

Sustainability – does it influence investors' decision?

An exploration to BREEAM, as part of a multi-criteria decision analysis

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Preface

This thesis is the result of research into the influence of sustainability to the investors' investment decision of commercial offices. This research has been executed under the authority of the KENWIB Foundation, which performs research for the municipality of Eindhoven to support the energy neutral ambition of Eindhoven. This graduation report is the last phase of the master thesis of 'Construction Management and Urban Development' at the University of Technology of Eindhoven.

From international experience at the National University of Singapore, my attention was triggered to the investment process of real estate projects, and the way in which the investment decision-making is structured. From different courses I was introduced to real estate investment appraisal, risk management, and decision analysis. Combining the question of the KENWIB Project with knowledge and experience from HEJA, I have carried out an interesting and relevant research topic.

This report would not have been possible without the support, advice, and cooperation of my parents, girlfriend, and friends. I would like to thank them for their support and distractions during the creation of this master' thesis. Of course I would like to thank my supervisors from the TU/e and HEJA. Wim and Bart, thank you for providing the guidance, feedback, and discussion in order to accomplish this thesis. Daniel (from HEJA), thanks for your extensive knowledge, discussions, and feedback about the project development sector. With your help this thesis is a perfect balance between conceptual thinking, research, and practical 'real-life' business.

Coen Kuijstermans
March, 2012

Management summary

In the indistinct exploration for more sustainable investment in the building environment, this research tries to provide insight and knowledge that could break up the traditional real industry, which operates in a 'Circle of Blame', and split-incentive in the investment decision. Sustainability becomes more prominent in the development of offices, where involved actors are not used to integrate sustainability and realize those sustainable ambitions. In addition actors have different ambitions and interests within the sustainable development process.

The '*replacement issue*' of the current Dutch office market is highly influenced by the demographic development, 'Nieuwe Werken', and the sustainability issue. Thereby in the traditional real estate industry, subjects such as return on investment and increasing value are stated as the most important factors in investment decision making, making it difficult to realize sustainable ambitions. This research focuses on the influence of sustainability on the investment decision of investors to the development of commercial offices. In addition this research provides insight into the consideration framework of investors into sustainable office development.

In this research a multi criteria decision analysis is used and the Analytical Network Process (ANP) research methodology is applied. Real estate investment is a complicated decision process, whereby multiple influential factors and the influence of feedback should be considered comprehensively in order to get the optimal decision. Twenty main influencing factors on micro level are identified to analyze. These factors are combined into five clusters derived from literature and interviews with experts, which include top 10 investors in the Dutch office market. From the ANP pairwise comparison questionnaire, the overall influence and priorities of the influencing factors and clusters are determined.

This research indicates that sustainability does influence investors' decisions of the commercial office development in an indirect manner. According to investors, a sustainable office minimizes the risk of vacancy in the future. Nevertheless investors try to maximize their return of investment, with a minimum of the perceived risk according to their investment strategy. From the obtained results, the cluster priorities confirms the preference of revenue and cost factors in the investment decision, whereby sustainability factors are not indicated with the highest priority values. The preferred overall micro-factors are exploitation costs, expected lease rate, and flexibility, but investors indicate that the 'Sustainable office' alternative is the most preferred alternative.

According to the sustainability aspects of an office object, investors don't prefer 'social' sustainability like ecological impact and pollution, but instead prefer the quality of an office like indoor user comfort, and aspects that influence the exploitation costs, like energy use and water use. Investors confirm sustainability as a corporate value, but the implementation of sustainability into the investment scheme on the micro-level of an office by several investors is (still) not realized. Overall it can be concluded this research enables other actors to specify their strategy to realize sustainable ambitions.

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1. Introduction

In this chapter the research justification is described. This chapter introduces the subject, problem, research question, and goal of this research. The context of the subject is a mixture of different views and statements on the subject. From this context, the problem statement, research goal, and research questions will be derived.

1.1. Context

'In an environment where consumers, employees and other stakeholders are asking what role businesses are playing in the sustainability crisis, it is in the business interests of companies to invest in being part of the solution regarding 'climate change'.' – Al Gore, former US Vice President and recipient of the Nobel Peace Prize, Global Brand Forum Singapore, 2007

The growing attention to sustainable development and the usage of renewable energy became more important as a result of possible consequences of climate change and the shrinking supply of fossil fuels for the next generation, since the publication of the Club of Rome 1972 *'Limits to growth'* (Meadows et al., 1972). Growing energy prices, sense of a limited supply of fossil fuels, and the consequences of fossil fuel use regarding the climate, personal health, and comfort are important causes of the growing attention for sustainability.

Concerning the sustainable development, the government has a condition creating role to stimulate sustainable development in our society. A characteristic example is the *Lente-akkoord Energiebesparing* in April 2008. In this covenant between the government and the businesses, the businesses committed to take an active role in the energy neutral development of buildings. Goal of this covenant is a reduced energy use of 25% in 2011 in new retail, residential and office development, and a reduction of 50% in 2015 (Lente-akkoord, 2008).

Real estate investors are still reserved to invest in sustainable real estate development projects. Investors are still not convinced of the fact of the higher value of sustainable real estate compared to 'unsustainable' real estate. Research and objective information is needed to convince investors of the higher risks of investing in 'unsustainable' real estate, e.g. smaller economic lifetime and lower 'exit yields' (Kok et al., 2011 & Bijsterveld, 2011).

Sustainable investments in real estate are often postponed because of a critical attitude of different earning models of sustainable investments. Users and owners often remark who is in fact responsible for the investment of sustainability. Most users are prepared to invest more in sustainable real estate, in case of a decrease of the exploitation costs, but if owners don't invest in sustainable real estate, the consequence is increased risk of an unmarketable real estate (NVM, 2011).

Nowadays, we live in a perspective of risk minimizing, while making as much profit as possible from a temporary involvement in the real estate development. We have to go to a

more users perspective focused vision based on continuity and value creation on long-term involvement with a continuous utilitarian value of real estate (Peek, 2011).

1.2.Problem framework

Sustainability becomes more prominent in the development of offices. Private businesses like contractors, developers, and users will be force to take sustainability into account of the development process. Sustainability is a relative new concept in real estate development of offices. Different actors are not used to integrate sustainability and realize those sustainable ambitions. Sustainability in real estate development of offices has a different focus compared to the traditional development. There are different ambitions and interests of actors involved in the sustainable development process. Sustainability is a broad understanding, with many 'soft' factors and different interpretations, which makes sustainability difficult to quantify. There are different assessment methods in order to quantify sustainability.

The 'sustainability crisis' in the traditional real estate industry, where subjects as return on investment and increasing real estate value are stated as the most important factors in investment decision making, it is difficult to realize sustainable ambitions. Traditional real estate investment analysis methods such as net present value, payback period, venture decision and uncertainty decision (Liu, 2000), are all single-objective decision-making methods. These methods cannot cover the entire and comprehensive analysis of an investment project, which might result in an improper decision. Therefore, it is necessary to use multi-indices comprehensive analysis methods for real estate investment decisions. More profound modeling of investment decisions in the inter-organizational context is needed in order to implement effective procedures for investing in sustainable offices. It could cover the development of clearer and uniform models to support investment decision-making and contracting (Ojala, 2006).

1.3.Problem definition & Research goal

From the context and problem framework the main problem is defined as:

In the current sustainable commercial office development process there is a misbalance between the considerations and ambitions of investors, users, contractors, and developers. There is an indistinct exploration in the willingness and considerations of investors and owners from a developers perspective in sustainable office development.

The actors involved in the sustainable development process of offices are looking to each other to take the (financial) initiative. Because the different actors are struggling with different considerations and ambitions, the goal of this research can be formulated as:

Providing insight into the consideration framework of investors into the sustainable office development, in addition to providing insight into the investment decision process of investors of offices.

The assessment of the influencing factors in the investment decision process enables developers and other actors to specify their strategy to realize sustainable ambitions into sustainable office development.

1.4. Research question

As a solution to the problem, the following general research question will be applied to this research:

To what extent does sustainability influence investors to invest into office development?

In support of the above mentioned research question, the following main sub-questions can be formulated:

- I. What are the ambitions, interests, and considerations to invest in sustainable commercial offices from an investors point of view?
- II. What are the characteristics of the current sustainable development process of commercial offices?
- III. What are the most important influencing factors in the investment decision analysis of development of offices?
- IV. How is sustainability embedded in the investment decision analysis of development of offices?

1.5. Research boundaries

This research focuses on the influence of sustainability on the Dutch investor's investment decision of new development of office projects. However, the existing office stock and the influence of sustainability is completely different from new development. The results of this research can be used as a starting point for the existing office stock.

Secondly, in this research only a certain amount of experts, like investors and funders, are assessed to the question if sustainability influences on the investment decision. In this research the main influencing factors on the micro level will be indicated and weighted in relation to the investment decision. Influencing factors on macro and medium level, like location, political environment are excluded. This research provides insight into a complicated decision making process of investment on the micro level.

1.6. Research relevance

Sustainability becomes more prominent in the development of offices. The *theoretical relevance* can be dedicated due to the lack of knowledge and experience of the integration of sustainability in the area of the development of offices. In the paragraph 1.1 Context

mentioned developments, actors are forced to take sustainability in account of the development process of offices. Accordingly, the *practical relevance* of this research is: in the development process of offices there is an indistinct exploration of sustainability of the involved stakeholders, due to a lack of experience and knowledge.

1.7. Research design

In figure 1.1 an overview of the research process is illustrated. This research consists of three main parts in order to accomplish the research target. First, a literature study in combination with interviews has been used to investigate and to explore the concepts of sustainability and the office development process. In addition, literature on the consideration framework of the investment decision of offices has been used to develop an investment decision model. Questions which should be answered are: what is meant by sustainability and sustainable real estate, what is the current sustainable development of sustainable offices, what are the considerations to invest in a sustainable commercial office, etc. From this contextual orientation the concept of the sustainable office investment consideration framework can be described.

Real estate investment is a complicated decision process. Owing to the particularity and complexity of real estate investment decision-making, multiple influential factors should be considered comprehensively in order to get the optimal decision. Within this research a multi-criteria analysis method will be used for the analysis of this investment decision process. This research uses the application of Analytical Network Process (ANP), a specific research method of the Multi Criteria Decision Analysis (MCDA) field, to determine the influence of sustainability in the investment decision of offices.

In the application of the research the influencing factors of the investment decision have been examined by in-depth interviews and a survey. These interviews and surveys were distributed to experts of the real estate industry, like insurance companies, pension funds, and funding investors.

From the literature orientation and application of the research, conclusions can be made and recommendations can be given.

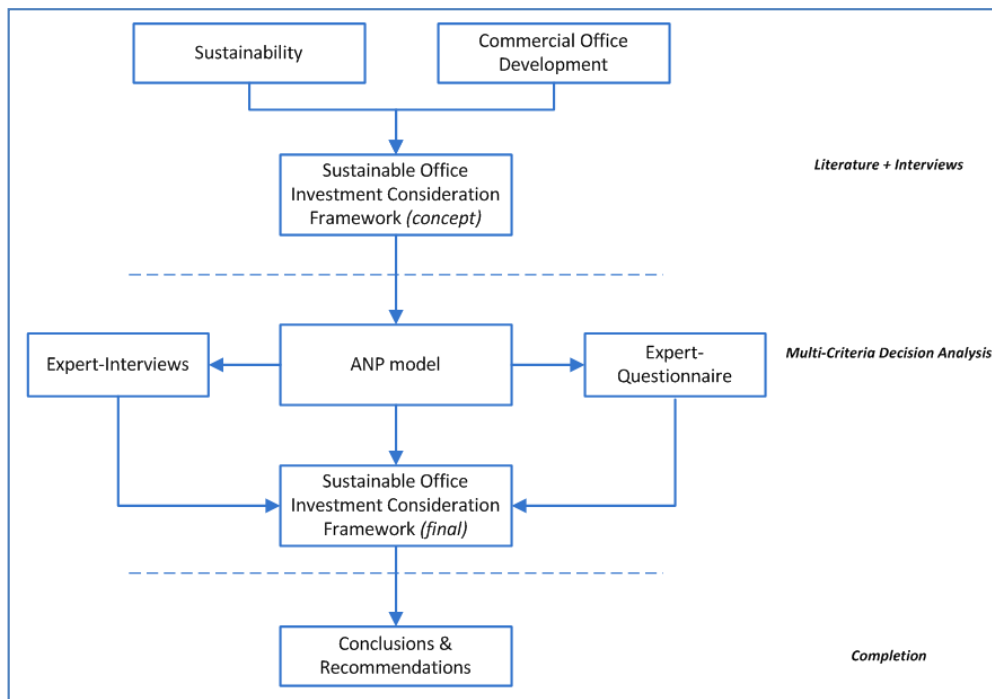


Figure 1-1 - Research design of the Master Thesis

1.8. Reading guide

This thesis consists of three main parts as described in the research design. Part I is about the contextual orientation of this research. The first chapter is about the concept of sustainability. The concepts of sustainability and sustainable real estate is elaborated, the assessment methods of sustainable real estate are described in order to define sustainable real estate, and the advantages and disadvantages of sustainable real estate are elaborated. The second chapter is about the commercial offices. The characteristics of the current Dutch office market situation, as well as the sustainable assignment and development of Dutch office market situation are described. The investment process is described in the third chapter. From the investment process with the main direct influencing factors, the investment decision model is elaborated for the decision to invest in an office development.

In part II the used research methodology Analytical Network Process is described, in the first chapter. The second chapter is about the application of the research methodology, whereby the process of model construction and data collection is elaborated. Furthermore, the used influencing factors extracted from the contextual orientation in part I are described.

The final part III of this thesis consists of results, conclusions, and recommendations. The measurement of priorities of the influencing factors in general, clusters, and alternatives are presented in the first chapter. In the second chapter, the results of the research will be related to investment decision model, whereby the conclusions among this research,

whereby the research question is answered and important findings are discussed. In the last chapter the recommendations among the sustainable commercial office development and further research are described.

Part I – Contextual Orientation

2. Sustainability

As part of the literature study, this chapter is about sustainability. The first part defines the concept of sustainability and sustainable real estate with the pros and cons of sustainable real estate. Further the assessment methods of sustainable real estate will be described. Thereafter, the price of sustainable real estate is exhibited. Nowadays, sustainability is an umbrella definition, different definitions are used and performed, so it's important to make a clear distinction of sustainability and sustainable real estate. In this chapter the following questions will be answered:

- What is meant by sustainability and sustainable real estate?
- How could sustainable real estate be defined/assessed?
- What is the 'price' of sustainable real estate?

2.1. Definition of sustainability

Sustainability is a Latin derivative of '*sustenare*' (which means literally uphold), which could be explained as until the end of time continues. Sustainability is a concept/ idea which originates from the conclusion 'it cannot be longer', wherein the worldwide process of technology, capital growth, production, and consumption each other chases and no longer conducted through the inherent limitations of the earth which is in fact unsustainable (Cörvers, 2008 & Derkse, 1995).

The concept sustainability is introduced in the report '*Our Common Future*' of the UN-commission Brundtland in 1987, whereby the connection between economic growth, environment issues, and poverty and development problems was described. Generally, sustainability can be determined from the ecology; sustainable use of a forest, means no more wood is taken from the natural supply, than the natural development. This consideration of 'environment using space' means that future generations are still in the possibility to use the environment and the nature (Rogers et al., 2008). With the report '*Our Common Future*' the definition sustainability shifts from an ecological perspective to a more social-economic understanding (WCED, 1987), the definition of sustainable development of the commission Brundtland is:

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

This definition is used in many studies (Lützkendorf et al., 2005; Rakhorst, 2007; Rotmans, 2007; VROM, 2009) and thereby it is the principle of this research. Later in this chapter there will be more explained of the complexity and use of sustainability in this research, like the aspects and the different assessment methods of sustainability.

2.2. Definition of sustainable real estate

The most sustainable way of construction is in fact no longer construct (Kok, Eichholtz & Quigley, 2009), whereby there is no longer an investment in stones, but in sustainability. The transition of sustainability to sustainable real estate is described by (Frej, 2005) and (IVBN, 2009). The elements of the definition of sustainable real estate, is not only about construction, but also the exploitation of real estate. Sustainable real estate is designed in such way, it to a minimum confiscates, or as efficient as possible use of raw materials, water, and energy during the whole life cycle period. At the same time, sustainable real estate has to operate to the users satisfaction, in an optimal indoor climate, in such way to fulfill all the users requirements. According to (VROM, 2009) sustainable constructing is improving the quality in the area of People, Planet and Prosperity compared to the current situation, without waste and pollution are averted to the future situation.

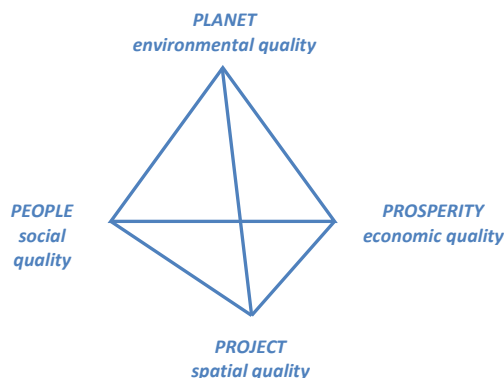


Figure 2-1 - Tetrahedron of People, Planet, Prosperity, and Project.
Source: Duijvestein, 2005

In this way (Duijvestein, 2005) illustrated sustainable real estate as an extended tetrahedron of the 'Triple bottom line' definition of J. Elkington, whereby *social quality (People)*, *environmental quality (Planet)*, *economic quality (Prosperity)* described sustainable real estate, but added with *spatial quality (Project)*. Although the fourth added P is meant for *Project*, the fourth P could also meant for *Process*.

In case of *Process* it means policy development, and in case of *Project* it means product development, like beauty, diversity, flexibility, and constructability. Considering the definition of sustainability, the definition of sustainable real estate used in this research is based on the tetrahedron of (Duijvestein, 2005), because the *Project* dimension complements the concept of sustainable real estate:

Sustainable real estate is a derivative of a sustainable development process broad based on a integrated sustainable vision, which conditions creates for sustainable applications according to this vision. In the development of sustainable real estate combinations are created between social (People), ecological (Planet), economic (Prosperity), and spatial (Project) qualities, in order to create a added value for the current actors, without compromising the interests of future actors.

The Planet aspect of the sustainable real estate development emphasis the aspects *energy, materials, waste, land use, and pollution*. The social quality (People) can be characterized by the aspects *health, safety, and participation*. The economic quality (Prosperity) of a sustainable real estate development emphasis; *financial feasibility, profitability, employment, and let ability and marketability*. The aspect Project is about the spatial quality and the product development. It is about the characteristics like *beauty, management, transport, identity, flexibility, diversity, robustness, and functional mix*.

The described aspects of sustainable real estate are extended described in *appendix A*.

