Developing an indicator-based sustainability assessment framework for office appraisal.

P5 - report
A.E.Demirel

exploring ways to integrate sustainability into appraisels

Colophon

Student

Student name	Aysu Demirel
Student number	4540476

University

University Faculty	Delft University of Technology
Track	Architecture and the Built Environment
Address	Management in the Built Environment
Date	Julianalaan 134, Delft
	December 7, 2020

Mentors

1st mentor	Laure Itard
2nd mentor	Peter de Jong
3rd mentor	Philip Koppels
External examiner	Gregory Bracken

Her zaman yanımda olan sevgili aileme çok teşekkür ederim.

Preface

Before you lies a report about the development of an indicator-based sustainability assessment framework for office appraisal, which is the final piece of my MSc Management in the Built Environment of the faculty of Architecture at Delft University of Technology.

My interest in sustainability in the built environment started during my bachelors' graduation project at the university of applied sciences (HvA), which was about re-designing a national monument in Amsterdam with an emphasis on improving the adaptability and sustainability performance. However, the courses during my bachelor were mainly covering topics like energy labels and thermal resistance. Here, in Delft, I became more aware of the social aspects that are inextricably linked to sustainable development. For an elective course, I tried to embed 'sustainability' within a valuation model by calculating investments costs for obtaining a 'greener label'. Perhaps you can call it naïve, but my thoughts were: How difficult can it be to estimate the costs for stepping up a label and adjust some parameters? However, while I started to discover more about the 'far-reaching tentacles' of sustainability, I realized that it is no easy task to attach a value to the 'true' potential of a sustainable office if a standard definition or even tool is lacking. Including data concerning the energy label is not sufficient to incorporate sustainability. As a 'newbie' to this topic, I experienced this attempt as very challenging and decided to write a thesis about it. Combining my interest in sustainability with my curiosity in valuation resulted in this research topic.

I would like to express my sincere gratitude to my mentors from the start, Philip Koppels and Peter de Jong, for their guidance, motivational speeches and their long patience during the whole process. I also want to thank Laure Itard for her help in guiding me towards the finishline , motivating me and taking the time for being a part of the mentor team. Furthermore, I would like to thank the participants of the interviews and online survey, their valuable contribution helped me finalize this thesis.

A special word of thanks goes to my parents and lovely sisters for supporting me during the long journey. And of course, my dear friends, who kept checking on me if I was still eating, sleeping, actually living, even though I went radio silent sometimes. Thank you all for your support.

It's done, the journey has come to an end.

Aysu Esra Demirel
Amsterdam, December 2020

Abstract

Sustainable development is the key solution to mitigate the impact of the 21st century's major challenges such as the depletion of our natural resources, emissions that accelerate climate change together with the large waste generation. One of the largest contributor to the aforementioned issues is the existing building stock, in particular the office sector. Upgrading the sustainability performance of the existing building stock is not only in the interest of regulators or society. Real estate professionals are interested in the sustainability performance of their property, portfolio or occupied property. Due to the complexity, it is not feasible for market participants to verify the sustainability performance of a property. As a consequence, voluntary certification schemes have emerged to provide an objective evaluation. However, at the same time, appraisers are paradoxically expected to provide an objective estimation/ opinion of the potential added value of sustainability while their duty according to governances is to derive the market value by analysing available data. The inability of current valuation practices for incorporating a thorough sustainability assessment resulted in decision-makers to focus solely on energy-related costs and justify their investment decisions based on energy-related benefits. For this reason, many investment decisions are believed to be profitable for users instead of owners. However, previous research has shown that property owners of sustainable offices might achieve positive effects in relation to an enhanced image, corporate social responsibility, less risky profile for investors and improved marketability. In the effort to shed light on these far-reaching tentacles of sustainability, this thesis sets forth the base for developing an indicator-based sustainability assessment framework for the appraisal of offices. The proposed framework integrates sustainability and the value it holds for various stakeholders by conceptualizing the relationship between sustainability indicators and different value systems as well as the economic parameters that are adjustable by an appraiser in the income capitalization method. In this way, an appraiser is able to provide an objective estimation on the possible added value of sustainability. Starting from an extensive literature review of different certification schemes, a pre-selection of sustainability indicators was made. Through conducting 8 semi-structured interviews with sustainability experts, the first selection of indicators could be determined together with their goals, measurement and criteria. It is remarkable that according to the participants, actively monitoring the consumption and other management-related indicators are defining the sustainability performance of an office as well, next to the physical characteristics. The online survey was distributed among sustainability experts with a questionnaire designed with the constant sum method and were requested to allocate points over the indicators as well as the categories to determine the relevance. Ultimately, the selection resulted in a set of 34 indicators. Combining the findings from the interviews, data from the survey and the literature review resulted in a framework which was discussed in an expert interview with an appraiser. The findings of the expert interview indicate that there is still a huge gap between practice and theory. The nature of the current valuation techniques hampers the integration of sustainability by focussing mainly on the rental agreement. In order to integrate sustainability aspects into the appraisal, a shift from only looking at the rental agreement to looking at the current use and the fitness for use would be needed. Future research could focus on validating and expanding the linkage between the sustainability indicators and the economic adjustable parameters and reducing the subjectivity of input for the indicators.

Keywords - sustainability indicators - sustainable property appraisal - added value - framework

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CH 01 Introduction background

This chapter provides the motivation and background information of the research proposal together with the main objectives and relevance. The need for sustainable development will be first explained and how sustainable offices can contribute to sustainable development and environmental goals. The key role of owner-investors and appraisers will be explained and what the barriers with regard to sustainable investments are.

1.1 The need for Sustainable development

The 21th century is marked by several major challenges such as the depletion of our natural resources, emissions that accelerate climate change together with the large waste generation. During the last decades, an increased attention to sustainable development by regulators and organizations has been seen, as an attempt to mitigate the above-mentioned challenges and accelerate the transition towards a sustainable built environment. A remarkable attempt by regulators from around the globe is the climate deal adopted at the Paris climate conference in 2015 by 195 countries, including the Netherlands, and sets out an action plan to avoid dangerous climate change by limiting global warming. Each country developed their own strategy for achieving the goals established with the agreement. The European Union has been at the forefront of efforts to reduce climate change by implementing several energy and climate policies and is committed to reduce greenhouse gas emissions with 40% in 2030 compared to 1990. Given that buildings are substantial greenhouse emitters (39% of the CO2 emissions) and large energy consumers (36% of the global use), sustainable improvements within the existing stock provide great opportunities for achieving this commitment.

Sustainable buildings are generally acknowledged as environmentally friendly and the key in achieving the constructed targets. At national and international levels, regulatory instruments and building codes are implemented to promote the construction of sustainable buildings. Subsidiary schemes are developed to provide investor-owners financial incentives in the investment of sustainable measures. The investment volume in sustainable upgrades has been increasing the last years; especially targeting the existing building stock. Despite many efforts, nationally and world-wide, research from the International Energy Agency (IEA) confirmed that greenhouse emitters, caused by the building stock, increased with 2% in 2018 for the second consecutive year, while between 2013-2016 a downward trend was noticed. The energy consumption has increased as well, driven by the growth in the building stock and expansion of the population. In the coming years, the building sector is expected to grow further with an addition of 230 billion square meters in 2060, which is equivalent to building the floor area of Japan every single year until 2060 (UN, 2017).

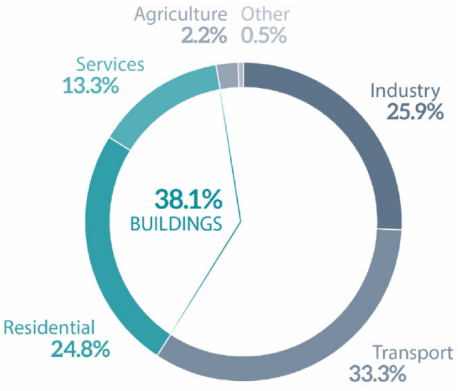


figure 1: energy consumption by sector in the EU (Eurostat, 2014).

This growth in the building stock will cause an increase in the energy consumption and thus further accelerate the impact of this century's challenges. Even though the construction of new buildings are regulated by governments to ensure the energy efficiency within the new stock, this only minimizes the consequences on the energy consumption in a very limited way. Improvement of the existing building stock becomes an important topic in order to achieve the environmental goals. Commercial real estate, especially offices are a big part of the existing building stock in many European countries. Operating these offices requires heating, ventilation, cooling etc. At the same time, the behaviour of employees plays an important role in the energy consumption. Sustainable improvement of the office buildings has become important for office owners not because of new incentives or regulations but also financial return of their investment regarding possible decrease on their energy expenditure.

1.2 Sustainability within the valuation profession

Investing in sustainable measures to upgrade the existing stock is the responsibility of property owners. Investment decisions are made mainly with financial considerations since investments in sustainable measures should be justified on an economic basis. Parameters such as an increased energy efficiency, which benefits the users, are often seen as the main characteristics of sustainability. For this reason, owner-investors perceive investing in sustainable measures as unprofitable because they aren't fully aware of the added value that comes with sustainability and consequently, the uptake of investments in sustainable measures remains slow. However, previous research has shown that sustainable buildings do have a higher return on investments for the investor-owner than conventional ones.

So, what is the value of a sustainable property? What are the benefits and how can this be reflected in the appraisal? Appraisers are often asked these types of questions but are most of the time unable to provide an answer due to the lack of guidelines in how to embed sustainability and the lack of a standard tool. Additionally, the long discussion on the definition of sustainability within the real estate profession has not led to consensus on what it actually means. Irrespective of the definition of sustainability, several certification schemes have been developed to assess the sustainability levels of properties and provide an indication of what sustainability covers. BREEAM, LEED, CASBEE, GreenStar, the variety in certification schemes confirms the wide scope of approaches to define and measure sustainability. These certification schemes go further than only assessing energy or ecological characteristics and are encompassing categories such as health & wellbeing, water, pollution, transportation etc.

This variety does not help appraisers to find answers for the aforementioned questions and make even appraisers face practical challenges. Carrying out a sustainability assessment to obtain a label/score for the certification schemes is a difficult process. An appraiser cannot carry out such an assessment to obtain the sustainability level of a property due to the lack of skills and knowledge. Next to the lacking skills, an assessment for the well-known certification schemes is time consuming and are performed by appointed assessors within the corresponding system/organization. Certified or not certified, a property can still contain sustainable characteristics without a label or certification, which should also be reflected in appraisals.

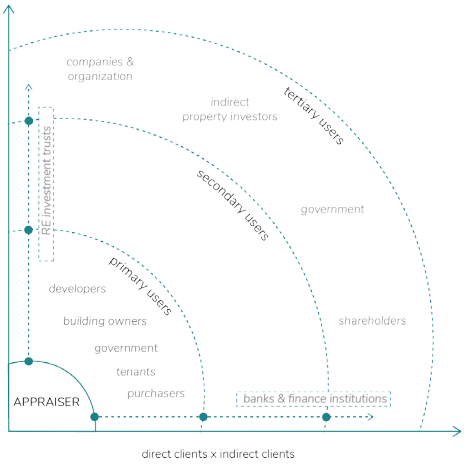


figure 2: direct x indirect clients (adapted from Warren-Myers 2013)

1.3 Problem field

Since sustainability gained more importance within the real estate industry, embedding sustainability criteria in the appraisal of properties becomes more urgent. The valuation profession has a key role in achieving a broader market adoption of sustainability within the built environment (figure 2). A common approach for depicting the relationship and value of sustainability has not been developed yet. The underlying problem is that the market has not found a reliable, mutually accepted way of identifying sustainability within the existing stock (Ellison & Sayce, 2007). Up until recently, different appraisers among the Netherlands used different methods to incorporate sustainability within their valuation models. In order to encourage property owners to invest in sustainable measures, appraisers need to understand the benefits that come along with sustainability. Second, the characteristics of a sustainable office should be understood. Most important, appraisers are expected to depict the relationship between market value and sustainability within valuation models. The question is not if sustainability affects property value, but how.

1.4 Objectives & main research questions

Thus, there is a need for a sustainability framework which entails relevant sustainability characteristics for offices that can be consulted by appraisers during the appraisal of offices. Sustainability assessments are increasingly employed by different stakeholders to promote mainly more sustainable decision-making. Despite the continuous development of sustainability assessments, there is no standard model implemented in the Netherlands for the valuation profession. The changing market demand necessitates assessment tools to be able to adapt. Because of this given, the assessment of properties is mainly time-dependent. Since existing green rating tools are time-consuming, the challnge is to find and select the most significant indicators related to sustainability which can be filled in by appraisers. This means resources with information or data need to be (publicly) accessible or third-parties should be willing to cooperate in sharing their data.

Problem statement:

There is a need for a validated sustainability assessment framework for offices which can be performed by appraisers in a manageable way, keeping in mind the available resources, but still encompassing relevant aspects of sustainability.

The main objective of the thesis is to develop an indicator-based sustainability assessment framework by incorporating feedback of relevant stakeholders (experts) and consulting existing theories. The framework will be able to assess the relevant sustainability aspects by covering sustainability objectives (e.g, energy efficiency; accessibility etc.) and to limit uncertainties and subjectivity associated with expert opinion. This framework will provide support in the area of valuing a sustainable office and assessing sustainability indicators and will present possible future directions for further research.

The main research question is as follows;

In which way can an appraiser assess the sustainability performance of offices for appraisal?

From the objective and main research question, the following sub-questions have been derived;

Research Questions	Goal	Outcome	Methodology
Which sustainability indicators should be included in the assessment?	by consulting/reviewing existing green rating tools, the most frequent occuring indicators can be identified	selection of the sustainability indicators for the assessment framework	literature review & semi-structured interviews
Which valuation methods allow the incorporation of sustainability aspects?	to create a better understanding of barriers for appraisers and propose a way to make a link between indicators and valuat.	selection of the proposed valuation method to incorporate sustainability characteristics	literature review
What is the weighting/ importance of the selected indicators?	to understand which indicators are of high importance according to experts + final selection	an overview with the final selection of indicators and their importance + goals	online survey with experts
How can the (financially) added value of the indicators be determined?	to identify links between the final indicators and economic parameters	an overview to embed in the framework to enable an understanding of the relationship	literature review & expert interview
How can the framework be applied on offices by an appraiser?	validation of the identified links between sustainability indicators and economic parameters	an overview with implications of using the framework & future suggestions	literature review & expert interview with appraiser

table 1: research questions overview

1.5 Methodology

The research methodology outlines the various steps that need to be taken for this thesis. To answer the research questions and the sub questions, different steps can be detected throughout the report.

