes it even harder to assess. Up to now there was no valuation model that can translate the sustainability of a building in numbers for calculations. Using the FDM the twelve most important criteria of sustainable office buildings are established and these are translated in four aspects that can objectively be taken into the calculations of the value of a sustainable building. This allows property appraisers to assess the sustainability of an office building in the determination of the value.

5.2.2 Societal relevance

These days, sustainable buildings only offer benefits for the buildings' users. This is due the fact that the added value of sustainable building is barely perceptible compared to an unsustainable building. By the lack of awareness of the users, property appraisers cannot take sustainability into the value of a building. Therefore, other stakeholders such as building owners, investors and banks do not profit from the positive effects of sustainable buildings.
The aim of this research was to incorporate sustainability within valuation and thereby, that benefits of sustainable office buildings become perceptible for all stakeholders. It is expected that unsustainable buildings will be upgraded to sustainable buildings when the value of sustainable buildings is significantly more relative to unsustainable buildings. When the value of a sustainable building is significantly more, it is profitable for investors to invest in a more sustainable building and banks want to finance these investments. This due to the benefits of sustainable buildings; investors will profit from reduced maintenance costs and a higher market rent and banks will benefit by the less risks. In addition to that, making existing buildings sustainable results in CO2-reduction what contributes to the CO2-emission goal of the European Union.

5.3 RECOMMENDATIONS

This study focussed on the design of a renewed valuation model for objective valuation of sustainable office real estate. However, additional and broadening research is of great importance for objective valuation of sustainable office real estate and the application of the renewed valuation model. Below are some recommendations:

Market awareness
Before sustainability can be included in the valuation of a building, users need to be aware of the positive effects of sustainable buildings. Only when users are open to pay more rent for a sustainable office building relative to an unsustainable office building, sustainability can be included in the value of a building. Though, the awareness of the market has to be created. To

accelerate the process of awareness creation, research needs to be done to the motives of users and in what way they can be encouraged to choose for sustainable office housing; what marketing techniques can be applied or/and which rules should be changed.

Application DCF-model
Results of this research show that the DCF-model is not governed by the majority of property appraisers. Despite the fact that the DCF-model is most appropriate for incorporation of sustainability. Research to the application of the DCF-model will indicate how well this technique is controlled and how this could be improved. In addition, what can the institutions that composes guidelines and policy makers do to persuade appraisers to use the DCF-model instead of the BAR-, or NAR-method.

Measurement absenteeism and productivity
When the awareness of the users is created, they will appreciate the productivity and absenteeism. What is showed in the interviews and the expert panel, is that the current methods to measure the productivity and absenteeism are doubtful. Research can be done to a proper tool for the measurement of absenteeism and/or productivity. This will result in less doubts and that will encourage users to appreciate productivity and absenteeism.

Reflection
The findings of this study show that there are many ways and opinions about the incorporation of sustainability in valuations. Despite the fact that there are many ways to incorporate sustainability within valuations and the fact that there is practically no awareness on the market, I think the incorporation of sustainability as the four aspects of sustainability (productivity, absenteeism, energy costs and maintenance costs) is the best way. This because of the early adapters on the market that are aware of the benefits of sustainable buildings such as increase of productivity and decrease of absenteeism. This study and the model is limited to valuation of sustainable office buildings, in the future this research can be improved by extending the model for applications like schools or healthcare real estate. In addition, the impact of sustainability measures that will be calculated within the valuation model can be considered in future research.

6 REFERENCES

Berkhout; Roggeveen. (2014). Praktijkhandreiking Nederlandse Vastgoedtaxaties commercieel vastgoed.

Berkthout, G. (2010). De meerwaarde van duurzaam vastgoed.

Bozorgi, A. (2015). Integrating value and uncertainty in the energy retrofit analysis in real estate investment—next generation of energy efficiency assessment tools. *Energy Efficiency*, 1015–1034. http://doi.org/10.1007/s12053-015-9331-9

Brounen, D., & Kok, N. (2011). On the economics of energy labels in the housing market. *Journal of Environmental Economics and Management*, *62*(2), 166–179. http://doi.org/10.1016/j.jeem.2010.11.006

Brown, B. J., Hanson, M. E., Liverman, D. M., & Merideth, R. W. (1987). Global sustainability: Toward definition. *Environmental Management*, *11*(6), 713–719. http://doi.org/10.1007/BF01867238

Campion, M. A., Palmer, D. K., & Campion, J. E. (1997). A review of Structure in the Selection Interview. *Personnel Psychology*. http://doi.org/10.1111/j.1744-6570.1997.tb00709.x

CBRE. (2007). Green Downtown Office Markets : A Future Reality. *Construction*.

Chegut, A., Kok, N., & Eichholtz, P. (2011). The Value of Green Buildings New Evidence from the United Kingdom, (July 2011), 1–43.

Ciegis, R., Ramanauskiene, J., & Martinkus, B. (2009). The Concept of Sustainable Development and its Use for Sustainability Scenarios. *Challenges*, *2*(2), 28–37. Retrieved from http://internet.ktu.lt/en/inzeko/

Cobouw. (2015). Mens uitgangspunt voor keurmerk gezond gebouw. Retrieved May 26, 2016, from http://www.cobouw.nl/artikel/1035676-mens-uitgangspunt-voor-keurmerk-gezond-gebouw

D'Amato, M., & Kauko, T. (2012). Sustainability and risk premium estimation in property valuation and assessment of worth. *Building Research and Information*, *40*(2), 174–185. http://doi.org/10.1080/09613218.2012.655069

DGBC. (2015). *Productiviteit in Kantoren*. Rotterdam.

DTZ Zadelhoff. (2015). Nederland compleet, 1–83.

Eccles, R. G., Krzus, M. P., Rogers, J., & Serafeim, G. (2012). The Need for Sector-Specific Materiality and Sustainability Reporting Standards. *Applied Corporate Finance*, *24*(2), 65–71. http://doi.org/10.1111/j.1745-6622.2012.00380.x

Eichholtz, P., Kok, N., & Quigley, J. (2010). Doing well by doing good? Green office buildings. *The American Economic Review*, *100*(5), 2492–2509. Retrieved from http://www.jstor.org/stable/41038771

Eichholtz, P., Kok, N., & Quigley, J. M. (2015). Who rents green? Ecological responsiveness and corporate real estate. *Business & Society*.

Elkington, J. (2002). Measuring Business Excellence. *Measuring Business Excellence*, *5*(2), 6–

12. http://doi.org/10.1108/13683040911006800

Europa 2020 | Europese Unie | Rijksoverheid.nl. (2015). Retrieved May 9, 2016, from https://www.rijksoverheid.nl/onderwerpen/europese-unie/inhoud/europa-2020

Faulconbridge, J. (2015). Mobilising sustainable building assessment models: agents, strategies and local effects. *Area*, *47*(2), 116–123. http://doi.org/10.1111/area.12148

Feige, A., Wallbaum, H., Janser, M., & Windlinger, L. (2013). Impact of sustainable office buildings on occupant's comfort and productivity. *Journal of Corporate Real Estate*, *15 No.1*, 7–34.

Flick, U. (2009). *An introduction to qualitative research* (Fourth edi). London: SAGE Publications Ltd.

French, N., & Gabrielli, L. (2004). The uncertainty of valuation. *Journal of Property Valuation and Finance*, *22*(6), 484 – 500. http://doi.org/10.1108/14635780410569470

Fuerst, F., & McAllister, P. (2011). Green Noise or Green Value? Measuring the Effects of Environmental Certification on Office Values. *Real Estate Economics*, *39*(1), 45–69. http://doi.org/10.1111/j.1540-6229.2010.00286.x

Glavič, P., & Lukman, R. (2007). Review of sustainability terms and their definitions. *Journal of Cleaner Production*, *15*(18), 1875–1885. http://doi.org/10.1016/j.jclepro.2006.12.006

Habibi, A., Jahantigh, F. F., & Sarafrazi, A. (2015). Fuzzy Delphi Technique for Forecasting and Screening Items. *Asian Journal of Research in Business Economics and Management*, *5*(2), 130–143. http://doi.org/10.1007/BF00027519s

Hemphill, L., McGreal, S., & Berry, J. (2002). An aggregated weighting system for evaluating sustainable urban regeneration. *Journal of Property Research*, *19*(4), 353–373. http://doi.org/10.1080/09599910210155491

Honing, H., & Marquard, A. (2014). Duurzaamheid als USP ?

Hordijk, A., Worms, C., & Bert, van den S. (2015). De praktijk van waarderen met DCF. *PropertyNL Magazine*, 90–92.

Hsu, Y.-L., Lee, C.-H., & Kreng, V. B. (2010). The application of Fuzzy Delphi Method and Fuzzy AHP in lubricant regenerative technology selection. *Expert Systems with Applications*, *37*(1), 419–425. http://doi.org/10.1016/j.eswa.2009.05.068

Ishikawa, A., Amagasa, M., Shiga, T., Tomizawa, G., Tatsuta, R., & Mieno, H. (1993). The max-min Delphi method and fuzzy Delphi method via fuzzy integration. *Fuzzy Sets and Systems*, *55*(3), 241–253. http://doi.org/10.1016/0165-0114(93)90251-C

IVVD. (2014). Hoe Rijksvastgoed verantwoord afstoten?

John Alker, Michelle Malanca, Chris Pottage, R. O. (2015). Productivity in Offices The next chapter for green building. *World Green Building Council*. Retrieved from http://www.worldgbc.org/files/4614/1152/1461/WorldGBC__Health_Wellbeing__Productivity_Short_Report.pdf

Jones Lang LaSalle. (2013). Occupier Special Sustainability, 12. Retrieved from http://www.joneslanglasalle.nl/ResearchLevel1/JLL_Occupier_Special_Sustainability_D

uurzaamheid_2013.pdf

Joslin, A. (2005). An investigation into the expression of uncertainty in property valuations. *Journal of Property Investment & Finance*, *26*(3), 269–285. http://doi.org/10.1108/02656710210415703

Klir, G. J., & Yuan, B. (1995). *Fuzzy sets and fuzzy logic*. USA: Prentice Hall PTR. http://doi.org/10.1111/j.1365-246X.2012.05469.x

Kok, N., & Jennen, M. (2011). The Value of Energy Labels in the European Office Market, 26.

Kok, N., & Jennen, M. (2012). The impact of energy labels and accessibility on office rents. *Energy Policy*, *46*, 489–497. http://doi.org/10.1016/j.enpol.2012.04.015

Koolmoes, J. (2014). *Duurzame huisvesting - De meerwaarde voor de kantoorgebruiker*.

Kuhlman, T., & Farrington, J. (2010). What is Sustainability? *Sustainability*, *2*(11), 3436–3448. http://doi.org/10.3390/su2113436

Kumar, R. (2011). *Research methodology a step-by-step guide for beginners* (3rd ed.). London.

Lange, K. T. de. (2011). *Rendement van duurzaamheid*. *Rendement van duurzaamheid*.

Lin, C., & Chuang, L. Z. (2012). Using Fuzzy Delphi Method and Fuzzy AHP for Evaluation Structure of the Appeal of Taiwan ' s Coastal Wetlands Ecotourism, 347–358.

Littig, B., & Pöchhacker, F. (2014). Socio-Translational Collaboration in Qualitative Inquiry: The Case of Expert Interviews . *Qualitative Inquiry* , *20* (9), 1085–1095. http://doi.org/10.1177/1077800414543696

Loi, R., Lam, L. W., Ngo, H. Y., & Cheong, S. (2015). Sustainability, materiality, assurance and the UK's leading property companies. *Journal of Managerial Psychology*, *Vol. 30 No*, pp. 645–658. http://doi.org/http://dx.doi.org/10.1108/02683940010305270

Lorenz, D. P., & Lützkendorf, T. (2008). Sustainability in property valuation: theory and practice. *Journal of P*, *16 No.6*(482-521).

Lorenz, D. P., & Lützkendorf, T. (2011). Sustainability and property valuation. *Journal of Property Investment & Finance*, *29 No.6*, 644–676.

Lorenz, D. P., Trück, S., & Lützkendorf, T. (2007). Exploring the relationship between sustainability of construction and market value. *Property Management*, *25 No. 2*, 119–149.

Lützkendorf, T., & Lorenz, D. (2005). Sustainable property investment: valuing sustainable buildings through property performance assessment. *Building Research & Information*, *33*(3), 212–234. http://doi.org/10.1080/09613210500070359

Mallinson, M., & French, N. (2000). Uncertainty in property valuation. *International Journal of Retail & Distribution Mangement*, *18*(1), 13–32. http://doi.org/10.1108/02656710210415703

Mason-Jones, R. and Towill, D. R. (2012). The effect of sustainability on commercial occupiers' building choice. *Journal of Property Investment & Finance*, *31*(3), 267–284.

http://doi.org/10.1108/09574090910954864

Meadows, D., Meadows, D., Randers, J., & Behrens, W. (1972). The Limits to Growth. *Journal of the American Water Resources Association*, *8*(4), 837–837. http://doi.org/10.1111/j.1752-1688.1972.tb05230.x

Meins, E., Wallbaum, H., Hardziewski, R., & Feige, A. (2010). Sustainability and property valuation: a risk-based approach. *Building Research & Information*, *38*(3), 280–300. http://doi.org/10.1080/09613211003693879

Myers, G., Reed, R., & Robinson, J. (2007). The Relationship between Sustainability and the Value of Office Buildings. *13th Annual Pacific Rim Real Estate Conference*, (January), 1–22.

Neimann, A. J. (2012). *"Waarderen van duurzaamheid."* TU Delft.

NVM. (2011). Duurzaamheid en commercieel vastgoed. *NVM Business*.

Paumgartten, P. Von. (2003). The business case for high performance green buildings: Sustainability and its financial impact. *Journal of Facilities Management*, *2*(1), 26–34. http://doi.org/10.1108/14725960410808096

PTA. (2014). Good Practices : voorbeelden voor de praktijk goed gewaardeerd vastgoed.

Reichardt, A., Fuerst, F., Rottke, N. B., & Zietz, J. (2012). Sustainable building certification and the rent premium: a panel data approach. *Journal Of Real Estate Research*, *34*(1), 99–126. Retrieved from http://ares.metapress.com/content/c3h2158g28k58653/?p=8c21a6d40b8f46c7b5081a6d91306ecc&pi=5

RICS. (2009). *Informatiedocument Taxatie nr. 13 Duurzaamheid en taxatie van commercieel vastgoed*.

RICS. (2016). Retrieved April 22, 2016, from http://www.rics.org/nl/

RICS-taxatiestandaarden januari 2014. (2014).

Rijksoverheid. (2010). Overheid kiest voor duurzame gebouwen.

Sayce, S., & Ellison, L. (2006). *The Sustainable Property Appraisal Project*. *Innovation*. Retrieved from http://eprints.kingston.ac.uk/1435/

Sayce, S., Sundberg, A., & Clements, B. (2010). Is sustainability reflected in commercial property prices: an analysis of the evidence base, (January).

Schekkerman, C. (2004). Nauwkeurigheid in taxaties, 1–55.

Schmidt, P., & Strauss, R. P. (1975). THE PREDICTION OF OCCUPATION USING By. *International Economic Review*, *16*(2), 471–486.

Schmidt, R., Lyytinen, K., Keil, M., & Cule, P. (2001). Identifying software project risks: An international Delphi study. *Journal of Management Information Systems*, *17*(4), 5–36. http://doi.org/Article

Schuur, R. (2016). Blog: Duurzaamheid moet zwaarder wegen in taxatie vastgoed. Retrieved

February 1, 2016, from https://www.vastgoedjournaal.nl/news/20539/blog-duurzaamheid-moet-zwaarder-wegen-in-taxatie-vastgoed

Simons, W. (2013). BREEAM meest toegepaste certificering in Europa - Platform Duurzame Huisvesting. Retrieved February 3, 2016, from http://www.platformduurzamehuisvesting.nl/2013/05/10/breeam-meest-toegepaste-certificering-in-europa/

Stasiak, E. K. (2013). Uncertainty of Property Valuation As a Subject of Academic Research. *Real Estate Management and Valuation*, *21*(4), 17–25.