2.3. Assessment methods of sustainability

To assess or define the level of sustainability of real estate there are different methods available. The most used and well-known assessment methods are BREEAM, LEED, GreenCalc+, GPR and EPL ('Energielabel'). Building Research Establishment Environmental Assessment Method (BREEAM) and Leadership in Energy and Environment Design (LEED) are international common used assessment methods.

In the research of (Dobbelsteen, 2008) different assessment methods were conducted. This research concluded in a comparison between LEED, BREEAM, Eco-Quantum, and GreenCalc+ based on performance directed, objective, robustness, simplicity,

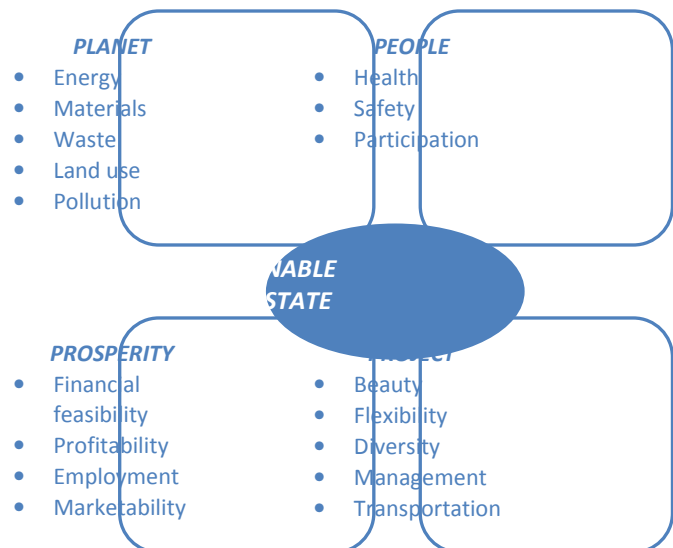


Figure 2-2 - Aspects of sustainable real estate. Source: (Duijvestein, 2005), BREEAM-NL



Figure 2-3 - Certified commercial buildings in Europe. Source: (RICS, 2011)

transparency, qualification, international character, harmonizing, affordable, and completeness the most appropriate assessment method. LEED and BREEAM are integral assessment methods with a multi-criteria-analysis based checklist, including advanced calculating tools behind it. EcoQuantum and GreenCalc+ are missing the integral aspects. The reason to choose for BREEAM as basis, is the use of the Life Cycle Analysis, good adaptation possibilities per country, and the scores are based on reference scores of other buildings.

Therefore, in order to assure the consistency within the research, BREEAM-NL will be

the main assessment method, because it's the most used assessment in the commercial real estate and the most integral assessment. In *appendix B* there is an overview of all the assessment methods of sustainable real estate.

2.4. Development of BREEAM

Because of the different assessment methods of sustainability, markets have witnessed a dynamic proliferation and spread of new certification systems as well as further development and expansion of existing ones. (RICS, 2011) illustrated the development of sustainability certification in Europe, which is certainly buoyant with regional preferences for individual system that may have the potential to develop into standards (figure 2.3). In terms of geographical spread and preferences, US investors are more likely to opt for LEED certification,

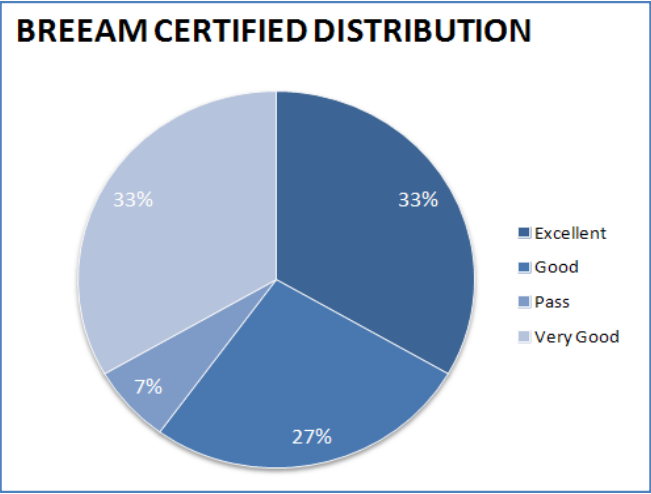


Figure 2-4 - BREEAM certified buildings distribution. Source: DGBC, BREEAM-NL

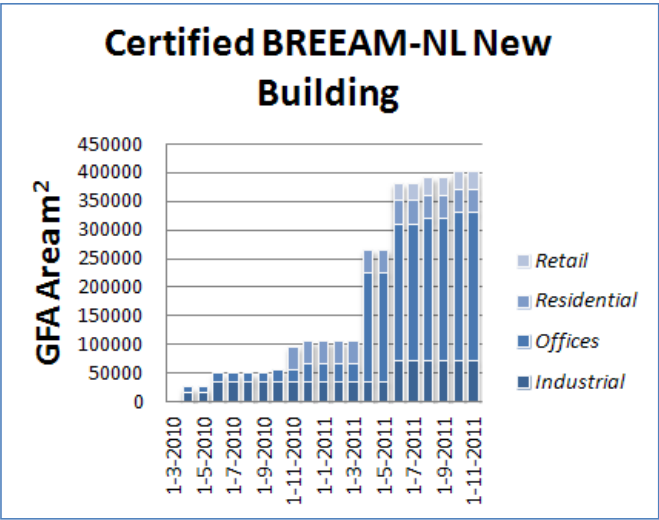


Figure 2-5 - Certified BREEAM-NL New Building. Source: DGBC

and British investors are more like to choose BREEAM. Thereby we see an approximately amount of 4.000 BREEAM certified and 1.500 registered assets in the United Kingdom, compared to the Netherlands with 8 BREEAM certified and 28 registered assets, at the date of May 2011.

At the date of December 2011, in the Netherlands 15 assets are BREEAM certified and 88 assets are registered to become BREEAM certified (www.breeam.nl/projecten). From (figure 2.4) we see the distribution on the BREEAM scores, whereby 33% of the assets are BREEAM Excellent certified. According to the Dutch Green Building Council, an independent non-profit enterprise, which developed and manages the BREEAM-NL certificate, shows the development in m² Gross Floor Area of BREEAM-NL new building certificates and registered new buildings. In *appendix C* the assessment process of BREEAM is described, as well an example of a sustainable office, conform BREEAM-Excellent certificate.

2.5. The 'price' of sustainable real estate

From a financial point of view, development of sustainable real estate does have higher initial investment costs compared to the development of un-sustainable projects, which is one of the most important disadvantages. (WBCSD, 2010) identifies an average higher investment cost of seven percent of the development of sustainable real estate compared to unsustainable real estate development, whereby it satisfies the objectives of the International Energy Agency.

Investments in sustainable real estate are; to extend the lifetime, to a more beneficial exploitation, and into 'soft' measures. Investment to extend the lifetime means a flexible property and possibilities to change-over functions and/or to extend to other functions. Investment to a more beneficial exploitation means a decrease of energy use and/or energy generation and a different use of materials. Investment into 'soft' measures means a healthy and comfortable environment of the employees, higher productivity of employees, and satisfied employees.

Another important disadvantage is the 'split incentive'. Which means if a sustainable investment is done by an investor the advantages of this investment are for a different stakeholder, e.g. the user, instead of the investor themselves.

The fact of higher investment costs of sustainable real estate doesn't mean automatically that the building is more expensive during the whole life cycle period. There are different researches (Eichholtz, Kok & Quigley, 2009), (Vrolijk, 2008), (Kats, 2003), (Vink, 2008), (Lorenz & Lützenkendorf, 2007) which exhibit different advantages of investments in sustainable real estate. The most important benefits of a sustainable real estate are; decrease of exploitation costs (energy use and maintenance), extended depreciation periods, higher rental level by decrease of exploitation costs, future proof design, increase let ability, decrease of risk of vacancy, increase of residual value, higher productivity, increase of health

of employees, decrease of absence through illness, increase of satisfied employees, and a green image.

Different researches are done to the financial results due to sustainable real estate. (Eichholtz, Kok & Quigley, 2009), have results of sustainable offices, with the assessment label Energy Star or LEED, investigated in the United States. This research determined the rental price of sustainable offices are 3 to 6 percent higher, and the selling price 16 percent higher, compared to conventional unsustainable real estate. In a follow-up study (Eichholtz, Kok & Quigley, 2010), the rental price of sustainable offices are 3 percent higher, and the selling prices are 13 percent higher compared to unsustainable real estate. (Wiley et al., 2008) concluded that offices with EnergyStar label or LEED do have significant higher rental prices (7-8 percent of EnergyStar, and 15-17 percent of LEED). This research concluded the selling prices of sustainable real estate are significantly higher, varying \$ 30,- to \$ 129,- higher per m².

The research of (Kok & Jennen, 2011) is comparable to the research (Eichholtz, Kok & Quigley, 2010) focused on the Netherlands instead of the United States. This research is based on data of 1100 transactions, which can be concluded that less energy saving offices (energy label D or lower) do have significant lower rental prices of 6,5 percent. From this research also the accessibility was examined, whereby real estate which 1 km is further away from a railway station, the rental price decreases with 13 percent. Figure 2.6 shows an example of a cash flow of sustainable investment, whereby different researches and statements are merged, to indicate the advantages and disadvantages in monetary terms.

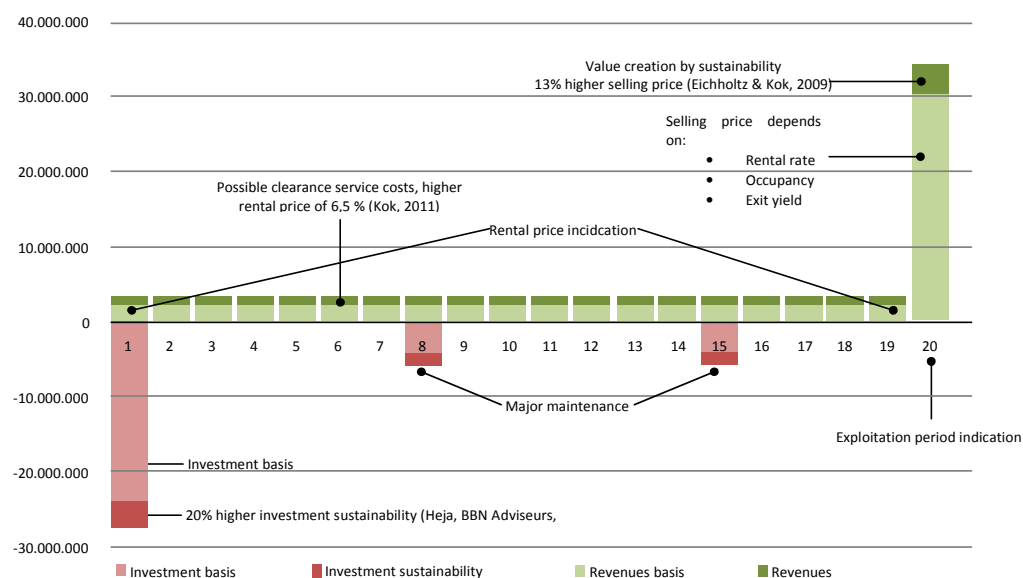


Figure 2.6 - Example of cash flow of sustainable real estate. Source: BBN Adviseurs

To determine the 'price' of sustainability compared to BREEAM-NL, different experts like consultants as BBN Adviseurs and Deerns Installatie Adviseurs were asked to determine the price of sustainability to the different levels of BREEAM-NL from 'Pass' till 'Excellent'. By the determination of the price of the BREEAM-NL levels there has been taken into account the following characteristics of the property: Gross Floor Area of 6.000 m², Gross Façade Area of 4200 m², location surrounded with sufficient parking facilities and

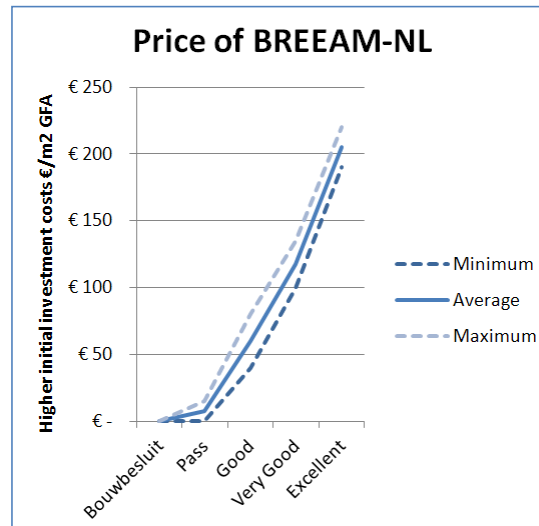


Figure 2.7 - Price of BREEAM-NL. Source: BBN Adviseurs, Deerns, 2012

direct access to the highway. From the results shown in figure 2.7, can be concluded of an increase of 5% (Good), 12% (Very Good), and 20% (Excellent) of higher investment costs per m² GFA.

If there is a maximum of all credits of BREEAM-NL with a certificate of *Outstanding*, it is possible to indicate the price per aspect of BREEAM-NL. The three most 'expensive' sustainable aspects are Energy (60%), Material (23%), and Indoor-climate (10%). The results are shown in figure 2.8.

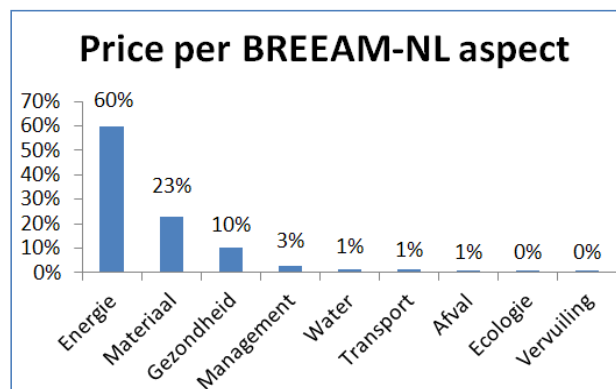


Figure 2.8 - Price per BREEAM-NL aspect. Source: Brink Groep, 2012

To certificate the property with a BREEAM-NL certificate there is a certain amount of certification costs. This varies from € 10.000/€ 20.000 to € 150.000. This amount of certification costs depends on the ambition of the stakeholders of the development of an office.

2.6. Conclusion

In this chapter the concept of sustainability and sustainable real estate is discussed. Sustainability assumes a balanced development of ecological, economical and social aspects. Defined as the 'Triple bottom line' of J. Elkington. Sustainable development means finding a combination in such way there is a balance between the triple P of *People*, *Planet*, and

Prosperity. The concept of sustainable real estate can be extended by *Project* with spatial aspects like beauty, diversity, flexibility, and constructability of an asset.

To define sustainability to physical aspects of real estate, this research uses BREEAM as basis, because of the Life Cycle Analysis, most integral assessment, good adaptation possibilities internationally, and most used assessment in the commercial real estate of offices in Europe. BREEAM-NL certification are nowadays becoming more common, because of the international and integral aspects, as we can see from the development of BREEAM in Europe, and more specific of BREEAM-NL.

From a financial point of view the development of sustainable real estate does have higher initial investment costs, another important disadvantage is the 'split-incentive' (like decreased energy costs, improved indoor climate, etc.) of sustainable investment, which are benefits to different stakeholders, instead of the investor themselves. To determine the 'price' of sustainability, it can be determined of an increase of 20% higher investment costs per m² GFA to become a sustainable real estate (BREEAM-Excellent).

3. Commercial offices

This chapter is about the sustainable commercial office market. To understand what the considerations and ambitions of sustainability are in the development of commercial offices, first the focus in which area of real estate development this question should be answered has to be clarified. Within the broad field of the development of offices, this research focuses on sustainable office development which are in property of investors and/or end users. In the first paragraph the definition of the concept of commercial offices is described. Next, the current market situation is described of the Dutch office market. Thereafter, the sustainable assignment of offices is described, and the current sustainable development of offices is exhibited. In this chapter the following questions will be answered:

- What is the sustainable development in the commercial offices?
- To what extent is sustainability embedded in the development of commercial offices?

3.1. Definition of commercial office

The real estate market is to distinguish in two main categories, commercial real estate market, and non-commercial real estate market. The *commercial real estate market* aims for commercial purposes, like offices, retail, factories, hotels, congress centers, parking lots, and leisure facilities. The *uncommercial real estate market* is often determined as the residential housing, hospitals, school buildings, jails, nursing facilities, etc (Gool, van, 2007).

Commercial real estate refers to the real estate used for business and commercial purposes divided by the application. The development of commercial real estate is not only meant for business purposes, but also the improvement of the shopping environment, quality of life, unemployment of the population, and the city's comprehensive competitiveness to some extent (Gool, van, 2007). The investment of commercial real estate has become a popular investment type. However, compared to uncommercial real estate, the commercial real estate do have a huge amount of capital investment, higher exit yields, smaller investment recovery period, and influences by the real estate industry as well as the economic and political environment.

3.2. Office market situation

The commercial office market segment has to deal with harsh times nowadays. Because of the economic situation the development is minimal and the demand of office space is minimal as a consequence of a decrease of office jobs. The office market is a rental market of 63 percent and 37 percent of sale offices (Bak, 2009). The supply of offices is increased, but the demand of offices decreased in 2010 (DTZ, 2011). From the figure 3.1 you can see the amount of office jobs decreased, the ratio between vacancy and used office space get worse, and the supply increased more than the supply.

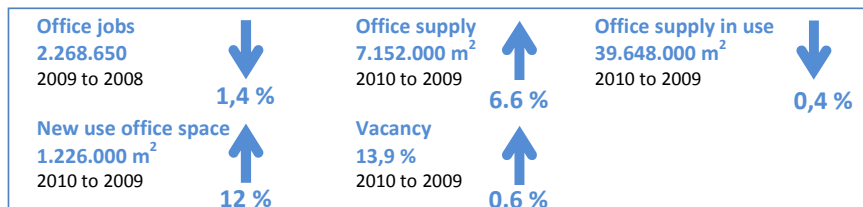


Figure 3-1 - Office market number. Source: DTZ Zadelhoff 2011

The office market is determined by the replacement issue, because of the demographic development, 'Het Nieuwe Werken', and the sustainability issue (FGH, 2011). There is a large challenge for a structural approach to solve the oversupply. The oversupply of offices arose from an increase of new developed offices, and large office users moved to smaller, flexible, and high-quality offices, and the existing offices which were not competitive were left behind. In order to break through the development of oversupply, it would be better to devaluate the real estate portfolios or to demolish, but not much investors and funders are willing to devaluate their real estate portfolios (Steinmaier, ABN AMRO, 2011).

Besides, there is an increased attention to flexible workplaces. In the research (Twynstra Gudde, 2010) to 300 large office users which uses 15 million m² of office space, concluded two-third a decrease of necessary office space as a consequence of flexible working. Office users do have intentions to use smaller, flexible, and high-quality offices.

3.3. Sustainability assignment commercial office market

The real estate supply and the construction industry are responsible of 30-40 percent of the carbon dioxide emissions (Royal Institute of Chartered Surveyors, 2005). From the research of (Stern, 2008) can be concluded, to improve the energy savings of the built environment is the most cost-effective way is to reduce the carbon dioxide emissions.