- Step 1:

The first step is characterized by collecting information, which involves consulting existing literature on sustainability objectives and indicators. The literature study in this report however is not linked to one phase throughout the process. Together with consulting existing theory on sustainability indicators, the most appropiate method for embedding sustainability characteristics will be indentified.

- Step 2:

The second step involves the first selection of the sustainability indicators based on literature review and consulting existing certification schemes.

- Step 3:

The empirical part starts at 'step' 3, the semi-structured interviews are the first methods of the empirical part which will be held with experts. During the interviews, the first selection of indicators will be validated. New indicators could be possibly added.

- Step 4:

Online survey

The online survey includes questions about the selected indicators gathered from the interviews. The result of the online questionnaire are the importance levels of all indicators within their categories.

- Step 5:

Incorporating the results from previous steps and 'develop' a sustainability assessment framework based on indicators. This means the sustainability indicators, together with their goal, measurement and relevance will be combined with the identified links between the economic impant and thus parameters.

- Step 6:

After synthesisizing the findings and results, the framework will be discussed with experts (in this case appraisers) to understand the implications for applying the framework.

- Step 7: Conclusions and recommendations for further research within this field will be presented in the end.

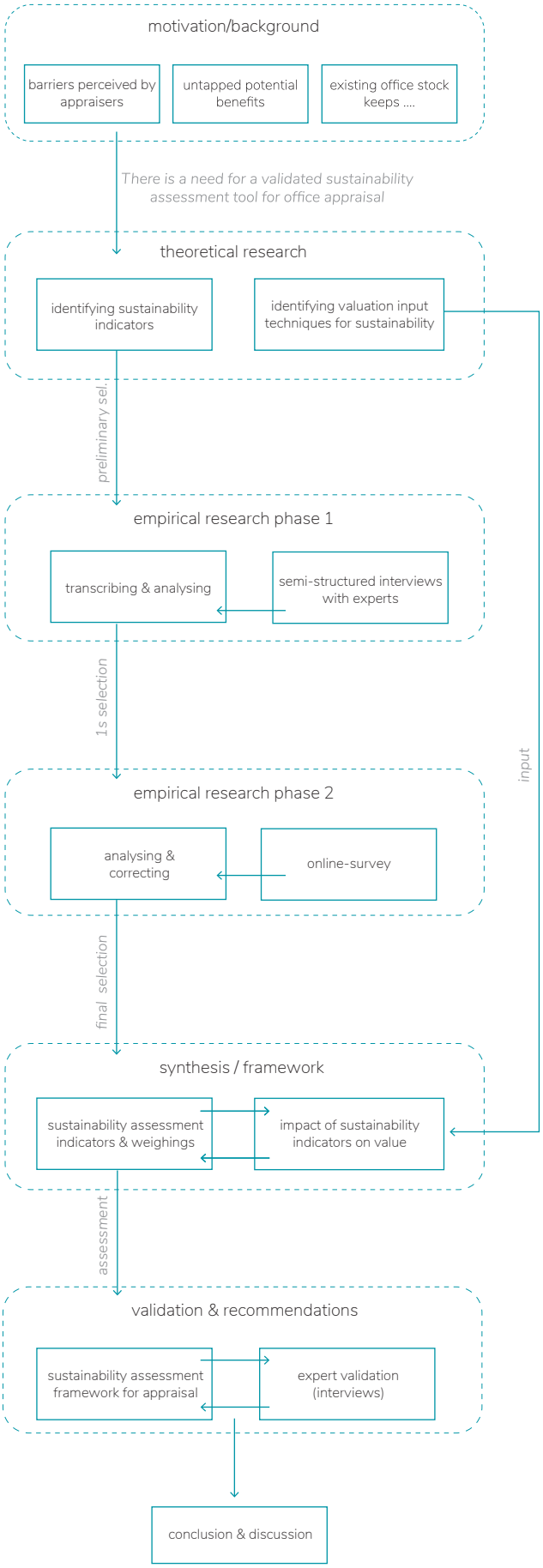
1.6 Scientific & Societal relevance

This thesis is not the first attempt to extend the body of knowledge on sustainable property appraisal. Throughout the past decades, extensive research has been conducted. Lorenz & Lützkendorf (2011) provided a systematic overview of publications on integrating sustainability into the valuation process. Their findings showed that the valuation profession and their professional bodies are confronted with a new reality of changing value perceptions (Lorenz & Lützkendorf, 2011). According to the authors, the current process of gathering, processing and presenting information regarding the property need to be changed to reflect the true potential of sustainability. In order to understand the impact of our changing value perceptions, impact chains can reveal how technical and performance data of a property affects a property's cash flow, risk profile and market value (Lützkendorf & Lorenz, 2014). However, even though these 'impact chains' could assist appraisers, the national guidelines do not provide such as system. Next, a crucial point that needs to be understood, is that appraisers rely on their market feeling to provide an 'objective estimation' of the market value. This 'market feeling', or gut instinct, is the result of their professional experience, and cannot be broadened if the valuation profession does not acknlowedge that the current markt demands an objective valuation of sustainability characteristics. A more recent review by Michl et al. (2016) concluded with similar suggestions. Driving change in the current methods is the responsibility for professional valuation bodies, appraisers and clients, but remains difficult without comparable evidence and definitions. This thesis aims to tackle the research gap, which is the lack of definitions and standardization and the lack of a value chain which depicts how to translate performance data into valuation impact data.

The need for this contribution is made clear in the introduction sector. At national level, ambitious building plans are developed to be 'Paris Proof' by 2050. In order to 'push' investors and owners to upgrade the building stock, the potential added value of sustainability needs to be reflected in appraisals. There is a belief that sustainability only offer benefits to it's users. However, if the benefits for investors and owners become more tangible, the upgrades within the building stock could be accelerated. Altogether, motivating these type of investments contributes to enhancing our built environment, and most important, ensures the quality of life of all humans. Not only in the Netherlands, but worldwide.

Research Design

figure 3: research design



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CH 02 Achieving Sustainability

This chapter has the aim to elucidate the origins of sustainability and sustainable development and how these definitions relate to real estate. After the attempt to clarify the definition of a sustainable office, a brief summary and description of sustainability assessments around the globe for obtaining an objective method for evaluation will be provided. The scope of the tools will be limited to a small selection. The first selection of indicators, which will be presented during the interviews, is based on the sustainability assessments described within this chapter and other mentioned authors.

2.1 evolution of sustainability and sustainable development

The definition of sustainability is open to varied, nuanced interpretations and perceptions, which change in time and vary between locations as well as countries (Livingstone & Ferm, 2017). The simplest way to describe sustainability is through its need for mankind to survive negative impacts on earth. The meaning of sustainability has always been strongly dependent on the context in which it is applied, ranging from the concept of maximum yield in forestry and fisheries management, to the vision of a sustainable society with a steady-state economy (Brown et al., 1987). According to Brown (1981), a sustainable society is 'an enduring one, self-reliant, and less vulnerable to external forces' and can be ensured by harvest regulation, renewable and efficient energy use, soil and water conservation. The origin of sustainability can be traced back to the forestry industry in Germany. The forestry industry in Germany recognized that only that much wood could be cut as it can be regrown. This first documented idea of sustainability was written by a mining director who recognized that the forest could not be saved only by the forestry industry alone but rather by the economy as a whole (Spindler, 2013). This holistic view is essential in achieving sustainability, which is why sustainability shouldn't be seen as an end-product, but as a process, and should be explained as process-oriented. The concept of sustainability from the forest industry has been adopted across different sectors.

The UN Conference on the Human Environment held in 1972, also known as the Stockholm conference, can be considered as the starting point of world leaders' attempt to limit the impact of human activities on the environment. The aim of this conference was to address the growing concerns related to environmental issues and to find global solutions. The conference acknowledged that the protection and improvement of the environment has a major impact on the well-being of the society and economic development. Several years later, the report of Brundtland (1987), popularly known as 'Our Common Future, was published by the Brundtland Commission, convened by the United Nations in 1983 and can be considered as a pioneer. The report proposed the concept of sustainable development, which was defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. The sustainability performance of properties can be deduced from this given definition by Brundtland (1987) and comprises two important elements (Truck, Lorenz & Lutzkendorf, 2007);

- satisfying human needs and requirements - quality of life; and
- intra- and intergenerational ethics.

The Brundtland report advised nations to stimulate development that takes into account not only economic growth, but also social and environmental aspects, all aspects must be considered and integrated (Pope et al., 2004). The report gained importance worldwide and attracted the attention of policymakers, planners, professionals and academics. The recommendations of the report were approved by the UN's conference on Environment and Development in Rio de Janeiro in 1992. At the latter conference, also called Earth Summit, Agenda 21 was established which is often described as the 'blueprint' for sustainability in the 21st century. Agenda 21 is a comprehensive framework and was established through global consensus and commitment of nations to stimulate development that takes into account the aforementioned issues. It can be seen as the starting point where nations pledged to take part in sustainable development. The framework includes 27 principles intended to guide sustainable development around the world and to achieve it by 2021. However, the framework had some modifications since 2021 seemed very optimistic and the new timeline is targeting 2030.

The Paris Agreement adopted at COP 21 in 2015 to address climate change is intrinsically linked to the goals of the Agenda 2030 for Sustainable Development. Since the SDGs (sustainable development goals) tackles climate change, governments all over the work are required to cooperate Under the Agreement, each nation must prepare, communicate and maintain nationally determined contributions that it intends to achieve. Together, these NDCs determine whether the goals of the agreement are achieved. These NDCs are submitted every 5 years.

2.2 Sustainability at national level: policies and regulations

Energy labels

The current certification system in the Netherlands is based on the Energy Performance Coefficient (EPC) and the Energy Index (EI), the latter is used to express the energy performance of existing properties. However, the EPC rates the property, not the usage. In many countries, including the Netherlands, the calculation is based on a standard indoor climate, standard user behaviour and other default values, which might cause discrepancy between the actual and theoretical situation. Since 2008, property owners are obliged to present and hand over an energy label during selling, renting or completing their property. Energy labels allow not only buyers but also occupiers to obtain information on the energy efficiency and carbon emission of the property. Recent studies has shown that the energy consumption of properties is approximately 25% to 30% higher than indicated, due to the often poorly adjusted climate systems (Menkveld, 2016). With often, an estimation of 70% of climate systems not functioning properly is meant. An analysis by Giersbergen et al. (2017) shows even that this 'performance gap' between the estimated energy prestation and the actual energy prestation, in other words the operational inefficiency, increases when better labels are provided. For this reason, a property owner should not only rely on the energylabel but should focus on the actual energy prestation by activtely monitoring the consumption.

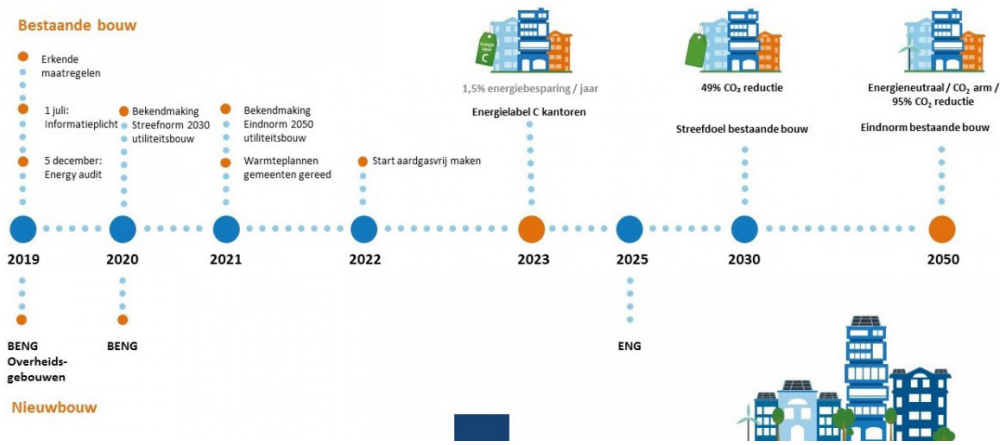

figure 4: sustainability policy timeline (rvo, 2019).

BENG - NEZB

The current certification system based on the EPC provided by the labels will be replaced by the so called BENG requirements (bijna energie neutraal gebouw, hereafter NEZB). Dwellings and utility buildings completed after 2020 need to be NEZB and will be tested according to 3 NEZB indicators; energy demand, primary fossil energy consumption and share of renewable energy (RVO, n.d.). Currently, the NEZB requirements and the criteria for the indicators aren't established yet. The first NEZB indicator depicts the amount of energy needed to heat and cool a building expressed in kWh per square meter per year. This indicator measures the energy efficiency of the building itself and takes into account the insulation, light and smarte use of heat and light. The second NEZB indicator concerns the amount of energy from non-renewable in kWh per square meter per year that is required to meet the energy requirement. Measures such as a heat pump, energy-efficient lightning, PV panels etc. can provide solutions to this criteria. The last indicator is the percentage of renewable energy in relation to the total energy consumption (taking into account f.e. the yield from solar panels, heat pumps, biomass boilers and wind energy etc.). At the moment, existing buildings do not need to comply with the BENG indicators, however, since the aim is to create an emission free built environment, the regulations will apply on the existing stock as well in the end. The current certification system, the BENG indicators, they all are steps towards the 'paris-proofness' of the building stock. The term paris proof refers to the climate deal of 2015 in Paris which is adopted by the Netherlands as well. The Paris proof term focuses on the situation in which offices only need 50 kwh per square meter for heating and cooling. Keeping in mind that older offices need nearly 200 kwh per square meter, it can be said that enormous energy saving measures still need to be realized.