Steinmaier, E. (2014). Duurzaam vastgoed wordt de standaard. Retrieved April 14, 2016, from https://insights.abnamro.nl/2014/07/19351/

Stoer, B. R. (2013). Duurzaamheid als huisvestingsmotief voor kantoorgebruikers.

TEGoVA. (2012). *Europese taxatiestandaarden*.

Ten Have, G., Berkhout, T., & van Arnhem, P. (2011). *Taxatieleer Vastgoed 1*.

Tervoort, A. (2010). *Wat is de waarde van een duurzaam kantoorgebouw ?*

The U.S. Green Building Council. (2013). The Business Case for Green Building, 124. Retrieved from http://www.worldgbc.org/activities/business-case/

TMI. (2014). Taxatierichtlijn Commercieel Vastgoed.

Tyler, C. L. (1999). Doing a Literature Review. *Journal of Business-to-Business Marketing*, *6*(3), 77. Retrieved from http://libezproxy.open.ac.uk/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=6704509&site=ehost-live&scope=site

VastgoedCert. (2014). *Discounted Cash Flow (DCF)*.

Vree, de J. (2010). Instrumentenvergelijking BiMi.

Warren, C., Bienert, S., & Myers, G. W. (2009). Valuation and Sustainability are Rating Tools Enough? European Real Estate Society Conference Stockholm, Sweden 24-27. *European Real Estate Society Conference Stockholm, Sweden 24-27th June 2009 Dr*, (June), 1–16.

Warren-myers, G. (2013a). Is the valuer the barrier to identifying the value of sustainability? *Journal of Property Investment & Finance*, *31*(4), 345–359. http://doi.org/10.1108/09574090910954864

Warren-myers, G. (2013b). Real Estate Valuation and Valuing Sustainability : A Case Study of Australia. *Pacific Rim Property Research Journal*, *5921*(March). http://doi.org/10.1080/14445921.2013.11104375

Yudelson, J. (2008). *Marketing Green Building Services: Strategies for Success* (First). Oxford: Elsevier. Retrieved from https://books.google.com/books?hl=nl&lr=&id=ZEUzGAK5X-YC&pgis=1

Yudelson, J. (2010). What Is a Green Building? *Gggc*, 1–6. Retrieved from http://link.springer.com/chapter/10.1007/978-90-481-2782-5_3

7 APPENDICES

APPENDIX 1. TOTAL LIST OF 290 SUSTAINABILITY CRITERIA

Total list of all criteria of BREEAM, LEED, Sayce & Ellison and Meins et al.

Sayce and Ellison		In S&E	In Meins et al.	In LEED	In BREEAM
1	**Operational energy efficiency**				
	Modern building management system	x			x
	Movement sensitive/auto-off lighting	x			
	Low energy lighting	x		x	
	Access to a local renewable energy source	x			x
	A CHP plant	x			
2	**Adaptability**				
	Regular footprint	x			
	Plant depth 15-18 m	x			
	Colum grid> 7,5 m	x			
	Floor - ceiling height >= 2,7 m	x			
	Raised floors	x			
	VAV, fan coil or no air-conditioning	x			
	Is this property adaptable across use	x			x
3	**Climate control**				
	A/C <5 years old	x	x	x	x
	A/C 5-9 years old	x	x	x	x
	A/C 9+ years old	x	x	x	x
	Mechanical ventilation <5 years old	x	x	x	x
	Mechanical ventilation 5+ years old	x	x	x	x
	Natural ventilation	x	x	x	x
	Capacity for alternative cooling system	x		x	
4	**Water management**				
	Low flush toilets	x	x	x	x
	Dual flush toilets	x	x	x	x
	Controlled taps	x	x	x	x
	Controlled flush urinals	x	x	x	x
	Washroom control system	x			
	Rainwater harvesting	x	x	x	x
	Grey water recycling	x			x
5	**Waste management**				
	Accessible waste storage facilities	x			x
	Adequate waste storage facilities	x			x
	Centrally controlled recycling service	x			
	Municipal recycling service	x			
6	**Accessibility**				
	Car	x	x	x	x
	Train (local)	x	x	x	x

	Train (major)	x	x	x	x
	Bus	x	x	x	x
	Underground	x	x	x	x
	Foot	x	x	x	x
	Bicycle	x	x	x	x
	Adequate parking	x	x	x	x
	Bicycle racks	x	x	x	x
	Showers				
7	**Pollution**	x			
	1 million	x			
	5 million	x			
	10 million	x			
	> 10 million	x			
Meins et al.					
1	**Flexibility and polyvalence**				
	Floor plan		x		
	Storey height		x		
	Accessibility, reserve capacity and wiring/pipes/building services		x		
	Wheelchair accessibility		x		
2	**Energy and water dependency**				
	Energy		x	x	x
	Locally produced renewable energy		x		x
	Water use		x	x	x
	Water disposal	x	x	x	x
	Rainwater use	x	x	x	x
3	**Accessibility and mobility**				
	Good connection to public transport	x	x	x	x
	Bicycle parking near the building	x	x	x	x
	Distance to shops		x	x	x
4	**Location regarding natural hazards**				
	Location regarding natural hazards		x		x
	Building safety and security measures		x		x
	Safety and security measures related to people		x		x
5	**Health and comfort**				
	Inside air quality	x	x	x	x
	Noise exposure		x		x
	Sufficient natural light		x	x	x
	Radiation exposure		x		
	Ecological construction materials		x		
LEED					
1	**Location and transportation**				
	Alternative transportation	x	x	x	x
2	**Sustainable sites**				
	Site management policy plan			x	x
	Site development			x	x

	Rainwater management		x	x	x
	Heat island reduction			x	
	Light pollution reduction		x	x	x
	Site management			x	x
	Site improvement plan		x	x	x
	Joint use of facilities			x	x
3	**Water efficiency**				
	Indoor water use reduction required	x		x	x
	Building-level water metering			x	
	Outdoor water use reduction			x	
	Indoor water use reduction	x		x	
	Cooling tower water use			x	
	Water metering			x	x
4	**Energy and atmosphere**				
	Energy efficiency best management practices			x	
	Minimum energy performance			x	x
	Building level energy metering			x	
	Fundamental refrigerant management			x	
	Existing building commissioning analysis and implementation			x	x
	Ongoing commissioning			x	
	Optimizing energy performance			x	
	Advanced energy metering			x	
	Demand response			x	
	Renewable energy and carbon offsets	x	x	x	x
	Enhanced refrigerant management			x	x
5	**Materials and resources**				
	Ongoing purchasing and waste policy			x	x
	Facility maintenance and renovation policy			x	x
	Purchasing - Ongoing			x	
	Purchasing - Lamps			x	
	Purchasing - Facility maintenance and renovation			x	
	Solid waste management - Ongoing and facility maintenance and renovation			x	x
	Solid waste management - Facility maintenance and renovation	x		x	x
6	**Indoor environmental quality**				
	Minimum indoor air quality performance equipment			x	x
	Environmental tobacco smoke control			x	
	Green cleaning policy			x	
	Indoor air quality management program			x	x
	Enhanced indoor air quality strategies			x	
	Thermal comfort	x	x	x	x
	Interior lighting			x	x
	Daylight and quality views			x	x
	Green cleaning - Custodial effectiveness assessment			x	
	Green cleaning - Products and materials			x	
	Green cleaning - Equipment			x	

	Integrated pest management			x	
	Occupant comfort survey			x	
7	**Innovation**				
	Innovation			x	
	LEED Accredited professional			x	
BREEAM Asset					
1	**Well-being and health**				
	Percentage glass in facade				x
	Preventing light disturbance		x		x
	Type of building ventilation	x			x
	Measuring fresh air				x
	Temperature regulation				x
	Microbiological contamination, legionella prevention system				x
	Availability relax room inside or outside				x
	Out in fine dust area PM 2,5				x
	View				x
	Ventilation, influence by users	x			x
	Lighting control	x		x	x
	Location intakes to air outlets				x
	Climate; local extraction systems	x			x
	Daylighting, visual comfort		x	x	x
	Indoor air quality, excess hours	x	x	x	x
	High frequency lighting	x		x	x
2	**Energy**				
	Energy coefficient (EPC)		x	x	x
	Airtightness asset				x
	Outdoor lighting - type accent / facade lighting				x
	Outdoor lighting - parking lights				x
	Share of locally generated renewables	x			x
	Energy consumption, distribution submeasurements use function				x
	Energy consumption, distribution submeasurements purpose				x
	Own meter per user			x	x
	Energy-efficient elevators				x
	Energy-efficient escalators and moving walkways				x
3	**Transport**				
	Facilities for cyclists	x	x	x	x
	Proximity to public transport (OV)	x	x	x	x
	Near basics		x	x	x
	Safety cyclists and pedestrians for deliveries				x
	Actual traffic information				x
	Shared facilities	x			x
	Restrict parking	x			x
4	**Water**				
	Metering water consumption			x	x
	Water-saving plumbing	x	x	x	x
	Urinals	x	x	x	x

	Sinks with water-saving faucet	x	x	x	x
	Showers with low water consumption	x	x	x	x
	Percentage of white goods with low water consumption				x
	Using collected rainwater	x	x	x	x
	Used collected grey water	x			x
	Toilets with motion sensors	x	x	x	x
	Leak detection central water supply				x
	Percentage of equipment with shut-off valves				x
	Use of grey water	x			x
	Storage tank for grey water and rainwater	x			x
	Use of information on water consumption				x
	Percentage of recycled water				x
	Separate sewer system for rainwater				x
5	**Materials**				
	Restore points/ faults				x
	Maintenance policy, age and subjects			x	x
	Security advisories, implementation				x
	Burglar alarm system, presence				x
	Burglar alarm system, by notification				x
	Adaptability building	x			x
	Environmental impact materials of the building				x
	Protection against damage				x
6	**Waste**				
	Facilities for separated waste	x			x
7	**Land use and ecology**				
	Type of landscape on the plot				x
	Green roofs, walls, planters				x
	Facilities for animals				x
8	**Pollution**				
	Discharges to surface waters	x			x
	Liquid separators (fat and oil)				x
	Flood asset	x			x
	Sub-sensitive areas	x			x
	Protection against flood damage				x
	Sustainable drainage system				x
	Cooling with CFCs or HCFCs	x			x
	Cooling systems with refrigerants	x			x
	NOx emission				x
	Use refrigerants for refrigeration	x		x	x
	Storage space chemicals				x

BREEAM Management

1	**Management**				
	Users manual	x			x
	Environmental policy, -plan, -system			x	x
	Environmental and goals			x	x
	Agreements with users				x

	Service manual			x
	Disclosure environmental sustainability users			x
	Sustainable procurement materials		x	x
	Scope sustainable procurement			x
2	**Well-being and health**			
	Acoustics research			x
	Internal air quality monitoring		x	x
	Protection users during work			x
	Policy limiting volatile organic compounds			x
	Encouraging use products with low solvent content			x
	Suppliers information on VOC emissions			x
	Cleaning, deep cleaning		x	x
	Users satisfaction survey		x	x
	Users satisfaction survey, responses and actions		x	x
	Lighting level inside and outside		x	x
	Microbiological contamination, procedures and processes			x
3	**Energy**			
	EPA-U customized advice		x	x
	Use of information on energy consumption			x
	Annual consumption per energy user		x	x
	Monitoring from renewable sources		x	x
	Secure plant performance			x
4	**Water**			
	Maintenance policy for water systems			x
	Metering water consumption		x	x
	Policy monitoring water consumption			x
5	**Materials**			
	Flood risks	x		x
	Condition measurement asset			x
	Expertise inspector			x
	Type of maintenance policies and age			x
	Fire safety, availability risk environment	x		x
	Fire safety, periodic execution risk environment			x
	Emergency fire, environmental risks	x		x
	Asset protection and content to fire	x		x
	Drafting security risk consultancy			x
6	**Land use and ecology**			
	Biodiversity management		x	x
	Policy ecological characteristics and building plot			x
	Ecological research and implementation			x
	Shared parking facilities		x	x
7	**Pollution**			
	Limiting air pollution		x	x
	Holder discharge permit			x
	Measures reducing discharger to surface water			x
	Maintenance policy liquid separators			x

	Automatic leak refrigerants		x
	Periodic monitoring of storage chemicals		x
	Research soil pollution plot		x
	Procedure pollution incidents		x
	Complaints light and noise pollution		x
	Replacement refrigerants	x	x
	Testing air duct		x
	Control discharge permit		x

BREEAM Use

1	**Management**		
	Environmental procedures	x	x
	Scope environmental		x
	Environmental policy, securing execution		x
	Environmental objectives, performance		x
	Management review environmental performance		x
	Sustainability reporting		x
2	**Well-being and health**		
	Provision of drinking water		x
	Training staff		x
	Welfare and health policy questions		x
	Welfare and health objectives achieved		x
3	**Energy**		
	Initiatives for saving energy	x	x
	Energy policy	x	x
	Energy targets, results	x	x
	Energy savings last 2 years		x
	Purchasing green energy		x
4	**Transport**		
	Transport, reduction/ registration environmental impact		x
	Transport management, policy		x
	Local amenities, publication		x
	Transport policy, results		x
	Commuting distances employees		x
	Environmental impact transport operations (transport employees)		x
	Environmental impact transportation of goods		x
5	**Water**		
	Limiting water consumption	x	x
	Implementation and monitoring of water policy	x	x
	Water policy, results		x
	Water use last year		x
6	**Materials**		
	Sustainable procurement materials	x	x
	Sustainable procurement materials, implementation	x	x
	Selection of suppliers		x
	Supplier criteria rate quality		x

		Supplier criteria environmental management		x
		Supplier quality management criteria		x
		Supplier criteria certified environmental management		x
		Results material procurement objectives		x
	7	**Waste**		
		Waste prevention measures	x	x
		Waste prevention, control	x	x
		Waste separate collection		x
		Waste separate, registration volumes		x
		Waste separate, active prevention	x	x
		Storing recyclable waste		x
		Waste performance monitoring frequency		x
		Waste management, performance targets	x	x
		Waste management, performance improvement proposals		x
		Amount of waste to landfill		x
		Amount of waste not to landfill		x
		Incinerated amount of waste		x
		Minimize environmental impact waste		x
	8	**Land use and ecology**		
		Sponsorship and active support		x
	9	**Pollution**		
		Environmental use of the asset		x
		Measures to reduce pollution and nuisances	x	x
		Reducing pollution: objectives	x	x
		Reducing pollution: measures	x	x

APPENDIX 2. RESEARCH TO THE RELATION BETWEEN SUSTAINABILTY AND VALUATION IN DIFFERENT COUNTRIES OVER THE WORLD

Researchers	Article	Country	Year
Kok & Jennen	The impact of energy labels and accessibility on office rents	The Netherlands	2011
Eichholtz, Kok & Quigley	The economics of green buildings	United States	2011
Sayce & Ellison	Assessing sustainability in the existing commercial property stock	United Kingdom	2006
Myers, Reed & Robinson	The relationship between sustainability and the value of office buildings	Australia	2007
Brounen & Kok	On the economics of energy labels in the housing market	The Netherlands	2011
Kok & Jennen	The value of energy labels in the European office market	The Netherlands	2012
Chegut,Kok & Eichholtz	The value of green buildings: new evidence from the United Kingdom	United Kingdom	2011
Fuerst & McAllister	Green noise or green value? Measuring the effects of environmental certification on office value	United States	2011
Lützkendorf & Lorenz	Sustainable property investment: valuing sustainable buildings through property performance assessment	Germany	2005
Myers et al.	The relationship between sustainability and the value of office buildings	Australia	2007
Jones Lang LaSalle	Fully engaged	The Netherlands	2013
Sayce & Ellison	The sustainable property appraisal project	United Kingdom	2006
Lützkendorf & Lorenz	Sustainability in property valuation: theory and practice	Germany	2008
Lützkendorf & Lorenz	Sustainability and property valuation	Germany	2011
Reed & Wilkinson	A comparison of international sustainable building tools	Germany	
Warren, Bienert & Myers	Valuation and sustainability: are rating tools enough?	Sweden	2009
Bijsterveld	Taxeren van vastgoed gaat verder dan alleen vierkante meters	The Netherlands	2010
Sayce, Sundberg & Clements	Is sustainability reflected in commercial property prices: an analysis of the evidence base	United Kingdom	2010
Loi,Lam,Ngo et al.	Sustainability, materiality, assurance and the UK's leading property companies	United Kingdom	2015
Mason-Jones, Towill	The effect of sustainability on the commercial occupiers' building choice	New-Zeeland	2012