Although in the UK more than 10.000 real estate objects do have a BREEAM-qualification, compared to 26 objects in the Netherlands of the office supply certificated with a BREEAM-NL qualification. But considering BREEAM-NL was used for the first time in 2009 (first use in the UK was in 1988) (NVM, 2011). From a cost perspective it is not realistic to expect that the Dutch office supply in large numbers will be labeled by a BREEAM-certificate. The 'energielabel' (EPL) is at this moment the most used assessment method, and per January of 2010 one third of the Dutch office supply had an EPC label.

It's not exactly possible to determine the sustainability assignment in the Netherlands of the building environment in exact amounts, but it will be several billions of Euros (Eichholtz, 2010). But as a benchmark of the office supply has to have a minimum of energielabel C, two third of the total office supply has to be preserved, which is 30 million m².

3.4. Sustainable development of commercial offices

The 'Circle of Blame' is a well-known concept of the current situation in the real estate market, an introduced concept of a British environmentalist named Jonathan Porritt. The

‘Circle of Blame’ is a vicious circle which illustrates different actors who feel compelled to develop more sustainable.

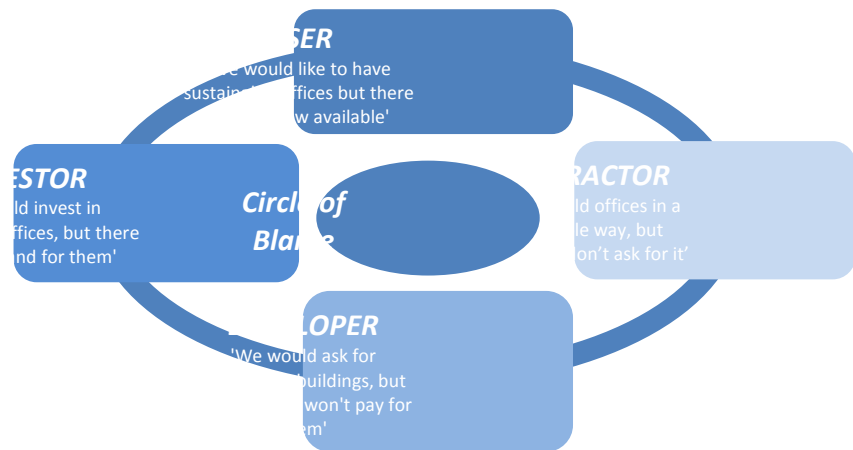


Figure 3-2 - Circle of Blame. Source: RICS, 2005

At the same time different actors in this ‘sustainable development process’ are blaming each other to take the (financial) initiative. Beside the ‘Circle of Blame’, the ‘split incentive’ could be an obstacle of the sustainable development process of offices. Whereby an investor invests in the sustainable improvement, while the user profits from the sustainable advantages.

The current sustainable development of real estate can be illustrated by the following example (Nijhoff, 2010):

*There is a story about four people named **everybody**, **somebody**, **anybody** and **nobody**. There was an important job to be done and **everybody** was sure that **somebody** would do it. **Anybody** could have done it, but **nobody** did it. **Somebody** got angry about that, because it was **everybody's** job. **Everybody** thought **anybody** could do it, but **nobody** realized that **everybody** would not do it. It ended up that **everybody** blamed **somebody** when **nobody** did what **anybody** could have.*

In accordance, the increased importance of sustainability into the development of offices, (Jones Lang LaSalle, 2010) indicated 73 percent of the Dutch office users whereby sustainable housing is an important theme to their corporate culture, whereby 83 percent are prepared to pay an extra charge to it. 53 percent of the office users are positive to have a sustainable certificate. BREEAM is indicated as the

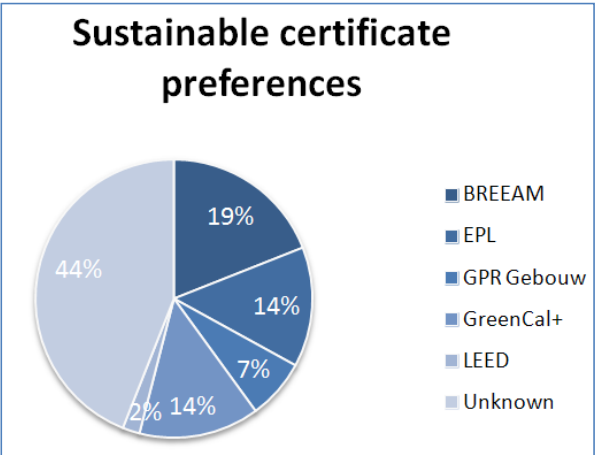


Figure 3-3 - Sustainable certificate preferences. Source: Jones Lang LaSalle, 2010

preferred sustainability certificate with 19 percent (figure 3.3).

Although from an international research (Eichholtz, Kok, 2010) to almost 200 real estate investors, indicated sustainability as an important theme to their corporate culture, but the implementation of sustainability is realized by only 10 percent of them. From (Walt, van der, Bennet, 2011) 80 percent of mainly UK investors agreed that improving the sustainability certification, by achieving a BREEAM or LEED rating, could be used to attract better occupiers. Two thirds indicated an implemented sustainable policy at fund level, and their investors or shareholders demanding evidence of sustainability performance.

3.5. Conclusion

Commercial real estate refers to the real estate used for business and commercial purposes divided by the application. The development of commercial offices is meant for business purposes, but also employment of people, and the city's comprehensive competitiveness.

The Dutch commercial office market is determined by the replacement issue (oversupply, high rate of vacancy), because of the demographic development, 'Het Nieuwe Werken', and the sustainability issue. Besides, there is an increased attention to use smaller, flexible, and high-quality offices. New office development have to deal with these challenges in a way to become an attractive investment opportunity.

It's not exactly possible to determine the Dutch sustainability assignment of the commercial office segment in exact amounts, but as a benchmark of the office supply has to have a minimum of energylabel C to be remarked as sustainable, two third of the total office supply has to be preserved, which is 30 million m².

The current sustainable development of the Dutch commercial office market is characterized by the 'Circle of Blame', whereby different stakeholders and actors in this 'sustainable development process' are blaming each other to take the (financial) initiative. Beside the 'Circle of Blame', the 'split incentive' could be an obstacle of the sustainable development process of offices.

4. Investment process

This chapter is about the investment process of commercial offices. One of the most important long term decisions for any business relates to investment. Investment is the purchase or creation of assets with the objective of making gains in the future. Typically investment involves using financial resources to purchase an asset like offices for example, which will then yield returns to an organization over a period of time. First the concept of investing in real estate is described, thereafter the different actors of the investment process are identified. From the investment process the investment decision model is elaborated for the decision to invest in an office development. In this chapter the following questions will be answered:

- What are the ambitions, interests, and considerations to invest in sustainable commercial offices?
- What are the characteristics of the current investment decision process of commercial real estate?
- What are the most important direct and indirect influencing factors in the investment decision analysis of development of offices?
- How is sustainability embedded in the investment decision analysis of development of offices?

4.1. Investing in real estate

Investing in real estate could be explained as direct or indirect capture capital in real estate, with the purpose to generate revenue by the exploitation and selling of real estate to ensure future cash flow. In this context capital is the accumulated savings. Investing in real estate whereby the owner has the aim to facilitate his business' services and products which deliver him as means of production, are primarily not investing in real estate. In fact, the business' services and products are directive instead of real estate or housing, and not the investment aspects (Gool, van, et al., 2007).

Investments of real estate do have different appearances. The most important distinction of investments of real estate are direct investments and indirect investments. *Direct investment* of real estate is an investment in a physical product, and *indirect investments* is an investment in shares. Direct investment of real estate means the investor will be the owner of the real estate or the owner of the financial capital securities which entitles the revenues of the real estate, whereby the investor has the majority holding and the power of control about the management of the real estate. Indirect investment of real estate means the investor has not the majority holding and not the power of control about the management of the real estate, although the revenues belong to the investors (Gool, van, et al., 2007). In figure 4.1 a graph is shown of the development of investments in real estate.

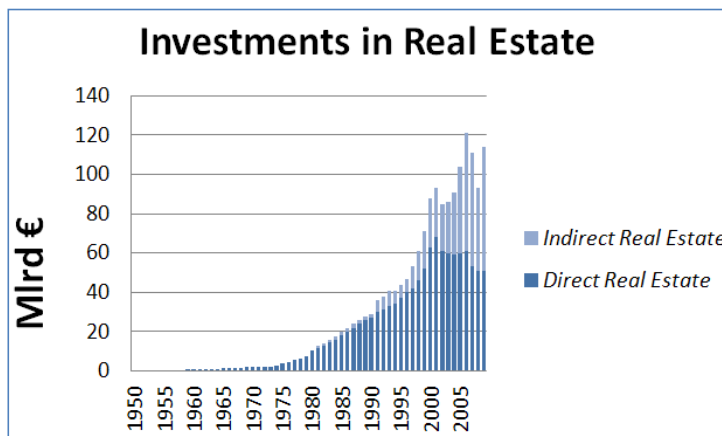


Figure 4-1 - Investments in real estate. Source: CBS

From figure 4.1 can be concluded since 1990 an increase of indirect investments of real estate, whereby in 2007 and 2009 there were more indirect investments instead of direct investments of real estate.

4.2. Actors

From the complexity of the investment process of commercial office development, different actors are constantly operating in a tension with different interests, ambitions, and objectives. By way of an actor analysis you can gain insight in the involvement and power and interest of different actors to delay, accelerate, facilitate, enrich or block the development. The main actors of the development of sustainable offices are the users, designers, developers, investors, constructors, public authorities, assessors, and administrators.

End users

The (end) users are important actors in the development of offices. The interests of users are directly affected by the development of offices. Offices are constructed in such way to fulfill the housing needs and wants of the user. An office is meant to execute the core business of a company as best as possible. Offices are used by corporations mainly for processing information (Dobbelsteen, van den, et al., 2004). An office has to provide a productive, healthy, and comfortable working place for its employees of an enterprise.

The main interest of an end-user are the costs of rent and exploitation. The main considerations to become an active stakeholder into this sustainable development are a 'green image' and reputation, higher productivity and satisfaction, and decrease of exploitation costs.

Public authorities

The public authorities have a role as legislator, but also a condition creating role, which influences the level of sustainability prohibited by regulation and legislation. Besides the 'public role', the public authorities are also responsible of the land allocation in a 'private role'. Preserving the existing supply is not stimulated by a generous land allocation policy. Nowadays with an oversupply of offices, land allocation for the development of new offices is unsustainable. The public authorities plays an exemplary role in the purchase and rental of

offices, the Dutch Government is one of the largest office users, determined a minimum of energy label C.

Project developers

Project developers often anticipate on the demand of the market situation, whereby sustainability whether or not is a derivative from the demand of users and investors, but project developers are also forced to develop in accordance to the Buildings Decree. The development of real estate is often initiated and coordinated by the project developer. Their purpose is usually to make financial profit from the process of development. There is a trend visible that an increasing number of developers are aiming at the market of sustainable offices (Wilkinson & Reed, 2008).

The main interest of a developer is a return on the development of a sustainable office. The main considerations to become an active stakeholder into this sustainable development are a 'green image' and reputation, and to achieve sustainable/ corporate social responsibility target.

Investors

Investors are important actors in the development of offices in case if a developer don't use their own resources. The investors are often pension funds or insurance companies, or large banks or other financial institutions can be investors. In the development of real estate there are two types of funding: short-term (development finance) to cover the costs during the development process; and long-term (funding) to cover the cost of holding the completed development as an investment (Tay, 2011). Investors could also be the developer themselves, they develop their own portfolio. Investors have real estate portfolios who are largely unsustainable, but often do have long-term rental contracts. This means that the preservation of real estate portfolios will take a long period. The top 5 ranking of Dutch real estate investors are shown in table 4.1.

Top 5 Ranking Dutch Real Estate Investors 2009 (mln €)					
Rank 2009	Rank 2008		2008	2009	% of total (cumulative)
1	(1)	ING Real Estate	66 500	64 352	29,6
2	(2)	Algemene Pensioen Groep APG (ABP)	18 675	20 546	39,1
3	(4)	Pensioenfonds Zorg en Welzijn (PGGM)	9 811	12 479	44,8
4	(3)	Syntrus Achmea Vastgoed	10 106	9 719	49,3
5	(5)	ING Group	9 341	7 904	52,9

Table 4.1 - Top 5 Ranking Dutch Real Estate Investors. Source: CBS, 2011

The main interest of an investor is a return on the investment of the development of a sustainable office (like IRR or BAR). The main considerations to become an active stakeholder into this sustainable development are a 'green image' and reputation, increase of value, increase of the rental price, and decrease of risk of vacancy.

Assessors

The assessors determine the value of the offices of portfolios of investors. They assess the valuation of sustainability of properties different (Steinmaier, ABN AMRO, 2011). From the conclusion in the research of (Berkhout, 2010) there are large differences in the treatment of sustainability into the value determinants intervention rate, exit yield, and rental rate. Sustainability is still not unambiguous assessed by the lack of market evidence.

Funders

The funders have financed the top of the market of offices with a high leverage. The devaluation influences the value of the properties, but also the funding. As a consequence of the devaluation the leverage and the risk increases, so the funding of the investment to preserve real estate has to meet the more precisely conditions.

Designers

In the development process the designing phase is directive. The main designer is usually the architect. Other advisors, such as structural engineers, physical engineers, and technical engineers also have a part in the designing phase. Key characteristic of sustainable office design processes is the need for cooperation between the different design parties to make a sustainable, high-quality, integral design.

Contractors

Contractors have to realize the result of the design phase.

Administrators

To preserve existing offices, administrators are important actors, they have to make an inventory of users needs and wants in an early stage in a way to extend the rental contract.

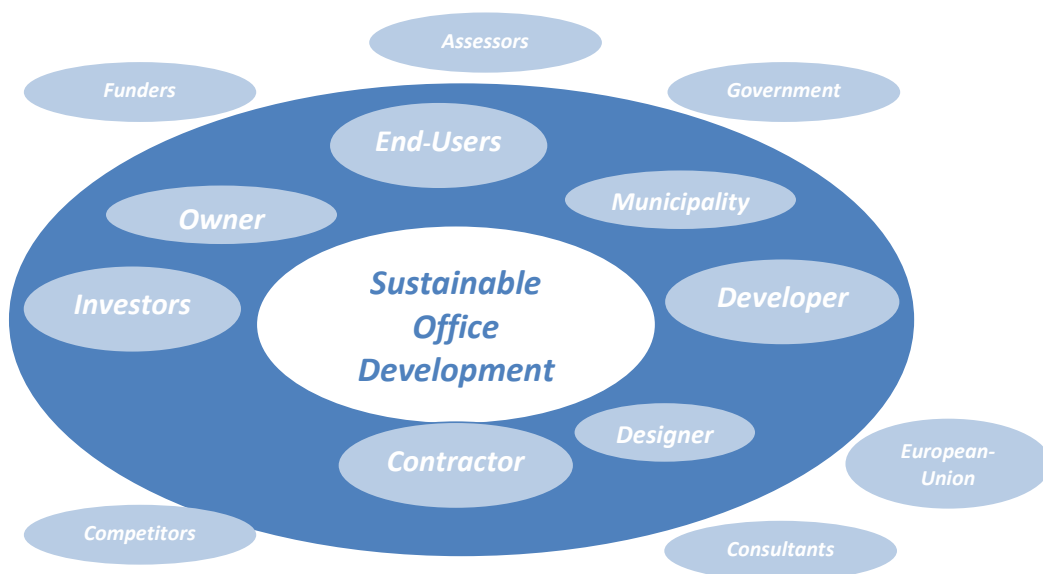
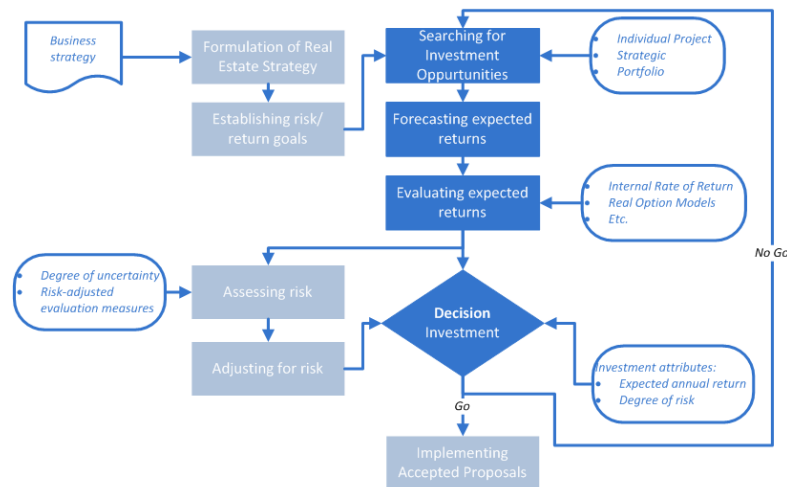


Figure 4-2 - Actors overview sustainable office development

4.3. Investment decision process

The scope of this research is on the investment decision of investors. The investment decision process is part of different phases of the development process. The decision-making process in real estate investment refers to the systematic research, acquisition, application, and analysis of the desired real estate asset in order to satisfy the investors' goals and strategy. The process consists of two main aspects: (1) estimation of market value, or most probable selling price of the asset, and (2) investment calculation (Shim et al., 2008).



(Farragher, 2008)

reports on the investment decision

Figure 4-3 - Investment decision process of Real Estate

making processes used by equity investors in the real estate, like REITs, pension funds, life insurance companies, and private investment and/or development organizations. The main stages of the investment decision making process are: setting strategy, establishing return/risk goals, searching for investment opportunities, forecasting expected returns, evaluating forecast returns, assessing risk, adjusting for risk, decision-making, implementing accepted proposals, and auditing operating performance. From the research the equity investors considered searching for establishing return/risk objectives and evaluating forecasted returns as the most important stages in the decision-making process. (Farragher, 2008) indicated to the investment decision process that individual project factors are more important than strategic and overall portfolio factors.

4.4. Investment decision model

There are multiple visions about the investment decision of real estate with causal relations between different factors. Typically investment involves using financial resources to purchase an asset like offices for example, which will then yield returns to an organization over a period of time. Key considerations in making investment decisions are:

- What is the scale of the investment – can the investor afford it?
- How long will it be before the investment starts to yield returns?
- How long will it take to pay back the investment?
- What are the expected profits from the investment?

- Could the money that is being ploughed into the investment yield higher returns elsewhere?

Real estate investment decision-making is influenced by many factors, such as macro, medium, and micro factors. Different researches (Liu, 2009), (Fang, 2011), (Khumpaisal, 2008), (Tang, 2009), and (Shim et al., 2008) are used to conduct an investment-decision model. The scope of this research investment decision is related to the investment decision process of (Farragher, 2008), whereby a translation of the forecast into a risk-adjusted evaluation of the expected costs and returns compared to the investment attributes with the investor's strategy are exhibited.