2.3 sustainable real estate

Three pillars of sustainability

Sustainable development comprises three pillars; environmental, social and economic. It is generally accepted that sustainable buildings should contribute to the pillars, however, some different interpretations exist. While some believe that in order to achieve sustainability, the three pillars should be viewed equally, others believe that the environmental aspects of sustainability should outweigh the other pillars. An example of threating the three aspects equally, is provided by Lutzkendorf & Lorenz (2007b): 'Thus, the concept of sustainable development can be interpreted as the journey towards one final destination: 'sustainability'. Sustainability is meant to be the desirable overall concept or goal of economies' or societies' development or evolution, respectively. The term circumscribes an equilibrium state of an economy or society with regard to environmental, economic and social conditions'' (p.645).

Towards a definition

Real estate is inextricably linked to the debate on sustainable development, particularly due to its impact on the environment. The building stock has been positioned as the key solution in achieving the constructed environmental goals. Since sustainability is a broad concept and related to time, this section aims to clarify the concept of a sustainable building and a sustainable office. There has been much debate on what sustainability actually means, but in short, it can be argued that a sustainable building is not simply a recipe or kit home (Warren et al., 2009).

According to Lutzkendorf & Lorenz (2007b), a sustainable property can be described as below;
''A sustainable building is meant to be a building that contributes – through its characteristics and attributes – to sustainable development. By safeguarding and maximizing functionality and serviceability as well as aesthetic quality a sustainable building should contribute to the minimization of life cycle costs; the protection and/or increase of capital values; the reduction of land use, raw material and resource depletion; the reduction of malicious impacts on the environment; the protection of health, comfort and safety of workers, occupants, users, visitors and neighbours; and (if applicable) to the preservation of cultural values and heritage'' (p.646).
Based on the previously given statement, sustainability should be considered during all the life cycles of properties, including design, construction, but also maintaining properties should be done in a sustainable way. A similar definition of sustainability in relation with the life cycle of a property is proposed by Berardi (2013) as well. According to the author (Berardi, 2013), which tried to provide an academically based definition, a sustainable building has a healthy facility design, built in an efficient manner, using ecological principles, social equity and life-cycle quality value. Within the literature, the terms sustainable buildings and green buildings are used often interchangeably. However, a distinction between the two definitions exists. A green building, often stated as an environmentally friendly building, could be achieved by reducing its environmental impact, while a sustainable building would ask for more.

Since it became clear that sustainability and the characteristics of sustainability goes beyond the energy labels and other future regulations, the following sections will describe the voluntary certification schemes which capture relevant aspects of sustainability.

2.4 green rating tools

Several green rating systems have been developed in the last years in order to estimate the sustainability levels of properties, with a focus on the impact on the environment and socio-economic context. While the primary role of these tools was to assess sustainability levels, their role shifted towards a market transformation tool and facilitating communication and creating dialogue among stakeholders that goes just beyond a design team (Cole, 2005). Rating tools are successful because of their simplicity in explaining what constitutes 'green/sustainable building' design and construction with a wide range of categories that can be understood by all stakeholders. Each of these tools have their own attributes for the assessment and weighting scheme according to the regional variations of its country of origin, the variations can be attributed to climate change, building typology, geographical features, government policy (Mahmoud et al., 2019). Differences within the weighting scheme make the use outside of the origin of the country difficult. For example, environmental factors such as energy, water and materials weigh 38% of the total score within the BREEAM scheme, while in LEED this is 53%. Despite the differences in the methodology and weighing scheme of the rating tools, the indicators of these tools are measures of dimensions of economic, social or environmental (un)sustainability which must be minimized to reach certain sustainability levels (Dahl, 2012).

The aim of rating tools is to provide an objective and comprehensive method for evaluating a broad range of sustainability in a consistent way. Most of these tools entail rating systems for assessing sustainability and are based on four components (Bernardi et al. 2017);

- Categories: categories of evaluation consist indicators with varying points, summed to a total number of points that can be achieved
- Scoring system: performance measurement system that cumulates the number of possible points than can be earned
- Weighting system: the relevance of the assigned points within each category to the overall scoring system
- Output: the output shows in a direct and comprehensive manner the results of the evaluations during the scoring phase

Bernardi et al. (2017) investigated the most adopted rating tools according to citations in existing theories, number of certified projects, and concluded that LEED (USA), BREEAM (UK), CASBEE (JAPAN) and the SBTool (CANADA) are implemented the most. GreenStar & Nabers (AUS) are other tools that are adopted frequently around the globe. Within the Netherlands, GreenCalc+, developed by RVO & Sureac, has been merged with BREEAM-NL to provide one common method to assess sustainability. The aforementioned rating tools are just a small selection of the many tools that exist. The rapid development of new tools is attributed to changing market demands and the dimensions of sustainability. Díaz-López etl. (2019) analysed the evolution of green rating tools and provided schemes with the development of indicators in different periods of time. Their results show an initial focus on environmental impacts and energy efficiency evolving in the gradual inclusion of social and economic aspects of sustainability. Research on categories and indicators of sustainability between 1990 and 2000 involved mainly themes such as construction materials, design, heat loss, energy efficiency and renewable energies. The following period, 2000-2009, was characterized by themes as assessment tools, LEED, BREEAM, heating, life-cycle and intelligent buildings. The last period was according to the authors remarkable due to the enormous increase in publications about assessments. Categories such as urban development, indoor environmental quality, terms such as NZEB, climate change environmental and social aspects were added and considered as the main themes within sustainability. The evolution described by Díaz-López etl. (2019) depicts how these tools have evolved from tools that only looked at environmental aspects into a comprehensive/complete tool including economic and social aspects as well and shows where sustainability assessments are heading. These evolved tool confirm that the real estate industry is aware of the importance of including different categories of sustainability since many benefits are induced through different layers.

2.4.1 BREEAM

BREEAM is one of the first building assessment tools for offices established by Building Research Establishment of the UK in 1990 and provides an environmental label. BREEAM has a long track record in the UK but is now widely expanded in European countries. The method integrates sustainable design and construction materials into a holistic framework aiming at mitigating environmental impacts to stimulate the demand for sustainable properties (Koutra et al., 2018). The tool measures sustainability through different categories, ranging from energy to ecology. The scores of the categories are calculated based on the achieved credits, and the weight of the category.

There is a national BREEAM scheme for the Netherlands, developed and managed by the DGBC. The reason for developing a national version is because some criteria might not be relevant in a certain country, because a criteria might be already a standard according to the regulations, However, the different national schemes are still comparable and valued similarly. The assessment tool awards points for different categories including: Management, Well-being and Health, Energy, Transport, Water, Materials, Waste, Land-use and ecology and Pollution.

The Dutch BREEAM labels are;

- BREEAM-NL New construction and renovation: to determine the sustainability level of mainly new buildings
- BREEAM-NL in Use: This scheme actually assesses three levels; ; Building/Asset, Management and Use and is used for existing buildings.

Although its' widely adoption, some disadvantages and perhaps lacking indicators exist. The current BREEAM schemes do not consist of circularity indicators, while circular economy principles can provide solutions for further improving sustainability frameworks and accelerate the transition to a sustainable built environment (Kubbinga et al., 2018). In current practices, the real estate industry exploits mainly non-renewable energy sources and consumes and discards materials that have an effect on our climate and environment. A circular economy can optimize the use of materials, minimize the use of scarce materials (and much more), both contribute to a more sustainable way of constructing. Kubbinga et al., (2018), investigated which indicators for circular buildings could be included in the BREEAM certification schemes and presented essential indicators; 1) reduce amount of materials, 2) design for reassembly, 3) maximise amount of reused materials, 4) maximise amount of renewable materials and 5) knowledge development and sharing (resulting in a building material passport).

Several authors addressed the significance of the TBL features in green building schemes and are suggesting to allocate equal weights for the environment, economy and social aspects. According to a comparative study among the different schemes by Varma & Palaniappan (2019), many green certification schemes fail to justify why the three pillars are treated unequally, while most of them claim to address sustainability holistically. Within the different BREEAM schemes, an emphasis on the environmental aspect can be noticed in figure x. However, comparing the importance of each category in relation to the overall score might lead to inaccurate observations since within the different categories, indicators also address for example energy savings per year. Of course, saving energy results in a less negative impact on the environment, but it could also lead to cuts in energy expenses. Thus, even though the categories might be treated unequally at first glance, the fact that some indicators within the environmental dimension still contribute to economic benefits, confirms the interrelated effects of the indicators on sustainability.

2.4.2 LEED

The Leadership in Energy and Environmental Design rating system developed by the US Green Building Council is one of the most famous tools for assessing sustainability for different phases; design, construction, maintenance and operation. The rating system has 8 categories that address key aspects of green buildings and are all the same for different project types. Within each category, varying points on their level of importance can be achieved. The assessment is based on an implicit weighting approach by simply adding the assigned points for each category, the sum of these points defines the achieved level: Platinum, Gold, Silver or Certified. The latest version of the LEED scheme (2019) underwent some changes in the Materials and Resources credits. The US Green Building Council's vision for the previous mentioned credits entails three strategies: reduce embodied carbon, protect human and ecological health, and advance the circular economy. While the BREEAM system is still developing a new version of the schemes which include subcategories for circular buildings, LEED has already incorporated indicators for circular buildings.

The LEED labels for mainly utility buildings are;

- LEED BD+C for new construction and major renovations
- LEED ID+C for complete interior fit out projects
- LEED O+M for existing buildings that are undergoing improvements

2.4.3 GreenStar

Green Star is another frequently adopted rating rool, developed by the Green Building Council of Australia. Like the previous tools, this assessment systems evaluates environmental issues. The latest version was published in 2016, and can be applied to the building construction phase, refurbishment phase and operation phases.

2.5 Recap

In the introduction of this chapter, a list of the most adopted sustainability assessment tools was provided. However, for this thesis, the sustainability indicators from BREEAM, LEED & GreenStar will be used for the first selection. These 3 certification systems/organizations are very transparent about their indicators, how it should be measured, and what kind of data is needed to assign points for each indicator. Other certification schemes do not always provide information on their indicators, and if they do, it is limited to which category they belong, without an exact explanation. Thus, due to the small selection of schemes that is open to the public, the choice has fallen on these 3 schemes. Additionally, these 3 schemes/organizations provide information on how their indicators contribute to the SDGs established by the UN.

For the preliminary selection, the following schemes are consulted;

BREEAM- in Use
Since appraisers mainly appraise existing properties, the BREEAM scheme (version 2016) for existing properties is consulted. The BREEAM in Use scheme contains 3 main parts;

- Part 1 Asset assessed property specific characteristics based on the structure, installation systems, interior and finishing.
- Part 2 Management assesses policies, procedures for operating a property, with the consumption being the most important criteria.
- Part 3 Use assesses the actual use and impact of policies and procedures, the most important input to assess the criteria is information obtained from the actual users.

After reviewing the green rating tools, 3 indicators are added to the BREEAM list in the appendix as a result of consulting publications on the possible new BREEAM scheme. These 3 indicators will be added in the new BREEAM version that will be published soon. The indicators are; 1) material passport 2) - 3)-

LEED
The LEED version 4 for Building Design and Construction is consulted since this scheme can be applied to renovations of existing properties as well. The LEED version 4 for Building Operations and Maintenance is consulted as well since it is applied to existing properties.

Green Star
The latest version of the Green Star certification scheme (2018) is consulted, this scheme is applicable to new buildings but major refurbishments as well.

Sayce & Ellison (2003;2006)
Sayce and Ellison (2006) were on of the first authors who tried to embed sustainability characteristics into valuation models by consulting experts on sustainability, propery owners and investors view. Since their work is based on years of research, the indicators and categories are included for the preliminary selection. The indicators and their link to valuation models by these authors will be discussed in chapter 3 and 4.

Meins et al. (2008)
Meins et al. (2008) tried to embed sustainability into valuation models by making transparent how sustainability characteristics affects the discount rate, and thus make valuations more transparent. The indicators and their link to valuation models by these authors will be discussed as well in chapter 3 and 4.

All the categories and indicators can be found in Appendix A, together with their frequency. This list in the Appendix contains other categories and indicators from authors as well that tried to embed sustainability within appraisals. The reason for adding indicators from previous research on this topic is based on the previously mentioned authors' contribution. In total, 325 indicators were identified from this list and a reducation to 43 is made (Appendix B). This reduction was made by counting the occurence of the indicators, and the most frequent indicators were selected to present to the sustainability experts during the interviews.

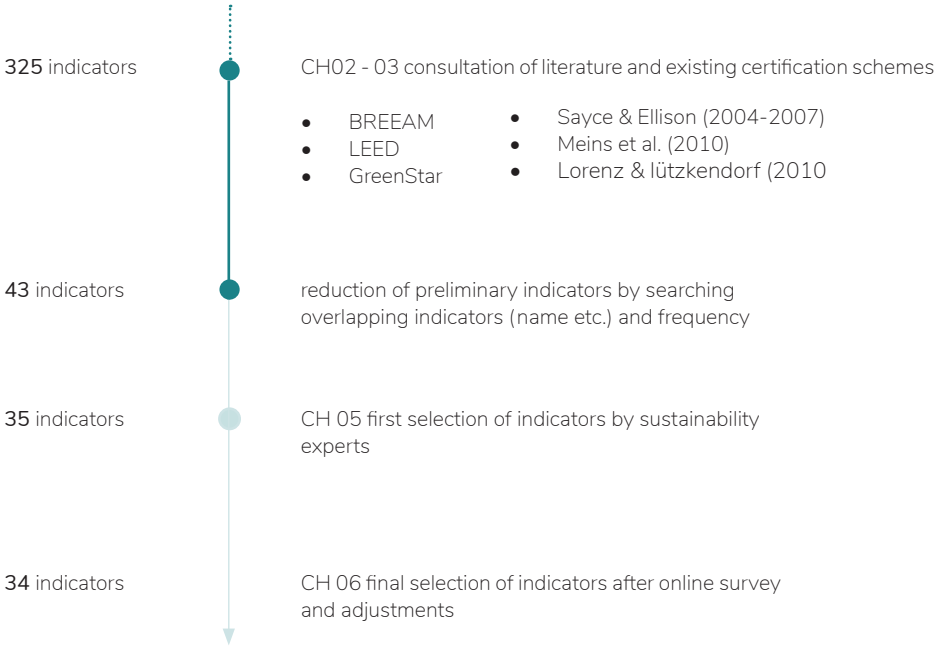

figure 5: approach of reduction of sustainability indicators (own ill.)