Warren-Myers	Real estate valuation and valuing sustainability	Australia	2013
Warren-Myers	Is the valuer the barrier to identifying the value of sustainability ?	Australia	2013
Meins, Wallbaum, Hardziewski et al.	Sustainability and property valuation: a risk-based approach	Switzerland	2010
Honing & Marquard	Duurzaamheid als USP?	The Netherlands	2014
Mallinson & French	Uncertainty in property valuation	United Kingdom	2000
French & Gabrielli	Discounted cash flow: accounting for uncertainty	United Kingdom	2004
Stasiak	Uncertainty of property valuation as a subject of academic research	Poland	2013
Joslin	An investigation into the expression of uncertainty in property valuations	United Kingdom	2005
French & Gabrielli	The uncertainty of valuation	United Kingdom	2004

APPENDIX 3. REMAINING CRITERIA AFTER SELECTION STEP 1

1	**Well-being and health**
	Percentage glass in facade
	Preventing light disturbance
	Type of building ventilation
	Temperature regulation
	Availability relax room inside or outside
	View
	Ventilation, influence by users
	Lighting control
	Location intakes to air outlets
	Climate; local extraction systems
	Radiation exposure
	Ecological construction materials
	Interior lighting
	Air Conditioning age
	Mechanical ventilation age
	Natural ventilation
	Capacity for alternative cooling system
	Noise exposure
2	**Energy**
	Energy coefficient (EPC)
	Own meter per user
	Energy sub meter
	Renewable energy and carbon offsets
	Modern building management system
	Movement sensitive/auto-off lighting
	Low energy lighting
	Access to a local renewable energy source
	A CHP plant
3	**Transport**
	Facilities for cyclists
	Proximity to public transport (OV)
	Near basics
	Safety cyclists and pedestrians for deliveries
	Shared facilities
	Restrict parking
	Adequate parking
	Bicycle racks
	Showers
4	**Water**
	Metering water consumption
	Urinals
	Sinks with water-saving faucet
	Showers with low water consumption

	Using collected rainwater
	Used collected grey water
	Toilets with motion sensors
	Leak detection central water supply
	Percentage of equipment with shut-off valves
	Use of grey water
	Storage tank for grey water and rainwater
	Separate sewer system for rainwater
	Low flush toilets
	Dual flush toilets
	Controlled taps
	Controlled flush urinals
	Washroom control system
	Rainwater harvesting
	Grey water recycling
5	**Materials**
	Burglar alarm system, presence
	Burglar alarm system, by notification
	Adaptability building
	Environmental impact materials of the building
	Recycling
	Protection against damage
	Ecological materials
6	**Waste**
	Facilities for separated waste
	Accessible waste storage facilities
	Adequate waste storage facilities
	Centrally controlled recycling service
	Municipal recycling service
7	**Land use and ecology**
	Type of landscape on the plot
	Green roofs, walls, planters
	Facilities for animals
	Location regarding natural hazards
8	**Pollution**
	Discharges to surface waters
	Flood asset
	Sub-sensitive areas
	Cooling with CFK's or HCFK's
	Cooling systems with refrigerants
	Use refrigerants for refrigeration
9	**Adaptability**
	Regular footprint
	Plant depth 15-18 m
	Colum grid> 7,5 m
	Floor - ceiling height >= 2,7 m

Raised floors
VAV, fan coil or no air-conditioning
Is this property adaptable across use
Accessibility, reserve capacity and wiring/pipes/building services
Wheelchair accessibility

APPENDIX 4. CRITERIA VALIDATION ONLINE RESULTS

	Remaining criteria after selection step 2	Clicks out of 15	Deleted
1	**Well-being and health**		
	Daylight	7	
	Type of building ventilation	8	
	Temperature regulation	4	x
	Availability relax room inside or outside	5	x
	View	6	x
	Ventilation, influence by users	7	
	Lighting control	6	x
	Climate; local extraction systems	6	x
	Radiation exposure	4	x
	Noise exposure	8	
	Acoustics	7	
	Functional	7	
2	**Energy**		
	Energy coefficient (EPC)	5	x
	Own meter per user	3	x
	CO2- emission	11	
	Modern building management system	6	x
	Access to a local renewable energy source	10	
	Actual consumption per square meter	7	
3	**Transport**		
	Facilities for cyclists	12	
	Proximity to public transport (OV)	12	
	Near basics	8	
	Restrict parking	3	x
	Adequate parking	3	x
	Shared facilities	5	x
	Collective use of cars	6	x
4	**Water**		
	Metering water consumption	7	
	Urinals	4	x
	Sinks with water-saving faucet	5	x
	Showers with low water consumption	5	x
	Using collected rainwater and grey water	10	
	Toilets with motion sensors	5	x
	Separate sewer system for rainwater	7	
5	**Materials**		
	Environmental impact materials of the building	8	
	Recycling	7	

	Ecological materials	9	
	Re-usability	9	
	Reduce maintenance costs	4	x
	Low emission-materials	6	x
6	**Waste**		
	Facilities for separated waste	12	
	Adequate waste storage facilities	3	x
7	**Land use and ecology**		
	Type of landscape on the plot	8	
	Green roofs, walls, planters	5	x
	Re-use soil	5	x
8	**Pollution**		
	Discharges to surface waters	8	
	Cooling with CFK's or HCFK's	7	
	Cooling systems with refrigerants	6	x
9	**Adaptability**		
	Regular footprint	5	x
	Plant depth	5	x
	Colum grid	5	x
	Floor - ceiling height	3	x
	Raised floors	2	x
	Is this property adaptable across use	10	
	Accessibility, reserve capacity and wiring/pipes/building services	7	
	Wheelchair accessibility	6	x
	Flex-factor	5	x

APPENDIX 5. ONLINE SURVEY FUZZY DELPHI METHOD

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Criteria duurzaam kantoorgebouw

Page: Welkom

Welkom, fijn dat u wilt deelnemen aan deze survey!

Deze survey bestaat uit twee onderdelen.

Het eerste onderdeel omvat 9 categorieën:

- Gezondheid
- Energie
- Transport
- Water
- Materialen
- Afval
- Landgebruik en ecologie
- Vervuiling
- Adaptief vermogen

Bij elke categorie horen een aantal criteria. Deze criteria zijn door middel van eerdere surveys vastgesteld. Per criterium wordt er gevraagd aan te geven hoe belangrijk u dit criterium vindt als fysieke eigenschap voor een duurzaam kantoorgebouw. Daarna wordt er gevraagd welke criteria invloed hebben op bepaalde aspecten van duurzaam kantoorvastgoed.

Het tweede onderdeel bestaat uit een aantal vragen over het taxeren van duurzaam kantoorvastgoed. In de survey wordt duidelijk aangegeven wanneer onderdeel twee begint.

In totaal duurt het invullen van de survey 10 tot 15 minuten. Gedurende het invullen van de survey kunt u uw antwoorden aanpassen. Wanneer u op versturen klikt worden uw antwoorden verzonden en kunt u deze niet meer aanpassen.

Met vriendelijke groet,
Maud Deenen

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Criteria duurzaam kantoorgebouw

Page: Gezondheid

Hoe belangrijk vindt u onderstaande criteria als fysieke eigenschap van een duurzaam kantoorgebouw in de categorie 'Gezondheid'?

	Zeer onbelangrijk	Heel onbelangrijk	Onbelangrijk	Redelijk belangrijk	Belangrijk	Heel belangrijk	Zeer belangrijk
C1 - Daglicht	○	○	○	○	○	○	○
C2 - Blootstelling aan lawaai	○	○	○	○	○	○	○
C3 - Type gebouwventilatie	○	○	○	○	○	○	○
C4 - Ventilatie beïnvloeding door gebruikers	○	○	○	○	○	○	○
C5 - Akoestiek	○	○	○	○	○	○	○
C6 - Functioneel	○	○	○	○	○	○	○

C1 - Daglicht: Werkplekken beschikken over voldoende daglicht
C2 - Blootstelling aan lawaai: Mogelijke blootstelling gebruiker aan lawaai van buiten bijv. door onvoldoende isolatie in de gevel
C3 - Type gebouwventilatie: Ventilatie strategie: natuurlijke toevoer, natuurlijke toevoer en mechanische afvoer of mechanische toevoer en mechanische afvoer
C4 - Ventilatie beïnvloeding door gebruikers: Ventilatie is beïnvloedbaar door gebruikers, door bijv. het openen van een raam of het aanpassen van het luchtdebiet
C5 - Akoestiek: Akoesitsche maatregelen zoals een goed absorberend systeemplafond en absorberende wanden
C6 - Functioneel: Functionaliteit installaties

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Criteria duurzaam kantoorgebouw

Page: Energie

Hoe belangrijk vindt u onderstaande criteria als fysieke eigenschap van een duurzaam kantoorgebouw in de categorie 'Energie'?

	Zeer onbelangrijk	Heel onbelangrijk	Onbelangrijk	Redelijk belangrijk	Belangrijk	Heel belangrijk	Zeer belangrijk
C7 - CO2- uitstoot	○	○	○	○	○	○	○
C8 - Duurzame energiebronnen	○	○	○	○	○	○	○
C9 - Feitelijk verbruik per m2	○	○	○	○	○	○	○

C7 - CO2- uitstoot: CO2 uitstoot van het asset
C8 - Duurzame energiebronnen: Aanwezigheid lokaal hernieuwbare bronnen, voorzien x procent van het totale energieverbruik van het asset
C9 - Feitelijk verbruik per m2: Energieverbruik per m2

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Criteria duurzaam kantoorgebouw

Page: Transport

Hoe belangrijk vindt u onderstaande criteria als fysieke eigenschap van een duurzaam kantoorgebouw in de categorie 'Transport'?

	Zeer onbelangrijk	Heel onbelangrijk	Onbelangrijk	Redelijk belangrijk	Belangrijk	Heel belangrijk	Zeer belangrijk
C10 - Faciliteiten voor fietsers	○	○	○	○	○	○	○
C11 - Dichtbij openbaar vervoer (OV)	○	○	○	○	○	○	○
C12 - Dichtbij basisvoorzieningen	○	○	○	○	○	○	○

C10 - Faciliteiten voor fietsers: Aanwezigheid van voldoende verlichte fietsrekken, voldoende kleedruimten en voldoende douchevoorzieningen
C11 - Dichtbij openbaar vervoer (OV): Goed te bereiken openbaar vervoer met regelmatige dienstregeling
C12 - Dichtbij basis voorzieningen: Op loopafstand van pinautomaat, supermarkt, brievenbus, lunchroom etc.

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Criteria duurzaam kantoorgebouw

Page: Water

Hoe belangrijk vindt u onderstaande criteria als fysieke eigenschap van een duurzaam kantoorgebouw in de categorie 'Water'?

	Zeer onbelangrijk	Heel onbelangrijk	Onbelangrijk	Redelijk belangrijk	Belangrijk	Heel belangrijk	Zeer belangrijk
C13 - Gebruik ingezameld hemelwater en grijswater	○	○	○	○	○	○	○
C14 - Waterverbruik meten	○	○	○	○	○	○	○
C15 - Gescheiden riolering voor regenwater	○	○	○	○	○	○	○

C13 - Gebruik ingezameld hemelwater en grijswater: Gebruik ingezameld hemel- en grijswater voor bijv. toiletspoeling, auto wassen, kleding wassen, irrigatie groen etc.
C14 - Waterverbruik meten: Waterverbruik meten bijv. per gebouw, per verdieping of per gebruiker
C15 - Gescheiden riolering voor regenwater: Gescheiden rioolaansluiting voor hemelwater

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Criteria duurzaam kantoorgebouw

Page: Materialen

Hoe belangrijk vindt u onderstaande criteria als fysieke eigenschap van een duurzaam kantoorgebouw in de categorie 'Materialen'?

	Zeer onbelangrijk	Heel onbelangrijk	Onbelangrijk	Redelijk belangrijk	Belangrijk	Heel belangrijk	Zeer belangrijk
C16 - Milieubelasting materialen gebouw	○	○	○	○	○	○	○
C17 - Ecologische materialen	○	○	○	○	○	○	○
C18 - Herbruikbaarheid	○	○	○	○	○	○	○
C19 - Recycling	○	○	○	○	○	○	○

C16 - Milieubelasting materialen van het gebouw: Milieuprestatie coëfficiënt van gebruikte materialen
C17 - Ecologische materialen: Toepassing ecologische materialen in en aan het gebouw
C18 - Herbruikbaarheid: Materialen van en in het gebouw zijn herbruikbaar, opnieuw te gebruiken
C19 - Recycling: Materialen van en in het gebouw zijn recyclebaar, afvalstoffen kunnen worden omgezet in nieuwe producten

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Criteria duurzaam kantoorgebouw

Page: Afval

Hoe belangrijk vindt u onderstaande criteria als fysieke eigenschap van een duurzaam kantoorgebouw in de categorie 'Afval'?

	Zeer onbelangrijk	Heel onbelangrijk	Onbelangrijk	Redelijk belangrijk	Belangrijk	Heel belangrijk	Zeer belangrijk
C20 - Faciliteiten voor gescheiden afvalstromen	○	○	○	○	○	○	○

C20 - Faciliteiten voor gescheiden afvalstromen: Er is voldoende ruimte op het terrein voor het scheiden van verschillende afvalstromen

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Criteria duurzaam kantoorgebouw

Page: Landgebruik & Ecologie

Hoe belangrijk vindt u onderstaande criteria als fysieke eigenschap van een duurzaam kantoorgebouw in de categorie 'Landgebruik & ecologie'?

	Zeer onbelangrijk	Heel onbelangrijk	Onbelangrijk	Redelijk belangrijk	Belangrijk	Heel belangrijk	Zeer belangrijk
C21 - Soort landschap op perceel	○	○	○	○	○	○	○

C21 - Soort landschap op perceel: Landschap aanwezig op perceel bijv. bos, weiland, meer, vijver, rivier, grasland, bebouwd, verhard, etc.

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Criteria duurzaam kantoorgebouw

Page: Vervuiling

Hoe belangrijk vindt u onderstaande criteria als fysieke eigenschap van een duurzaam kantoorgebouw in de categorie 'Vervuiling'?

	Zeer onbelangrijk	Heel onbelangrijk	Onbelangrijk	Redelijk belangrijk	Belangrijk	Heel belangrijk	Zeer belangrijk
C22 - Lozingen op oppervlaktewater	○	○	○	○	○	○	○
C23 - Koeling met CFK's of HCFK's	○	○	○	○	○	○	○

C22 - Lozingen op oppervlaktewater: De gebruiker is in het bezit van een vergunning voor het lozen van oppervlakte water
C23 - Koeling met CFK's of HCFK's: Aanwezigheid koelinstallaties die CFK's of HCFK's of andere stoffen bevatten die de ozonlaag afbreken

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Criteria duurzaam kantoorgebouw

Page: Adaptief vermogen

Hoe belangrijk vindt u onderstaande criteria als fysieke eigenschap van een duurzaam kantoorgebouw in de categorie 'Adaptief vermogen'?