Almost all researches indicated the *economic* and *technological environment* as investment attributes in the real estate investment decision. The economic environment can be described as the market environment like GDP, interest rate, currency

conversion, etc. The *technological*

environment is mostly described as the object aspect of the investment, like design, concept, site conditions, etc. The *financing method* is according to (Tang, 2009) also important, like the fund using time and financing difficulty. Other researches indicate the financing environment in relation with the economic environment. (Liu, 2009) and (Tang, 2009) concluded the *investment type*, like rate of return, NPV, and investment recovery period, as an important decision attribute.

Since none of the existing investment decision models suits for every sustainable office development, the various existing researches with different decision attributes are merged and evaluated to create the investment decision model (figure 4.4). The model consists of macro-level, medium-level, and micro-level factors. However, the model should not be interpreted as a strict model since the phases are not strictly passed through in the investment decision process.

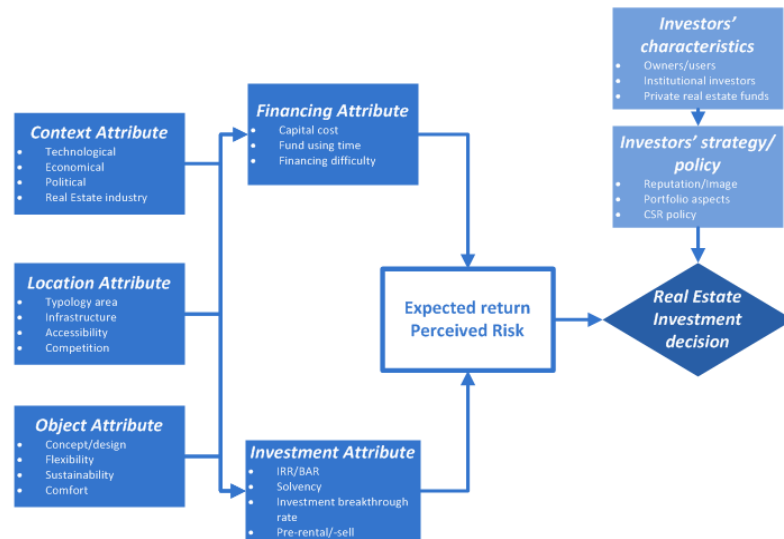


Figure 4-4 - Investment decision model

4.5. Conclusion

Two categories of real estate can be distinguished, namely direct investment and indirect investment, with the purpose to realize revenue by the exploitation and selling of real estate to ensure future cash flow. The main interest of an investor is a return on the investment of the development of a sustainable office (like IRR or BAR), and a minimum of the perceived risk of the investment. The main considerations into this sustainable development are a 'green image' and reputation, increase of value, increase of the rental price, and decrease of risk of vacancy.

The most important macro factors are the contextual factors like technological, economical, political environment which influences the investment decision. Location factors, which are medium factors influences the investment decision, like parking facilities or distance to public transport. Besides these macro and medium factors, on micro level, the object factors, like design, flexibility, comfort, influences the attractiveness of an investment. The financing method is also an important influencing factor, like the fund using time and financing difficulty.

Part II – Research application

5. Methodology

To enable the assessment to the research question if sustainability influences investors' decision, a multi criteria decision analysis will be applied. This research uses the application of Analytical Network Process to determine the influence of sustainability in the investment decision of offices. In the first paragraph the concept of multi-criteria decision analysis is described. Next, the Analytical Network Process and the basic principles is described. Thereafter, the inductive statistics which are used in this research are elaborated.

5.1. Multi-criteria decision analysis

The Multi Criteria Decision Analysis (MCDA) field is the study of methods and procedures which concerns about multiple conflicting criteria, which can be formally incorporated into the management planning process. The aim of the MCDA is to guide the decision maker in determining the course of action that best achieves the long-term goals, by providing the decision-maker with some measure of consistency (Stewart, 1992). There is no uniform classification of MCDA methods, thus, there are many ways to classify them, such as form or model (e.g. linear, non-linear, stochastic), characteristics of the decision space (e.g. finite or infinite), or solution process (prior specification or preferences or interactive). (Saaty, 1990) observed that MCDA included three general groups of approaches; Multi Attribute Utility Theory, Analytical Hierarchy Process, and Outranking.

Real estate investment is a complicated decision process. Owing to the particularity and complexity of real estate investment decision-making, multiple influential factors, including economic, social, object, and environment factors, should be considered comprehensively in order to get the optimal decision. Traditional real estate investment analysis methods such as net present value, payback period, venture decision, and uncertainty decision (Liu, 2000) are all single-objective decision-making method. These methods cannot get entire and comprehensive analysis of an investment project, which might result in an improper decision. Therefore, it is necessary to use multi-indices comprehensive analysis methods for real estate investment decisions.

(Shi-Jian-Gang, 2003) and other researches worked on using fuzzy analysis methods in real estate appraisal of construction projects. In addition, research of (Wang Wu-Jun, 2004) has used the application of Analytical Hierarchical Process (AHP) on real estate investment decision-making. However, in actual investment decision-making projects, a variety of factors should be considered, such as the dependence and feedback relationships between different factors, like contextual and location factors.

5.2. Analytical Network Process (ANP)

Analytic Network Process was defined by (Saaty, 2001) as a general theory of relative measurement used to derive composite priority ratio from individual ratio scale reflecting relative measurement of interconnected elements within control criteria. (Azis, 2003)

defined ANP as a mathematic theory that allows to deal systematically with dependence and feedback, which makes it possible to combine tangible and intangible factors by using ratio scale.

ANP provides a general framework in treating decisions without making any assumption about independency of elements in higher level from elements in lower level and about independency of elements within the same level. The main concept of ANP is influence, while the main concept of AHP is preference. AHP with its dependency assumptions on clusters and elements are a special case of ANP.

In a AHP network, there are levels of goal, criteria, sub criteria, and alternatives, each level has its own elements. Meanwhile, in a ANP network, level is called cluster that consist of criteria and alternative which now is called node (figure 5.1).

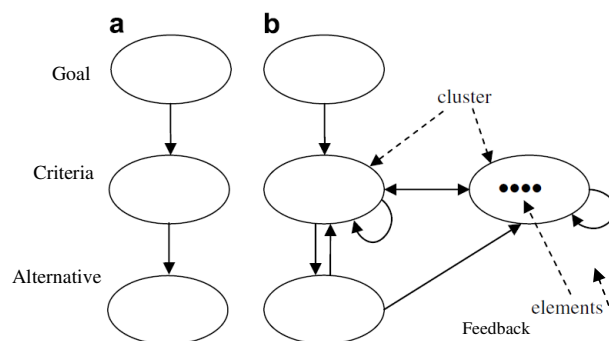


Figure 5-1 - Comparison overview AHP-ANP methodologies. Source: Saaty, 2005

With the feedback, alternatives can depend on criteria, like in a hierarchy, but it can also depend on other criteria. Furthermore, those criteria can depend on alternatives and other criteria. Feedback improves priority which derived from judgment and makes prediction more accurate. Therefore, the result of ANP is expected to be more stable. In a network, an element in one cluster can influence other elements in the same cluster (inner dependence) and can also influence elements in other clusters (outer dependence) with respect to each criteria (Saaty, 2001).

The intended results from the ANP method is to determine the overall influence from all elements to the decision. Thereby, all criteria must be configured and set their priority in a framework of control hierarchy or network. The comparison and data synthesis is needed to obtain the order of priority from these criteria. The influences from the elements in the feedback system with respect to each criterion is provided. Finally, the results of these influences are weighted according to the importance level of the criteria, and summed them up to get the overall influence from each element.

5.3. Basis principles of ANP

There are three related basic principles of ANP, namely decomposition, comparative judgments, and hierarchic composition or synthesis priorities (Saaty, 1996).

1. **Decomposition** – decomposition is used to structure a complex problem into a hierarchy or network of clusters and sub-clusters, resulting into the ANP framework. Structuring complexity includes developing ANP network of the problem;
2. **Comparative judgments** – comparative judgments are applied to construct pairwise comparisons. These pairwise comparisons are used to derive ‘local’ priorities of the elements in a cluster with respect to their parent. The pairwise comparison is based on ratio measurement, it measures proportion and judgments of each pair of factors in the network to derive ratio scale measures;
3. **Synthesis** –synthesis is applied to multiply the local priorities of the elements in a cluster by the ‘global’ priority of the parent element, producing global priorities throughout the network and then adding the global priorities for the lowest level elements (usually the alternatives). Synthesis involves construction of: a) original (unweighted) supermatrix; b) weighted supermatrix; and c) calculation of the global priority weights (limited supermatrix).

In general, the process of the ANP is comprised of four major steps which are: network model construction, pairwise comparisons, supermatrix formation, and synthesis (Chung et al., 2005). In *appendix E* these steps are described.

5.4. Inductive statistics

5.4.1. Consistency ratio

In the ANP research method, decision makers or experts who make judgments or preferences must be checked by consistency tests, which are conducted based on consistency ratios (*CR*) of the comparison matrixes. The consistency ratio (*CR*) is defined as:

$$CR = \frac{CI}{RI} \quad [1.1]$$

Where *CI* denotes consistency index, *RI* denotes random index. Consistency indicators denote the level of variances between the maximum characteristic value and the number of hierarchy levels and serve as the measurement for the level of consistency. If $CI < 0,1$, the level of consistency is satisfactory. Random index is based on the number of levels in the comparison matrix, i.e. the *N* number of comparative elements. If $CR = 0,1$, it means that the level of consistency of the comparison matrix is satisfactory and acceptable (Saaty, 2001).

5.4.2. Geometric mean

A method to enable group decision making to incorporate a situation when different people with different levels of authority and expertise and different opinions can affect the outcome is needed for this research. The geometric mean, a theorem in mathematics, is a

way to combine group judgments. Judgments can be combined so that the reciprocal of the synthesized judgments must be equal to the syntheses of the reciprocals of these judgments (Saaty, 2001). Geometric mean is a type of mean or average in mathematics, which indicates the central tendency or typical value of a set of number. To calculate the geometric mean, the numbers are multiplied and then the n^{th} root of the resulting product is taken (n is the count of numbers in the set). The geometric mean of a data set $\{a_1, a_2, \dots, a_n\}$ is given by:

$$(\prod_{i=1}^n a_i)^{1/n} = \sqrt[n]{a_1, a_2, \dots, a_n} \quad [1.2]$$

The basis for using this method has been justified mathematically by (Saaty, 2001).

5.5. Conclusion

In this research a multi criteria decision analysis (MCDA) is used. The aim of the MCDA is to guide the decision maker in determining the course of action that achieves long-term goals, by providing the decision-maker with some measure of consistency.

Real estate investment is a complicated decision process. Owing to the particularity and complexity of real estate investment decision-making, multiple influential factors should be considered comprehensively in order to get the optimal decision. It is necessary to use multi-indices comprehensive analysis methods for real estate investment decisions.

Analytic Network Process (ANP) is a general theory of relative measurement used to derive composite priority ratio from individual ratio scale reflecting relative measurement of interconnected elements within control criteria. ANP provides a general framework in treating decisions without making any assumption about independency of elements in higher level from elements in lower level and about independency of elements within the same level. The main concept of ANP is influence, whereby in this research the influence of sustainability factors is determined on the real estate investment decision of a new development office. The geometric mean is used in this research to combine group judgments of different experts with different levels of authority and expertise and different opinions.

6. Application to research

The intended results from the ANP method is to determine the overall influence from all elements to the investment decision. To be able to analyze the multi criteria decision analysis of real estate investment of offices, data needs to be collected. In this chapter the ANP research goal, problem focus, variables, process of data collection and experimental design are elaborated.

6.1. ANP Research goal

The output of the ANP research application enables the assessment of the different influencing factors of the real estate investment decision of offices, and to determine if sustainability influences this decision. The goal of the ANP research is to investigate the comparison of the different influencing factors with the highest importance or influence in the ANP model of real estate investment decision of offices.

Besides the assessment of the sustainability factors and the investment decision, the relations between the use of the object, technical aspects, revenue aspects, costs aspects related to the investment decision will be tested.

6.2. Research process

This study comprises several steps of the main ANP modeling, which can be grouped into three phases. Phase 1 is model construction to identify, analyze and structure the complexity of the problems into an appropriate ANP network. Phase 2 is model quantification or pairwise comparison. Phase 3 is synthesis and results analysis.

6.2.1. Model construction

The ANP model is determined from literature and in-depth interviews by experts like investors, funders, and consultants. The steps needed for the construction of the network are determination of (i) factors, (ii) clusters, and (iii) influence network.

Selection of the criteria

The quality of the assessment is dependent on the completeness of the variables of the research. Office investment decision-making is influenced by many factors, such as macro, medium, and micro factors. In this research the aim is to get insight in the influence on micro level of the real estate investment decision of offices. Macro (e.g. market situation) and medium factors (e.g. location) are in this research constant. Five clusters of influencing factors are derived from literature and in-depth interviews, the used influencing factors are illustrated in table 6.1.

1. Economic factors
 - 1.1. Revenues
 - c1. *Investment return* – expected exit yield to the investor
 - c2. *Expected lease rate* – expected vacancy rate of the property
 - c3. *Rental value* – expected rental income from tenants. The average rental revenue indicates the profitability of an office.
 - 1.2. Costs
 - c4. *Construction costs* – total amount of costs due to realize the office object
 - c5. *Exploitation costs* – total amount of maintenance and operational costs
2. Object factors
 - 2.1. Technical aspects
 - c6. *Architecture/Design* – amenity or architectural quality of a property, identity or appearance of a property
 - c7. *Size GFA* - size of a office to gross floor area
 - c8. *Parking norm* – degree of parking facilities of the office
 - c9. *Economic lifetime* - probability of refurbishment requirements during buildings lifecycle, indicated by the degree of maintenance condition
 - c10. *Finishing level materials* – high-quality finishing level of property details by the use of sustainable materials or definite materials
 - 2.2. Use aspects
 - c11. *Flexibility* – flexible arrangement of floors, expanding possibilities of property
 - c12. *Multipurpose* – degree of multipurpose compared to specific use
 - c13. *Management exploitation* – degree of experience and quality of exploitation management
 - 2.3. Sustainable aspects
 - c14. *Ecological impact* – degree of impacts to use and value due to environment
 - c15. *Indoor user comfort* – temperature indoor climate, acoustic disturbance, degree of direct daylight entrance, and degree of use of fresh air
 - c16. *Energy use* – degree of energy use (EPA)
 - c17. *Water use* – degree of water use
 - c18. *Waste management* – degree of effective waste management
 - c19. *Pollution* – degree of pollution caused by CO₂ emissions for example
 - c20. *Sustainable certification* – degree of sustainable certification like BREEAM

Table 6.1- Influence relationships ANP model

For the determination of the influences a zero-one *interfactorial dominance matrix* was used (Saaty, 2001) whose elements a_{ij} take the value 1 or 0 depending on whether there is or there is not some influence of element i on element j (appendix F1). The rows and columns of the matrix are formed by all the elements of the network.

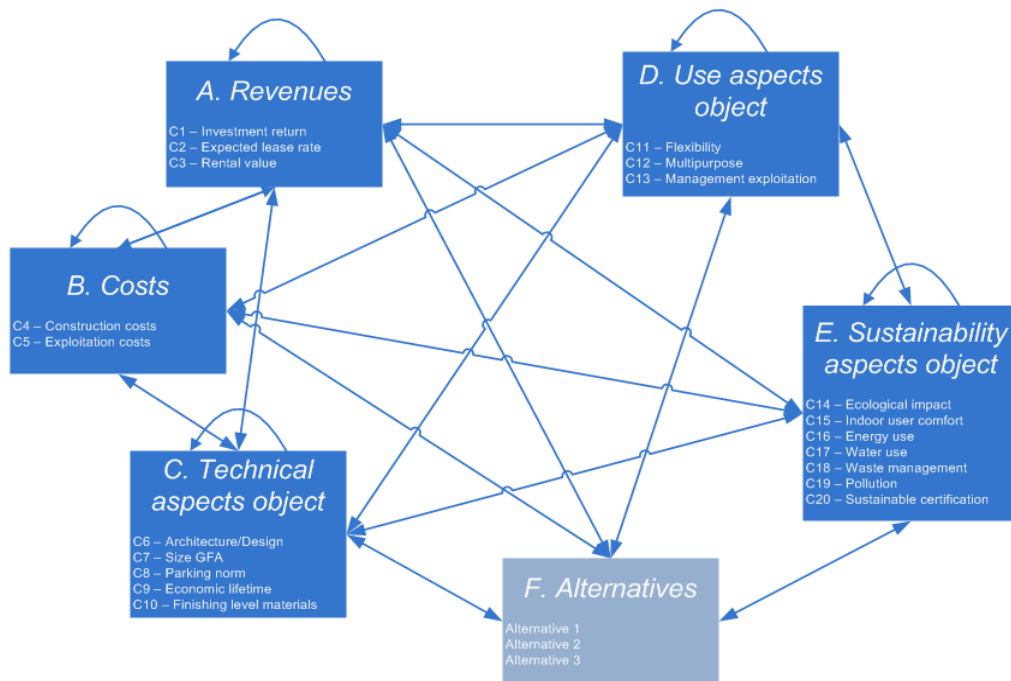


Figure 6-1 - ANP model

Feedback loop

In an ANP network, an element in one cluster can influence other elements in the same cluster (*inner dependence*), for example Indoor User Comfort (E2) with respect to Energy Use (E3), and can also influence elements in other clusters (*outer dependence*) with respect to each criteria, for example Energy Use (E3) with respect to Rental Value (A3). A *feedback loop* of influence between elements can cause an unimportant element to become important, because an element which has low priority in its component, but a high priority of influence on elements in other components, could obtain a high overall priority in the limited supermatrix, for example Energy Use (E3) with respect to Exploitation Costs (B2). There is a feedback loop, because the higher the energy use, the higher the exploitation costs, but a focus on decrease of exploitation costs influences the energy use. In figure 6.2 a part of the used ANP network is illustrated, to show above described example of the ANP advantages over the preference hierarchy based AHP research method.

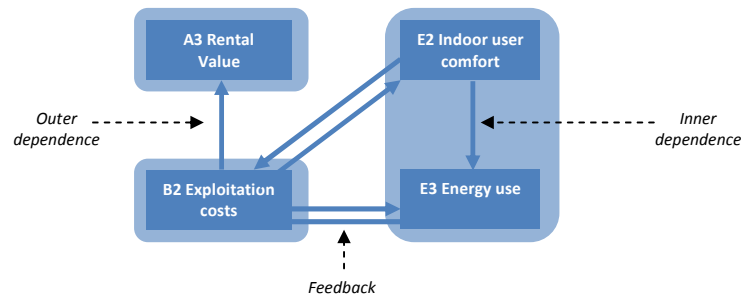


Figure 6-2 - Inner and outer dependence and feedback loop ANP method

6.2.2. Model quantification

To quantify and measure the ANP model or network in phase 2, a pairwise questionnaire is conducted from phase 1. A pairwise questionnaire is conducted to the cluster comparisons, element comparisons, and alternatives comparisons. This phase consists of assigning priorities to related elements in order to build the unweighted supermatrix. Each influencing factor is analyzed in terms of which other factors have influence upon it; the corresponding pairwise comparisons are generated in order to obtain the corresponding eigenvectors.