2.6 Discussion

In chapter 03 and 04 in this report, some other authors' contribution on appraising sustainability indicators are consulted as well. These previous studies consulted existing sustainability assessments/ rating tools for selecting relevant indicators as well. However, it is remarkable that in these previous studies, indicators related to categories such as management are often left out because an appraiser cannot measure these. The exclusion of indicators related to management issues gives the impression that perhaps only visible and physical characeristics of an office building contributes to sustainability. This thesis does not follow the same approach. It does not make sense to exclude these indicators already during the first selection. Our definition of what constitutes a sustainable building and how it should be measured changes over time and will further change. As proposed and promoted by the UN and other researchers, in order to achieve sustainability, a holistic approach is required in which, tracking the process is very important.

The inclusion of management or process related indicators highlights the gained importance of these indicators in achieving sustainability. Excluding these indicators during the first selection for this selection might corrupt formulating the definition of a sustainable office for appraisers. Even if some indicators cannot be linked to property value or measured directly during property observation/ inspection, leaving them out means they won't appear in the for this thesis attempted sustainability assessment tool, with implying those are not relevant, which is not the case. Sayce & Ellison (2010), Meins et al. (2010), Lorenz & lützkendorf (2008;2010) attempted to embed sustainability within valuation models by mainly/only looking at the physical aspects of a sustainable building. Performing the same method will not lead to new insights. More recent studies on the effect of sustainable on property value suggested changes are needed for embedding sustainability. Additionally, throughout the years research on sustainability highlighted that the use of a property has a huge impact on the sustainability level, which means not only physical characteristics should be taken into account.

CH 03 Appraisal of sustainability

This chapter discusses three major areas found in the literature concerning the integration of sustainability within property appraisals. The first section discusses the evidence found for added market value by sustainability, the second section discusses the costs and benefits associated with sustainable properties and ultimately, the third section elaborates on current practices and their shortcomings according to researchers and professionals. The chapter concludes with an extended framework drawn on conclusions and suggestions from literature and provides the step-by-step plan for the integration of sustainability within property appraisal. Within the literature, several key areas can be found in the barriers in embedding sustainability by appraisers. The findings are interrelated and can be categorized in; valuation techniques and the role of the appraiser, perceived definition of sustainability characteristics, market response towards sustainability, potential costs and benefits.

3.1 Valuation techniques

''A valuation is not a fact, it is an opinion'' (Banfield, 2014, p.114). A valuation contains the opinion, or estimate, of an appraiser on the market value or market rent of a specific object, which is the capital sum at a point in time that might be paid by a willing buyer or the annual rent at which the object might be leased (Shapiro et al., 2019). Within the valuation profession, three main approaches exist, and are all based on the economic principles of price equilibrium, anticipation of benefits or substitution (French & Gabrielli, 2018). Within the existing literature and/or theory on valuation practices, the terms 'approach' and 'method' are used sometimes interchangeably, however, they do not have the same meaning. The following approaches are detected in the literature;

The market approach can be considered as a direct valuation approach and is carried out by comparing the object to be valued with recent transactions of other similar objects in the same market and at the same point in time. However, even if the similar objects contain very similar characteristics, some judgement by the appraiser is required to obtain a value. An object cannot be identical to any other property, therefore, this approach requires sound judgements based on experience. Obtaining the value for sustainable properties is extremely difficult, if possible, through the market approach, since appraisers lack transactions of sustainable buildings, this is a world-wide occurring issue. As mentioned by Myers, et al. (2007): ''In the current market, sustainable buildings have limited market data to make effective comparisons and the market is at a point of immaturity where the market's perception is still cloudy as to the value or value attributed to sustainable buildings. This inherently makes using this standard valuation methodology for determining the value of sustainable building difficult, and until the market matures or significant market evidence eventuates this approach remains inaccurate'' (p.8).

The cost approach is applied to properties with a special purpose, and often used when there is a lack of comparables. This approach derives the value of a property by the current building costs, the price of the site, which are depreciated to reflect age and aspects of obsolescence. The assumption within this method, is that the value of the property equals the cost for rebuilding the property. This approach is not suitable for appraising sustainable properties.

In contrast to the previously mentioned approaches, the income approach offers a broad range of possibilities to embed sustainability aspects within the appraisal. The income approach provides an indication of value by converting future cash flows into a single capital value. The appraiser assesses the net income of the property, based on comparable lettings or properties, and uses the level of return required by investors for similar properties. Within the Netherlands, the NAR method, BAR method and the DCF method are the most common methods within the income approach and are often used together.

The BAR-method (bruto aanvangst rendement=gross initial yield) is a ratio that is used to express the market value based on the gross market rent (theoretical) of a property. This percentage is the estimated gross investment results, that chould be acheived during the first year of operating an object. The formula is as follows;

$$W = \frac{H}{Ybar} - kk$$

W=Value
Y=yield (bar)
H= rental income (first year)
kk= legal transactions

The NAR (netto aanvangst rendement = net initial yield) calculates the value of a property based on the net rental income. which is derived from the gross income adjusted with exploitation costs (such as operating costs and capital corrections). The formula is similar to the BAR method, however, since expenses are taken into account, the outcome is always lower. The formule used within the NAR method is as follows;

$$W = \frac{H\text{-}Ke}{Ynar} \quad +/- \; CW * Kc \qquad - kk$$

W=Value
Y=yield (nar)
H= rental income (first year)
kk= legal transactions
Ke= operating costs
CW=present value
Kc= capital corrections

As can be seen in the formula of the BAR & NAR method, these methods are less suitable for incorporating sustainability aspects into the appraisal of offices. These methods do cover only a few characteristics which means that sustainability characteristics cannot be reflected in a transparent way in appraisals. Next to the lack of transparency, it is common to use references of other transactions within the BAR and NAR method to underpin the appraisers estimates and opinion. As mentioned in the previous sections as well, due to the non-transparent market, transactions are not fully detailed published and shared, which means that it is difficult to compare sustainability characteristics of properties. Additionally, even if these transactions will be fully public available, not all property owners, appraisers keep track of sustainability characteristics.

The discounted cash flow method is commonly used in investment analysis to determine the value of any income producing investment. The DCF method evaluates the net present value (hereafter NPV) of the future cash flows generally over 10 years and takes into account market assumptions. Since cash flows in the future are prone to risks, each cash flow in the model is discounted at a determined rate of interest. The market assumptions encompass the appraiser's judgement on rental growth, exit yields etc. The formula of the DCF method is;

NPV (Net Present Value)
CF equals cash flow
i equals discount rate
n equals time period

$$= \frac{CF_1}{(1+i)^1} + \frac{CF_2}{(1+i)^2} + \cdots + \frac{CF_\infty}{(1+i)^\infty} = \sum_{n=i}^{\infty} \frac{CF_n}{(1+i)^n}$$

Previous research has shown that some properties with sustainable characteristics or certification labels may have or not have a higher rent or sale price, but do have a higher occupancy rate, absorption rate, lower turnover rate etc. compared to conventional properties (Bozorgi, 2015). The aforementioned parameters are part of the DCF method. Some studies (Wiley et al., 2008; Miller et al., 2008; Kok, 2008; Pivo & Fisher, 2009) show that the occupancy rate of properties can be higher due to sustainable characteristics compared to conventional ones, resulting in higher rents, higher cash flow and thus a possible higher value. The following sections elaborate on other research findings on embedding sustainability characteristics into the appraisal. Since it became clear that the DCF method is the most suitable for this purpose, the focus will be on the parameters (input) within the DCF method and how these are possibly affected by sustainability characteristics.

3.2 The role of the appraiser

According to Dixon et al. (2008), the rationale for embedding sustainability within valuation method can be based on two basic forces: ''(1) from the role of valuations and valuation professionals within the economy and society; and (2) from the basic goal and tool of any property valuation undertaken'' (p.486). Lorenz and Lutzkendorf (2011) identified two more reasons why sustainability should be embedded in valuation methods and concluded with a longer list;

- appraisers are required to foresee market developments when observing transactions
- the ethics within the valuation profession
- failure in embedding sustainability and poor property valuation can lead to an under-investment in sustainability while sustainable properties can be underpriced, conventional properties can be overpriced

Apart from the previously mentioned authors, the national and international guidelines of the valuation profession cover the importance and inclusion of sustainability within the appraisal in several papers. In the Netherlands, the standard guidelines that provide guidance for Dutch appraisers are The International Valuation Standards (IVS), the Red Book of the Royal Institution of Chartered Surveyors (RICS), and the European Valuation Standards (EVS). The IVS provide a global standard while the Red Book and the EVS guidelines focus on the European practice and legislation which follow the EU laws and regulations. The Red Book is written to ensure that appraisers undertake valuations in accordance with the IVS.

The RICS (2016) covered the topic of sustainability and argued that appraisers reflect the market and do not lead it. However, appraisers are advised to gather data on sustainability even if it does not impact the value. The national guidelines do not propose the best tool to embed sustainability within appraisals. However, due to the changing client demand such as depicting the long-term value, often associated with sustainability, the RICS acknowledged that the role of the appraiser will change in the future. Clients often request the long-term value of investments, not knowing how it actually looks like. With this given, the role of risk assessments will become more important for the valuation profession. Despite the changing client demands, the market value will for no doubt remain the key valuation method within the valuation profession (Scheurwater, 2016).

In a paper from 2013, the RICS (2009) covered sustainability in an information paper, and argues that;

''As part of establishing market value, fair value, market rent and investment value, all valuers should keep abreast of features, technologies and approaches and ensure that they collect appropriate and sufficient sustainability data when inspecting property, as this will enable them to analyse and apply them any property valuation, as appropriate'' (p.17). The question that arises here is whether, next to recognizing the importance of embedding sustainability within models, the definition of sustainability is explained by the guidelines as well. Some definitions are proposed by the different guidelines.

''There is a general expectation that buildings that minimise environmental impact through all parts of the building life cycle and focus on improved health for their occupiers may retain value over a longer term than those that do not. Sustainable buildings should optimise utility for their Owners and occupiers and the wider public, whilst minimising the use of natural resources and presenting low environmental impact, including their impact on biodiversity.” (RICS, 2011)

''A “green” or “sustainable building” uses resources such as energy, water, materials and land more efficiently than buildings constructed to existing minimum standards, producing less waste and fewer emissions and potentially offering a better internal working environment, benefitting health comfort and usefulness. As the concept of sustainability expects that the needs of the present should not compromise the ability of future generations to meet their own needs, green buildings should also take social, ecological and environmental issues into account. That broader definition includes external effects and the impact across generations and so the property’s life cycle (EVS, 2016). ''

The standard guidelines for appraisers acknowledge that there is no precise definition of sustainable properties, and that the definition may change over time. Apart from a not precise definition, appraisers are advised by the RICS (2014) to: '' assess the extent to which the subject property currently meets sustainability criteria and arrive at an informed view on the likelihood of these impacting on value, i.e. how a well-informed purchaser would take account of them in making a decision as to offer price'' (p.59).

3.3 Attempts by other authors

Within existing research, some suggestions are made on how to embed sustainability into existing models, such as the discounted cash flow method, and are based on three approaches:''1) the direct adjustment of single valuation-input parameters, 2) lump-sum adjustments and 3) the calculation of a sustainability-correction factor'' (Lorenz & Lützkendorf, 2011, pp.651). The single valuation-input parameters of the first approach are for example the rent, rental growth, absorption rate, discount rates, operating costs and other key parameters. Lorenz and Lützkendorf (2011) illustrated (figure 7) the key parameters that can be affected by sustainability. However, in order to justify the adjustments to the parameters, analysis has to be carried out and all parameters that are adjusted should be justified. This approach increases the valuation transparency and is therefore favored by most researchers, however, this approach is very complex and time-consuming for the appraiser. A better understanding of value chains are needed to identify the relationship between sustainability characteristics, property performance and ultimately the parameters. Muldavin (2010) suggests to include sub-analyses into this approach since measuring and understanding sustainable property performance is the key in financial analysis and valuation. Sub-analyses should compromise users demand, investors' demand and regulator demand, since they are the three drivers of financial property performance (Bozorgi, 2015).

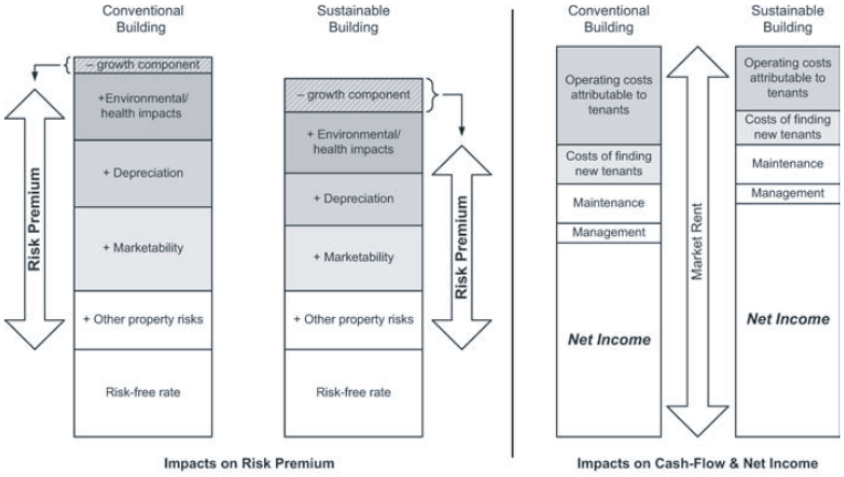

figure 6: sustainability impacts on conventional and sustainable buildings Lützkendorf & Lorenz (2011)

Sayce & Ellison (2003) were one of the first that attempted to reflect sustainability within appraisals. The aim of their research was to provide a tool for appraisers to incorporate sustainability within calculation of investment worth, taking into account the TBL. Their research started back in 2003 by reviewing the wide range of existing indicators. After a first selection was made, the set of indicators were presented to environmental specialists and occupier and investor communities for consultation. The outcome of consultation resulted in the selection of the following categories (with indicators); energy efficiency, pollution, waste management, water management, climate control, accessibility, adaptability, occupier and contextual fit. The framework with the selected sustainability indicators were tested on the commercial market in the UK, resulting in evidence that sustainable buildings do get a higher value compared to 'unsustainable' buildings. The evidence of a higher value for sustainable buildings became visible through analysing the impact of CSR, image or as a potential cost and whether these impacts the investor, occupier or both (Myers et al., 2007). Sayce and Ellison (2003) however did not incorporate tools to assess risks and uncertainties related to the parameters and the influence of sustainability. Indicators related to management and policy issues were excluded since their research required a very simple assessment tool designed around the physical attributes of the building that can be controlled by the investor-owner. Sayce et al. (2004) further researched their project from 2003, and tried to develop a model that allows the incorporation of sustainability through four key variables; the rental growth, depreciation, risk premium and cash flow (table 2).