	Zeer onbelangrijk	Heel onbelangrijk	Onbelangrijk	Redelijk belangrijk	Belangrijk	Heel belangrijk	Zeer belangrijk
C24 - Aanpasbaarheid voor verschillende gebruiksfuncties	○	○	○	○	○	○	○
C25 - Toegankelijkheid, reservecapaciteit en bedrading/leidingen/building service	○	○	○	○	○	○	○

C24 - Aanpasbaar voor verschillende gebruiksfuncties: Gebouwindeling is makkelijk aan te passen naar nieuwe gebruiksfunctie
C25 - Toegankelijkheid, reservecapaciteit en bedrading/leidingen/building service: In geval van reparatie zijn de bedrading/leidingen etc. zijn goed bereikbaar voor monteur

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Criteria duurzaam kantoorgebouw

Page: Energiekosten

Welke van de onderstaande criteria hebben invloed op de energiekosten van een duurzaam kantoorgebouw?

- [ ] C1 - Daglicht
- [ ] C2 - Blootstelling aan lawaai
- [ ] C3 - Type gebouwventilatie
- [ ] C4 - Ventilatie beïnvloeding door gebruikers
- [ ] C5 - Akoestiek
- [ ] C6 - Functioneel
- [ ] C7 - CO2 -uitstoot
- [ ] C8 - Duurzame energiebronnen
- [ ] C9 - Feitelijk verbruik per m2
- [ ] C10 - Faciliteiten voor fietsers
- [ ] C11 - Dichtbij openbaar vervoer (OV)
- [ ] C12 - Dichtbij basisvoorzieningen
- [ ] C13 - Gebruik ingezameld hemelwater en grijswater
- [ ] C14 - Waterverbruik meten
- [ ] C15 - Gescheiden riolering voor regenwater
- [ ] C16 - Milieubelasting materialen gebouw
- [ ] C17 - Ecologische materialen
- [ ] C18 - Herbruikbaarheid
- [ ] C19 - Recycling
- [ ] C20 - Faciliteiten voor gescheiden afvalstromen
- [ ] C21 - Soort landschap op perceel
- [ ] C22 - Lozingen op oppervlaktewater
- [ ] C23 - Koeling met CFK's of HCFK's
- [ ] C24 - Aanpasbaarheid voor verschillende gebruiksfuncties
- [ ] C25 - Toegankelijkheid, reservecapaciteit en bedrading/leidingen/building service

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Criteria duurzaam kantoorgebouw

Page: Onderhoudskosten

Welke van de onderstaande criteria hebben invloed op de onderhoudskosten van een duurzaam kantoorgebouw?

- [ ] C1 - Daglicht
- [ ] C2 - Blootstelling aan lawaai
- [ ] C3 - Type gebouwventilatie
- [ ] C4 - Ventilatie beïnvloeding door gebruikers
- [ ] C5 - Akoestiek
- [ ] C6 - Functioneel
- [ ] C7 - CO2 -uitstoot
- [ ] C8 - Duurzame energiebronnen
- [ ] C9 - Feitelijk verbruik per m2
- [ ] C10 - Faciliteiten voor fietsers
- [ ] C11 - Dichtbij openbaar vervoer (OV)
- [ ] C12 - Dichtbij basisvoorzieningen
- [ ] C13 - Gebruik ingezameld hemelwater en grijswater
- [ ] C14 - Waterverbruik meten
- [ ] C15 - Gescheiden riolering voor regenwater
- [ ] C16 - Milieubelasting materialen gebouw
- [ ] C17 - Ecologische materialen
- [ ] C18 - Herbruikbaarheid
- [ ] C19 - Recycling
- [ ] C20 - Faciliteiten voor gescheiden afvalstromen
- [ ] C21 - Soort landschap op perceel
- [ ] C22 - Lozingen op oppervlaktewater
- [ ] C23 - Koeling met CFK's of HCFK's
- [ ] C24 - Aanpasbaarheid voor verschillende gebruiksfuncties
- [ ] C25 - Toegankelijkheid, reservecapaciteit en bedrading/leidingen/building service

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Page: Markthuur

Welke van de onderstaande criteria hebben invloed op de markthuur van een duurzaam kantoorgebouw?

- [ ] C1 - Daglicht
- [ ] C2 - Blootstelling aan lawaai
- [ ] C3 - Type gebouwventilatie
- [ ] C4 - Ventilatie beïnvloeding door gebruikers
- [ ] C5 - Akoestiek
- [ ] C6 - Functioneel
- [ ] C7 - CO2 -uitstoot
- [ ] C8 - Duurzame energiebronnen
- [ ] C9 - Feitelijk verbruik per m2
- [ ] C10 - Faciliteiten voor fietsers
- [ ] C11 - Dichtbij openbaar vervoer (OV)
- [ ] C12 - Dichtbij basisvoorzieningen
- [ ] C13 - Gebruik ingezameld hemelwater en grijswater
- [ ] C14 - Waterverbruik meten
- [ ] C15 - Gescheiden riolering voor regenwater
- [ ] C16 - Milieubelasting materialen gebouw
- [ ] C17 - Ecologische materialen
- [ ] C18 - Herbruikbaarheid
- [ ] C19 - Recycling
- [ ] C20 - Faciliteiten voor gescheiden afvalstromen
- [ ] C21 - Soort landschap op perceel
- [ ] C22 - Lozingen op oppervlaktewater
- [ ] C23 - Koeling met CFK's of HCFK's
- [ ] C24 - Aanpasbaarheid voor verschillende gebruiksfuncties
- [ ] C25 - Toegankelijkheid, reservecapaciteit en bedrading/leidingen/building service

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Page: Arbeidsproductiviteit

Welke van de onderstaande criteria hebben invloed op de arbeidsproductiviteit binnen een duurzaam kantoorgebouw?

- [ ] C1 - Daglicht
- [ ] C2 - Blootstelling aan lawaai
- [ ] C3 - Type gebouwventilatie
- [ ] C4 - Ventilatie beïnvloeding door gebruikers
- [ ] C5 - Akoestiek
- [ ] C6 - Functioneel
- [ ] C7 - CO2 -uitstoot
- [ ] C8 - Duurzame energiebronnen
- [ ] C9 - Feitelijk verbruik per m2
- [ ] C10 - Faciliteiten voor fietsers
- [ ] C11 - Dichtbij openbaar vervoer (OV)
- [ ] C12 - Dichtbij basisvoorzieningen
- [ ] C13 - Gebruik ingezameld hemelwater en grijswater
- [ ] C14 - Waterverbruik meten
- [ ] C15 - Gescheiden riolering voor regenwater
- [ ] C16 - Milieubelasting materialen gebouw
- [ ] C17 - Ecologische materialen
- [ ] C18 - Herbruikbaarheid
- [ ] C19 - Recycling
- [ ] C20 - Faciliteiten voor gescheiden afvalstromen
- [ ] C21 - Soort landschap op perceel
- [ ] C22 - Lozingen op oppervlaktewater
- [ ] C23 - Koeling met CFK's of HCFK's
- [ ] C24 - Aanpasbaarheid voor verschillende gebruiksfuncties
- [ ] C25 - Toegankelijkheid, reservecapaciteit en bedrading/leidingen/building service

Welke van de onderstaande criteria hebben invloed op het ziekteverzuim binnen een duurzaam kantoorgebouw?

- [ ] C1 - Daglicht
- [ ] C2 - Blootstelling aan lawaai
- [ ] C3 - Type gebouwventilatie
- [ ] C4 - Ventilatie beïnvloeding door gebruikers
- [ ] C5 - Akoestiek
- [ ] C6 - Functioneel
- [ ] C7 - CO2 -uitstoot
- [ ] C8 - Duurzame energiebronnen
- [ ] C9 - Feitelijk verbruik per m2
- [ ] C10 - Faciliteiten voor fietsers
- [ ] C11 - Dichtbij openbaar vervoer (OV)
- [ ] C12 - Dichtbij basisvoorzieningen
- [ ] C13 - Gebruik ingezameld hemelwater en grijswater
- [ ] C14 - Waterverbruik meten
- [ ] C15 - Gescheiden riolering voor regenwater
- [ ] C16 - Milieubelasting materialen gebouw
- [ ] C17 - Ecologische materialen
- [ ] C18 - Herbruikbaarheid
- [ ] C19 - Recycling
- [ ] C20 - Faciliteiten voor gescheiden afvalstromen
- [ ] C21 - Soort landschap op perceel
- [ ] C22 - Lozingen op oppervlaktewater
- [ ] C23 - Koeling met CFK's of HCFK's
- [ ] C24 - Aanpasbaarheid voor verschillende gebruiksfuncties
- [ ] C25 - Toegankelijkheid, reservecapaciteit en bedrading/leidingen/building service

APPENDIX 6. OVERVIEW CLICKS FOR EACH CRITERION ON EACH ASPECT

C	Criteria*	Energy costs	Maintenance costs	Market rent	Productivity	Absenteeism	Total clicks
C1	**Daylight**	48	7	57	67	65	244
C2	**Noise exposure**	5	2	39	66	65	177
C3	**Type of building ventilation**	64	54	45	55	62	280
C4	**Ventilation, influence by users**	57	38	29	55	56	235
C5	**Acoustics**	2	8	36	67	57	170
C6	**Functional**	13	28	61	39	22	163
C7	CO2- emission	23	10	15	5	10	63
C8	**Access to local renewable energy sources**	53	37	35	1	3	129
C9	**Actual consumption per square meter**	42	14	51	4	3	114
C10	Facilities for cyclists	5	11	26	24	13	79
C11	**Proximity to public transport**	8	3	61	27	14	113
C12	**Near basics**	4	0	55	34	12	105
C13	Metering water consumption	12	16	7	1	1	37
C14	Using collected rain and grey water	20	10	7	1	0	38
C15	Separate sewer system for rainwater	8	28	10	0	0	46
C16	Environmental impact materials of building	11	17	9	5	2	44
C17	Recycling	9	32	10	2	2	55
C18	Ecological materials	7	25	10	1	0	43
C19	Re- usability	6	17	10	0	0	33
C20	Facilities for separated waste	6	23	12	28	0	69
C21	Type of landscape on the plot	5	10	29	1	11	56
C22	Discharges to surface waters	4	7	5	5	0	21
C23	Cooling with CFK's or HCKF's	30	32	11	17	5	95
C24	**Is this property adaptable across use**	14	26	45	10	10	105
C25	**Accessibility, reserve capacity and wiring/pipes/building services**	8	35	25	1	5	74

*The bold criteria are selected by the Fuzzy Delphi Method

APPENDIX 7. ONLINE SURVEY QUALITATIVE

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Criteria duurzaam kantoorgebouw

Page: Onderdeel 2

Onderdeel 2 Stellingen en vragen

Eerst worden er 4 stellingen aan u voorgelegd betreft het taxeren van duurzaam kantorenvastgoed. U kunt hierbij aangeven in welke mate u het eens/oneens bent met de stelling.

Daarna worden er 6 vragen gesteld betreft de weging van enkele aspecten van duurzaam kantorenvastgoed in de DCF-methode.

Vorige | Volgende

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Criteria duurzaam kantoorgebouw

Page: Stelling 1

Duurzaamheid moet zwaarder wegen in taxaties van kantorenvastgoed.

- Zeer mee eens
- Eens
- Oneens
- Zeer mee oneens

Technische Universiteit Eindhoven University of Technology

Criteria duurzaam kantoorgebouw

Page: Stelling 2

Duurzame kantoorgebouwen brengen vele voordelen met zich mee voor de gebruiker waaronder, reductie van het ziekteverzuim, toename arbeidsproductiviteit, een beter imago en een lagere energierekening.
Een goede klimaatbeheersing verhoogt bijvoorbeeld de productiviteit met 11% door betere ventilatie en met 3% door individuele beïnvloeding van de temperatuur.
Door een aangenaam akoestisch klimaat, goed uitzicht en voldoende daglicht kan het ziekteverzuim worden beperkt. (DGBC,2014)
Door deze voordelen kan de gebruiker vele financiële voordelen behalen door huisvesting in een duurzaam kantoorgebouw ten opzichte van huisvesting in een niet duurzaam kantoorgebouw.

Ziekteverzuim en arbeidsproductiviteit moeten meewegen in taxaties van duurzaam kantorenvastgoed.

- Zeer mee eens
- Eens
- Oneens
- Zeer mee oneens

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Criteria duurzaam kantoorgebouw

Page: Stelling 3

Imago moet meewegen in taxaties van duurzaam kantorenvastgoed.

- Zeer mee eens
- Eens
- Oneens
- Zeer mee oneens

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Criteria duurzaam kantoorgebouw

Page: Stelling 4

Het verduurzamen van bestaand kantorenvastgoed vindt eerder plaats wanneer ziekteverzuim en arbeidsproductiviteit worden meegenomen in de waardering.

- Zeer mee eens
- Eens
- Oneens
- Zeer mee oneens

Geef per methodiek aan in hoeveel procent van de gevallen u deze toe past bij taxaties van kantoorvastgoed? (totaal = 100%)

BAR -methode	Zonder % teken
NAR -methode	Zonder % teken
DCF -methode	Zonder % teken
Comparatieve methode (o.b.v. referenties)	Zonder % teken
Anders:	Methode + percentage

Stel, een nieuwe manier van waarderen wordt toegepast op basis van de DCF- methode, waarbij de disconteringsvoet wordt gedifferentieerd in verschillende risicoprofielen. Welke bandbreedte zou u toekennen aan de volgende aspecten: energiebesparingen, onderhoudskosten, arbeidsproductiviteit en ziekteverzuim?

Hoe groot zou de disconteringsvoet voor de energiebesparing moeten zijn bij een duurzaam kantoorgebouw?

- [ ] < 5 %
- [ ] 5 - 7 %
- [ ] 7 - 9 %
- [ ] 9 - 11 %
- [ ] 11 - 13 %
- [ ] 13 - 15 %
- [ ] > 15 %

Onder onderhoudskosten worden verstaan: de bouwkundige maatregelen en intallaties

Hoe groot zou de disconteringsvoet voor de onderhoudskosten moeten zijn bij een duurzaam kantoorgebouw?

- [ ] < 5 %
- [ ] 5 - 7 %
- [ ] 7 - 9 %
- [ ] 9 - 11 %
- [ ] 11 - 13 %
- [ ] 13 - 15 %
- [ ] > 15 %

Hoe groot zou de disconteringsvoet voor arbeidsproductiviteit moeten zijn bij een duurzaam kantoorgebouw?

- [ ] < 5 %
- [ ] 5 - 7 %
- [ ] 7 - 9 %
- [ ] 9 - 11 %
- [ ] 11 - 13 %
- [ ] 13 - 15 %
- [ ] > 15 %

Hoeveel procent neemt de exit yield toe dan wel af wanneer een kantoorgebouw duurzaam is? (standaard is 10%)

- [x] 0 tot 5 %
- [ ] 5 tot 10 %
- [ ] 10 tot 15 %
- [ ] 15 tot 20 %
- [ ] 0 tot -5 %
- [ ] - 5 tot - 10 %
- [ ] -10 tot -15 %

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Criteria duurzaam kantoorgebouw

Hoeveel procent neemt de exit yield toe dan wel af wanneer het kantoorgebouw energieneutraal is? (standaard = 10%)

- [x] 0 tot 5 %
- [ ] 5 tot 10 %
- [ ] 10 tot 15 %
- [ ] 15 tot 20 %
- [ ] 0 tot -5 %
- [ ] - 5 tot - 10 %
- [ ] -10 tot -15 %
- [ ] -15 % tot - 20 %

Wanneer u op 'versturen' klikt worden uw antwoorden verzonden en kunt u deze niet meer aanpassen.