Suppose that some elements e_{ik} of cluster C_k influence one element e_{ij} of cluster C_j . To determine which elements of C_k have more influence on element e_{ij} of C_j , a reciprocal pairwise comparison matrix is built with the elements elements of C_k . In order to fill in each component of the matrix $n(n-1)/2$ questions (whereby n is the number of elements of C_k that influence e_{ij}) have to be answered. This procedure has to be repeated for each cluster whose elements exert some influence on element e_{ij} of the unweighted supermatrix whereby from phase 1 the clusters that exert some kind of influence on that element and whose values form the eigenvector that represents the relative influence of the elements of each cluster on element e_{ij} .

Due to the fact that in this research different elements from different clusters have influences on one element, the unweighted matrix is non-stochastic by columns. According to (Saaty, 2001), all clusters that exert any kind of influence upon each group have to be prioritized using the corresponding cluster pairwise comparison matrices. The value corresponding to the priority associated with a certain cluster weights the priorities of the elements of the cluster on which it acts (in the unweighted supermatrix), and thus the weighted supermatrix can be generated.

Questionnaire

The questionnaire designed about priorities by the pairwise comparisons was conducted to different experts like investors, funders, and consultants. The selection of the experts was based on their expertise in the area of real estate investment. The experts had an average of more than 10 years of professional experience in the real estate investment. The experts are

the decision makers that select the investments of their organizations or consult in organizational decision making of real estate investment. Thereby, the response sample is from high quality, since the experts are from the top 10 real estate investors in the Dutch office market, like: ASR Vastgoed, Bouwfonds REIM, PGGM Private Real Estate, Syntrus Achmea Vastgoed, and Wereldhave. The sample size of 6 experts is considered as acceptable, compared to ANP related studies (Gomez-Navarro, et al., 2009), (Chung, et al., 2005), (Lin, et al., 2008), and (Wu, et al., 2008).

The questionnaire was designed as a multiple-choice test into tables, that grouped the decisions relative to the pairwise comparison matrices. The respondents were asked to determine priorities among clusters, factors, and alternatives. The relative importance values are determined with Saaty's 1-9 scale, where a score of 1 represents equal importance between the two elements and a score of 9 indicates the extreme importance of one element compared to the other.

The questionnaire of the pairwise comparisons was extensive, therefore the questionnaire was split into two parts, whereby the pairwise comparisons of the clusters and factors of *A Revenues* and *E Sustainability* aspects formed one part and the pairwise comparisons of the clusters and factors of *B Costs*, *C Technical aspects*, and *D Use aspects* the other part. In figure 6.3 examples of the questionnaire of the pairwise comparison of the cluster B and factor C1 is presented. From the interfactorial dominance matrix (*appendix F1*), for each column, pairwise comparisons are made for all dependent criteria, the inner and outer dependencies of each criteria.

*** Instructies**

In relatie tot het criterium cluster '**Kosten (B)**', vergelijkt u voor ieder paar aan clusters, de mate van invloed. Welke cluster groep heeft de meeste invloed t.a.v. de andere cluster groep, waarin:

1 - Even belangrijk
3 - Matig belangrijker
5 - Gemiddeld belangrijker
7 - Zeer belangrijker
9 - Extreem belangrijker

	9	7	5	3	1	3	5	7	9	
Opbrengsten (A)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Technische aspecten (C)
Opbrengsten (A)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Gebruiksaspecten (D)
Opbrengsten (A)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Duurzaamheidsaspecten (E)
Technische aspecten (C)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Gebruiksaspecten (D)
Technische aspecten (C)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Duurzaamheidsaspecten (D)
Gebruiksaspecten (D)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Duurzaamheidsaspecten (E)

*** Instructies**

In relatie tot het criterium '**Architectuur (C1)**', voor ieder paar aan criteria vergelijkt u de mate van invloed. Welke criteria heeft de meeste invloed t.a.v. de andere criteria, waarin:

1 - Even belangrijk
3 - Matig belangrijker
5 - Gemiddeld belangrijker
7 - Zeer belangrijker
9 - Extreem belangrijker

	9	7	5	3	1	3	5	7	9	
Grootte BVO (C2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Parkeernorm (C3)
Grootte BVO (C2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Afwerkingsniveau materialen (C5)
Parkeernorm (C3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Afwerkingsniveau materialen (C5)
Flexibele indeelbaarheid (D1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Alternatieve aanwendbaarheid (D2)
Binnenklimaat/comfort gebruiker (E2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Afval management (E5)

Figure 6-3 - Examples of cluster and factor pairwise comparison with respect to Costs (B) and Architecture (C1)

Experiment design

Applied to this research, a case study on the choice of the best alternative for the future plan of an office to a certain location is tested. To rank the alternatives among the pairwise comparison from the investor point of view, comparisons are made by the respondents to three different plans.

- *Alternative 1: State of the Art Design* – focus on amenity, design, powerful identity created by the design of the office. This plan is meant to distinguish from surrounding offices;
- *Alternative 2: Multi-functional* – efficient, multi-purpose compared to specific use, flexible arrangement of floors, expanding possibilities of property. The design of the office is basic and not distinguishing;
- *Alternative 3: Sustainability* – this plan is focused on sustainability and comfort of the user, it has a BREEAM-Excellent certificate.

The three different plans which are used in this research, determine different plans with different scores to the clusters. A base alternative as multi-functional is used to determine the basic level of sustainability, with a focus on cost efficiency, and to prohibit high revenues. A medium alternative as state-of-the-art is used to determine the influence of identity and amenity to an investors' decision, with an average focus on sustainability. The sustainable alternative is focused on sustainable quality and indoor comfort, scored with a BREEAM-Excellent score. In table 6.2 there is score indicated from the alternatives to the different clusters of the ANP model.

Alternatives ANP Model			
	Alternative 1 – State of the Art Design	Alternative 2 – Multi-functional	Alternative 3 - Sustainable
A Revenues	Medium	High	Low
B Costs	Medium	Low	High
C Technical aspects	High	Medium	Low
D Use aspects	Low	High	Medium
E Sustainability aspects	Medium	Low	High

Table 6.2 - Overview alternatives ANP model

In the figure 6.4 an example of the questionnaire of the pairwise comparison of the alternatives with respect to factor B1 Construction costs is presented.

*** Instructies**

In relatie tot het criterium '*Stichtingskosten (B1)*', voor ieder paar aan alternatieven vergelijkt u de mate van invloed. Welke alternatief heeft de hoogste waarde van '*Stichtingskosten (B1)*' t.a.v. het andere alternatief, waarin:

1 - Even belangrijk
3 - Matig belangrijker
5 - Gemiddeld belangrijker
7 - Zeer belangrijker
9 - Extreem belangrijker

9 7 5 3 1 3 5 7 9

Alternatief 1 (F1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Alternatief 2 (F2)
Alternatief 1 (F1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Alternatief 3 (F3)
Alternatief 2 (F2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Alternatief 3 (F3)

Figure 6-4 - Example of alternative pairwise comparison with respect to Construction costs (B1)

6.2.3. *Synthesis and analysis*

In phase 3, analysis of the data of the pairwise comparisons is performed. To produce consensus results, the geometric means of all respondents' responses are calculated, and synthesized to the ANP network model. The data is processed and synthesized by using ANP software SUPERDECISIONS. The unweighted and weighted supermatrix are raised to successive power whereby the limited matrix is obtained.

6.3. Conclusion

The aim of this research is to get insight in the influence on micro level of the real estate investment decision of offices. Twenty influencing factors are used in the real estate investment decision analysis of a new development office. Macro factors (like market situation, political situation, etc.) and medium factors (like location, public transport) are in this research constant. The influencing factors are combined into five clusters derived from literature and in-depth interviews which are used in this research. Only the possible variable influencing factors on micro level are assessed in this research.

This study comprises three steps of the main ANP modeling. Phase 1 is model construction to identify, analyze and structure the complexity of the problems into an appropriate ANP network. Phase 2 is model quantification or pair-wise comparison. The questionnaire

designed about priorities by the pairwise comparisons was conducted to different experts. The response sample is from high quality, since the experts are from the top 10 real estate investors in the Dutch office market. The questionnaire was designed as a multiple-choice test into tables that grouped the decisions relative to the pairwise comparison matrices. Phase 3 is synthesis and results analysis, to determine the overall influence from all elements to the investment decision.

Part III – Results & Discussion

7. Results

This chapter elaborates the results of the research method ANP. First, the adjustment of the consideration framework of the real estate investment of offices is discussed. Thereafter, the results derived from the program SUPERDECISIONS are described, like priorities of the influencing factors, clusters and alternatives.

7.1. Preferences investors

From the in-depth interviews and the questionnaire almost all investors agreed that improving the sustainability certification, by achieving a BREEAM rating, could be used to attract better occupiers and tenants. The investors indicated an implemented sustainable policy at fund level. Although, investors implemented sustainability on different ways, it varies from a reticent attitude to a pro-active attitude.

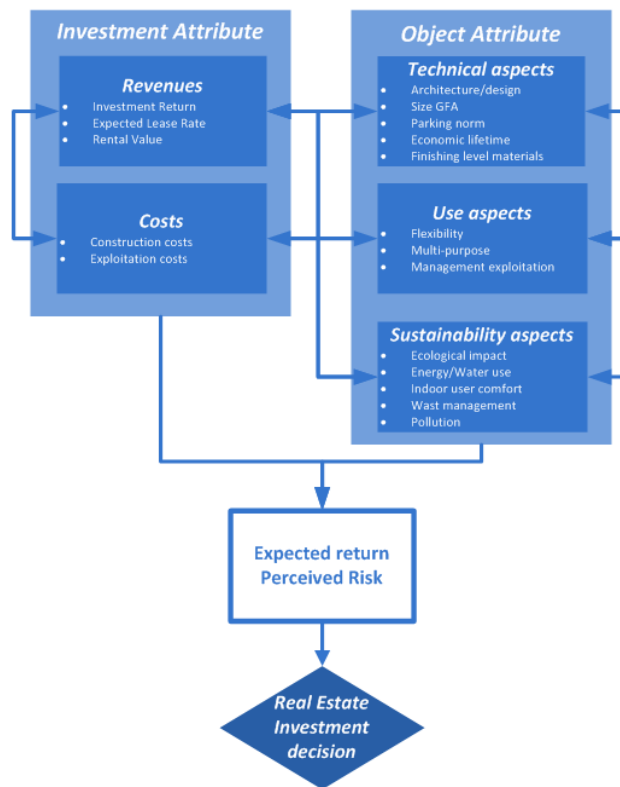
Investments of sustainable real estate have different motives. Sustainable real estate is indicated as a public relationship (PR) or investor/tenant relations issue, shareholders of investors are more demanding in terms of sustainability in real estate, and sustainability in offices is an important element to minimize the risk of vacancy of offices. Sustainable offices can produce better asset performance through fewer voids. Although, investors don't agree with the fact that sustainability in offices offers the potential to generate additional revenue.

Investors indicated sustainability of offices, is driven by occupiers and tenants, and not by owners and investors. If occupiers demand sustainability, owners and investors will respond to it accordingly. Improving sustainability of offices attracts on the long-term better occupiers and tenants.

The interviewed investors didn't have an agreed perception about the level of higher investment costs and/or higher value of the asset caused by sustainability. Sustainability is a relative new concept, which has to be integrated on an innovative way, whereby the development of BREEAM rating is indicated as the most important and used assessment method for offices, because of the international and integral aspects. International operating investors indicated the comparison tools, e.g. developments of the EGS database, as a stimulation to preserve the unsustainable real estate supply. The 'split incentive' is in the opinion of the investors the most important obstacle of the sustainable development process of offices. Investors try to create a win-win situation for occupiers, tenants and the investors themselves to integrate sustainability.

7.2. Validation investors' consideration framework

The adjusted investment decision model (figure 7.1) is a refinement of different models derived from the literature and consists of more detailed factors. The different models are merged and evaluated by the in-depth interviews with experts and the pairwise comparison questionnaire of the ANP, to create the investment decision model on micro-level for this research.



From the obtained results from the ANP multi-criteria decision analysis, the output confirms in general the influencing factors on micro level of the investment decision model developed in paragraph 6.2.1. Some influencing factors, like ecological

impact, show an overall preference of less than 1%,

which can be noted as a non-influencing factor, either there is no relationship. From the ANP research method only the influence between clusters and factors can be tested with the output, if there is a relation between factors, it is tested by the level of influence. The final investment decision consideration framework, developed in this research provides a clear and specific oversight in the investment decision process on micro-level of offices.

Figure 7-1 - Final investors' investment scheme on micro level

7.3. Priorities of influencing factors

Several results can be obtained by the analysis and synthesis of the unweighted, weighted, and limited supermatrices. The eigenvector which is derived from the pairwise comparison, is part of some column of the supermatrix. It represents the impact of a given set of elements in a component on another element in the network. The unweighted supermatrix (appendix F2) contains the local priorities derived from the pairwise comparisons questionnaire throughout the network. The weighted supermatrix (appendix F3) is obtained by multiplying all the elements in a component of the unweighted supermatrix by the corresponding cluster weight. Finally, the limited supermatrix (appendix F4) is obtained by raising the weighted supermatrix to the powers until all columns are identical to within a

certain decimal place. The final values of priorities of all the elements are obtained by normalizing each element, so that the columns of the limited supermatrix become identical.

7.3.1. ANP Cluster priorities

Concerning the output of the ANP results, the priorities of the clusters of the office real estate investment decision can be calculated. When cluster weights are analyzed in the ANP model (obtained from the sum of the weight values of the criteria within the clusters) with the program SUPERDECISIONS, the priority order of the clusters can be observed. The priorities among the influencing factor clusters are illustrated in the figure 7.2.

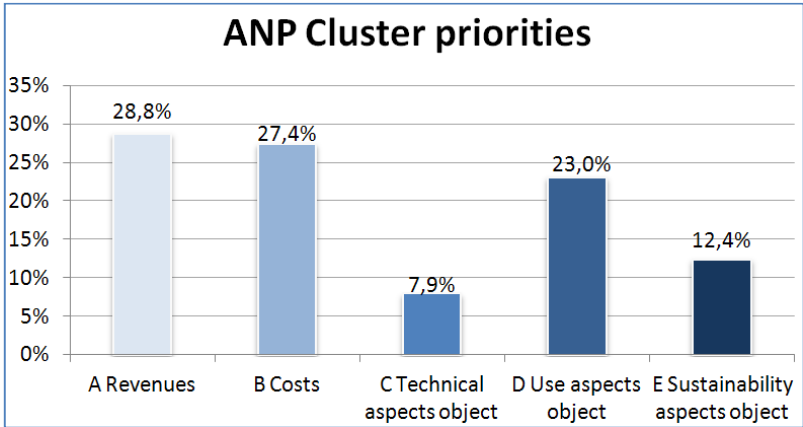


Figure 7-2 - ANP cluster priorities

Regarding the overview of the priorities among clusters, investors prefer the revenue aspects of an office like investment return, expected lease rate, and rental value, followed by cost factors like exploitation costs, and construction costs. This confirms the dominant financial/economic point of view of investors to an office investment. Investors prefer revenue, cost, use, and sustainability aspects over the technical aspects of an office, like architecture, size GFA, and parking norm, in the real estate investment decision of an office. The sustainability aspects of an office have an influence of 12,4% to the investment decision, which is quite less compared to the revenue, cost, and technical aspects clusters.

7.3.2. Priorities within cluster

From the unweighted supermatrix (appendix F2) the local priorities are derived from the pairwise comparisons questionnaire throughout the network. The local priorities of the influencing factors within the clusters can be calculated. Since, the focus of this research is the influence of sustainability on the investment decision, the cluster of sustainability aspects (BREEAM aspects) is described. Other local priorities are illustrated in appendix F5.

According to the sustainability aspects of an office object, one can observe that the most important factors among this sustainability cluster (BREEAM factors) are 'Indoor user comfort' criterion with a priority of 35,8%, followed by 'Energy use' 17,7%, and 'Sustainable certification' 16,5%. These priorities indicate the level of importance within the sustainability

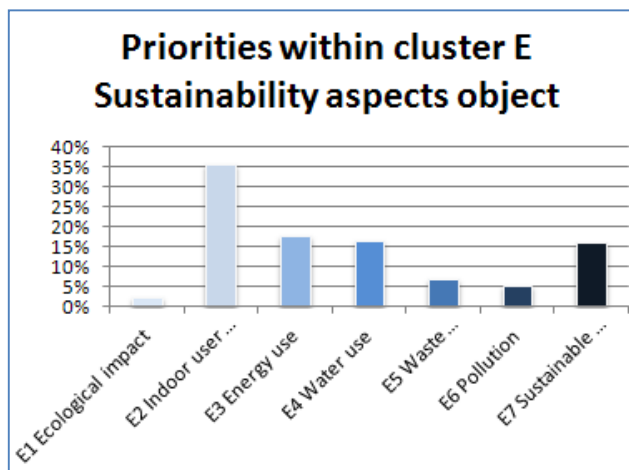


Figure 7-3 - Priorities within cluster E Sustainability aspects object

aspects cluster in the real estate investment decision of an office. The level of priority of the 'Ecological impact' is the lowest within the cluster of sustainable aspects with 2,1%. Investors don't prefer the social sustainability like ecological impact and pollution, but prefer the quality of an office by indoor user comfort, and sustainable aspects that

he exploitation costs, like energy use and water use.