Table x depicts only sustainability aspects and which parameters are affected due to sustainable characateristics of an office, but not how. At the end of this chapter, a total overview of the authors' findings discussed in this section will be shown. Despite their further attempts and developed models, their work did not become a standard within the UK. Myers et al. (2007) argued that the aforementioned authors tested their model with pilot studies, resulting in a devaluation of properties, which probably won't be accepted and favoured by the industry. Many existing properties would probably be devalued. Another limitation within their study is their limited amount of sustainability indicators.

Sustainability Aspect	Valuation impact
building adaptability	risk premium, cash flow, rental growth
accessibility	rental growth, depreciation
building quality	rental growth, cash flow
energy efficiency	rental growth, risk premium
pollutants	rental growth, risk premium
contextual fit	rental growth
waste and water	rental growth, cash flow
occupier satisfaction	risk premium
occupier impact	risk premium

table 2: Sustainability indicators and conduit(Lorenz & Lutzkendorf 2008)

Meins et al. (2010) applied a risk-based approach for the inclusion of sustainability characteristics within the appraisal of sustainable properties. The authors attempted to analyse the impact of several sustainability indicators on the components of the discount rate by collecting expert opinion. By consulting experts, the authors tried to be more transparent, with the aim to make the 'valuation black box' more transparent. The long-term impacts and consequences of the sustainability indicators are quantified through the estimated impact on property value. However, this approach analysed only the discount rate, while other key parameters within the DCF method can have a significant effect on property value.

Lützkendorf and Lorenz (2014) acknowledge that current research on sustainability is in abundance, however, linking sustainability to the economic side remains scarce. Therefore, the authors developed a framework in 2014 for corporate real estate sustainability management purposes within the property investment profession. Building upon their previous research, in which key parameters are highlighted, the new framework made it possible to link property performance to sustainability by an impact chain. The impact chain proposed by the authors composed of several key steps such as gathering data on the physical property characteristics, which impact the sustainable performance of the property, and ultimately, how sustainability performance affects economic decision-making parameters. In order to understand how sustainability performance affects economic parameters, understanding tenant preferences and satisfaction is crucial. Muldavin (2010) and Bozorgi (2015) concluded with the same suggestions. Their findings showed that some physical characteristics and performance can be linked directly to property performance. However, other factors such as the corporate image, reputational gains are indirectly tied to property value. By analysing the market response, in other words, how for example tenants value sustainability related characteristics, the translation to adjustments of the parameters can be made.

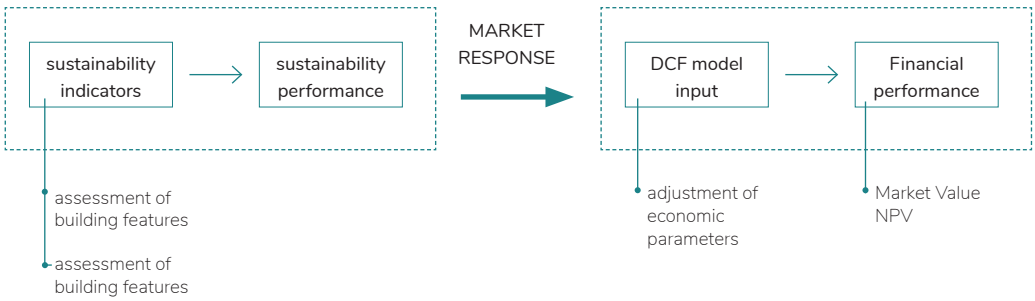

figure 7: abstract representation of translating sustainability characteristcs into the appraisal (adapted from Bozorgi, 2015)

Muldavin (2010) developed a framework 'GBFC' to make links between the sustainable performance of a property and the financial performance through several sub-analyses. According to Muldavin (2010), it is not possible to directly link the sustainable performance of a property to the financial performance without conducting an analysis on the market's response to the sustainable performance. The market's response will determine several parameters within the DCF method, such as the rent, rental growth, absorption rate, discount rates, operating costs and other key parameters. Because the DCF method allows a transparent way to include sustainability, by justifying all decisions made on the parameters, it's generally accepted that this method is suitable for embedding sustainability. This is in line with other suggestions made by authors such as Bienert et al., (2010), Bozorgi (2015), Bendewald et al., (2015). According to the framework (Muldavin 2010) several sustainability characteristics could lead to (the list is not a total overview but a summary) ;

Sustainability Aspect	Green impact	Market performance	Valuation Impact
Energy • artificial and natural light • HVAC system and natural ventilation	• lower energy costs • lower operating costs • longer lifecycle	• increased demand by tenants, investors • reduced vacancy	• higher NOI • less depreciation
Water • low-flow toilets & faucets • water efficient landscaping • rain water harvesting	• lower operating costs • insurance costs	• increased demand • reduced vacancy	• higher NOI • less depreciation
Indoor environmental quality • low emitting materials • exterior windows views • enclosed, ventilated mechanical rooms • under-floor ventilation	• increased productivity of occupants • increased tenant satisfaction	• increased demand by tenants • reduced vacancy • improved marketing	• stable cashflow • higher NOI
Material & Resources • Certified or renewable materials • Construction waste management plan • Greater design flexibility	• improved health of occupants • lower cost of repair and replacement • longer lifecycle	• increased demand • reduced vacancy	• higher NOI • less depreciation
Sustainable Sites • reflective roof/surface • green roof • stormwater management	• integrated planning with effective transportation	• increased demand • improved marketing	• higher NOI
Flexibility & Adaptability • design layout • materials • systems • energy sources		• increased demand • reduced vacancy • refurbishment costs	• discount rate • less depreciation • sale price
Innovation • innovative design	• longer lifecycle	• increased demand • improved image & CSR	• higher NOI • less depreciation

table 3: translation of sustainability characteristics into financial performance (Muldavin, 2010).

In Appendix E the total overview of the theoretical linkage by other authors is depicted in a summary table.

		sustainability 'values'	benefiter: investor-owner	benefiter: occupier	benefits / economic impact on property	adjustable parameters by apraisser: market rent	operati.	rental	occupancy	vacancy	refurb.	renew.	cap/	insurancce	exit value
en.	1	Energy performance	x	x	reduced operating costs attributable to occupiers could lead to wtp more rent, reduced risks through changes in energy prices, NOI, incr. occupance, red. vacancy periods	x	x	x	x	x	x	x	x	x	x
en.	2	Water consumption	x	x	reduced operating costs attributable to occupiers could lead to wtp more rent, lower insurance, reduced risk		x	x	x		x	x	x	x	
en.	3	Waste (business activities)	x	x	reduced operating costs attributable to occupiers could lead to wtp more rent, reduced risks through changes in energy prices, NOI		x	x							
ec.	4	Maintenance & repair costs	x	x	reduced maintenance and repair costs due to results in lower operating costs, possible higher NOI		x	x			x		x		
tc.	5	Flexibility & adaptability of the property	x	x	faster anticipation on changing preferences of users can reduce the risk of obsolescence, extend economic life, reduced vacancy period and risk	x	x	x	x	x	x	x	x		x
so.	6	Transport & accessibility	x	x	easily and safe reachable office could lead to employee/ tenant satisfaction, higher demand, resulting higher NOI, reduced risk	x		x	x	x			x		x
fu.	7	Durability of the property	x	x	longer economic life of property, reduced depreciation resulting in higher multiplier, better serviceability			x		x	x		x		x
ec.	8	Marketability of the property	x		increased marketability due to sustainable image can lead to reduced risk, positive impact on demand and thus higher NOI and/or higher multiplier	x			x	x		x	x		
ec.	9	Compliance with policies/regulations	x	x	compliance with current/future regulations can reduce risk premium, positive impact on demand and thus possible higher NOI and/or multiplier	x		x	x	x		x	x	x	x
en.	11	Resilience (environmental)	x	x	Climate adaptation, less impact by extreme weather conditions leads to resilient offices and sits, can reduce insurance and property specific risks*			x		x			x		x
so.	12	Image gains & CSR	x	x	higher tenant demand resulting in higher NOI, higher investor demand reduced risk, reputation gains for tenant resulting in			x	x	x		x	x		
so.	13	Healthy and comfortable indoor/work environment	x	x	higher tenant demand due to increased employee productivity and satisfaction resulting in higher NOI, reduced vacancy risk and periods, risk of losing tenant	x		x	x	x		x	x		

Table 4: linkage of value systems with paramters

3.4 Conclusion & Discussion

This chapter provided the answer for the following sub-question;

Which appraisal methods do allow the incorporation of sustainability aspects?

Reflecting sustainability in valuations is not a development of valuation approaches but a development in the application of methods. The national guidelines that govern the valuation profession do not provide a framework or a method to incorporate sustainability, however, they do acknowledge that sustainability characteristics have become more important and 'should' be taken into account. According to literature, several methods can be used to embed sustainability within the appraisal. However, it can be concluded that no miraculous tool exists that allows the embedding without analysis, knowledge and skills. Despite the lacking standard tool, investors or owner-occupants still have to make a decision whether to invest in sustainable measures or not. According to literature, existing/traditional valuation methods, such as the DCF, need to be complemented with preliminary research on the (technical, social & ecologic) sustainable performance of the property. The reason why several researchers propose the DCF method as the 'best' method, is because it allows the incorporation of different levels of market rent, rental growth, operating costs, expenditures and other parameters to reflect market performance. For this reason, many researchers based their search to the added value of sustainability characteristics on the DCF method, by mainly including financial benefits such as reduced operating costs, enhanced image and other financial and non-financial benefits.

As discussed in the previous sections, sustainable offices are expected to offer economic, social and environmental benefits for tenants and property owners, and should be reflected in the valuation models. Based on the summary table of the theoretical linkage by other authors (table x.x), it can be concluded that sustainability characteristics of an office can be explicitly reflected by adjustments made to the following key parameters within the DCF method;

- Rental growth: The assumptions on rental growth could be higher after/with sustainable characteristics, after sustainable improvements tenants could be willing to pay more due to a decrease in occupier costs
- Market rent: Tenants could be willing to pay a higher rent due to increased demand
- Renewal probability: Increased occupant and tenant satisfaction might lead to renewal of the contract
- Absorption rate: Increased demand for sustainable offices could affect the duration to sale and rent, and shorten the period on the market
- Discount rate: Property related risk can be reduced due to sustainable characteristics, resulting in a lower discount rate, site related characteristics such as building quality and aesthetics
- Operating costs: Can be reduced through improvements in the energy efficiency and water, maintenance and repair costs
- Vacancy: Reduced vacancy periods due to a faster absorption, image/quality of the property, increased tenant demand
- Occupancy: Especially in multi tenant office buildings the occupancy can be maximal due to an increased demand
- Refurbishment costs: the costs for refurbishment could be lower due to
- Insurance: The insurance costs could be lower due to reduced risk caused by extreme weather conditions
- Exit value: Sustainable characteristics can extend the life span of a property and thus affect depreciation and obsolescence, which both are adjusted by the appraiser to determine the exit yield

Before an appraiser can adjust these parameters, research has to be carried out to collect information about property characteristics and determine market response, which is the demand of regulators, space users and investors. It is the task of the appraiser to translate the sustainability performance into financial performance by evaluating market response and integrating it into quantitative tools such as simulations. Without research, it is not possible to depict the quantitative relationship between sustainability and value. For this reason, it is crucial for appraisers to understand which characteristics of a property contribute to a sustainable property and what the market response is towards these sustainable characteristics. To determine the value, all relevant aspects and factors need to be reflected in the appraisal of the market value.

The next chapter will discuss how the market response towards different sustainability characteristics/ aspects could be estimated by an appraiser. By understanding the value systems of occupiers and investors

CH 04 Linking the indicators to appraisal

The value of properties is linked to the needs and interests of different market players, such as the owners and users. For this reason, the valuation process of properties is always closely related to market participant's value systems and consequently influence the economic value of properties in the marketplace (Lorenz & Lutzkendorf, 2014).

4.1 Value systems

This chapter creates the link between the selected sustainability indicators resulting from chapters 05 and 06 and the value systems detected in the previous chapter (04). This enables the integration of the indicators into the appraisal of offices. The chapter concludes with an overview of the impact of sustainability indicators on 'value systems' and thus on the adjustable economic parameters. Figure 9 presents an abstract overview of this process. In order to make the link between the indicators and parameters, input from the table in Appendix D was consulted and complemented with the theory in this chapter to create a better understanding. The findings from this chapter will be discussed with an appraiser to confirm the detected links and get a further understanding of the gap between practice and theory.