Vorige | Versturen

APPENDIX 8. OVERVIEW USE OF VALUATION METHODS

Statistics

		NAR	DCF	COM	Anders	BAR
N	Valid	88	88	88	88	88
	Missing	0	0	0	0	0
Mean		58,40	50,14	40,47		40,13

NAR

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	12	13,6	13,6	13,6
	5	2	2,3	2,3	15,9
	7	1	1,1	1,1	17,0
	8	1	1,1	1,1	18,2
	10	4	4,5	4,5	22,7
	20	3	3,4	3,4	26,1
	25	3	3,4	3,4	29,5
	30	3	3,4	3,4	33,0
	33	1	1,1	1,1	34,1
	40	6	6,8	6,8	40,9
	45	2	2,3	2,3	43,2
	50	5	5,7	5,7	48,9
	60	2	2,3	2,3	51,1
	65	1	1,1	1,1	52,3
	70	1	1,1	1,1	53,4
	80	3	3,4	3,4	56,8
	85	1	1,1	1,1	58,0
	90	4	4,5	4,5	62,5
	97	1	1,1	1,1	63,6
	99	1	1,1	1,1	64,8
	100	31	35,2	35,2	100,0
	Total	88	100,0	100,0	

DCF

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	9	10,2	10,2	10,2
	4	1	1,1	1,1	11,4
	5	2	2,3	2,3	13,6
	10	8	9,1	9,1	22,7
	15	2	2,3	2,3	25,0
	20	8	9,1	9,1	34,1
	25	7	8,0	8,0	42,0
	30	2	2,3	2,3	44,3
	33	1	1,1	1,1	45,5
	35	2	2,3	2,3	47,7
	40	4	4,5	4,5	52,3
	50	8	9,1	9,1	61,4
	60	1	1,1	1,1	62,5
	65	1	1,1	1,1	63,6
	75	1	1,1	1,1	64,8
	80	3	3,4	3,4	68,2
	90	1	1,1	1,1	69,3
	100	27	30,7	30,7	100,0
	Total	88	100,0	100,0	

COM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	26	29,5	29,5	29,5
	1	1	1,1	1,1	30,7
	5	4	4,5	4,5	35,2
	10	9	10,2	10,2	45,5
	15	1	1,1	1,1	46,6
	20	4	4,5	4,5	51,1
	25	8	9,1	9,1	60,2
	30	1	1,1	1,1	61,4
	33	1	1,1	1,1	62,5
	50	1	1,1	1,1	63,6
	65	1	1,1	1,1	64,8
	70	1	1,1	1,1	65,9

	75	3	3,4	3,4	69,3
	90	1	1,1	1,1	70,5
	95	1	1,1	1,1	71,6
	97	1	1,1	1,1	72,7
	100	24	27,3	27,3	100,0
	Total	88	100,0	100,0	

BAR

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	25	28,4	28,4	28,4
	5	2	2,3	2,3	30,7
	10	11	12,5	12,5	43,2
	15	2	2,3	2,3	45,5
	20	3	3,4	3,4	48,9
	25	5	5,7	5,7	54,5
	30	3	3,4	3,4	58,0
	40	3	3,4	3,4	61,4
	45	1	1,1	1,1	62,5
	50	5	5,7	5,7	68,2
	65	1	1,1	1,1	69,3
	75	2	2,3	2,3	71,6
	90	2	2,3	2,3	73,9
	97	1	1,1	1,1	75,0
	99	1	1,1	1,1	76,1
	100	21	23,9	23,9	100,0
	Total	88	100,0	100,0	

APPENDIX 9. OVERVIEW DISCOUNT RATES AND EXIT YIELDS

V1= Discount rate energy savings
V2= Discount rate maintenance costs
V3= Productivity
V_4= Absenteeism
V5= Exit yield sustainable building
V6= Exit yield energy neutral building

Statistics

		V1	V2	V3	V_4	V5	V6
N	Valid	88	88	88	88	88	85
	Missing	0	0	0	0	0	3
Mean		2,52	2,58	2,35	2,27	3,25	3,26
Median		2,00	2,00	2,00	2,00	3,00	3,00

V1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 5 %	17	19,3	19,3	19,3
	5 - 7 %	33	37,5	37,5	56,8
	7 - 9 %	23	26,1	26,1	83,0
	9 - 11 %	11	12,5	12,5	95,5
	11 - 13 %	1	1,1	1,1	96,6
	> 15 %	3	3,4	3,4	100,0
	Total	88	100,0	100,0	

V2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 5 %	18	20,5	20,5	20,5
	5 - 7 %	28	31,8	31,8	52,3
	7 - 9 %	25	28,4	28,4	80,7
	9 - 11 %	13	14,8	14,8	95,5
	11 - 13 %	1	1,1	1,1	96,6
	> 15 %	3	3,4	3,4	100,0
	Total	88	100,0	100,0	

V3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 5 %	29	33,0	33,0	33,0
	5 - 7 %	23	26,1	26,1	59,1
	7 - 9 %	18	20,5	20,5	79,5
	9 - 11 %	14	15,9	15,9	95,5
	11 - 13 %	2	2,3	2,3	97,7
	13 - 15 %	2	2,3	2,3	100,0
	Total	88	100,0	100,0	

V_4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 5 %	34	38,6	38,6	38,6
	5 - 7 %	18	20,5	20,5	59,1
	7 - 9 %	20	22,7	22,7	81,8
	9 - 11 %	12	13,6	13,6	95,5
	11 - 13 %	2	2,3	2,3	97,7
	13 - 15 %	2	2,3	2,3	100,0
	Total	88	100,0	100,0	

V5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 tot 5 %	13	14,8	14,8	14,8
	5 tot 10 %	28	31,8	31,8	46,6
	10 tot 15 %	16	18,2	18,2	64,8
	15 tot 20 %	3	3,4	3,4	68,2
	0 tot -5 %	15	17,0	17,0	85,2
	- 5 tot - 10 %	9	10,2	10,2	95,5
	-10 tot -15 %	4	4,5	4,5	100,0
	Total	88	100,0	100,0	

V6

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 tot 5 %	16	18,2	18,8	18,8
	5 tot 10 %	22	25,0	25,9	44,7
	10 tot 15 %	18	20,5	21,2	65,9
	15 tot 20 %	5	5,7	5,9	71,8
	0 tot -5 %	10	11,4	11,8	83,5
	- 5 tot - 10 %	6	6,8	7,1	90,6
	-10 tot -15 %	7	8,0	8,2	98,8
	-15 % tot - 20 %	1	1,1	1,2	100,0
	Total	85	96,6	100,0	
Missing	System	3	3,4		
Total		88	100,0		

APPENDIX 10. TEST CASE VALUATION MODEL

Building information	
Location	Amsterdam
Type location	Business park
Building year	After 1990
Renovations	None
Gross floor area	2.570 m2 GFA
Lettable floor area	2.235 m2 LFA
Current rent	€ 120 per m2 LFA

Additional building information	
Gas consumption (per year)	22.000 m3/year
Electricity consumption (per year)	170.730 kWh/year
Staff organization	196
Number off FTEs	182
Salary costs per FTE	€ 51.000
Average occupancy (year)	80%
Number of gross floor area per employee	13,1 m2
Absenteeism rate	3,5%
Planned maintenance budget	€ 20.000
Exit yield no investments	12%
Structural vacancy no investment	15% within 10 years

APPENDIX 11. RENEWED VALUATION MODEL APPLICATION

Handleiding taxatiemodel

Het DCF- model is de basis van dit taxatiemodel. Aan dit model is een gedeelte toegevoegd zodat de duurzaamheid van een gebouw meegenomen kan worden in de waardering
Het invullen van het model dient te gebeuren op onderstaande volgorde:

1. Gebouwgegevens invoeren op het tabblad 'Basisgegevens'.
   De disconteringspercentages voor energiebesparing (8%), onderhoudskosten(2%), ziekteverzuim(13%) en arbeidsproductiviteit(13%) zijn vastgesteld d.m.v. uitvoerig onderzoek.
   De disconteringspercentages voor de markthuur en de kosten kunnen worden bepaald door eigen inzicht van de taxateur
2. Gegevens invoeren op het tabblad 'Duurzaam'.
   De exit yield voor een duurzaam gebouw is vastgesteld door uitvoering onderzoek op xx% maar kan naar eigen inzien van de taxateur worden bijgesteld wanneer gebouw niet ''volledig'' duurzaam is.
   Energiebesparing:
      Huidige energietarieven invullen exlc. BTW
      Energieverbruik invullen vóór verduurzamingsmaatregelen
      Besparing energiekosten: gemiddelde besparing energiekosten na verduurzamingsmaatregelen ligt tussen de 20 - 30%
   Onderhoudskosten:
      Percentage onderhoudskosten van totale markthuur: standaard percentage niet duurzaam kantoorvastgoed ligt op 10%
      Reductie onderhoudskosten duurzaam gebouw: naar inzien van taxateur te bepalen of dit percentage toe dan wel af neemt bij duurzaam kantoorvastgoed
   Ziekteverzuim:
      Ziekteverzuim gemiddeld: gemiddelde ziekteverzuim Nederland 3,7%
      Reductie ziekteverzuim: naar inschatting van de taxateur reductie naar aanleiding van duurzame huisvesting
   Arbeidsproductiviteit:
      Stijging productiviteit: naar inschatting van de taxateur stijging productiviteit naar aanleiding van duurzame huisvesting
3. Wanneer alle gegevens zijn ingevuld is op het tabblad 'DCF' de uitkomst te zien.
   Wanneer van toepassing kunnen op dit tabblad de incidentiele kasstromen nog worden ingevoerd.

Uitleg kleuren:

Input: handmatig invullen

Input: belangrijke percentages te schatten door taxateur t.b.v. besparingen

In de tabel hieronder worden feitelijke cijfers gegeven welke de taxateur helpen met het inschatten van bovengenoemde percentages

Temerpatuur		**Productiviteit**
Overhitting		
A	Percentage glas x ZTA* waarde beperkt (<15) en volledige koeling (To max = 24°C)	0,0%
B	Percentage glas x ZTA waarde beperkt (<15) en beperkte koeling of PGxZTA laag (<8) en geen koeling (To max = 26°C	-0,5%
C	Percentage glas x ZTA waarde beperkt (<15) en geen koeling of PGxZTA hoog (>15) en beperkte koeling (To max = 28°C)	-1,5%
D	Percentage glas x ZTA waarde hoog (>15) en geen koeling (To max = 30°C)	-2,5%
Onderkoeling		
A	Thermische isolatie en luchtdichtheid gevel goed (BB niveau +1995) en mechanische ventilatie of idem en zelfregelende natuurlijke toevoer incl. tochtplank of een andere anti-tocht voorziening (To min =20°)	0,0%
B	Thermische isolatie en luchtdichtheid gevel goed (BB niveau 1995+) & niet-zelfregelende natuurlijke toevoer zonder tochtplank (To min = 20 °C, periodiek met tocht)	-0,5%
C	Thermische isolatie en luchtdichtheid gevel matig met dubbel glas (bouwjaar 1970-1995) (To min = 18 °C)	-1,0%
D	Thermische isolatie en luchtdichtheid gevel slecht met enkel glas (bouwjaar voor 1970) (To min = 16 °C)	-1,5%
Temerpatuur beïnvloeding		
A	Thermostatische temperatuurknop aanwezig voor beïnvloeding verwarming en koeling of idem maar dan temperatuurbeïnvloeding zomer indirect mogelijk via gebruik handmatig bediende / overrulebare zonwering	0,0%
B	Thermostatische regelknop aanwezig alleen voor handmatige beïnvloeding verwarming	-1,0%
C	Niet-thermostatische regelknop aanwezig voor handmatige beïnvloeding verwarming	-2,0%
D	Geen temperatuurknop aanwezig of overwegend open werkvloeren	-4,0%

**ZTA = De zontoetredingsfactor van een raam of beglazingssysteem, geeft de verhouding tussen de binnenkomende en de opvallende zonnestraling*

Luchtkwaliteit

Luchttoevoer		
A	Luchttoevoer basisventilatiesysteem hoog (> 7 L/s p.p.) en te openen ramen	0,0%
B	Luchttoevoer basisventilatiesysteem hoog (> 7 L/s p.p.) en geen te openen ramen	-1,5%

C	Luchttoevoer basisventilatiesysteem laag (< 7 L/s p.p.) en te openen ramen	-2,5%
D	Luchttoevoer basisventilatiesysteem laag (< 7 L/s p.p.) en geen te openen ramen	-4,0%
Verontreiniging		
A	Geen verontreinigingsbronnen	0,0%
B	Één van de volgende 3 verontreinigingsbronnen is aanwezig: 1. vervuilde, textiele interieurmaterialen >10 jr oud, 2. nieuwe, sterk geurende interieurmaterialen (<1 jr oud), 3. vervuild mechanisch ventilatiesysteem incl. luchtfilter >12 maanden oud	-2,0%
C	Als bij B, maar 2 van de 3 verontreinigingsbronnen aangwezig	-2,5%
D	Als bij B, maar 3 van de 3 verontreinigingbronnen aanwezig	-3,0%
Geluid		
Betekenisvol geluid		
A	Overwegend 1- en 2-persoons kamers (STI** < 0,2)	0,0%
B	Overwegend 3- tot 6-persoons kamers (STI < 0,2)	-3,0%
C	Overwegend open werkvloeren en akoestisch goed dempende ruimten bv. t.g.v. volledig akoestisch absorberend plafonds en textiele vloerbedekking (STI 0,3 a 0,4)	-4,0%
D	Overwegend open werkvloeren en akoestisch slecht dempende ruimten bv. t.g.v. gebruik van hoofdzakelijk harde interieurmaterialen (STI > 0,6)	-7,0%
Niet betekenisvol geluid		
A	Achtergrondgeluidniveau t.g.v. installaties en bronnen buiten (bv. verkeer) laag (< 35 dB(A) totaal)	0,0%
B	Achtergrondgeluidniveau t.g.v. installaties en bronnen buiten middelmatig (35-40 dB(A) totaal)	-1,0%
C	Achtergrondgeluidniveau t.g.v. installaties en bronnen buiten verhoogd (40-45 dB(A) totaal)	-1,5%
D	Achtergrondgeluidniveau t.g.v. installaties en bronnen buiten hoog (> 45 dB(A) totaal)	-2,0%
***STI = Speech Transmission Index, grootheid om de spraakverstaanbaarheid te karakteriseren*		
Licht		
Kunstlicht		
A	Verlichtingsniveau in taakzones >500 lux en overal uplighters of beeldschermvriendelijke armaturen (UGR*** waarde < 19)	0,0%
B	Verlichtingsniveau in taakzones < 500 lux en overal uplighters of beeldschermvriendelijke armaturen (UGR waarde < 19)	-1,0%
C	Verlichtingsniveau in taakzones > 500 lux en (deels) niet- beeldschermvriendelijke armaturen (UGR waarde > 19)	-2,5%
D	Verlichtingsniveau in taakzones < 500 lux en (deels) niet- beeldschermvriendelijke armaturen (UGR waarde > 19)	-3,0%
Daglichtwering		
A	Beeldschermvriendelijke, handmatig instelbare binnenlichtwering	0,0%
B	Beeldschermvriendelijke, handmatig instelbare (overrulebare) buitenzonwering bv. in de vorm van screens, jaloezieën of uitvalschermen	-2,0%
C	Niet-beeldschermvriendelijke instelbare binnenlichtwering of centraal geregelde (niet handmatig te overrulen) beeldschermvriendelijke buitenzonwering	-3,0%
D	Geen binnenlichtwering dan wel buitenzonwering aanwezig	-5,0%
****URG = Unified Glare Rating. Dit is een getal dat aangeeft in welke mate armaturen en hun werking in de ruimte lichthinder veroorzake vanuit de ooghoogte en kijkrichting van de gebruiker.*		
Bron: BBA Binnenmilieu - Kentallen binnenmilieu & productiviteit ten behoeve van de EET value case tool, ir. A.C. Boerstra & ir. F. van Dijken (2015,		

Lucht			**Productiviteit**
Luchttoevoer			
A	Verdubbeling luchttoevoer (buitenlucht)	+	1,5%
Bron: Wargocki et al.(2008), Seppänen et al. (2006a)			
Persoonlijke beïnvloeding			
A	Combinatie temperatuur en ventilatie	+	6,0%
B	Temperatuur	+	3,0%
Bron: Gezondheid, Welzijn & Productiviteit in Kantoren, DGBC (2015)			