7.3.3. Overall priorities real estate investment decision

From the limited supermatrix (appendix F4) the overall values of priorities of all the elements are obtained by normalizing each element. If we consider the relative importance of all

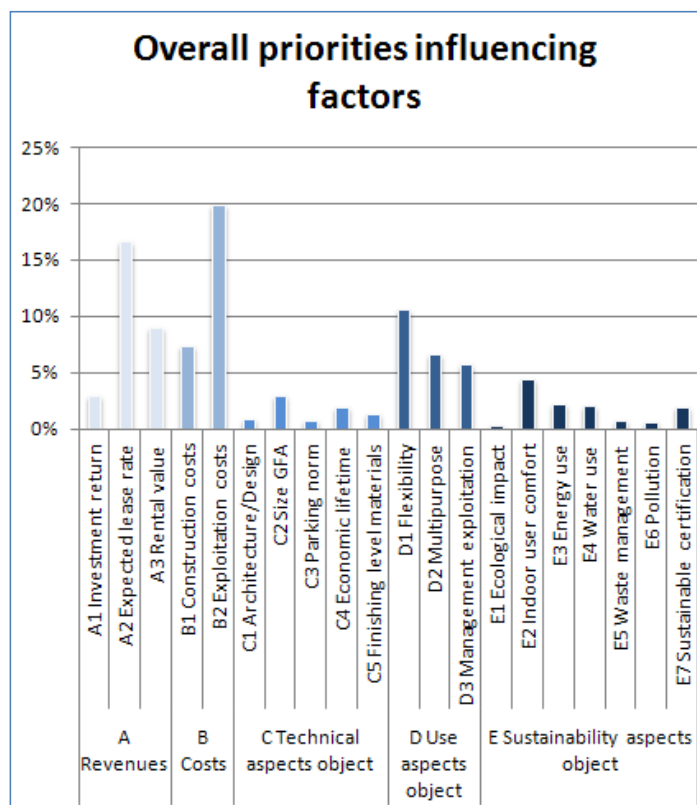


Figure 7-4 - Overall ANP priorities of influencing factors

criteria in the model, one can observe that the most important factors among all are the 'Exploitation costs' criterion with a priority of 20,0%, followed by 'Expected lease rate' with a priority of 16,7%, and 'Flexibility' criterion with a priority of 10,6%. From the results of the overall priorities, the sustainability aspects are preferred less than 5% according to the overall office real estate investment decision. The overall priorities shows a dominance of the financial (exploitation costs and expected lease rate) and economic

robustness aspects (like flexibility and multi-purpose), compared to the sustainability and technical aspects of an office.

The influencing factors ‘Ecological impact’ (E1), ‘Waste Management’ (E5), ‘Pollution’ (E6), and ‘Parking Norm’ (C3) do have a priority of less than 1%, which can be indicated as there is no relationship between these factors and the office real estate investment decision. Remarkable is the level of priority of the parking norm, which was identified by several investors from the interviews as an important influencing factor. This can be caused by the fact of the low cluster weight of the technical aspects of an office.

7.3.4. *Priorities alternatives*

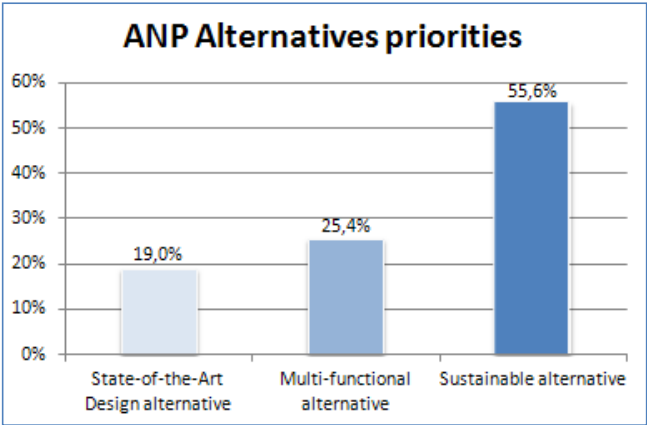


Figure 7-5 - ANP alternatives priorities

From the results obtained within the ANP model (appendix F6), the ‘best’ alternative is the alternative with the overall highest value. The results are synthesized from the raw column, which are the limiting priorities obtained from the limiting supermatrix for the alternatives.

ed results indicate that the ‘Sustainable office’ alternative is the most preferred alternative with a normalized priority of 55,6%. The ‘Multi-functional’ alternative is the second preferred alternative, with a score of 25,4%, followed by the ‘State-of-the-Art Design’ alternative with a preference of 19,0%. According to the alternative priorities there is a highly preference to the wide-concept of sustainability. The lowest preference of investors is to an alternative focused on a strong identity and amenity by an impressive design. The costs-efficient multi-functional focused alternative scores a medium preference.

7.4. *Consistency check*

As discussed in 5.4.1., the consistency index (CI) denotes the level of variances between the maximum characteristic value and the number of hierarchy levels and serve as the measurement for the level of consistency. If $CI < 0,1$, the level of consistency is satisfactory. The relative weightings estimated by the ANP approach were deemed acceptable in this model, as the consistency-ratio was lower than 0.10, indicating a high validity.

7.5. Conclusion

From the in-depth interviews, investors indicated improving the sustainability certification, by achieving a BREEAM rating, could be used to attract better occupiers and tenants. Most important considerations of sustainable real estate are a PR or investor/tenant relations issue, shareholders of investors are more demanding in terms of sustainable assessment certification, and sustainability is an important element to minimize the risk of vacancy of offices. Sustainable offices can produce better asset performance through fewer voids.

From the output of the Analytical Network Process almost the complete investment decision consideration framework can be confirmed. With use of the unweighted, weighted, and limited supermatrices the priorities of all the influencing factors are determined, tested, and confirmed. Regarding the overview of the priorities among clusters investors prefer the revenue and cost aspects of an office. Investors don't highly prefer sustainability factors in the real estate investment decision of an office in general.

If we consider the relative importance of all criteria in the model the most important factors among all are the 'Exploitation costs' criterion, followed by 'Expected lease rate', and 'Flexibility'. The obtained results indicate that the 'Sustainable office' alternative is the most preferred alternative.

8. Conclusion

In this chapter the results of the research will be reviewed for its fit for answering the main research question and main sub-questions, the main research question is:

To what extent does sustainability influence investors to invest into office development?

The main sub-questions are:

- I. What are the characteristics of the current sustainable development process of commercial offices?
- II. What are the ambitions, interests, and considerations to invest in sustainable commercial offices from an investors point of view?
- III. What are the most important influencing factors in the investment decision analysis of development of offices?
- IV. How is sustainability embedded in the investment decision analysis of development of offices?

The conclusions are based on the contextual orientation, in-depth interviews and the Analytical Network Process research methodology.

8.1. Influence of sustainability

According to the research question: *'To what extent influences sustainability investors to invest into an office development?'*, the investment decision can be explained as a complicated decision process, owing to the particularity and complexity of real estate investment decision-making.

From this research the office investment decision-making problem is analyzed by providing a comprehensive analytic framework in order to achieve the investment scheme on micro-level, whereby sustainability factors are not indicated with the highest priority values.

Sustainability does influence investors' decision of the commercial office development in an indirect manner. According to investors, a sustainable office minimizes the risk of vacancy in the future, caused by the current Dutch commercial office market situation which is determined by the replacement issue (oversupply, high rate of vacancy). Investors try to maximize their return of investment, but with a minimum of the perceived risk according to their investment strategy. Securing the lease rate is a way to minimize the risk of failing in their return of investment, hence investors foresee in improving the sustainability of offices, attracts on the long-term better occupiers and tenants.

From the ANP model results, the 'Sustainable office' alternative is the most preferred alternative. But from the investment decision analysis, indicated by the overall priorities of the influencing factors, the sustainability aspects don't have a high preference. Investors have a dominant financial/economic point of view in the investment of an office.

Sustainability can be explained as a development that meets the needs of the present, whereby it tries to decrease the exploitation costs, which is the most preferred influencing factor to the investment decision. Though, political correctness can be noticed from the ANP research, whereby the wide concept of 'sustainability' is preferred, indicated from the preference of the sustainable alternative. But from the criteria factors of the investment scheme on micro-level, there is no preference of the sustainability factors.

Investors try to create a sustainable image/reputation, in order to please their shareholders and environment by choosing the wide concept of 'sustainability' in different alternatives, as part of their public relation strategy (PR). But from the more detailed investment scheme on micro-level there is no preference to sustainability.

Corresponding to the international research (Eichholtz, Kok, 2010) to almost 200 real estate investors, sustainability is indicated as an important theme to their corporate culture, but the implementation of sustainability is realized by only 10 percent of them. This research confirms sustainability as a corporate value (interviews), but the implementation of sustainability into the investment scheme on micro-level of an office by several investors is not realized (ANP research method). From the results of the interviews and the ANP research method a divergent, non-consistent response can be noticed, which confirms the political correctness attitude.

Real estate investors, like insurance companies and pension funds, are still reserved to invest in sustainable real estate development projects. Investors are still not convinced of the fact of higher value of sustainable real estate compared to 'unsustainable' real estate. Investors have a dominant financial/economic point of view, whereby the financial results of a sustainable office is (still) not sufficient, instead of a corporate social responsibility like a sustainable real estate portfolio. Research and objective information is needed to convince investors of the higher 'exit yields', higher rental values, decrease of exploitation costs, and/or larger economic lifetime of 'sustainable' offices compared to 'unsustainable' offices.

8.2. Investors' consideration framework

In the Introduction chapter the main sub-research questions are formulated. These questions will be answered related to the investors' consideration framework of the investment of an office.

8.2.1. Characteristics current sustainable development

The current sustainable development of the Dutch commercial office market is characterized by the 'Circle of Blame'. The 'Circle of Blame' is a vicious circle which illustrates different stakeholders and actors in the 'sustainable development process' who are blaming each other to take the (financial) initiative. For example, as a benchmark of the office supply has to have a minimum of energylabel C to be remarked as sustainable, two third of the total office supply has to be preserved, which is 30 million m². Still investors indicated sustainability of offices, is driven by users, and not by owners and investors. But, 73 percent

of the Dutch office users indicated sustainable housing is an important theme to their corporate culture.

The 'split incentive' is another obstacle of the sustainable development process of offices. Which means if a sustainable investment is done by an investor the advantages of this investment are for a different actor, e.g. the user, instead of the investor themselves. From a financial point of view the development of sustainable real estate does have higher initial investment costs compared to the development of un-sustainable projects, the fact of a decrease of exploitation costs is not always obvious.

8.2.2. Sustainable interests and considerations investors

According to investors, a sustainable office minimizes the risk of vacancy in the future, caused by the current Dutch commercial office market situation which is determined by the replacement issue (oversupply, high rate of vacancy).

The main considerations to invest into sustainable offices are image/reputation, demanding shareholders of investors in terms of sustainability in offices, and minimizing the risk of vacancy of offices (future-proof). Nevertheless, the main interest of an investor is the maximum return and minimum of the perceived risk of the investment of an office, and not the corporate social responsibility like a sustainable real estate portfolio.

8.2.3. Influencing factors investment decision

From the obtained results from the ANP multi-criteria decision analysis, the cluster priorities confirms the preference of revenue and cost factors as the most influencing cluster factors in the investment decision of a new development office. According to the investors, the use aspects of an office like flexibility and multi-purpose do have an higher influence to the investment decision of an office, compared to the sustainability aspects and technical aspects of an office.

According to the sustainability aspects of an office object, investors don't prefer the social sustainability like ecological impact and pollution, but prefer the quality of an office by indoor user comfort, and sustainable aspects that influence the exploitation costs, like energy use and water use.

The most overall important factors that influence the investment decision are exploitation costs, expected lease rate, and flexibility. Investors don't highly prefer sustainability factors in the real estate investment decision of an office in general. Investors have a dominant financial/economic point of view, but if there would be more attention and requirements to technical and sustainable aspects from investors, the quality of an office will be increased, whereby the chance of a high lease rate increases and the risk of vacancy decreases.

8.2.4. Implementation of sustainability

Investors indicated sustainability as an important corporate value, whereby it is implemented to their investment decision. This implementation is done by the use of an

assessment method like BREEAM or an own method. Till now, many different assessment methods were used by different actors, whereby EPL ('EnergieLabel') is already implemented in the investment decision.

The assessment method of BREEAM rating is indicated as the most important and used method for offices, because of the international and integral aspects. International operating investors indicated the comparison tools, e.g. developments of the EGS database, as a stimulation to preserve the unsustainable real estate supply. Investors and other stakeholders of the real estate industry plead for one broad-used sustainable assessment method, in order to stimulate the communication and collaboration.

8.3. Discussion

This research focuses on the influence of sustainability on the Dutch investor's investment decision of new development of office projects. However, the influence of sustainability is completely different from new development compared to the investment of existing offices. In fact, the most sustainable way of sustainability is no longer new development, but preserve existing offices on A-locations with a high potential of a high lease rate. Nevertheless, it is interesting to analyze the integration and influence of sustainability in new developments, because of the influence on the plan development, instead of preserving a possible restricting existing asset.

The focus of this research are the investors considerations to sustainability in new commercial office development. The current Dutch commercial office market is strongly influenced by the replacement issue. Nevertheless, this research didn't take into account the future situation of a possible decrease of commercial real estate, influenced by new technologies and/or new operating conditions. Still, this research gives insight into the consideration framework of investors and possible problems in the current situation, which enables other actors to specify their strategy to realize sustainable ambitions.

In this research only a certain amount of experts, like investors and funders, are assessed to the question if sustainability influences the investment decision of offices. These experts were chosen based on their expertise in the area of real estate investment, since the experts are from the top 10 real estate investors in the Dutch office market. The main influencing factors on micro level are indicated and weighted in relation to the investment decision, influencing factors on macro and medium level, like location, political environment, are constant.

Nevertheless, the use of the ANP method as multi-criteria decision method is not free of criticism. Firstly, ANP prescribes comparisons that occasionally get to be complex to understand for experts who are not familiarized with this method. Hence, much attention must be devoted to the elaboration of the questionnaires. Besides, to arrange an experts' panel with adequate number of participants of sufficient qualification can pose the major problem of the method. Finally, ANP gets much more unclear and complicated as the

number of alternatives and/or criteria grows, and therefore, it gets much more difficult to apply with efficiency, compared to the 'real life' investment decision.

The investment decision can be explained as a complicated decision process, which in practice is strongly influenced by emotion and subjective appraisal of the investment opportunities. The ANP method analyzes the dependence and feedback of factors in a objective way, without subjectivity. The ANP method illustrates the investment scheme in an ideal image and situation, without the external influences and subjectivity of the 'real life business'.

Although the new proposal has been specifically applied to the evaluation of new office development proposals, this tool can be adapted to any type of decision-making problem, the provided criteria are correctly identified and there are some dependencies among them. This tool constitutes a very promising future research line in the field of construction management and urban development.

9. Recommendations

In this final chapter recommendations are given to different actors in the office development process, with special attention to developers. Next, a review and recommendations of the research process are described, whereby the research method ANP is discussed. Finally, follow-up considerations are given for further research.

9.1. Product

In case of a new office development, the following considerations would be suggested to implement, to enable developers to specify their strategy to realize sustainable ambitions into the sustainable office development. Within a collaboration of a new office development, the objectives and interests have to adjusted as much as possible, because actors need each other to achieve their joint objective.

The office market is determined by the replacement issue, because of the demographic development, 'Het Nieuwe Werken', and the sustainability issue. There is a large challenge for a structural approach to solve the oversupply and to preserve the existing supply of offices. The chance to break up the traditional real estate industry, which operates in a 'Circle of Blame', is to bring the actors in contact with new, powerful, and wealthy stakeholders from side value chains to come to new and innovative collaborations and organizations to realize interests and ambitions. In this new integrated perspective, actors have to aim for robust and flexible solutions, of financial side chains like energy, communication, water, and/or transport, and take into account new technologies and/or new operating conditions to look forward of the future situation of the commercial real estate.

The most sustainable way of sustainability is no longer new development of offices, but preserve existing offices on A-locations with a high potential of a high lease rate. It would be better to devalue the existing real estate portfolios or to demolish uncompetitive offices. Not much investors are willing to devalue their real estate portfolios. Investors have to be convinced of the financial advantages of 'sustainable' offices. Developers have to focus on redevelopment instead of obtaining the profit/return of 'unnecessary' new development of offices. Office users have to be prepared to pay an extra charge to the rental price, and to demand high-quality offices that meets the needs of the users. All actors have to take their losses and stop with the range of ideas of creating as much as possible profit from a temporary involvement of 'unnecessary' new developments. Instead, actors have to provide insight in their ambitions and interests in order to create a long-term joint objective. Different actors have to collaborate to create an appropriate solution to the replacement issue of the Dutch office market.

There should be an users perspective focused vision based on continuity and value creation on long-term involvement and collaboration with a continuous utilitarian value of real estate. Continuity is provided with a focus on the use of an office, with a decrease of exploitation

costs (decrease energy use, and decrease of maintenance), increase of health and well-being of end-users (increase productivity), future proof design from an increase of quality an office by stimulating flexible arrangement of floors and possibilities of multipurpose, and increased attention to the exploitation of an office. Within a focus on users perspective and continuity, sustainable offices enable a decrease of exploitation costs, extended depreciation periods, higher rental level, increase of let ability, and a decrease of risk of vacancy.

The development of the BREEAM rating is an important tool to preserve offices and should be integrated by all actors of the real estate industry, because of the international and integral perspective. One assessment-method instead of different perspectives and views of sustainability, as an international sustainable language, used and integrated by all actors, stimulates the communication, collaboration, and integration of sustainable qualities within offices. An increase of attention and requirements to sustainable aspects from users and authorities, stimulates the acknowledgment to sustainable development.

The Dutch government has to take an example of France, Germany, and the United Kingdom in order to stimulate the sustainable development in the real estate industry by creating conditions and requirements in the legislation, with requirements of commitment of a certain level of sustainability, charges if the real estate development lacks the sustainable quality, and/or provide subsidies to certain sustainable technologies.

9.2. Process

From the international experience at the National University of Singapore, my attention was triggered to the investment process of real estate projects, and how the investment decision-making is structured. From different courses I was introduced to real estate investment appraisal, risk management, and decision analysis.

In this research, the theory of Analytic Network Process is used, considering the interaction and restriction relationship between indices, and is used to set up a multi-criteria decision-making indices system and model for real estate investment of an office. Comparing with traditional multi-criteria decision methods, the ANP method reflects not only the nonlinear relationship between influencing factors, but also the interaction and restriction relationship between internal indices.

Nevertheless, the use of the ANP method as multi-criteria decision method does have some disadvantages. Firstly, ANP prescribes comparisons that occasionally get to be complex to understand for experts who are not familiarized with this method. Hence, much attention must be devoted to the elaboration of the questionnaires. Besides, to arrange an experts' panel with adequate number of participants of sufficient qualification, knowledge, and expertise was the major problem of the method in this research. Finally, ANP gets much more unclear and complicated as the number of alternatives and/or criteria grows, and therefore, it gets much more difficult to apply with efficiency, compared to the 'real life' investment decision.

Although, the investors who participated in this research need a special thank. In the in-depth interviews, the investors were reserved to discuss about the investment strategy and the relation to sustainability. Most investors still do have a reticent attitude to sustainability, but they are prepared to start the discussion about sustainability.