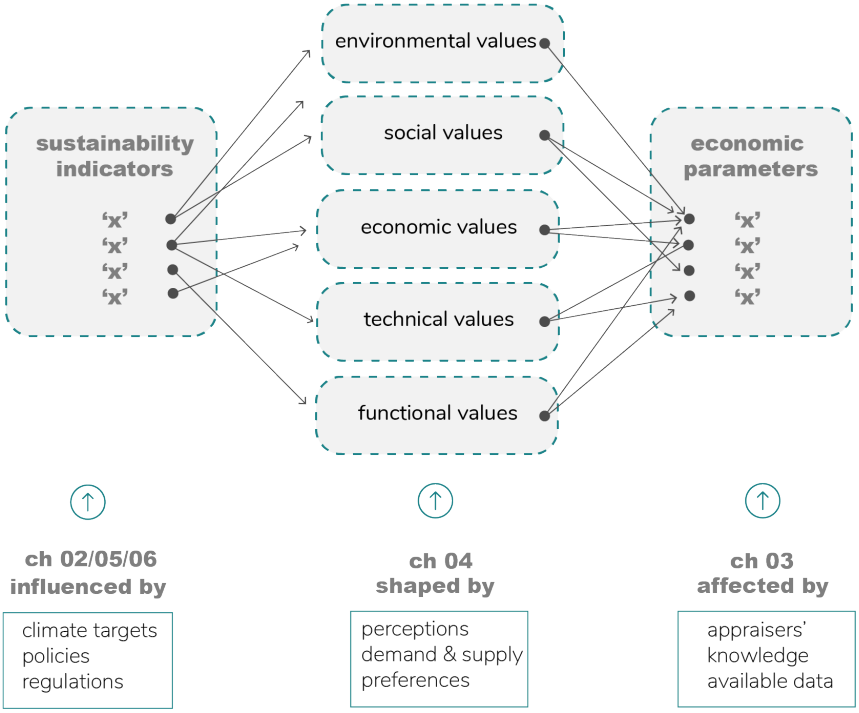

figure 8: approach of linking the selected indicators to the adjustable parameters

Throughout the years, an extensive body of knowledge has been developed to examine occupiers' motives for the demand of sustainable offices. Eichholtz et al (2009) analysed pointed out four main determinants for corporations accommodating sustainable properties.. As stated by Gluszak and Zieba (2016) these determinants are; '' (A) direct economic benefits resulting from lower operating costs and lower energy consumption in those buildings; (B) indirect economic benefits drawn from improved image, increased work efficiency of staff, lower staff turnover, lower absenteeism due to sick building syndrome; (C) risk avoidance which in market conditions translates into the rate of functional and moral deterioration of sustainable building, commercial character of a facility, future changes of energy prices and future institutional and legal changes; (D) ethical conduct related to CSR (Corporate Social Responsibility), responsible property investing, and corporate culture'' (p.739). The following sections will discuss the aforementioned drivers in more detail.

4.1.1 Image & CSR

The concept of CSR, which has a long history, can be understood as corporations' strategy to instrumentally shape their environments (Barley, 2010). An often referred model that explains how CSR can be practised at different levels is the pyramid of CSR by Caroll. This model was based on the four part definition of CSR and ''was originally stated as follows: "Corporate social responsibility encompasses the economic, legal, ethical, and discretionary (philanthropic) expectations that society has of organizations at a given point in time" (Caroll, 2016, p.2). While some theorists are convinced that CSR can lead to potential financial gains through social and environmental performance, some studies found that CSR neither harms nor improves returns, claiming that 'companies can do good and do well, even if they don't do well by doing good (Margolis & Elfenbein 2008, as cited in Pivo & Fischer 2010). However, corporations with well defined CSR policies are likely to benefit from outperforming others through an improved image, less intrusion from activists and governmental organizations, reduces risk from regulation, and an improved profitability through lower input costs and higher employee productivity (Eichholtz et al., 2010a). Based on the aforementioned benefits, it is likely that sustainable offices do have an impact on an organisations' accommodation strategy. Nappi-Choulet and Decamps (2013) demonstrated that green buildings are attractive to corporate property occupiers and indeed influences location decisions. While the rising importance of sustainability within corporations' location strategies can be seen as a response to the strict regulatory environments, their study highlights three reasons why organiations perceive sustainability as an important location strategy. First, there is a rising importance on sustainability by especially listed companies, which can be explained by their duty to report on their social and environmental responsibility towards governments. Listed companies also practice management such as space planning or evaluating its impact on their employees' health and well-being. Another striking result is that the ownership of an office is strongly associated with a strong concern for sustainability while tenants seem to be more sensitive. Their third finding shows that mainly the location for headquarters is the reason for considering sustainability in the corporate decision. Tenants with mainly short leases are less likely to be attracted to green certified properties since the cost of occupying green offices may not outweigh the long-term benefits (Nurick et al., 2015). As part of CSR strategies of organizations, tenants prioritize sustainable offices also due to an improved image that leads to attracting and retaining employees. Employees attach a value to sustainable offices due to the healthy 'character' of sustainable offices. For this reason, next to the 'epc' and 'sustainable energy sources' indicators, the indicators of the health category are expected to have an impact on the image and CSR of an organization.

- Indicators contributing to image & CSR

epc - sustainable energy sources - air quality - daylighting - temperature control - relaxing spaces - views from workplaces - light regulation - reduced car/park use - facilities for cyclists -

- Adjustable economic paramters

vacancy (periods) - rental growth - occupancy - renewal probability - discount rate

4.1.2 Health & Indoor environment

It is widely accepted that offices could and should contribute to the health and well-being of occupants in a positive way (Ornetzeder et al., 2016). A survey carried out by JLL (2013) among 137 office organizations revealed that an increased productivity and improved well-being of employees are the main reasons for selecting a sustainable office accommodation. Their research highlighted a shift in the occupier preferences concerning sustainability categories. While in 2010, Energy was the most important aspect of sustainability, a shift to Health-and Wellbeing is noticed. Sustainable buildings promote better health and well-being, comfort and productivity of the end-users, which reduce absenteeism and increase productivity. Kats (2003) reviewed 33 sustainable building projects, and concluded that sustainable buildings do provide financial benefits and conventional buildings not. The study revealed that sustainable buildings provide financial gains through savings from reduced energy, water, and waste, lower operation and maintenance costs, and enhanced productivity. The financial gains from productivity and less absenteeism, range between 37-55 dollars per square foot. Aspects such as better ventilation, lighting and the work environment are the main reasons for an enhanced productivity and health.

Feige et al. (2013) investigated how sustainability can lead to financial gains for organizations through understanding the impact of building features on the comfort, work engagement and thus the company affect (figure 10). According to Feige et al. (2013), the comfort of employees cannot be directly tied to the productivity level which benefits the organization. However. the comfort level is directly tied to the work engagement.

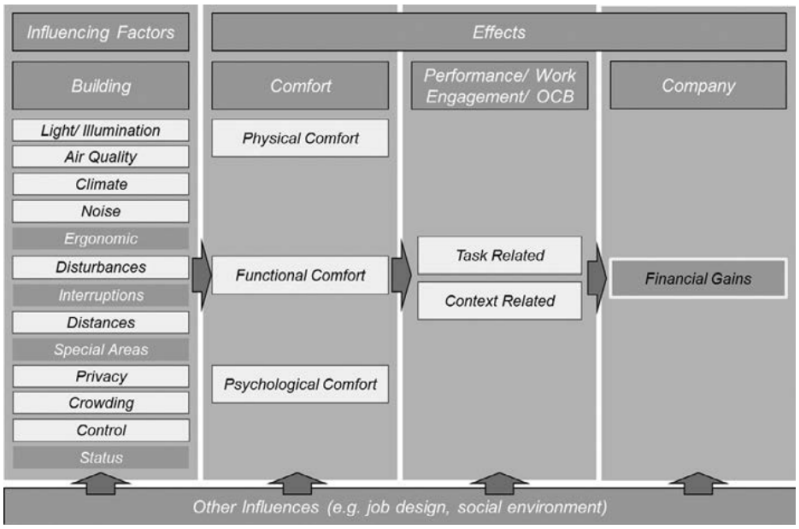

figure 9: Influencing factors on financial gains. Feige et al. (2013)

According to Storey and Pedersen (2006), well-being compromises physical, intellectual and emotional aspects, and architectural design is related to all these aspects. The classical indoor environment features, such as the thermal comfort, humidity comfort, air quality, light control, noise and pollution, contribute mostly to the physical well-being of users (Ornetzeder et al., 2016). According to the DGBC (2015), thermal comfort, in which the end-user is able to control the temperature at workplaces increases the productivity with 3%, and temperature control in combination with ventilation control with 6%.

Even though the benefits of healthy offices are mainly affecting the occupiers, the property owner could benefit indirectly from an increased tenant satisfaction, which is affected by the organization's employees and their well-being. According to a survey among American and Canadian property owners conducted by Jones and Laquidar-Carr (2016), 35% of the property owners expect to lease properties more quickly due to investments in healthy upgrades, with an average premium of 1,9%, and 52% of the owners do not know whether there is an impact. The property owners (26%) also expect a positive impact on the property value, with an increase of 2,5%, while a large group (58%) does not know whether there is an impact. The same survey revealed tenants

Buskermolen (2019) studied tenants' WTP for healthy offices and identified workplace aspects that could be beneficial to investor-owners through investigating the preferences of tenants. According to the study conducted in the Netherlands, tenants are willing to pay more rent for several healthy design aspects, such as the indoor quality, the thermal comfort, noise and acoustics and views. The maximum overall WTP for healthy offices depends on the improvements made. The price ranges from a low to a medium quality (healthy) office is 6.37-12.33%, and medium to a high health quality office is between 6.17 – 12.43%. The same study revealed that big improvements, transforming a low health quality into a high health quality office, results in tenants willing to pay 12.54-24.76% more rent.

- Indicators contributing to health & well-being

air quality - daylighting - temperature control - relaxing spaces - views from workplaces - light regulation - green facilities - monitoring emissions - condition monitoring - ecologic facilities

- Adjustable economic parameters

vacancy (periods) - rental growth - rent - occupancy - vacancy - renewal probability - discount rate - exit value

4.1.3 Operating costs

Important financial aspects for tenants are the share of operating costs attributed to them, together with the net rent, and both have an important role in the decision-making in to rent or not to rent an office. In the Netherlands, operating costs of commercial properties are normally paid by tenants.
Sustainable offices are characterized by energy efficient systems and offer occupants direct benefits through lower operating costs, and thus lower exposure to rising energy prices (Eichholtz et al., 2012). It is believed that sustainable buildings can offer a reduction in energy bills, which account for 30% of the total operating costs, and consequently a reduction in the total cost of occupancy (Eichholtz et al., 2010). While it's true that occupant behaviour plays an important role in the level of operating costs, an office' energetic quality has an impact on heating costs, water saving installations on water costs and waste-water, and solutions for waste separation on costs for waste disposal (Lowe & Ponce, 2010). Although the tenant benefits from lower operating costs, the question is whether they should be willing to pay a higher rent to occupy energy efficient offices, while their total cost of occupancy remains constant, and other benefits such as increased productivity are also attributable to them. Hüttler et al. (2011) pointed out that the rental premium cannot exceed the tenant's reduction in operating costs.

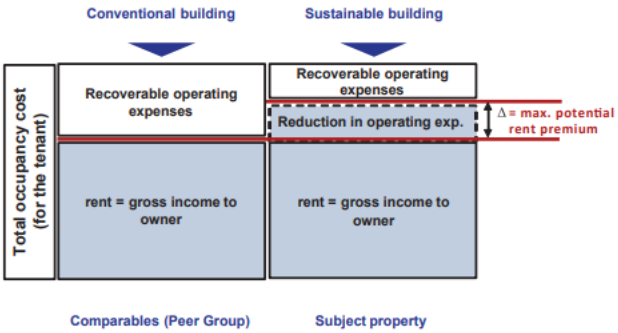

Figure 10: (Hüttler et al., 2011)

The financial benefits of lower operating costs can be measured through consulting the EPC (electricity, gas, oil), However, since deviations in the actual performance and theoretical performance exist, due to the general information provided by the labels, monitoring the actual use is needed. Another cause for deviations is the poor performance of installations caused by the lack of commissioning. Proper building commissioning of existing buildings can result in reduced operating, maintenance and repair costs. It decreases the risk of savings not delivered and no return on investment, can lead to energy savings exceeding the commissioning costs and a reduction in greenhouse gas emissions (Mills, 2011).

Another element of the operating costs is the water consumption for operating an office. The costs for water are generally low. However, the installation of a separate greywater system might lead to water savings in the long term by re-using collected rainwater for other purposes than drinking water, such as flushing toilets. Water management by tenants seems at a first glance irrelevant for property owners or investors. However, tenants are nowadays driven by CSR policies and managing water is an important element. A property without facilities that enables proper water management need result in the owner investing in refurbishment to maintain the demand.

The same applies to the aforementioned, installing waste management facilities might not be in the interest of a property owner or investor. However, nowadays CSR policies also focus on waste management which is also required by regulators. This means that an office should offer the space for waste storage and recycling services.

Indicators contributing to operating costs

epc - sustainable energy sources - monitoring energy consumption - commissioning - monitoring water consumption - separate grey/rainwater - watersaving sanitary - reuse collected water - separate waste collection -

Adjustable economic parameters

vacancy (periods) - rental growth - rent - refurbishment costs - occupancy - discount rate - insurance - exit value - operating costs

4.1.4 Adaptability & Flexibility

Adaptability can be described as 'the ease with which buildings can be physically modified, deconstructed, refurbished, reconfigured, repurposed and/or expanded' (Ross et al., 2016, p.421). The drivers for implementing adaptability as a strategy to achieve sustainable development are likely to be legislative and economic drivers (Gosling et al., 2013). The adaptivity of a building enhances the longer-term usefulness, which is why adaptation is a more sustainable option dan demolition and rebuilding if the building does not meet legal and functional requirements anymore. According to Bullen (2007), the benefits of adaptivity entail: a) reduced energy consumption and emissions b) extended useful life c) cost-effectiveness d) reduced land consumption e) increased demand for retained existing buildings. Even though the benefits related to the saved energy consumption and emissions are hard to quantify, an appraiser can adjust the economic parameters within an appraisal by estimating how an adaptive office contributes to tenant and owner satisfaction. The office sector is most prone to be affected by changing occupier requirement. An improved space flexibility and adaptability is nowadays essential due to fast changes, such as new ways of working due to pandemics, and can reduce risk caused by changes in the market participants' requirements. An office space that is not easily able to support the variety in working practices now being adopted will be subject to refits in order to counteract functional obsolescence and maintain occupier demand (Sayce & Ellison, 2006). The adaptability of an office can affect its ability to meet changing demand in the future and thus potentially increases or decreases the depreciation rate and the time in future when redevlopment or upgrades are needed (Ellison & Sayce, 2007). For a property owner-investor, having a flexible and adaptable office design would save costs when refurbishment is needed and saves time in the construction phase. Additionally, being able to anticipate tenant demand quickly would increase tenant satisfaction and retention.
According to Slaughter (2001), three types of change can occur in built facilities, change in the functions, capacity of systems (load) and the movements within and around a building relating to the surrounding environment. The loads on the structural elements depend mainly on the function within the building, thus, to provide a high level of indeterminacy, structural elements should be designed for overcapacity (Gosling et al., 2013). Another important element in the change of functions is the size and height of buildings as well as the internal layout (Gann & Barlow 1996). An open floorplan with the separation of 'fit-out', which refers to all the componentry and elements that enable the use, contributes to the independence of design. In large office buildings with multi tenants, separate multiple entrances connected to the main circulation of the building increases the adaptability (Schmidt III & Austin, 2016).