Basisgegevens object

Test Case

d.d. 24-06-2016

Algemeen		
Objectnaam/referentienummer	Test Case	
Straatnaam en huisnummer	Entrada 301	
Postcode	1114 AA	
Woonplaats	Amsterdam	
Taxatiedatum	27-5-2016	
Waardepeildatum	27-5-2016	

Gebouwgegevens		
Bruto vloeroppervlak (BVO)	2.570	m2 bvo
Verhuurbaar vloeroppervlak (VVO)	2.235	m2 vvo
VVO / BVO	0,87	
Bouwjaar	na 1990	
Perceel oppervlak	600	m2
BVO/ perceelopp.	4,28	

Financiële uitgangspunten			
Exploitatieperiode			
Start exploitatie		2016	
Einde exploitatie		2030	
Beschouwingsperiode		15	jaar
Huur			
Markthuur	€	120	per/m2 VVO
Totale markthuur	€	268.200	(basisjaar 2016)
Leegstand			
Huidige leegstand		0,00%	
Structurele leegstand		15,00%	
Structurele leegstand bereikt na		10	jaar
Discontovoet		Defaultwaarden	
Energiebesparing		0,00%	
Onderhoudskosten		0,00%	
Ziekteverzuim		0,00%	
Arbeidsproductiviteit		0,00%	
Markthuur		6,50%	
Zakelijke lasten		4,00%	
Indices		Defaultwaarden	
Inflatie (2006 = 100)		2,00%	
Exploitatiekostenstijging		2,00%	
Energie-index		Geen	
Ziekteverzuim-index		Geen	
Productiviteits-index		Geen	
Overige financiële parameters			
Herbouwwaarde	€	1.000	per/ m2 BVO
Herbouwwaarde, totaal (inclusief BTW)	€	3.109.700	
Exit yield		12,00%	
Kosten koper		6,50%	
BTW		21,00%	

Zakelijke lasten	Tarief		Grondslag
Onroerende zaakbelasting		0,2994%	w.e.v. overige objecten
WOZ-waarde (prijspeil: heden)	€	3.000.000	
Rioolrechten	€	231	aantal eenheden
Aantal eenheden		4,00	
Waterschapslasten		0,0264%	w.e.v.
Premie opstal		0,75%	herbouwwaarde
Assurantiebelasting		21%	
Instandhouding onderhoud		0%	herbouwwaarde
	€	10,00	per m2 BVO
Beheer/ vastgoedmanagement		2,00%	contracthuur
Leegstand (structureel)		15,00%	huurwaarde
Verhuurcourtage		0,00%	huurwaarde
BTW niet verrekenbaar	€	-	
Erfpachtscanon	€	-	n.v.t.
Servicekosten voor rekening eigenaar	€	-	
Oninbare huren		0,1%	huurwaarde
Overig (nader te specificeren)	€	-	

Additionele gegevens object — Test Case

d.d. 24-06-2016

Algemeen		
A.1 - Waar is uw kantoorgebouw gevestigd?	K - Financiële dienstverlening	
A.2 - Wat is uw SBI-codering?	Kantorenpark	

Binnenmilieu		
B.1 - Wat is de bezettingsgraad van het kantoorgebouw (gemiddelde bezetting gedurende een jaar)	80,00%	
B.2 - Wat is de gemiddelde kamergrootte in het kantoor?	3-6 personen	
B.3 - Zijn er te openen ramen?	Ja	
B.4 - Wanneer is het ventilatiesysteem voor het laatst gereinigd?	Meer dan 10 jaar geleden	
B.5 - Wat voor type vloerbedekking is er (overwegend) toegepast?	Zacht/textiel ouder dan 10 jaar	
B.6 - Welke type interieurmateriaal is er toegepast?	Niet geurend	
B.7 - Hoe groot acht u het cumulatie-effect (dempingsfactor) voor de toename van de productiviteit als gevolg van individuele fysieke maatregelen (binnenmilieu) met elk een individuele impact op arbeidsproductiviteit?	0,00%	
B.8 - Als de productiviteit van uw organisatie toeneemt, waar heeft het dan invloed op? (hoe kan een productiviteitstoename worden uitgedrukt)	Toename winst	

Ziekteverzuim		
Wat is het ziekteverzuimpercentage (totaal)?	3,50%	
Gemiddelde ziekteverzuimpercentage 2014 Q2 SBI-codering	*2,90%*	
Wat is het ziekteverzuimpercentage t.g.v. kortlopende ziekte?	0,80%	
Wat is uw personeelsverloop in dienst (aantal medewerkers)?	6,00	mdw
Wat is uw personeelsverloop uit dienst (aantal medewerkers)?	18,00	mdw
Maakt u gebruik van een eigen risicodrager?	Nee	
Hoeveel geld is er gedemarceerd in de eigen risicodrager?	€ -	

Financiële uitgangspunten		
Discontovoet	Defaultwaarden	
Energiebesparing	0,00%	
Onderhoudskosten	0,00%	
Ziekteverzuim	0,00%	
Arbeidsproductiviteit	0,00%	
Markthuur	6,50%	
Zakelijke lasten	4,00%	
Indices	Defaultwaarden	
Inflatie (2006 = 100)	2,00%	
Exploitatiekostenstijging	2,00%	
Energie-index	Geen	
Ziekteverzuim-index	Geen	
Productiviteits-index	Geen	
Overige financiële parameters		
Herbouwwaarde	€ 1.000	per/ m2 BVO
Herbouwwaarde, totaal (inclusief BTW)	€ 3.109.700	
Exit yield	12,00%	
Kosten koper	6,50%	
BTW	21,00%	

Indices prijsontwikkeling

d.d. 24-06-2016

Indices prijsontwikkeling															
		2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Inflatie (2006 = 100)		1,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%
Exploitatiekostenstijging		1,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%
Energie-index	Geen	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
Ziekteverzuim-index	Geen	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
Productiviteits-index	Geen	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
Correcties																
Leegstandscorrectie		0,00%	1,50%	3,00%	4,50%	6,00%	7,50%	9,00%	10,50%	12,00%	15,00%	15,00%	15,00%	15,00%	15,00%	15,00%

Additionele gegevens object

Test Case

d.d. 24-06-2016

Gegevens			
Aantal m2 BVO		2.570	
Aantal m2 VVO		2.235	
Totale markthuur	€	268.200	
Werknemers		196	
Totaal aantal fte		182	
Gemiddelde omzet per fte	€	95.000	
Totale omzet	€	17.290.000	per jaar
Salariskosten per fte	€	51.000	
Totale salariskosten (op huidige locatie)	€	9.282.000	per jaar
Aantal m2 per werkplek BVO		13,1	m2
Bezettingsgraad		80%	
Gemiddeld aantal werkdagen per medewerker per jaar		228	

Energiebesparing						kg CO2/ m2 jr
Elektraverbruik per jaar		173.730	kWh/jr			92077
Elektra (per m2 VVO)		77,73				
Gasverbruik per jaar		22.000				11660
Gas (per m2 VVO)		9,84	m3/jr			19
Totaal						**103.755**
Energietarieven						
Elektra per kWh (levering en belasting)						
- 0 - 10.000 kWh	€	0,2512	per kWh			
- 10.000 - 50.000 kWh	€	0,1131	per kWh			
- 50.000 - 10.000.000 kWh	€	0,0815	per kWh			
Gas per m3 (levering en belasting)						
- 0 - 170.000 m3	€	0,4687	per m3			
- 170.000 - 1.000.000 m3	€	0,4246	per m3			
- 1.000.000 - 100.000.000 m3	€	0,3963	per m3			
						CO2 (kg)
Besparing energiekosten in %		0%				
Besparing elektrische energie per jaar		0	kWh	€	-	0
Besparing gas per jaar		0	m3	€	-	0
Totale besparing energiekosten per jaar	**€**	**-**	**m2/VVO**	**€**	**-**	**0**

Onderhoudskosten			
Percentage onderhoudskosten van totale markthuur		10%	
Preventief onderhoud	€	26.820	per jaar
Planmatig onderhoud	€	20.000	per jaar
Correctief onderhoud	€	-	per jaar
Reductie onderhoudskosten duurzaam gebouw		0%	
Onderhoudskosten nieuw per jaar	€	46.820	
Totale besparing onderhoudskosten	**€**	**-**	

Ziekteverzuim		
Ziekteverzuim gemiddeld		3,50%
Ziekteverzuimpercentage t.g.v. kortlopende ziekte		0,80%
Reductie ziekteverzuim		0,00%
Huidige kosten ziekteverzuim	€	324.870
Huidige kosten ziekteverzuim per m2 VVO	€	145,36
Kosten naar reductie ziekteverzuim	€	324.870
Besparing reductie ziekteverzuim per m2 VVO	€	-
Totale besparing reductie ziekteverzuim	**€**	**-**
Dempingsfactor		*0%*
Totale reductie ziekteverzuim na demping	**€**	**-**

Productiviteit		
Verwachte stijging productiviteit		0%
Huidige omzet per jaar	€	17.290.000
Omzet per m2 VVO	€	7.736
Omzet met verbetering productiviteit	€	17.290.000
Verbetering productiviteit omzet per m2 VVO	€	7.736
Opbrengsten stijging productiviteit per jaar per m2 VVO	€	-
Totale verbetering productiviteit per jaar	**€**	**-**
Dempingsfactor		*0%*
Totale verbetering productiviteit na demping	**€**	**-**

DCF inclusief verduurzaming Test Case

d.d. 24-06-2016

Samenvatting berekening			
Totale bruto opbrengst huur	jaar 1	€	268.200
Zakelijke lasten	jaar 1	€	33.344
Netto opbrengsten	jaar 1	€	234.856
Discontovoet			
Energiebesparing			0,00%
Onderhoudskosten			0,00%
Ziekteverzuim			0,00%
Arbeidsproductiviteit			0,00%
Markthuur			6,50%
Zakelijke lasten			4,00%
Exit Yield			12,00%
Maximale investering	Contante waarde kasstromen	€	3.073.142
Correctie v.o.n. naar k.k.	CW kasstromen -/- correctie k.k.	€	2.885.579
Gecorrigeerde marktwaarde		**€**	**2.885.000**

Samenvatting berekening regulier		
Verhuurbaar vloeroppervlakte (vvo)		2.235
Huurprijs per m2 vvo	€	120
Huurprijs (totaal)	€	268.200
Netto aanvangsrendement		9,50%
Beleggingswaarde	**€**	**2.823.158**

Jaar	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Inkomsten															
Markthuur	€ 268.200	€ 273.564	€ 279.035	€ 284.616	€ 290.308	€ 296.114	€ 302.037	€ 308.077	€ 314.239	€ 320.524	€ 326.934	€ 333.473	€ 340.142	€ 346.945	€ 353.884
Leegstandsrisico	€ -	€ -4.186	€ -8.538	€ -13.064	€ -17.767	€ -22.653	€ -27.727	€ -32.995	€ -38.463	€ -49.040	€ -50.021	€ -51.021	€ -52.042	€ -53.083	€ -54.144
Subtotaal	€ 268.200	€ 269.378	€ 270.497	€ 271.552	€ 272.541	€ 273.462	€ 274.310	€ 275.082	€ 275.776	€ 271.484	€ 276.913	€ 282.452	€ 288.101	€ 293.863	€ 299.740
Besparing energie	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Reductie ziekteverzuim	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Vebetering productiviteit	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Besparing onderhoudskosten	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Totaal bruto inkomsten	**€ 268.200**	**€ 269.378**	**€ 270.497**	**€ 271.552**	**€ 272.541**	**€ 273.462**	**€ 274.310**	**€ 275.082**	**€ 275.776**	**€ 271.484**	**€ 276.913**	**€ 282.452**	**€ 288.101**	**€ 293.863**	**€ 299.740**
Zakelijke lasten															
Vaste lasten															
Onroerende zaak belasting	€ 8.982	€ 9.162	€ 9.345	€ 9.532	€ 9.722	€ 9.917	€ 10.115	€ 10.317	€ 10.524	€ 10.734	€ 10.949	€ 11.168	€ 11.391	€ 11.619	€ 11.852
Rioolrechten	€ 924	€ 942	€ 961	€ 981	€ 1.000	€ 1.020	€ 1.041	€ 1.061	€ 1.083	€ 1.104	€ 1.126	€ 1.149	€ 1.172	€ 1.195	€ 1.219
Waterschapslasten	€ 792	€ 808	€ 824	€ 840	€ 857	€ 874	€ 892	€ 910	€ 928	€ 947	€ 965	€ 985	€ 1.004	€ 1.025	€ 1.045
Premie opstal	€ 23	€ 24	€ 24	€ 25	€ 25	€ 26	€ 26	€ 27	€ 27	€ 28	€ 28	€ 29	€ 30	€ 30	€ 31
Assurantiebelasting	€ 5	€ 5	€ 5	€ 5	€ 5	€ 5	€ 6	€ 6	€ 6	€ 6	€ 6	€ 6	€ 6	€ 6	€ 6
Totaal vaste lasten	€ 10.726	€ 10.941	€ 11.160	€ 11.383	€ 11.610	€ 11.843	€ 12.079	€ 12.321	€ 12.567	€ 12.819	€ 13.075	€ 13.337	€ 13.603	€ 13.876	€ 14.153
Beheerkosten															
Verhuurcourtage	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Beheer/ vastgoedmanagement	€ 5.364	€ 5.471	€ 5.581	€ 5.692	€ 5.806	€ 5.922	€ 6.041	€ 6.162	€ 6.285	€ 6.410	€ 6.539	€ 6.669	€ 6.803	€ 6.939	€ 7.078
Totaal beheerkosten	€ 5.364	€ 5.471	€ 5.581	€ 5.692	€ 5.806	€ 5.922	€ 6.041	€ 6.162	€ 6.285	€ 6.410	€ 6.539	€ 6.669	€ 6.803	€ 6.939	€ 7.078
Onderhoudskosten															
Instandhouding onderhoud	€ 22.350	€ 22.797	€ 23.253	€ 23.718	€ 24.192	€ 24.676	€ 25.170	€ 25.673	€ 26.187	€ 26.710	€ 27.245	€ 27.789	€ 28.345	€ 28.912	€ 29.490
Totaal onderhoudskosten	€ 22.350	€ 22.797	€ 23.253	€ 23.718	€ 24.192	€ 24.676	€ 25.170	€ 25.673	€ 26.187	€ 26.710	€ 27.245	€ 27.789	€ 28.345	€ 28.912	€ 29.490
Overige kosten															
Niet verrekenbare BTW	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Oninbare huren	€ 268	€ 274	€ 279	€ 285	€ 290	€ 296	€ 302	€ 308	€ 314	€ 321	€ 327	€ 333	€ 340	€ 347	€ 354
Servicekosten voor rekening eigenaar	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Overig (nader te specifceren)	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Totaal overige kosten	€ 268	€ 274	€ 279	€ 285	€ 290	€ 296	€ 302	€ 308	€ 314	€ 321	€ 327	€ 333	€ 340	€ 347	€ 354
Totaal bruto zakelijke lasten	€ 33.344	€ 34.011	€ 34.692	€ 35.385	€ 36.093	€ 36.815	€ 37.551	€ 38.302	€ 39.068	€ 39.850	€ 40.647	€ 41.460	€ 42.289	€ 43.135	€ 43.997
Netto operationele kasstroom	**€ 234.856**	**€ 235.367**	**€ 235.805**	**€ 236.167**	**€ 236.448**	**€ 236.647**	**€ 236.759**	**€ 236.780**	**€ 236.708**	**€ 231.634**	**€ 236.267**	**€ 240.992**	**€ 245.812**	**€ 250.728**	**€ 255.743**
Incidentele kasstromen	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Groot onderhoud volgens MJOP	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Toekomstige renovatie	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Toekomstige afkoop erfpacht	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Aanvangsleegstand	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Huurconcessies	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Opbrengst bij uitponding	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Totaal incidentiele kasstromen	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -

Totale kasstroom															
Netto kasstroom op jaarbasis	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
	2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Totale inkomsten en uitgaven	€ 234.856	€ 235.367	€ 235.805	€ 236.167	€ 236.448	€ 236.647	€ 236.759	€ 236.780	€ 236.708	€ 231.634	€ 236.267	€ 240.992	€ 245.812	€ 250.728	€ 255.743
Eindwaarde	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ 2.497.833
Ongebonden grond	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Contante waarde kasstromen	€ 214.611	€ 200.996	€ 188.129	€ 175.970	€ 164.485	€ 153.637	€ 143.394	€ 133.724	€ 124.598	€ 113.375	€ 107.865	€ 102.601	€ 97.574	€ 92.772	€ 1.059.410

Totaal NCW =	**€ 3.073.142**

Basisgegevens object

Test Case

d.d. 24-06-2016

Algemeen		
Objectnaam/referentienummer	Test Case	
Straatnaam en huisnummer	Entrada 301	
Postcode	1114 AA	
Woonplaats	Amsterdam	
Taxatiedatum	27-5-2016	
Waardepeildatum	27-5-2016	

Gebouwgegevens		
Bruto vloeroppervlak (BVO)	2.570	m2 bvo
Verhuurbaar vloeroppervlak (VVO)	2.235	m2 vvo
VVO / BVO	0,87	
Bouwjaar	na 1990	
Perceel oppervlak	600	m2
BVO/ perceelopp.	4,28	

Financiële uitgangspunten			
Exploitatieperiode			
Start exploitatie	2016		
Einde exploitatie	2030		
Beschouwingsperiode	15	jaar	
Huur			
Markthuur	€ 120	per/m2 VVO	
Totale markthuur	€ 268.200	(basisjaar 2016)	
Leegstand			
Huidige leegstand	0,00%		
Structurele leegstand	5,00%		
Structurele leegstand bereikt na	10	jaar	
Discontovoet	Defaultwaarden		
Energiebesparing	8,00%		
Onderhoudskosten	2,00%		
Ziekteverzuim	13,00%		
Arbeidsproductiviteit	13,00%		
Markthuur	6,50%		
Zakelijke lasten	4,00%		
Indices	Defaultwaarden		
Inflatie (2006 = 100)	2,00%		
Exploitatiekostenstijging	2,00%		
Energie-index	Gemiddeld		
Ziekteverzuim-index	Gemiddeld		
Productiviteits-index	Gemiddeld		
Overige financiële parameters			
Herbouwwaarde	€ 1.000	per/ m2 BVO	
Herbouwwaarde, totaal (inclusief BTW)	€ 3.109.700		
Exit yield	8,50%		
Kosten koper	6,50%		
BTW	21,00%		

Zakelijke lasten	Tarief		Grondslag
Onroerende zaakbelasting		0,2994%	w.e.v. overige objecten
WOZ-waarde (prijspeil: heden)	€	3.000.000	
Rioolrechten	€	231	aantal eenheden
Aantal eenheden		4,00	
Waterschapslasten		0,0264%	w.e.v.
Premie opstal		0,75%	herbouwwaarde
Assurantiebelasting		21%	
Instandhouding onderhoud		0%	herbouwwaarde
	€	10,00	per m2 BVO
Beheer/ vastgoedmanagement		2,00%	contracthuur
Leegstand (structureel)		5,00%	huurwaarde
Verhuurcourtage		0,00%	huurwaarde
BTW niet verrekenbaar	€	-	
Erfpachtscanon	€	-	n.v.t.
Servicekosten voor rekening eigenaar	€	-	
Oninbare huren		0,1%	huurwaarde
Overig (nader te specificeren)	€	-	

Additionele gegevens object — Test Case

d.d. 24-06-2016

Algemeen		
A.1 - Waar is uw kantoorgebouw gevestigd?	K - Financiële dienstverlening	
A.2 - Wat is uw SBI-codering?	Kantorenpark	

Binnenmilieu		
B.1 - Wat is de bezettingsgraad van het kantoorgebouw (gemiddelde bezetting gedurende een jaar)	80,00%	
B.2 - Wat is de gemiddelde kamergrootte in het kantoor?	3-6 personen	
B.3 - Zijn er te openen ramen?	Ja	
B.4 - Wanneer is het ventilatiesysteem voor het laatst gereinigd?	Meer dan 10 jaar geleden	
B.5 - Wat voor type vloerbedekking is er (overwegend) toegepast?	Zacht/textiel ouder dan 10 jaar	
B.6 - Welke type interieurmateriaal is er toegepast?	Niet geurend	
B.7 - Hoe groot acht u het cumulatie-effect (dempingsfactor) voor de toename van de productiviteit als gevolg van individuele fysieke maatregelen (binnenmilieu) met elk een individuele impact op arbeidsproductiviteit?	30,00%	
B.8 - Als de productiviteit van uw organisatie toeneemt, waar heeft het dan invloed op? (hoe kan een productiviteitstoename worden uitgedrukt)	Toename winst	

Ziekteverzuim		
Wat is het ziekteverzuimpercentage (totaal)?	3,50%	
Gemiddelde ziekteverzuimpercentage 2014 Q2 SBI-codering	*2,90%*	
Wat is het ziekteverzuimpercentage t.g.v. kortlopende ziekte?	0,80%	
Wat is uw personeelsverloop in dienst (aantal medewerkers)?	6,00	mdw
Wat is uw personeelsverloop uit dienst (aantal medewerkers)?	18,00	mdw
Maakt u gebruik van een eigen risicodrager?	Nee	
Hoeveel geld is er gedemarceerd in de eigen risicodrager?	€ -	

Financiële uitgangspunten		
Discontovoet	Defaultwaarden	
Energiebesparing	8,00%	
Onderhoudskosten	2,00%	
Ziekteverzuim	13,00%	
Arbeidsproductiviteit	13,00%	
Markthuur	6,50%	
Zakelijke lasten	4,00%	
Indices	Defaultwaarden	
Inflatie (2006 = 100)	2,00%	
Exploitatiekostenstijging	2,00%	
Energie-index	Gemiddeld	
Ziekteverzuim-index	Gemiddeld	
Productiviteits-index	Gemiddeld	
Overige financiële parameters		
Herbouwwaarde	€ 1.000	per/ m2 BVO
Herbouwwaarde, totaal (inclusief BTW)	€ 3.109.700	
Exit yield	8,50%	
Kosten koper	6,50%	
BTW	21,00%	

Indices prijsontwikkeling

d.d. 24-06-2016

Indices prijsontwikkeling																
		2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Inflatie (2006 = 100)		1,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%
Exploitatiekostenstijging		1,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%
Energie-index	Gemiddeld	2,25%	4,50%	4,50%	4,50%	4,50%	4,50%	4,50%	4,50%	4,50%	4,50%	4,50%	4,50%	4,50%	4,50%	4,50%
Ziekteverzuim-index	Gemiddeld	0,50%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%
Productiviteits-index	Gemiddeld	1,50%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%
Correcties																
Leegstandscorrectie		0,00%	0,50%	1,00%	1,50%	2,00%	2,50%	3,00%	3,50%	4,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%

Additionele gegevens object

Test Case

d.d. 24-06-2016

Gegevens			
Aantal m2 BVO		2.570	
Aantal m2 VVO		2.235	
Totale markthuur	€	268.200	
Werknemers		196	
Totaal aantal fte		182	
Gemiddelde omzet per fte	€	95.000	
Totale omzet	€	17.290.000	per jaar
Salariskosten per fte	€	51.000	
Totale salariskosten (op huidige locatie)	€	9.282.000	per jaar
Aantal m2 per werkplek BVO		13,1	m2
Bezettingsgraad		80%	
Gemiddeld aantal werkdagen per medewerker per jaar		228	

Energiebesparing						kg CO2/ m2 jr
Elektraverbruik per jaar		173.730	kWh/jr			92077
Elektra (per m2 VVO)		77,73				
Gasverbruik per jaar		22.000				11660
Gas (per m2 VVO)		9,84	m3/jr			19
Totaal						**103.755**
Energietarieven						
Elektra per kWh (levering en belasting)						
- 0 - 10.000 kWh	€	0,2512	per kWh			
- 10.000 - 50.000 kWh	€	0,1131	per kWh			
- 50.000 - 10.000.000 kWh	€	0,0815	per kWh			
Gas per m3 (levering en belasting)						
- 0 - 170.000 m3	€	0,4687	per m3			
- 170.000 - 1.000.000 m3	€	0,4246	per m3			
- 1.000.000 - 100.000.000 m3	€	0,3963	per m3			
						CO2 (kg)
Besparing energiekosten in %		10%				
Besparing elektrische energie per jaar		17.373	kWh	€	-3.346	9.208
Besparing gas per jaar		2.200	m3	€	-1.031	4.136
Totale besparing energiekosten per jaar	**€**	**-1,96**	**m2/VVO**	**€**	**-4.377**	**13.344**

Onderhoudskosten			
Percentage onderhoudskosten van totale markthuur		10%	
Preventief onderhoud	€	26.820	per jaar
Planmatig onderhoud	€	20.000	per jaar
Correctief onderhoud	€	-	per jaar
Reductie onderhoudskosten duurzaam gebouw		8%	
Onderhoudskosten nieuw per jaar	€	43.074	
Totale besparing onderhoudskosten	**€**	**-3.746**	

Ziekteverzuim			
Ziekteverzuim gemiddeld		3,50%	
Ziekteverzuimpercentage t.g.v. kortlopende ziekte		0,80%	
Reductie ziekteverzuim		1,00%	
Huidige kosten ziekteverzuim	€	324.870	
Huidige kosten ziekteverzuim per m2 VVO	€	145,36	
Kosten naar reductie ziekteverzuim	€	232.050	
Besparing reductie ziekteverzuim per m2 VVO	€	-41,53	
Totale besparing reductie ziekteverzuim	**€**	**-92.820**	
Dempingsfactor		*30%*	
Totale reductie ziekteverzuim na demping	**€**	**-27.846**	

Productiviteit		
Verwachte stijging productiviteit		5%
Huidige omzet per jaar	€	17.290.000
Omzet per m2 VVO	€	7.736
Omzet met verbetering productiviteit	€	18.154.500
Verbetering productiviteit omzet per m2 VVO	€	8.123
Opbrengsten stijging productiviteit per jaar per m2 VVO	€	-387
Totale verbetering productiviteit per jaar	**€**	**-864.500**
Dempingsfactor		*30%*
Totale verbetering productiviteit na demping	**€**	**-259.350**

DCF inclusief verduurzaming Test Case

d.d. 24-06-2016

Samenvatting berekening			
Totale bruto opbrengst huur	jaar 1	€	268.200
Zakelijke lasten	jaar 1	€	33.344
Netto opbrengsten	jaar 1	€	533.182
Discontovoet			
Energiebesparing			8,00%
Onderhoudskosten			2,00%
Ziekteverzuim			13,00%
Arbeidsproductiviteit			13,00%
Markthuur			6,50%
Zakelijke lasten			4,00%
Exit Yield			8,50%
Maximale investering	Contante waarde kasstromen	€	7.791.488
Correctie v.o.n. naar k.k.	CW kasstromen -/- correctie k.k.	€	7.315.951
Gecorrigeerde marktwaarde		**€**	**7.315.000**

Samenvatting berekening regulier		
Verhuurbaar vloeroppervlakte (vvo)		2.235
Huurprijs per m2 vvo	€	120
Huurprijs (totaal)	€	268.200
Netto aanvangsrendement		6,50%
Beleggingswaarde	**€**	**4.126.154**

Jaar	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Inkomsten															
Markthuur	€ 268.200	€ 273.564	€ 279.035	€ 284.616	€ 290.308	€ 296.114	€ 302.037	€ 308.077	€ 314.239	€ 320.524	€ 326.934	€ 333.473	€ 340.142	€ 346.945	€ 353.884
Leegstandsrisico	€ -	€ -1.395	€ -2.846	€ -4.355	€ -5.922	€ -7.551	€ -9.242	€ -10.998	€ -12.821	€ -16.347	€ -16.674	€ -17.007	€ -17.347	€ -17.694	€ -18.048
Subtotaal	€ 268.200	€ 272.169	€ 276.189	€ 280.261	€ 284.386	€ 288.564	€ 292.794	€ 297.079	€ 301.418	€ 304.177	€ 310.261	€ 316.466	€ 322.795	€ 329.251	€ 335.836
Besparing energie	€ 4.476	€ 4.677	€ 4.887	€ 5.107	€ 5.337	€ 5.577	€ 5.828	€ 6.091	€ 6.365	€ 6.651	€ 6.950	€ 7.263	€ 7.590	€ 7.931	€ 8.288
Reductie ziekteverzuim	€ 28.124	€ 28.687	€ 29.261	€ 29.846	€ 30.443	€ 31.052	€ 31.673	€ 32.306	€ 32.952	€ 33.611	€ 34.284	€ 34.969	€ 35.669	€ 36.382	€ 37.110
Vebetering productiviteit	€ 261.944	€ 267.182	€ 272.526	€ 277.977	€ 283.536	€ 289.207	€ 294.991	€ 300.891	€ 306.909	€ 313.047	€ 319.308	€ 325.694	€ 332.208	€ 338.852	€ 345.629
Besparing onderhoudskosten	€ 3.783	€ 3.859	€ 3.936	€ 4.015	€ 4.095	€ 4.177	€ 4.260	€ 4.346	€ 4.432	€ 4.521	€ 4.612	€ 4.704	€ 4.798	€ 4.894	€ 4.992
Totaal bruto inkomsten	**€ 566.527**	**€ 576.574**	**€ 586.799**	**€ 597.206**	**€ 607.797**	**€ 618.576**	**€ 629.547**	**€ 640.712**	**€ 652.076**	**€ 662.007**	**€ 675.414**	**€ 689.096**	**€ 703.059**	**€ 717.310**	**€ 731.855**
Zakelijke lasten															
Vaste lasten															
Onroerende zaak belasting	€ 8.982	€ 9.162	€ 9.345	€ 9.532	€ 9.722	€ 9.917	€ 10.115	€ 10.317	€ 10.524	€ 10.734	€ 10.949	€ 11.168	€ 11.391	€ 11.619	€ 11.852
Rioolrechten	€ 924	€ 942	€ 961	€ 981	€ 1.000	€ 1.020	€ 1.041	€ 1.061	€ 1.083	€ 1.104	€ 1.126	€ 1.149	€ 1.172	€ 1.195	€ 1.219
Waterschapslasten	€ 792	€ 808	€ 824	€ 840	€ 857	€ 874	€ 892	€ 910	€ 928	€ 947	€ 965	€ 985	€ 1.004	€ 1.025	€ 1.045
Premie opstal	€ 23	€ 24	€ 24	€ 25	€ 25	€ 26	€ 26	€ 27	€ 27	€ 28	€ 28	€ 29	€ 30	€ 30	€ 31
Assurantiebelasting	€ 5	€ 5	€ 5	€ 5	€ 5	€ 5	€ 6	€ 6	€ 6	€ 6	€ 6	€ 6	€ 6	€ 6	€ 6
Totaal vaste lasten	€ 10.726	€ 10.941	€ 11.160	€ 11.383	€ 11.610	€ 11.843	€ 12.079	€ 12.321	€ 12.567	€ 12.819	€ 13.075	€ 13.337	€ 13.603	€ 13.876	€ 14.153
Beheerkosten															
Verhuurcourtage	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Beheer/ vastgoedmanagement	€ 5.364	€ 5.471	€ 5.581	€ 5.692	€ 5.806	€ 5.922	€ 6.041	€ 6.162	€ 6.285	€ 6.410	€ 6.539	€ 6.669	€ 6.803	€ 6.939	€ 7.078
Totaal beheerkosten	€ 5.364	€ 5.471	€ 5.581	€ 5.692	€ 5.806	€ 5.922	€ 6.041	€ 6.162	€ 6.285	€ 6.410	€ 6.539	€ 6.669	€ 6.803	€ 6.939	€ 7.078
Onderhoudskosten															
Instandhouding onderhoud	€ 22.350	€ 22.797	€ 23.253	€ 23.718	€ 24.192	€ 24.676	€ 25.170	€ 25.673	€ 26.187	€ 26.710	€ 27.245	€ 27.789	€ 28.345	€ 28.912	€ 29.490
Totaal onderhoudskosten	€ 22.350	€ 22.797	€ 23.253	€ 23.718	€ 24.192	€ 24.676	€ 25.170	€ 25.673	€ 26.187	€ 26.710	€ 27.245	€ 27.789	€ 28.345	€ 28.912	€ 29.490
Overige kosten															
Niet verrekenbare BTW	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Oninbare huren	€ 268	€ 274	€ 279	€ 285	€ 290	€ 296	€ 302	€ 308	€ 314	€ 321	€ 327	€ 333	€ 340	€ 347	€ 354
Servicekosten voor rekening eigenaar	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Overig (nader te specifceren)	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Totaal overige kosten	€ 268	€ 274	€ 279	€ 285	€ 290	€ 296	€ 302	€ 308	€ 314	€ 321	€ 327	€ 333	€ 340	€ 347	€ 354
Totaal bruto zakelijke lasten	€ 33.344	€ 34.011	€ 34.692	€ 35.385	€ 36.093	€ 36.815	€ 37.551	€ 38.302	€ 39.068	€ 39.850	€ 40.647	€ 41.460	€ 42.289	€ 43.135	€ 43.997
Netto operationele kasstroom	**€ 533.182**	**€ 542.562**	**€ 552.108**	**€ 561.820**	**€ 571.704**	**€ 581.761**	**€ 591.995**	**€ 602.410**	**€ 613.008**	**€ 622.158**	**€ 634.767**	**€ 647.636**	**€ 660.770**	**€ 674.176**	**€ 687.857**
Incidentele kasstromen	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Groot onderhoud volgens MJOP	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Toekomstige renovatie	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Toekomstige afkoop erfpacht	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Aanvangsleegstand	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Huurconcessies	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Opbrengst bij uitponding	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Totaal incidentiele kasstromen	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -

Totale kasstroom															
Netto kasstroom op jaarbasis	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
	2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Totale inkomsten en uitgaven	€ 533.182	€ 542.562	€ 552.108	€ 561.820	€ 571.704	€ 581.761	€ 591.995	€ 602.410	€ 613.008	€ 622.158	€ 634.767	€ 647.636	€ 660.770	€ 674.176	€ 687.857
Eindwaarde	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ 8.610.055
Ongebonden grond	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Contante waarde kasstromen	€ 479.162	€ 442.884	€ 409.583	€ 378.996	€ 350.886	€ 325.036	€ 301.250	€ 279.350	€ 259.173	€ 239.702	€ 223.416	€ 208.378	€ 194.482	€ 181.632	€ 3.517.558

Totaal NCW =	**€ 7.791.488**

APPENDIX 12. EXPERT PANEL

Deelnemers van het expert panel:

Roderick van der Horst (Troostwijk)
Jan Pieter Klep (The support factory)
Joel Scherrenberg (Scherrenberg Groep BV)
Matthijs Schriek (DTZ Zadelhoff)

Stelling 1: Duurzaamheid moet zwaarder wegen in taxaties van kantoorvastgoed

De taxateur bepaald te marktwaarde aan de hand van hoe de markt vandaag de dag denkt over een pand. De marktwaarde is dus een inschatting van wat de taxateur denkt dat het pand zal opbrengen als het vandaag de dag op de markt komt. Doordat de eindgebruikers geen besef hebben van de voordelen van duurzame gebouwen, zijn ze vandaag de dag niet bereid om meer te betalen voor een duurzaam pand. Ondanks dat de taxateurs duurzaamheid niet kunnen meenemen in de waarderingen omdat er nog geen besef is bij de eindgebruikers, kunnen ze wel besef creëren bij de eindgebruikers. Dit kan door in het taxatierapport de toekomstwaarde van het pand mee te nemen. Er kan bij een pand met energielabel G bijvoorbeeld gezegd worden dat het pand over 5 jaar leeg zal staan terwijl een pand met een energielabel opnieuw verhuurd kan worden. Vandaag de dag wordt er vooral gefocust op de markthuur, hierdoor zal men misschien eerder een pand met energielabel G huren omdat de markthuur lager ligt. Met total costs of ownership wordt geen rekening gehouden. Dit terwijl een pand met energielabel C misschien wel 10 euro meest kost per m2 maar door energiebesparing uiteindelijk 5 euro goedkoper is per m2.

Taxateurs kijken vooral in de achteruitkijkspiegels terwijl ze zich meer zouden moeten focussen op de toekomst. Wanneer ze zich meer zouden focussen op de toekomst zou een duurzaam pand een hogere restwaarde moeten hebben ten opzichte van een niet duurzaam pand. In principe weet iedereen dat een duurzaam gebouw een hogere toekomstwaarde heeft, alleen zolang de markt dit niet adopteert kan een taxateur de waarde niet aanpassen. Het grote probleem is dat eindegebruikers zich er niet bewust van zijn dat je voor het ene gebouw misschien wel meer betaald maar dat je dan lagere kosten hebt, mede hierdoor is het ook lastig om eigenaren te overtuigen om te investeren in een duurzamer pand. Het moet er daarom naar toe dat een duurzaam pand een gezamenlijk doel is van de eigenaar en gebruiker.

De banken daarin tegen beginnen langzamerhand wakker te worden. Zij kijken naar hun portefeuille en zien dat hun risicoprofiel verslechtert. Hierdoor komen de banken in actie en gaan in gesprek gaan met ondernemers over de herfinanciering. Banken willen meedenken in de verduurzaming van de panden en geven rentekortingen op herfinancieringen om ervoor te zorgen dat ondernemers hun panden verduurzamen.

Het komt er op neer dat pas wanneer de gebruiker kritisch wordt en de voordelen ziet van duurzame panden, de taxateur duurzaamheid kan meenemen in de waardebepaling.

Stelling 2 Ziekteverzuim en arbeidsproductiviteit moeten meewegen in taxaties van duurzaam kantorenvastgoed

Arbeidsproductiviteit en ziekteverzuim zouden zeker moeten meewegen in taxaties. Echter is de markt zich nog niet bewust van de effecten van duurzaamheid op ziekteverzuim en arbeidsproductiviteit. Hierdoor kan de taxateur deze aspecten nog niet meenemen in de waardebepaling. Gebruikers zouden arbeidsproductiviteit en ziekteverzuim mee moeten wegen in hun keuze voor huisvesting echter staat dit nog verder van de gebruikers af dan duurzaamheid. De marketing waarde voor duurzaamheid is groot, de marketing waarde voor arbeidsproductiviteit en ziekteverzuim daarin tegen is veel kleiner. Onderzoek wijst uit dat het een duurzaam gebouw effect heeft op arbeidsproductiviteit en ziekteverzuim, echter de gebruiker moet het ook nog geloven.

Duurzaamheid is tot op zekere hoogte verweven in de waardering van een pand. Dit komt doordat duurzaamheid zich vertaald in bijvoorbeeld de uitstraling en de onderhoudskosten. Daarbij komt dat een pand met energielabel G er waarschijnlijk minder aantrekkelijk uitziet voor een gebruiker dan een pand met energielabel A. Duurzaamheid heeft dus eigenlijk al een klein plekje in waarderingen, het wordt alleen niet letterlijk benoemd. Daarnaast wordt duurzaamheid in enkele gevallen gezien als ‘’mooi meegenomen’’. De keuze voor een pand is een afweging van verschillende kwaliteitsaspecten, de locatie en het aantal parkeerplaatsen blijft nog steeds belangrijker dan het uitzicht.

Een belangrijk verschil dat benoemd moet worden is het verschil tussen midden- kleinbedrijf (MKB) en corporate. Waarbij de keuzes van MKB gebruikers vooral gebaseerd worden op emoties, wordt er bij corporate gebruikers veel aandacht geschonken aan bewust huisvestingkeuzes.

Dat de helft van de respondenten heeft aangegeven te vinden dat arbeidsproductiviteit en ziekteverzuim mee moeten wegen in taxaties is vreemd. Dit omdat de markt er op dit moment nog niet om vraagt waardoor arbeidsproductiviteit en ziekteverzuim zelfs niet meegenomen kúnnen worden in de waardering.

Stelling 3: Imago moet meewegen in taxaties van duurzaam kantorenvastgoed

Imago weegt altijd al mee in taxaties. Onder imago vallen veel factoren, duurzaamheid is een van die factoren. Voor een duurzaam imago willen gebruikers niet per definitie meer betalen, met uitzondering van de groenste gebouwen van Nederland. Voor imago in het algemeen is de gebruiker wel bereid meer te betalen. Veel partijen willen onderscheidend vermogen hebben, dit creëren ze onder andere door voor een pand met een bepaald imago te kiezen.

Toch heeft een derde van de respondenten oneens ingevuld. Dit kan onder andere komen door de onduidelijkheid omtrent het begrip imago.

Stelling 4: Het verduurzamen van bestaand kantorenvastgoed vindt eerder plaats wanneer ziekteverzuim en arbeidsproductiviteit worden meegenomen in de waardering

De stelling zou eigenlijk moeten zijn: het verduurzamen van bestaand kantorenvastgoed vindt eerde plaats wanneer er beter wordt gekeken naar ziekteverzuim en arbeidsproductiviteit. Wanneer de gebruiker zich realiseert wat het effect van het gebouw is op ziekteverzuim en arbeidsproductiviteit zal er meer naar gekeken zal worden. Het zal dan ook terug te zien zijn

in de waarde van een gebouw. Wanneer het inzichtelijk gemaakt zou worden wat de effecten van een gebouw op het ziekteverzuim en de arbeidsproductiviteit zijn en wat men kan besparen op personeel wil iedereen dit doen. In de huidige situatie zeggen nog veel gebruikers dat vastgoed irrelevant is omdat het maar 6% van de kosten omvat. Ze kijken dus totaal niet naar de effecten op het primair proces.

Op dit moment begeven we ons in een transitie, het is een kwestie van tijd totdat de bewustwording ontstaat bij de gebruikers. Het is lastig om in te schatten hoe lang dit proces zal. Wanneer een aantal grote corporaties ervoor kiezen om ziekteverzuim en arbeidsproductiviteit mee te wegen in hun keuze voor huisvesting zal het proces versneld worden. Op dit moment loont het nog niet om te verduurzamen omdat de verduurzaming niet wordt doorgerekend in de waardebepaling, verduurzaming is dus niet haalbaar. Wanneer duurzaamheid wel wordt doorgerekend in de waardebepaling is het dus wel degelijk wat waard om te investeren in een duurzaam pand. Een duurzaam gebouw is per definitie geen goed gebouw maar een goed gebouw is wel per definitie een duurzaam gebouw.

De spreiding in de uitkomsten van de stellingen zijn waarschijnlijk ontstaan door verschillende interpretaties van de stelling door de respondenten.

<u>Vragen disconteringsvoet</u>
Omdat er geen standaard disconteringsvoet is gegeven is het lastig om te zeggen wat de hoogte van de disconteringsvoet per aspect moet zijn. In zijn algemeenheid geldt, hoe lager de disconteringsvoet hoe groter de garanties. Wanneer het over een paar jaar zo is dat de productiviteit en het ziekteverzuim gegarandeerd worden om bepaalde condities kan de disconteringsvoet een stuk omlaag.

Wanneer de markt naar all-in huren toe gaat (markthuur + energiekosten) zal er voor de eigenaren een incentive ontstaan om te hun pand te verduurzamen. De eigenaar zal willen investeren doordat hiermee winst te behalen valt en de huurder zal wat meer willen betalen omdat deze bespaart om energiekosten door duurzaamheidsmaatregelen. Echter, wanneer de energiebesparing 10 euro per m2 is, kan de huur niet verhoogd worden met 10 euro per m2. Dit doordat de gebruiker het ook moet geloven. Daarnaast realiseert bijna niemand zich dat investeringen terug verdient kunnen worden op andere elementen zoals waarde verhoging van het pand.

Ook al ligt het bewijs er dat duurzame gebouwen positieve effecten hebben op de energiekosten, onderhoudskosten, het ziekteverzuim en de arbeidsproductiviteit, wanneer de markt zich er niet bewust van is kan het niet zichtbaar worden gemaakt in de waardering. Het enige wat taxateurs op dit moment kunnen doen is het uitleggen van de effecten voor de eigenaar en de gebruiker, zo wordt er beetje bij beetje bewust zijn gecreëerd. Taxateurs zijn daarbij verplicht tot het maken van een SWOT- analyse in de taxatie, die in principe dient als kern van de waardering. Echter is de SWOT- analyse vaak onjuist of onvolledig ingevuld. Daarnaast is het schrikbarend hoe weinig taxateurs een goede DCF waardering kunnen maken, wat niet impliceert dat ze geen goede waardering kunnen maken.

Ondanks dat de uitslagen lastig te interpreteren zijn omdat er geen standaard disconteringsvoet is ingesteld, kunnen er wel een aantal algemene conclusies worden

getrokken uit de resultaten. Het is vreemd dat energiekosten en onderhoudskosten tegen een hogere disconteringsvoet worden weggezet ondanks dat ze veel grijpbaarder zijn dan arbeidsproductiviteit en ziekteverzuim. De disconteringsvoet voor de onderhoudskosten is schrikbarend hoog. Doordat er een meerjarige onderhoudsbegroting wordt gemaakt is de zekerheid bijzonder hoog. Dit wil zeggen dat de disconteringsvoet laag moet zijn, ongeveer 2%. Daarin tegen is de zekerheid bij arbeidsproductiviteit en ziekteverzuim laag, wat betekend dat de disconteringvoet hoog moet zijn. Dit terwijl er uit de resultaten blijkt dat de disconteringsvoet voor ziekteverzuim en arbeidsproductiviteit lager ligt dan de disconteringsvoet voor energiekosten en onderhoudskosten.

Hieruit valt te concluderen dat de respondenten hoogstwaarschijnlijk niet begrijpen wat ze hebben ingevuld, daarom zijn ze waarschijnlijk in het midden van de bandbreedte gaan zitten. Het verloop van de grafiek zou eigenlijk omgekeerd moeten zijn.

Exit yield

Hoe duurzamer het gebouw, hoe lager de exit yield. Een energieneutraal gebouw zou een lagere exit yield moeten hebben dan een duurzaam gebouw omdat het toekomstbestendiger is. Er is een segment in de markt die geld over hebben voor duurzame gebouwen maar er is een veel groter segment waarvoor duurzaamheid geen issue is en het niet meenemen in hun afwegingen. De markt komt in het algemeen langzaam in beweging. In 2024 mogen er geen asbest daken meer zijn, het aantal partijen dat nu al actie onderneem is er klein. Dit geeft aan dat veranderingen in de markt lastig zijn en tijd nodig hebben.

Op de woningmarkt is onderzoek gedaan naar de link tussen het energielabel en de waarde van een woning. Doordat er enorm veel data beschikbaar is welke makkelijk is in te delen in categorieën, kan de link tussen het energielabel en de waarde goed gelegd worden. Uit onderzoek blijkt dan ook dat woningen met een hoger energielabel een hogere waarde hebben en sneller verkocht worden. Deze link kan door het ontbreken van voldoende informatie en de heterogeniteit van bedrijfsmatig vastgoed op dit gebied niet gelegd worden.

Naar aanleiding van de resultaten kan ook hier geconcludeerd worden dat de respondenten het niet goed begrepen. Uit de resultaten blijkt dat het rekenen met de DCF- methode door het merendeel niet wordt beheerst.

Dempingsfactor

Op dit moment is de dempingsfactor voor ziekteverzuim 0% omdat er totaal nog niet naar wordt gekeken op de markt. De dempingsfactor voor arbeidsproductiviteit is ongeveer 5% omdat hier door enkele gebruikers enigszins rekening mee wordt gehouden. Wanneer deze aspecten geadopteerd worden door de markt zullen de dempingspercentages stijgen.

Adoptie door de markt kan gestimuleerd worden door marketing of het aanpassen van de regelgeving. Wanneer de regelgeving wordt aangepast zullen partijen ernaar moeten handelen.