9.3. Follow-up considerations

This research provides in a practical way insight in a complicated decision process of investment. The influence of sustainability is completely different from new development compared to the investment of existing offices, the results of this research can be used as a starting point for the existing office stock. Providing insight into the considerations, ambitions, and motives of the different actors into the sustainable office development, gives more insight in the decision process of offices, which enables actors to collaborate in order to have an appropriate solution to the replacement issue of the Dutch office market. Besides, more research and objective information is needed to convince investors of the advantages of 'sustainable' offices. Recommendations for further research are:

- Influence of sustainability compared to *meso factors* (like location factors) and/or *macro factors* (like political environment)
- Influence of sustainability compared to the possible future development of new technologies, alternative working situations, and commercial office market situation
- Multi-criteria decision making model of occupiers, users and tenants compared of offices
- Willingness-to-pay of investors or tenants to sustainability factors based on stated preference
- Influence of BREEAM, indoor user comfort to occupiers, users, and tenants
- Influence of design, indoor user comfort, flexibility and multipurpose to the rental price

List of Abbreviations

AHP	Analytical Hierarchy Process
ANP	Analytical Network Process
BREEAM	Building Research Establishment Environmental Assessment Method
DGBC	Dutch Green Building Council
EPL	Energie Prestatie Label
MCDA	Multi Criteria Decision Analysis

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Appendices

Appendix A – Aspects of sustainable real estate

The concept of sustainability is described to the different aspects which are considered to be important for sustainable real estate. The aspects which will be described are deducted from the BREEAM-NL design stage assessment (DGBC, 2011) and (Nijhoff, 2010), because the BREEAM-NL is the most used assessment method (*appendix B*).

Sustainability is a concept which is wide and very complex, which means it is interpreted in many different ways. There are many different definitions and there are different focuses of the definition of sustainability. The aspects of sustainable real estate are described to the tetrahedron model of *Planet, People, Prosperity* and *Project*, operationalized with underlying characteristics and applications to the level of building development.

Planet (environmental quality)

The building industry is energy- and material intensive industry, whereby the planet aspect is very important. The planet aspect of the sustainable real estate development emphasis the aspects *energy, materials, waste, land use, pollution*.

Energy



The built environment is responsible for 30 to 40 percent of the total national energy use. The aim of the energy aspect is to recognize and encourage buildings designed to minimize operational energy demand, consumption and CO₂ emissions. Energy is used for the use of electricity and for heating and cooling of buildings. The energy assignment can be distinguished into heating, cooling, lightning, and the use of electricity of devices.

Examples of applications of energy are the use of solar energy, wind energy, use of mention sensors, use of a central heat and cold storage (eg. Aquifer Thermal Energy Storage), and the use of residual heat.

Issues of the energy aspect of sustainability are: reduction of CO₂ emissions, energy monitoring, energy efficient external lighting, low or zero carbon technologies, energy efficient cold storage, energy efficient transportation systems, energy efficient laboratory syst , energy efficient equipment (process), and drying space.

Materials



The four major aspects of the sustainability of materials are: 1) the renewability of the source of the material. This means the degree and rate in which the source of the material renews itself. In the case of wood, there is the FSC certificate, but for many other natural materials such a certificate does not yet exist, 2) the production conditions on the production site. This also includes whether there is any form of unacceptable working hours, 3) the impact of the material winning to the environment, and 4) the location of production and the transportation costs of the material.

Issues of the material aspect of sustainability are: life cycle impacts, hard landscaping and boundary protection, responsible sourcing of materials, insulation, and designing for robustness.

Waste



The aspect waste means efficient use of resources by effective and useful waste management on the building site and during the exploitation phase of the building. Waste separation and reuse of materials are important strategies in the waste aspect of sustainability.

Issues of the waste aspect of sustainability are: construction waste management, recycled aggregate, operational waste, and speculative floor and ceiling finishes.

Land use



The (re-)use of land aspect of sustainability means stimulating project developers, municipalities, housing corporations, and other actors to realize building projects on a location with low ecological and landscape value, to stimulate the re-use of developed land, to prevent new developments of buildings on rural area. Also the green structure of the surrounding area is important to this aspect.

Issues of the land use aspect of sustainability are: site selection, ecological value of site, protection of ecological features, mitigating ecological impact, enhancing site ecology, and long term impact on biodiversity.

Pollution



The aim of the aspect of pollution in sustainability is to reduce the contribution of climate change by stimulating the use of materials and techniques with a low contribution to the greenhouse effect.

Issues of the pollution aspect of sustainability are: impact of refrigerants, NO_x emissions from heating/cooling source, surface water run-off, reduction of night time light pollution, and noise attenuation.

Water



Efficient use of water is another important aspect of sustainability. The scarcity of water is a global issue. In the built environment, a number of measures can be taken to reduce the demand for fresh water. Here, the same strategy as with energy can be taken. Firstly, lower the demand by technical measures, such as water saving toilets, showers, and taps and installing water meters. Secondly, recycle used water by collecting and filtering rainwater and household water. A second issue concerning water is the reduction of water pollution. This can be achieved by using natural filter systems like green roofs. Runoff water should be carried off towards the sewerage, but should be discharged in the soil at the building location, to prevent soil dehydration in dense urban areas.

Issues of the water aspect of sustainability are: water consumption, water monitoring, water leak detection and prevention, and water efficient equipment (process).

People (social quality)

In the essence the aspect of People is connected with the users and actors of the development of sustainable real estate. People is mostly identified with the quality of live, which is really hard to quantify. Compared to financial investments, social investments are difficult to quantify its result. The social quality can be characterized by the aspects *health*, *safety*, and *participation*.

Health & Comfort



Buildings do have several functions and uses. To ensure a healthy environment is always important. Employees of organizations need to be healthy and feel comfortable to execute their jobs, clients of shops like to be in comfortable surroundings, and people want to live in comfortable houses. It is therefore very important to ensure a good indoor air quality, (social) safety and security, sufficient daylight, sound insulation and a positive atmosphere. Thereby sustainability doesn't only involve technical aspects, but also involves aspects like comfort, pleasure, and atmosphere.

Issues of the health aspect of sustainability are: visual comfort, indoor air quality, thermal comfort, and water quality.

Safety

The aspect safety is about the experience of feeling safe. Issues of the safety aspect are: orientation of the building, design of the public and private spaces, clear routing, and sightlines. Also the use of different functions influences the safety, because of the level of liveliness it could increase the level of social control and safety.

Participation

Participation can be distinguished into participation during the development process and participation of the users during the exploitation phase. In case of the participation in the development process, transparency is essential, whereby different actors and stakeholders are involved into the decision and plan development process. Participation during the exploitation phase is focused on the constant improving development of the property. A high level of participation will result into an increased quality level, because actors and stakeholders are more involved in the development process, whereby their needs and requirements can be satisfied.

Prosperity (economic quality)

The economic quality of a sustainable real estate development is decisive; *financial feasibility, profitability, employment, and let ability and marketability* are important factors of the prosperity aspect of sustainability. The added value of sustainability could be indicated into monetary terms like, increase of value of properties and lower exploitation costs. The profitability of sustainability arise during the exploitation phase.

Project (spatial quality)

The aspect Project is about the spatial quality and the product development. It is about the characteristics like *beauty, management, transport, identity, flexibility, diversity, robustness, and functional mix*.

The aspect of beauty indicates the individual architectural quality of the property. A good visual quality of the built environment increases the experience value and the identity. The robustness is about the retrievable and length of lifetime of the built environment. Flexibility is important to the level of adjustment to different uses and activities. Diversity of target groups, functions, and facilities increases the quality of the plan. A higher level of diversity creates anticipation space to fulfill the needs and requirements in the future.

Management



The aspect of management is about how the user of the building is dealing with sustainability. This aspect illustrates the stimulation of performance assurance of installations, whereby an optimal use is assured.

Issues of the management aspect of sustainability are:

sustainable procurement, responsible construction practices, construction site impacts, and stakeholder participation.

Transportation



Transportation is important because of the acknowledgement and stimulation of developments in the neighborhood of good public transport, whereby transport related emissions and traffic jams are reduced and minimized. It also means an improvement of walking, cycling and use of public transport to change habits in reducing car use. It ensures transport impacts are reflected in investment decisions and the costs that users pay.

Issues of the transport aspect of sustainability are: public transport accessibility, proximity to amenities, cyclist amenities, maximum car parking capacity, and travel plan.

Appendix B – Assessment Methods

BREEAM

The BREEAM method is developed by the Building Research Establishment (BRE) in the United Kingdom. BREEAM-NL is the Dutch version and is developed and maintained by the Dutch Green Building Council under license of BRE Global Ltd. BREEAM is an assessment method which assesses the integral environmental impact of a building. It contains the sustainable standard of a sustainable building and the sustainable performance a building has. BREEAM is used to analyze and to improve of new developments and existing real estate. BREEAM is based on a qualitative weighting; whereby the total score of a building could be *pass*, *good*, *very good*, *excellent* or *outstanding*. BREEAM is the leading and most used assessment method of sustainable performance of buildings worldwide. It's the standard of best-practice of a sustainable design and the de-facto ruler to describe the sustainable performances of buildings.



LEED

LEED is a worldwide known assessment method and developed by the US Green Building Council (USGBC) and is based on the assessment method of the World Green Building Council. LEED has a sustainability score based on the elements: spatial development, water savings, energy savings, materials choice, indoor climate and innovativeness. All these elements will give a score of the building: *certified*, *silver*, *gold* or *platinum*. Worldwide there are 27.000 buildings with a LEED-certificate.



GreenCalc+

GreenCalc+ is a method to assess and to compare the level of sustainability of buildings and urban areas. GreenCalc+ is developed by DGMR in cooperation with NIBE and NUON Tecno, acting upon instructions from the foundation Sureac. With GreenCalc+ the environmental impact is assessed during the life-cycle period of construction, exploitation, and demolition. Based on the method program the environmental-index will be assessed. The environmental impact of a building is determined by materials, energy-use, water use, and mobility. The environmental-index is assessed and compared to a reference building. The reference building has a environmental-index of 100, which is based on materials and installations from 1990. The limit of GreenCalc+ to qualify a building sustainable is minimum of environmental-index of 185.



In the summer of 2011, an intention agreement is signed by BREEAM (DGBC) and GreenCalc+ (Sureac), to harmonize BREEAM and GreenCalc+ into BREEAM-Light. This new assessment-method will be a harmonized method, which supports the development of real

estate in the designing phase. BREEAM-light will give insight into the expected sustainability score.

GPR Gebouw

GPR (Gemeentelijke Praktijk Richtlijn) Gebouw was initially developed for residential housing. The assessment method is developed by W/E Adviseurs and Municipality Tilburg, and could be used by new buildings and existing buildings. GPR is an ordinary and performance focused method which makes it possible to make concrete agreements between governments and building companies. The level of sustainability is assessed on the parts of energy, materials, water, disposal, and health. A sustainability score of 5 indicates that the building satisfies the Buildings Decree (Bouwbesluit). A higher score of sustainability indicates a lower level of environmental impacts and a higher level of sustainable quality.



EPL

The European guideline Energy Performance Building Directive (EPDB) is focused to get insight into the energy performance of buildings in the European Union and to improve the energy performance. The EPDB is an European guideline for the energy performance of buildings, whereby every new building/development has to satisfy to a certain minimum level of energy performance. For the existing buildings it is necessary at the moment of a deal (rent, sell) a energy label is present.



The energy performance of buildings of an energy-index is categorized from A++ to G. The A++ score means a very low building energy use, a G score means a very high building energy use. The assessment of the energy performance is done by the Energy Performance Coefficient (EPC) and Buildings Decree (Bouwbesluit).

In the next table the advantages and disadvantages of assessment methods based on the results of different researches (Eck, van, 2010), (Pluijm, van der, 2009), and (Forsberg, Malmberg, von, 2003), are described, whereby the elements of the assessment methods are identified.

	BREEAM	LEED	GreenCalc+	GPR gebouw	EPL
Characteristics					
Process tool	Process tool	Process tool	Design tool	Design tool	Design tool
Quality assurance	Quality assurance	Quality assurance	Limited quality assurance	No quality assurance	Limited quality assurance
Independent	Independent	Independent	Independent	Market driven	Independent
Spatial development	✓	✓	✓	✗	✗

Energy	✓	✓	✓	✓	✓
Climate/Health	✓	✓	✗	✓	✗
Economy	✓	✓	✗	✗	✗
Social	✓	✗	✗	✗	✗
Sources/material use	✓	✓	✓	✓	✓
Management	✓	✗	✗	✓	✗
Synergy	✓	✗	✗	✗	✗

Commercial and implementation factors

Assessment costs	€€€	€€€	€€	€€	€
Ease of use	0	--	+	+	+++
Assessment time	--	--	0	0	++

Practical quality of the assessment method

Trustworthiness and robustness	++	++	+	---	--
Transparent	++	+	+	--	0
Effectiveness regarding EPBD	---	-	+	+	+++
Comprehensiveness	+++	++	-	0	-

Appendix C – BREEAM Assessment Process

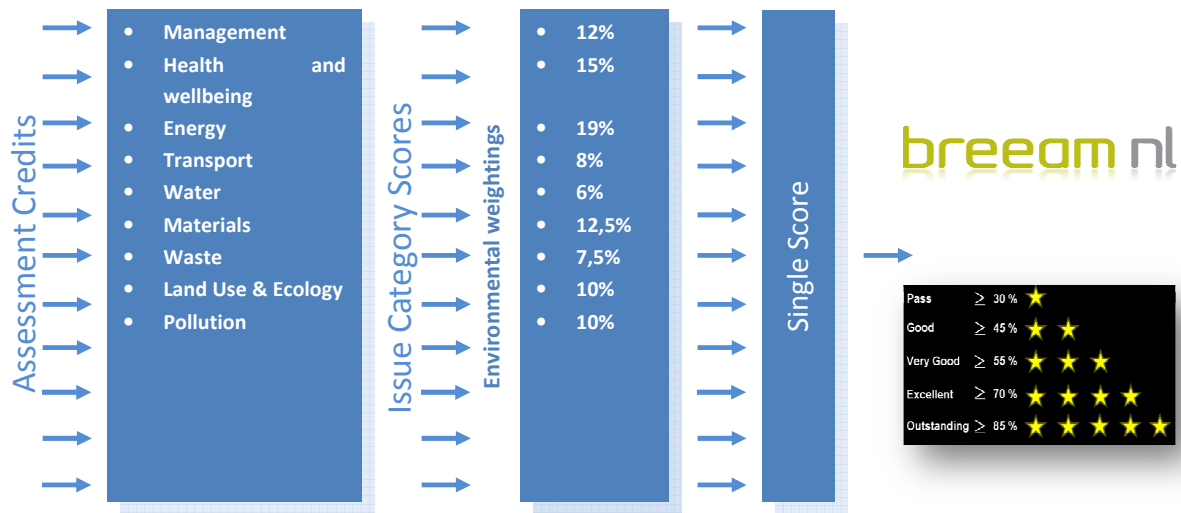
BREEAM assessments are carried out by licensed assessors. Dutch Green Building Council (DGBC) trains, examines and licenses organizations and individuals to help design teams (or facilities management companies) gather the appropriate data and to carry out the assessments. These assessors are examined and educated by the DGBC.

For each assessment, the assessor produces a report outlining the development's performance against each of the criteria, its overall score and the BREEAM rating achieved.

This report is sent to DGBC who review the report using a strictly defined quality assurance process. Once a report has successfully passed the Quality assurance process, DGBC issues the client with a certificate that confirms the development's BREEAM rating. The time an assessment takes to complete varies according to the agreement between client and assessor, and the fee can vary between €4.000 and €20.000. There is also a certification fee which is paid, through the assessor, to DGBC.

The BREEAM methodology calculates an environmental rating by awarding points, or credits, for meeting the requirements of series of criteria that, if complied with, would result in a reduction of the building's negative environmental impact and an increase in its environmental benefits. Each of the criteria is usually worth a single credit except where there is a large variation in the performance of buildings which meet the requirements of the criteria. The criteria are divided into different aspects like: management, health and wellbeing, energy, transport, water, materials, land use & ecology, and pollution. Each of these environmental issue categories is weighted according to the perceived importance of the environmental issues that the section aims to address. The weightings are applied to the percentage score for each issue category. Once added together this will give the BREEAM score. The variation of the BREEAM ratings are:

- Pass - 30%
- Good - 45%
- Very Good - 55%
- Excellent - 70%
- Outstanding - 85%



Appendix D – Real-Estate Investment attributes, considerations & risks

The commercial offices real estate has become a popular investment opportunity. Compared to residential real estate, the investment characteristics are different, like huge amount of capital, long investment recovery period, and influences of the commercial environment. Thereby the investment of commercial offices real estate has much more influencing factors and risk (Liu, 2009). Real estate investment decision-making is influenced by many factors, such as macro, medium, and micro factors. Different researches (Liu, 2009), (Fang, 2011), (Khumpaisal, 2008), (Tang, 2009), (Shim et al., 2008) are used to conduct a complete investment-decision model.

Complete overview of influencing factors

To identify the consideration factors of the real estate investment decision as mentioned above like macro-contextual, location, financing, investment, and object were taken into consideration. These factors are mutually related. Since this step is essential in the decision-making process, the influencing factors was done in an iterative way.

In the first iteration the influencing factors was elaborated by studying different literature. The influencing factors were grouped into specific categories: macro-contextual (M), location (L), financing (F), investment (I), and technical object related (O). In the second iteration, experts were interviewed to extract the most important influencing factors in the different categories and the relationships between those factors. Below is a description of the influencing factors analyzed:

1. Macro-contextual

1.1. Economic market

- c1. *GDP* – Gross Domestic Product (GDP) refers to the market value of all final goods and services within a country in a given period. The Gross Domestic Product is the indicator of the economic well-being of a country. The higher the GDP it indicates a positive economic prospective of a country.
- c2. *Employment rate country* – Degree of employment people within a country, the demographic trend of the employment people within a country is an important macro-contextual aspect which influences the demand of offices. An increase of the employment rate of a country could have a positive influence on the demand of offices.
- c3. *Inflation rate* – Degree of impacts due to increment of the currency. The inflation rate influences the project cash-flow over the office life span.

1.2. Financing market

- c4. *Interest rate* – Degree of impacts due to increment of loan rate. The interest rate influences the financing possibilities and costs over the office life span.

1.3. Political regulations

- c5. *Obtaining of construction license* – degree of possible approval of the license due to requirements Buildings Decree. The assessment of the interest to grant the license and the

regulations and requirements of the Buildings Decree. Project approval of great interest are more likely to be approved.

- c6. *Possibility of subsidy* – degree of possible subsidy provided by the national government. Subsidy could decrease the amount of costs during the project, this could lead to a higher return. Subsidy are provided by the national government to stimulate developments which have an positive impact to the environment for example.
- c7. *Possibility of penalty* – degree of possible penalty due to a lack of agreement to Buildings Decree.

1.4. Real Estate market

- c8. *Demand and supply* – degree of the national office supply. The national amount of office demand and supply indicates if there is a demand to new offices.
- c9. *Market liquidity* – selling rate of same kind of properties in the market. Within a high market liquidity there is a high chance of a high selling rate and/or rental rate of the office.
- c10. *Market vacancy* – degree of vacant properties in the real estate market of offices. The amount of vacant properties indicates the market situation of a specific property type. The market vacancy influences the demand and supply.

2. Location

2.1. Typology area

- c11. *Level of urban area* – degree of urban area, nearby the city centre or more in periphery. The more a location is nearby the city centre, there are more represented facilities, like shopping or public transport, which has a positive impact to an area.
- c12. *Location concentration* – degree of location concentration.
- c13. *Employment rate* – employment rate within the surrounding area . The employment rate within the surrounding area indicates the amount of office jobs, which means a high potential area to users of offices.