- Indicators contributing to adaptability

demountable materials - material passport - adaptability of functions - adaptability of structure - integral accessibility - commissioning - condition monitoring

- Adjustable economic parameters

vacancy (periods) - rental growth - refurbishment costs - discount rate - exit value - occupancy

4.1.5 Marketability

The marketability of a property affects the risk premium which is an important determinant on the market value. When an appraiser assesses the marketability of a property, the ability to be sold (marketed), attractiveness to potential buyers, the current use and future alternative use together with the local market conditions are considered. An improved marketability affects property value through a higher stability of cash flows, and thus the discount rate. Green certified properties are promoted as easily marketable properties because market stakeholders have become more environmentally conscious and socially responsible now than ever (Levy & Peterson, 2013 as cited in Oyedokun, 2017). Sustainable offices have improved marketability, which provides them with a competitive advantage: easier and faster to sell and lease, which in turn reduces vacancy periods and thus income losses (Muldavin, 2010). This makes sustainable properties an attractive asset for many investors in the commercial estate since they are likely to have a longer economic life, and thus a lower risk of technical and regulatory obsolescence (Eichholtz et al., 2010). According to a study by Bowman and Wills (2008), investors and financiers are willing to pay more for green properties due to the advantage in marketability compared to competitors.
According to a survey conducted by Nurick et al (2015), nearly three-quarters of appraisers that filled in the survey indicated that a green certified property would yield a higher value compared to properties without a certification, with improved marketability as the reason. However, the marketability of a property is not discernible upon inspection, an appraiser may need to require new types of information such as the energy use data, comparables and market participant behaviour in order to properly assess marketability (Runde, 2015). Properties with good thermal quality are likely to have a lower risk regarding the marketability, while properties with poor thermal quality will suffer from lower rents, higher vacancy rates, resulting in lower demand and higher yield (Warren et al., 2009). The reason for the latter is that tenants value healthy and comfortable work environments, which has proofed to be beneficial for organizations in many different ways (see health section).

- Indicators contributing to marketability

epc - sustainable energy sources - green facilities - adaptability of functions - adaptability of structure - proximity of facilities - proximity of public transport - facilities for cyclists - separate waste collection - air quality - daylighting - temperature control - relaxing spaces - views from workplaces - light regulation -

- Adjustable economic parameters

vacancy period - rent - discount rate - exit value - occupancy - renewal probability - discount rate

4.1.6 Resilience

'Resilience has emerged as a notion seeking to capture the differential and uneven ability of places to react, respond and cope with uncertain, volatile and rapid change (Pike et al., 2010, p.1). Different ways exist to define what resilience means, ranging from the individual to the spatial context. Within the engineering sector, resilience has been mainly focussing on the vulnerability of people and places to hazardous environments, natural disasters, forecasting the likelihood of catastrophic events and systematic breakdowns and their social and economic implications (Vale & Campanella 2017 as cited in Pike et al., 2010). Resilient buildings are key to achieving sustainable development. Our built environment is becoming more prone to extreme weather conditions which nessasates buildings and surrounding sites to be able to react to these conditions in order to maintain a long useful life. The value of resilience for the real estate sector is the ability to manage risks more efficiently, mitigate hazards, lower building operating costs resulting in lease downtimes and increased tenant retention. Climate adaptation can be considered as one strategy to achieve resilience. Mitigating flood risks is becoming more urgent at locations where there is a medium or high risk of flood. The presence of flood measures, such as green roofs, a balance between pavement and greenery on the site, and other water storage facilities on sites mitigate the impact of flood, with land contamination as an example. Even though these risks are calculated in the insurance costs, properties that are perceived as riskier due to the location and the lack or presence of flood measures will probably cost more than average to insure.
Another example of a resilient office might be an office that is able to cope with the urban heat island effect. The urban heat island effect affects the built environment as well as the quality of life in several ways. "It is well documented that urban overheating is causing a serious increase of the energy consumption for cooling purposes, a considerable rise of the peak electricity demand, affects in a negative way local vulnerability levels, increases heat related mortality and morbidity, while it augments the concentration of harmful pollutants" (Santamouris, 2020, p.2). Given that most users spend a lot of time at offices and equipment is generally continously active, implementing measures to reduce the effect does not only lead to reduced energy consumption, reduced pollution damaging the ozone layer, but improves the comfort level of end-users as well. Temporarily storing water on surfaces can increase evaporation and contribute to cooling the surrounding site (Richards & Edwards, 2018). Water scarcity has become an important issue as well due to the dry summers which are becoming more frequent in European countries. For a property owner-investor, owning a resilient office means --

Indicators contributing to resilience

sustainable energy sources - green facilities - ecologic facilities - flood measures - separate grey&stormwatersystem - monitoring emissions - ecologic value - light pollution - reuse collected water -

Adjustable economic parameters

insurance - refurbishment costs - occupancy - discount rate - exit value

4.1.7 Durability

Several characteristics of a property can contribute to the durability such as the selected materials, assemblies and systems that require less maintenance, repair and replacement. These characteristics of durability extend the lifetime of materials and thus properties as well. The durability of a property is an important component of sustainability. Durability is closely linked to adaptability and flexibility since the goal is to maximize the time available to benefit. For materials, durability can be defined as its ability to resis deterioration processes caused by its external environment, such as weathering. Paying attention to the materials, their finished, and protection, will impact the maintenance and repair costs, optimizing the functionality. For a property owner, this means having reduced disruption in operating an office when maintenance is required. The durability affects the depreciation rate as well since it consists of the estimated useful life of the asset. However, in order to to assess the durability of materials an appraiser should consult data resulting from condition monitoring.

Indicators contributing to durability
demountable materials - MPG / environmental impact - material passport - condition monitoring - commissioning - flood measures -

Adjustable economic parameters
vacancy (periods) -rental growth -discount rate - insurance

4.1.7 Transport & Accessibility

The accessibility of a property is currently already an important component of the market value and worth. However, for an appraiser to assess the transportation options and accessibility, and how it may attract and retain tenants depends on the end-user. Travelling by car to offices may be environmentally damaging, however, it is an important form of access in both social and economic terms for a large part of the existing office stock (Ellison & Sayce, 2006). Offices located outside inner cities, might be dependent on car access, while on the other hand, offices located close to transport nodes may not require an optimal access by car. The added value of a reduced or improved access is influenced by an organizations contribution to its CSR policies. Currently, the availability of parking places at the site, proper access by car and the presence of transport nodes increase the marketability of offices. Therefore, the presence of facilities for cyclists and reduced car/park use might not always lead to added value for property owners. Keeping in mind the current developments, such as the new trend working-from-home, it might be expected that more office space will become available in the market, offering organizations more opportunities to locate within inner cities.

4.2 Recap

This chapter explored the different links between 'value systems' and the sustainability indicators selected by the experts. It should be noted that this linkage is theoretical, and could be further researched on local scale, within the Dutch context. The findings are summarized in table x on the next page. The table demonstrates that the selected sustainability indicators do not contribute to one value system only but can contribute to different levels within the economic, environmental, social technical and functional context. Understanding this 'impact chain' allows a better interpretation of the financial risk related to operating an office, the locational characteristics and the performance of building components.

4.7 Indicators and parameters

		energy consumption	water	waste	Healthy environment	CSR / image	flexibility & adaptability	durability	compliance	resilience	marketability
	× direct/high impact × indirect/low impact										
1	sustainable energy sources	×	×		×	×	×	×	×	×	×
2	EPC	×			×	×			×		×
3	monitoring energy use	×			×	×			×		
4	commisioning	×	×		×		×	×	×		
5	air quality				×	×	×	×	×		×
6	daylighting	×			×	×			×		×
7	temperature control	×			×	×					×
8	relaxing spaces				×	×					×
9	views from workplaces	×			×	×			×		×
10	light regulation	×			×	×					×
11	environmental impact materials						×	×	×		
12	demountable materials	×		×		×	×	×			×
13	material passport						×	×	×		
14	condition monitoring	×					×	×	×		
15	ecological facilities				×	×		×	×	×	
16	green facilities	×			×	×		×		×	×
17	ecologic value				×	×			×	×	
18	adaptability of functions					×	×	×			×
19	adaptability of structure					×	×	×			×
20	integral accessibility					×	×	×	×		×
21	roadmap towards sustainability	×	×	×	×	×	×		×		×
22	greenlease	×	×	×		×					×
23	reduced car park/use				×	×					×
24	proximity of public transport				×	×	×				×
25	facilities for cyclists				×	×					×
26	proximity of facilities				×	×	×				×
27	separate waste collection			×		×			×	×	
28	monitoring emissions				×	×			×	×	
29	light pollution (reduce)								×	×	
30	flood measures							×		×	
31	monitoring water consumption		×							×	
32	water saving sanitary		×							×	
33	reuse collected water		×			×				×	
34	separate grey&stormwater		×			×		×		×	

performance & quality indicators → impact on value systems

table 5: the impact of the selected indicators (chapter 5&6) on value systems

Indicators and parameters continued

		rent	rental growth	operating costs	occupancy	vacancy	renewal prop.	discount rate	insurance	exit value
	x direct/high impact × indirect/low impact									
1	sustainable energy sources	x	×	x	×	×	x	×		x
2	EPC	x	×	x	x		x	×		x
3	monitoring energy use		×	x						
4	commisioning			x				×	×	×
5	air quality		x		x	x	x			
6	daylighting		x		x	x				
7	temperature control		x		x	x				
8	relaxing spaces		x		x	x				
9	views from workplaces		x		x	x				
10	light regulation		x		x	x				
11	environmental impact materials							×	×	×
12	demountable materials				×	×	×	x		x
13	material passport				×	×		×		×
14	condition monitoring		×	x				x	×	x
15	ecological facilities	x	x		x	x	x			
16	green facilities	×	x		x	x	x			
17	ecologic value	x			x	x				
18	adaptability of functions	x	x		×	x	x	x		x
19	adaptability of structure	x	x		×	x	x	x		x
20	integral accessibility		x		×		×			
21	roadmap towards sustainability	×	×	×	×	×	×			
22	greenlease	×	×	×	×	×				
23	reduced car park/use	×	×		×	×	×			
24	proximity of public transport	×	×		×	×	×	x		x
25	facilities for cyclists	×	×		x	x	x			
26	proximity of facilities	×	×		x	x	x			
27	separate waste collection			x						
28	monitoring emissions		×		×	×	×		×	
29	light pollution (reduce)									
30	flood measures								x	
31	monitoring water consumption			×						
32	water saving sanitary		×	x						
33	reuse collected water		×	x						
34	separate grey&stormwater		×	×					×	

performance & quality indicators → adjustable parameters

table 6: the impact of the selected indicators (chapter 5&6) on adjustable parameters

Empirical Research

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CH 05 Indicators confirmed through interviews

This chapter outlines the data collection methods and data analysis methods that have been adopted in this thesis, as well as why they are chosen. Figure x shows an overview of the data collection and analysis methods adopted at different stages. The empirical research of this thesis comprises three sections. The chapter elaborates first on the semi-structured interviews, followed by the survey design and ...

The literature review in the previous chapters was conducted to mainly collect frequent occurring sustainability indicators that should be considered in a sustainability assessment tool for offices. Based on the selected certification schemes and the count of the indicators, the extensive list of indicators was reduced, from 324 to 45 indicators. These preliminary indicators with their corresponding category can be found in appendix A.

5.1 Semi-structured interviews

Semi-structured interviews seemed suitable for the purpose of the data collection, validating the obtained sustainability indicators, and for exploring perceptions and views on complex issues related to the sustainability indicators. Through interviews, especially semi-structured interviews, theoretical results can be linked into practice. Validation of the sustainability indicators for this thesis was required as the first empirical step to develop a new sustainability framework for offices. To validate these sustainability indicators, data is collected through 8 semi structured interviews with experts from different companies. The interviews are with the permission of the participants voice recorded. Prior to all the interviews, a brief summary of the goal of this thesis was sent together with the first selection of indicators.

The interviews were conducted through Microsoft Teams/Skype, an internet-based method of communication that seemed appropriate due to the implications of Covid-19 occurring during writing this thesis. Interviews lasted around 45-75 minutes and followed the initial guiding question list (Appendix B), depending on the answers received, questions from the list were followed by in-depth questions in specific directions of interest. During the interviews, the first selection of sustainability indicators based on the literature review was presented. The participants were asked to select the relevant indicators for each category based on their knowledge and experience. Not all participants selected relevant indicators prior to the interview meeting, which is why the selection was presented during the interview as well. All participants reviewed the same sustainability indicators list. Additionally, the experts were asked if they wanted to add other indicators which were missing in the presented list according to their experience. Based on the added indicators, questions were asked how and why to incorporate these new indicators.