2.2. Competition

- c14. *Demand and supply* – degree of competition properties of the same function, degree of regional competitiveness in the surrounding region.
- c15. *Appealing located companies* – degree of appealing located companies in other properties. Appealing located companies could stimulate the business climate to attract other users to this location.

2.3. Infrastructure

- c16. *Location accessibility* – distance to the nearest highway, degree of local infrastructures usability. A close distance to local infrastructures and a highway increases the accessibility of an office, which is very useful to users of an office which live in another city or to customers of users.
- c17. *Public transport* – degree of presented public transport stations and number of public transport per hour. Public transport increases the accessibility of an office.
- c18. *Area vacancy* – degree of vacant properties in the surrounding area. Vacancy in the surrounding area influences the demand of an area of offices by users and the image of a location.

2.4. Facilities

- c19. *Surrounding parking* – degree of surrounding parking facilities. A high degree of surrounding parking facilities could influence the parking facilities of an office, whereby a less amount of parking lots to the object are necessary.
- c20. *Surrounding residential, eating and drinking, shops* – degree of surrounding shopping, eating and drinking, and residential facilities. Surrounding facilities influences the image and attractiveness of an area.

3. Investment

3.1. Investment return

- c21. *Investment return*– expected capitalization rate/IRR.
- c22. *Investment breakthrough rate* – expected investment breakthrough time.

- c23. *Rentability* – expected annual lease rate
- c24. *Sellability* – expected annual selling rate
- c25. *Rental revenue* – average rental revenue. The average rental revenue indicates the profitability of an office.

3.2. Investment costs

- c26. *Operation costs* – costs due to office operational costs, like energy-use, facility management, etc.
- c27. *Maintenance costs* – costs due to office maintenance costs, like painting.

3.3. Financing

- c28. *Capital exposure* – rate of estimated capital costs to fund the development of the office.
- c29. *Obtaining bank financing* – difficulty of obtaining bank financing for the project
- c30. *Fund using time* – expected fund using time.
- c31. *Fiscal advantageousness* – degree of fiscal advantages

4. Object

4.1. Technical object

- c32. *Design* – amenity or architectural quality of a property, identity or appearance of a property
- c33. *Size* – size of a office to gross floor area
- c34. *Parking facilities property* – degree of parking facilities of the property
- c35. *Constructability* – degree of technical difficulties in construction
- c36. *Durability* – probability of refurbishment requirements during buildings lifecycle
- c37. *Maintenance condition* – degree of maintenance condition
- c38. *Materials finishing level* – high-quality finishing level of property details by the use of sustainable materials or definite materials

4.2. Use of object

- c39. *Flexibility* – degree of alternative use or splitting of functions, flexible arrangement of floors, expanding possibilities of property
- c40. *Multipurpose* – degree of multipurpose compared to specific use
- c41. *Type of object* – single tenant or multi tenants
- c42. *Object accessibility* – degree of easy accessible property, entrance of a property
- c43. *Exploitation management* – degree of experience and quality of exploitation manager

4.3. Sustainable aspect

- c44. *Ecological/environment impact* – degree of impacts to use and value due to environment
- c45. *Indoor user comfort* – Temperature Indoor climate, acoustic disturbance, degree of direct daylight entrance, and degree of use of fresh air
- c46. *Energy use* – degree of energy use (EPA)
- c47. *Water conservation* – degree of water use
- c48. *Waste management* – degree of effective waste management
- c49. *CO₂ emissions* – degree of CO₂ emissions
- c50. *Sustainable certification* – degree of sustainable certification like BREEAM, GPR, LEED

Appendix E – ANP Technique

In general, the process of the ANP is comprised of four major steps which are: network model construction, pairwise comparisons, supermatrix formation, and synthesis (Chung et al., 2005).

1. **Network model construction** – first step of the ANP method is the representation of the decision problem using a network model. The steps needed for the construction of the network are (i) determination of the elements, (ii) determination of the clusters, (iii) determination of the influence network. In order to establish relations and dependencies among the elements, the influences of elements in the feedback system with respect to common attributes are derived. Influences are not only considered from top to bottom but influences can be among other elements in the same cluster or other clusters with respect to each of several properties.
2. **Pairwise comparison matrices and priority vectors** – Pairwise comparisons are performed within the structure so that elements of each cluster are compared pairwise with respect to their impacts on an element in the cluster. In addition, pairwise comparisons are made for interdependency among elements outside clusters (Maede, 1999). The following paired comparisons are to be performed:
 - *Cluster comparisons* – clusters that influence a given cluster with respect to a control criterion;
 - *Element comparisons* – paired comparisons are performed on the elements within the clusters. Elements in a cluster are compared to their influence on an element in their own cluster or in another cluster; and
 - *Alternatives comparisons* – alternatives are to be pairwised compared with respect to all elements.

The influence of each element on other elements can be represented by an eigenvector. The relative importance values are determined with Saaty's 1-9 scale, where a score of 1 represents equal importance between the two elements and a score of 9 indicates the extreme importance of one element compared to the other one. A reciprocal value is assigned to the inverse comparison, $a_{ij} = 1 / a_{ji}$, where a_{ij} denotes the importance of the i th (j th) element. The pairwise comparison is performed in the framework of a matrix, and a local priority vector can be derived as an estimate of the relative importance associated with the elements (or clusters) being compared by solving the equation:

$$A * w = \lambda_{max} * w$$

Where A is the matrix of pairwise comparison, w is the eigenvector, and λ_{max} is the largest eigenvalue of A (Saaty, 1996).

3. **Supermatrix formation** – to obtain global priorities in a system with interdependent influences, the local priority vectors are entered in the appropriate columns of a matrix. As a result, a supermatrix is actually a partitioned matrix, where each matrix segment represents a relationship between two clusters in a system. Let the clusters of a decision system be C_k , $k = 1, 2, \dots, n$, and each cluster k has m_k elements, denoted by $e_{k1}, e_{k2}, \dots, e_{mk}$. The local priority vector obtained from the pairwise comparisons are grouped and placed in the appropriate positions in a supermatrix based on the flow of influence from one cluster to another, or from a cluster to itself, as in the loop (Saaty, 1996). A standard form for a supermatrix is as show in figure.

$$\begin{array}{c}
 \begin{array}{c} C_1 \\ C_k \\ C_n \end{array} \\
 \begin{array}{c} e_{11} \\ e_{12} \\ \vdots \\ e_{1m_1} \\ \vdots \\ e_{k1} \\ e_{k2} \\ \vdots \\ e_{km_k} \\ \vdots \\ e_{n1} \\ e_{n2} \\ \vdots \\ e_{nm_n} \end{array}
 \end{array}
 \begin{array}{c}
 C_1 \quad C_k \quad C_n \\
 e_{11} \ e_{12} \ \dots \ e_{1m_1} \ \dots \ e_{k1} \ e_{k2} \ \dots \ e_{km_k} \ \dots \ e_{n1} \ e_{n2} \ \dots \ e_{nm_n}
 \end{array}
 \begin{array}{c}
 \left[\begin{array}{ccc}
 W_{11} & \dots & W_{1k} & \dots & W_{1n} \\
 \vdots & & \vdots & & \vdots \\
 W_{k1} & \dots & W_{kk} & \dots & W_{kn} \\
 \vdots & & \vdots & & \vdots \\
 W_{n1} & \dots & W_{nk} & \dots & W_{nn}
 \end{array} \right]
 \end{array}
 \end{array}
 \quad W =$$

A matrix segment w_{ij} which represents a relationship between the i th cluster and the j th cluster is illustrated in figure.

$$w_{ij} = \begin{bmatrix} W_{i1}^{(j)} & W_{i2}^{(j)} & \dots & W_{in}^{(j)} \\ W_{i2}^{(j)} & W_{i2}^{(j)} & \dots & W_{i2}^{(j)} \\ \dots & \dots & \dots & \dots \\ W_{im_i}^{(j)} & W_{im_i}^{(j)} & \dots & W_{im_i}^{(j)} \end{bmatrix}$$

Each column of w_{ij} is a local priority vector derived from pairwise comparisons in the usual way of the AHP. When there is no relationship between clusters, the corresponding matrix segment is a zero matrix. Since all the local priority information can be read directly non-column stochastic supermatrix it is called the unweighted supermatrix (Saaty, 1996).

To transform the supermatrix into the weighted supermatrix. This can be done by determining a cluster priority vector each cluster (which indicated the relative importance of influences of other clusters on each cluster) by conduction pairwise comparisons among clusters with respect to the column cluster. The resulting priority vector is used to weigh the matrix segments that fall in the column under the given cluster by multiplying all the elements in a component of the unweighted supermatrix by the corresponding cluster weight (Saaty, 1996).

Raising a matrix to exponential powers gives the long-term relative influences of the elements on each other. To achieve convergence on the importance weights, the

weighted supermatrix is raised to power of 2^{k+1} , where k is an arbitrarily large number, the new matrix is called the limit supermatrix. The limit supermatrix has the same form as the weighted supermatrix, but all the columns of the limit supermatrix are the same. The final priorities of all elements in the matrix can be obtained by normalizing each cluster of this supermatrix. The reason to multiply the weighted supermatrix is to capture the indirect influence of an element by any other element.

4. **Synthesis** – if the supermatrix is formed, the priority weights of the alternatives can be found in the column of alternatives in the normalized supermatrix. On the other hand, if a supermatrix only comprises clusters that are interrelated, additional calculations must be made to obtain the overall priorities of the alternatives.

Appendix F – ANP Model Results

1. Interfactorial Dominance Matrix

With respect to

	A1	A2	A3	B1	B2	C1	C2	C3	C4	C5	D1	D2	D3	E1	E2	E3	E4	E5	E6	E7	F1	F2	F3
A Overigsten																							
	A1 Rendement	1																					
	A2 Percentage verhuurd - leegstandpercentage	1	1																				
	A3 Huurwaarde	1	1	1																			
B Kosten	B1 Stichtingskosten	1	1	1	1																		
	B2 Behandskosten	1	1	1	1	1																	
	C1 Architectuur/Design/Belevingswaarde/Uitstraling	1	1	1	1	1	1																
	C2 Grootte - B.V.O.	1	1	1	1	1	1	1															
C Technische aspect object	C3 Parkietvorm object	1	1	1	1	1	1	1	1														
	C4 Mogelijkheden tot renovatie - Economische levensduur - Onderhoudsmaat	1	1	1	1	1	1	1	1	1													
	C5 Aandachtspunten voor materialen (duurzaam/bijloos)	1	1	1	1	1	1	1	1	1	1												
	D1 Flexibele inderbaarheid	1	1	1	1	1	1	1	1	1	1	1											
D Gebruiksaspecten object	D2 Alternatieve aanwendbaarheid/ multi functionaliteit	1	1	1	1	1	1	1	1	1	1	1	1										
	D3 Management exploitatie	1	1	1	1	1	1	1	1	1	1	1	1	1									
	E1 Ecologische/milieus impact	1	1	1	1	1	1	1	1	1	1	1	1	1	1								
	E2 Binnenmilieu/comfort/gebruiker (licht/temper./luchtstof)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1							
E Duurzame aspecten	E3 Energiegebruik	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1						
	E4 Watergebruik	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					
	E5 Afval management	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
	E6 Vervuiling - uitstoot van gassen, CO2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
	E7 Duurzame certificering (BREEAM, LEED, GRI)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
	F1 Alternatief 1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	F2 Alternatief 2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	F3 Alternatief 3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

2. Unweighted Supermatrix

[illegible]

3. Weighted Supermatrix

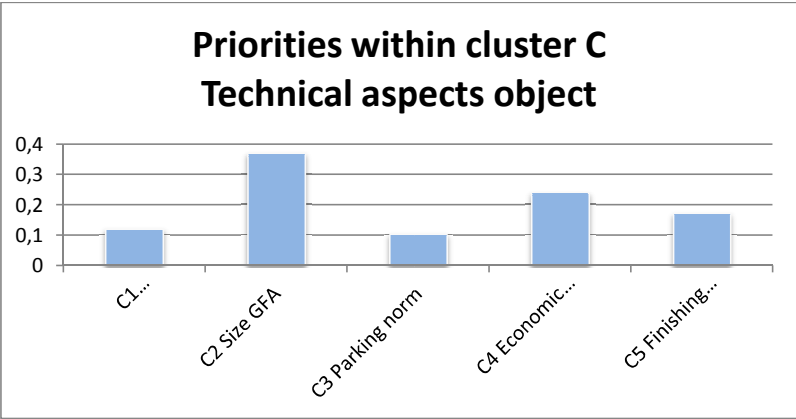
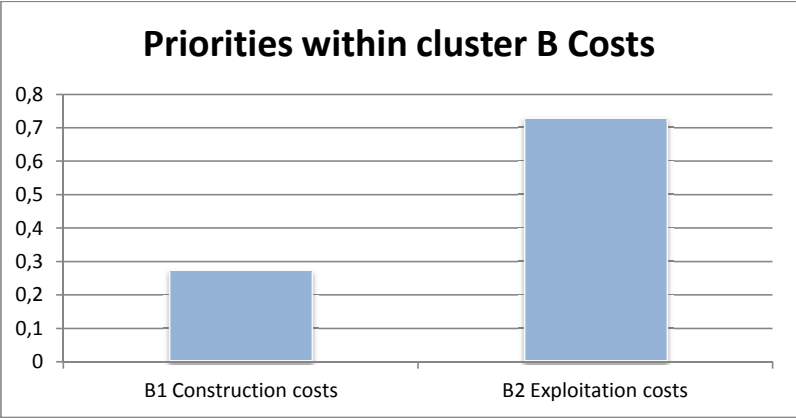
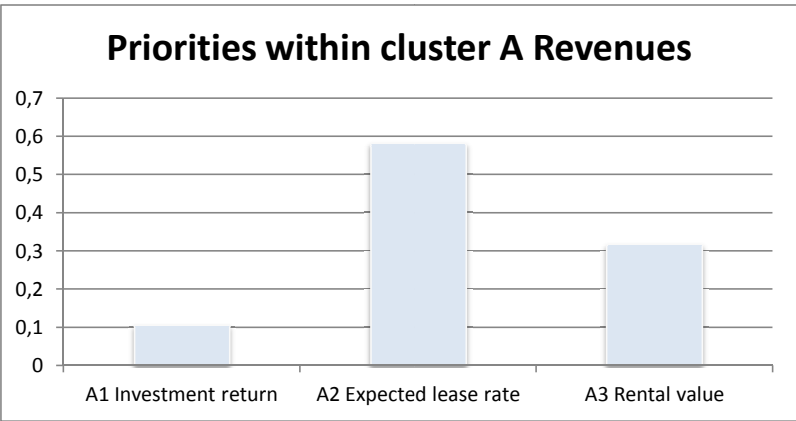
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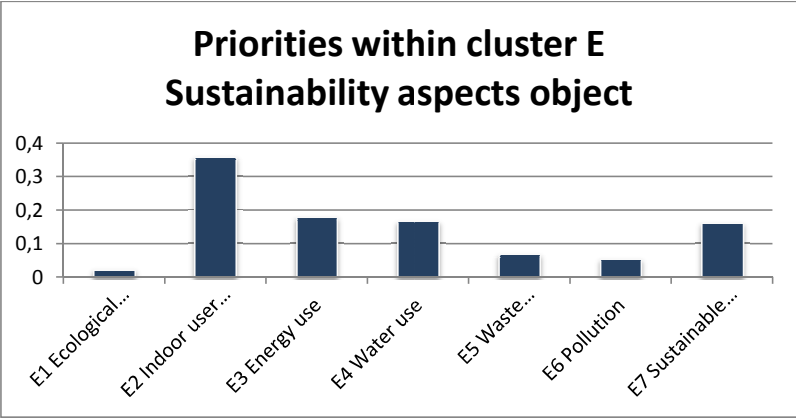
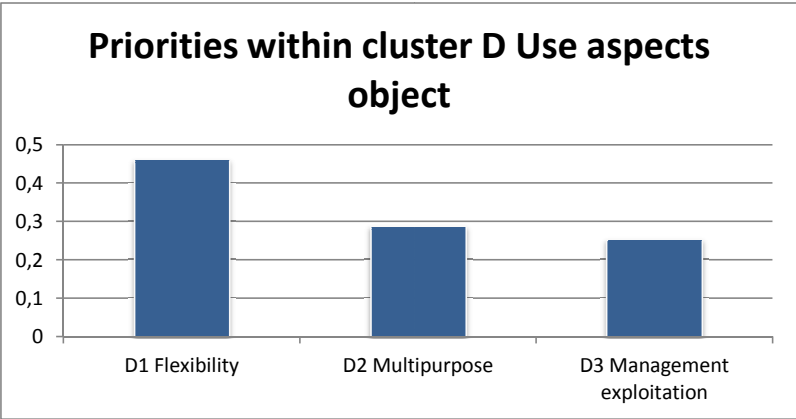
4. Limited Supermatrix

[illegible]

5. Priorities among clusters

<i>Cluster</i>	<i>Influencing factor</i>	<i>Normalized By Cluster</i>	<i>Limiting (overall)</i>
A Revenues	A1 Investment return	0,10416	0,029958
A Revenues	A2 Expected lease rate	0,58054	0,166978
A Revenues	A3 Rental value	0,31531	0,09069
B Costs	B1 Construction costs	0,27167	0,074509
B Costs	B2 Exploitation costs	0,72833	0,199757
C Technical aspects object	C1 Architecture/Design	0,12013	0,009486
C Technical aspects object	C2 Size GFA	0,36866	0,029112
C Technical aspects object	C3 Parking norm	0,10222	0,008072
C Technical aspects object	C4 Economic lifetime	0,23905	0,018877
C Technical aspects object	C5 Finishing level materials	0,16993	0,013419
D Use aspects object	D1 Flexibility	0,46041	0,105971
D Use aspects object	D2 Multipurpose	0,28705	0,066069
D Use aspects object	D3 Management exploitation	0,25255	0,058129
E Sustainability aspects object	E1 Ecological impact	0,02145	0,002658
E Sustainability aspects object	E2 Indoor user comfort	0,35751	0,044306
E Sustainability aspects object	E3 Energy use	0,17701	0,021937
E Sustainability aspects object	E4 Water use	0,16508	0,020458
E Sustainability aspects object	E5 Waste management	0,06645	0,008235
E Sustainability aspects object	E6 Pollution	0,0524	0,006494
E Sustainability aspects object	E7 Sustainable certification	0,16011	0,019842





6. Alternatives priorities

Name	Description	Ideals	Normals	Raw
F1 Alternative 1	<i>State-of-the-Art Design alternative</i>	0,341099	19,0%	0.000956
F2 Alternative 2	<i>Multi-functional alternative</i>	0,457724	25,4%	0.001283
F3 Alternative 3	<i>Sustainable alternative</i>	1	55,6%	0.002803