5.1.1 Sampling

The selected experts were chosen with a reference to the research questions and the purpose of this thesis. The research question that had to be answered through interviews aimed to validate sustainability indicators. The sampling for this thesis had to be therefore related to sustainability and sustainable offices, which can be seen as purposive sampling. The participating experts were selected based on their experience with different certification schemes, in this case BREEAM, within the commercial real estate and/or their experience with the transition towards sustainable real estate within the commercial real estate. The experts were approached through social media. The experts' names are coded into numbers to enable anonymity among the participants. Quotes that are presented in this thesis will be referred to the interviewee numbers which are depicted below.

Interviewee	Function / Role	Experience
1	Sustainability consultant	BREEAM expert and assessor
2	Sustainability consultant	BREEAM expert
3	Project manager (sustainability)	Development of Dutch BREEAM schemes
4	Sustainability consultant	BREEAM assessor
5	Sustainability consultant	BREEAM expert and assessor
6	Sustainability consultant	Sustainability expert on policies for the commercial real estate in the Netherlands
7	Program manager (sustainability)	Development of Dutch BREEAM schemes
8	Managing director / sustainability consultant	Consultanct in sustainable real estate

table 7: participants

5.1.2 Preparation

Guiding question list

The initial guiding question list included questions about the definition of sustainability, (perceived) barriers in the implementation of a simplified tool, market adoption/acceptation and how to measure the selected indicators. The interviews provided insight into the practice of achieving sustainability within the built environment and how indicators could and should be measured as well as the perceived barriers of the indicators.

Informed consent

Regarding the processing of empirical research according to the GDPR (general data protection regulation), a few measures are carried out. The informed consent was sent to the participants to ensure a full understanding of the purpose of this thesis and how data would be processed. The informed consent included some questions for the participants and were asked to agree upon the conditions of the interviews. The participants were asked to agree with the following aspects mentioned in the informed consent form; the voluntary participation in the study, the participants can refuse to answer the questions and can choose to withdraw from the study at any time, the interviews are audio-recorded to facilitate the process of translating the transcripts into findings for this study, the participants remain anonymous and no personal information will be included in the thesis so that they are not traceable.

Storing Data

With regard to the privacy of the participants, the audio-records of the interviews are stored offline and are deleted one year after the graduation date. The records can be accessed by the research team only. The personal information of the participants, including e-mail addresses, or other personal details, are not shared beyond the research team. All the interview transcripts are anonymized to ensure that the sensitive company information is treated confidentially.

5.2 Analysis of qualitative data

Coding in Atlas.ti

The initial step in analysing data was transcribing the recordings shortly after each interview, and relevant portions of the transcripts were coded in Atlas.ti. This thesis rests upon mainly a deductive approach, in which a coding list was already created before analysing the data. First, each indicator of the initial/first selection was given a code. Second, issues related to the sustainability indicators, such as barriers in collecting the data for measurement or barriers related to the capacity of the appraiser were created. This allowed to identify links between different concepts. Additionally, a code for new information and suggestions by the experts was created as well. The main purpose of coding was not to count the codes but to be able to find relevant portions of the transcript referring to a specific theme/ topic. The selected indicators are counted during the interviews.

Towards the second selection of indicators

Before conducting the interviews, the approach to make a final selection was based on the count of the selected indicator. However, during transcribing the interviews and assigning codes, the interrelated nature of indicators became more visible. At this point, the decision was made to elaborate on the goal of the selected indicators and the interrelated relationships among the indicators, new information provided by the interviewees. The following subchapter presents this elaboration and discussion on the inclusion of certain indicators, together with the reasoning why certain indicators are adjusted, merged and eliminated.

Input for online survey

While initially the semi-structured interviews were conducted to gather views on indicators, their goals, criteria and measurement, not all topics could be covered during the interviews due to the extensive list of indicators and the available time. For this reason, topics that were not covered fully or not discussed at all, are included in the questionaire of the online survey. To prepare the questions arising from the interviews, or including unanswered questions, the following sub-chapter highlights these issues.

Total Overview

table 8

		Sustainability Indicators	int. 1	int. 2	int. 3	int. 4	int. 5	int. 6	int. 7	int. 8	total counts
Energy	1	EPC	x	x	x			x	x	x	6
	2	share renewable energy/carbon offset	x			x		x	x		4
	3	monitoring energy use		x	x	x	x	x	x	x	7
	4	energy saving lights		x		x	x	x			4
	5	energy use of elektrcity net	x					x	x	x	4
	6	use of fossil fuels						x	x		2
	7	type of sustainable sources			x			x			2
Health	8	daylighting	x	x	x	x	x	x	x		7
	9	views	x	x	x		x	x	x		6
	10	air quality	x	x	x	x		x	x		6
	11	fresh air supply	x	x	x		x	x	x		6
	12	light regulation (presence)	x		x			x	x		4
	13	temperature regulation	x		x		x	x	x		5
	14	relaxing spaces	x		x	x	x	x	x		6
	15	acoustic comfort			x		x	x			3
Water	16	watersaving sanitary	x	x		x	x	x	x		6
	17	leak detection	x						x		2
	18	reduce use of water (public)	x		x		x	x	x		5
	19	seperate greywater / stormwater		x	x	x	x	x	x	x	7
	20	monitoring water use		x	x	x	x		x		5
Materials	21	demontable materials/parts	x		x	x	x	x			5
	22	material passport	x	x	x	x	x		x	x	7
	23	environmental impact materials		x	x	x	x		x		5
	24	condition monitoring	x	x	x		x	x	x	x	7
	25	safety measures materials		x					x		2
Pollution	26	impact refrigerants			x	x	x	x	x		5
	27	separate liquids			x				x		2
	28	separate waste	x	x	x	x	x	x	x	x	8
	29	waste collection area	x	x	x	x	x	x	x	x	8
	30	emission of CO2				x	x	x	x	x	5
Ecology	31	ecologic value/facilities		x	x	x	x		x	x	6
	32	green facilities	x	x	x		x	x	x	x	7
	33	ecologic research	x	x	x	x	x	x		x	7
	34	reduce light pollution		x			x	x	x	x	5
Transport	35	proximity of public transport	x	x	x	x	x		x	x	7
	36	proximity of facilities	x	x			x		x	x	5
	37	facilities for cyclists	x	x	x	x	x	x	x	x	8
	38	pedestrians route		x			x		x	x	4
	39	reduce car/park use		x	x	x	x		x	x	6
Future	40	integral accessibility	x	x	x	x	x	x	x	x	8
	41	adaptability of structure	x	x	x		x	x	x		6
	42	adaptability of functions	x	x	x	x	x	x			6
	43	urbanization of area			x			x			2

5.3 Interview findings

This section presents the findings from the conducted interviews. The findings are presented below and structured into different themes and categories related to the research question. First, the perceived definition of sustainability by the experts will be briefly presented. Second, the selected indicators are mentioned. Third, the selected indicators and their corresponding categories will be elaborated on based on the insights provided by the experts. Ultimately, based on the gained insights and expertise by the experts, the adjusted indicators list will be presented.

Definition of a sustainable office

To get a first impression of what constitutes a sustainable office according to the interviewees, the question what defines a sustainable office was asked. In general, the majority of the interviewees acknlowedged that sustainability nowadays in relation with real estate means doing better than wat is standard. With standard, compliance with current regulations was meant. Some interviewees emphasized that the hardware of buildings are the most important elements that can contribute to sustainability. Some examples are the isolation capacity, heating, cooling and lighting. Next to the hardware of buildings, the users have an impact on the sustainability performance as well. Not only by adjusting their behaviour, such as switching of lights, but by ensuring systems that are installed correctly (see Appendix C).

'Legislation is for laggards'.
(interviewee 6)

'Buildings are never truly sustainable,
they always use energy, materials and water.
What you can do is make it better than the standard'.
(interviewee 1)

So, if consulting regulations and the ambition plans of climate accord is not enough to define sustainability, what is a sustainable office than? The definition of sustainability has been expanding and covers nowadays circularity, climate adaptation and health related aspects which is in line with the findings from the literature review. Some interviewees gave a description based on the Brundlant Commissions' contribution to sustainable development.

'Leaving the earth behind for the future generation
so that they benefit just as much as we do'
(interviewee 2)

'We want to meet our needs as human beings,
but not only now, also later in time, not only here but also elsewhere'.
(interviewee 7)

An emphasis on the location of offices is noticed among all the sustainability experts. A property that does not function properly in accommodating the function/use, can be considered as less sustainable. ''You will also see that investors, very good investors who look far ahead, are looking for buildings that are in the right place, well obviously, but obvious also means that a good place always leads to the use of a building. So location location location actually means use use use of a building. And we just said that buildings should be used to ensure that no other resources are needed'' (interviewee 8).

'Think it starts with realizing that we are depleting the Earth.
And, that depletion of the earth immediately follows in which order your
buildings should be made more sustainable'.
(interviewee 8)

5.3.1 Energy Category

In total, 7 indicators were identified relating to the category energy, 5 of those indicators were selected by fore or more interviewees. However, 1 of the selected indicators won't be included in the online survey, which will be explained below.

	Indicator	Goal	Measurement	total count
1	EPC	providing insight in energy efficiency of the property	presence and compliance with regulation /compare with actual use	6
2	monitoring energy use	gaining insight in energy consumption	energy consumption per year /actual energy use compared with label / use of fossil fuels	7
3	sustainable energy sources	provide sustainable/green energy to reduce demand for energy from the public net	presence and share of renewable energy/ check from energy bill	4
4	commissioning	ensure energy performance in accordance with design requirements	performance of installations has been tested and adjusted accordingly / every 5-10 years	4

x = input for online survey

x = (new) proposed indicator based on interview findings

table 9: Energy category

Actual energy use versus theoretical use (energy performance)

It is no surprise that 'monitoring actual energy use' is selected by almost all experts during the interviews. Monitoring the energy use of a property is actually seen as the precondition for other indicators within the category energy. As stated by most interviewees, consulting the energy label to obtain information about the EPC is not sufficient, monitoring the actual energy use is a more reliable method of gaining insight and should be compared with the information provided by the energy label. The actual energy use deviates in most cases from the theoretical use, and is mainly dependent on the behaviour of the end-users. A study by Sipma et al. (2017) revealed that factors such as higher occupancy rates (due to larger floor area), the building-specific use, cause a higher actual energy consumption than the average theoretical energy consumption, for mainly labels A and B. An interviewee (4) stated; "... I wouldn't really consult an energy label ... you hear often, it is a paper exercise than that it says something about practice." "

"... With energy, it is important to measure the actual CO2 emissions of the actual energy consumption. So 3, the actual CO2 emissions, and then also with the associated mix of energy. So you have actual CO2 emissions and actual energy consumption. The actual energy consumption in kWh, of gas, electricity and heat. CO2 emissions are, which belongs to 5, the actual CO2 emissions. But it is a separate one, do not believe it was there. 5 is actual energy consumption and then, 8 is actual CO2 emissions from that energy consumption, and then you already have 2, and 1 I would continue to measure it temporarily. I would measure that for a while. until we start doing 5 and otherwise, 8, the energy label is the only measurement we have. So 1, 5, and 8, that's monitoring energy consumption. ""(interviewee 8)

However, conflicting views about the energy labels with the EPC are noted. While some interviewees were doubtful about the inclusion of the energy label in an assessment, or even neglected the inclusion, other interviewees depicted the labels as a helpful tool. As stated by interviewee 8;"... the good thing about the labels is that they are actually recipes how you can improve your building to have less impact on your environment and a good building for the users. But what is missing is how you make a building circular, namely that it will last, for example, another 100 years. " Another interviewee (1) stated; ''...Maar als je het hebt over een taxateur, en wat verschil zal uitmaken, de energielabel is er al. Dat betekent dat de categorie energie al redelijk goed ingevuld zou moeten zijn. ''

Based on the contrasting views, it can be said that the indicators in the category energy lacked some specificity, indicating a lack of consensus among the interviewees. The lack of specificity is partly attributed to the changing regulations within the Netherlands. The interviewees noticed the overlapping areas of the indicators related to the current regulation on the energy performance of buildings. As explained in chapter 2.x, the Dutch government intends to take through the BENG indicators effective from January 1, 2021. Based on the changing regulations, the suggestion to link the inclusion of indicators to a timespan is made. Until the BENG indicators are implemented and taken through, the indicators 'epc', 'monitoring (actual) energy use together with the share of sustainable energy should be assessed.`

''... And I see within the energy category, you have EPC as well as the BENG indicators, but also energy share .. and energy consumption and electricity grid, while if you start working with the beng, beng consists of three parts and considers also the share of energy generated . So then I would go for 1 epc label and go for actual energy consumption when they are available, and actively monitor with each other. Nowadays there are more and more systems that are able to do so, connect the actual energy consumption of the building to the energy consumption that you would expect based on label. and an analysis of that, that should contribute to, that has to do with energy performance drilling, all has to do with those 3 things. There is a lot of duplication in this list, maybe you can reduce this to 1/2/3 ... Then I would say energy performance building and in combination with energy consumption, and the energy-efficient outdoor lighting. The rest is all in the epc, if you work with BENG, then you do not have to take them all separately and share sustainable energy sources. "(interviewee 2)

Commissioning

Several interviewees underpinned the importance of 'commissioning' which is proposed as a new indicator within the category energy. Commissioning was mentioned during the interviews mainly in relation to the capacity of installations within buildings. Some studies in the Netherlands by Menkveld (2016) concluded that 70% of climate systems in utility buildings consume about 25-30% more energy compared to the designated systems and expected energy consumption. Performance assurance enables potential savings in energy consumption intended for heating, cooling and ventilation by adjusting the systems according(ly) to the use. With this given, it can be said that integrating an indicator that addresses the aforementioned issue, performance assurance, is essential in assessing sustainability since it has a large savings potential. The interviewees suggested to incorporate this indicator to make sure the property owner inspects and configures the heating, cooling and ventilation system in accordance with the initial design and program of requirements to ensure an optimal use. For this reason, the indicator 'commissioning' will be included in the selection and online survey.

''Performance assurance from management category, this is one that can also be applied in existing construction and so much energy can be saved. You could also place this under energy, under monitoring actual energy consumption. After completion, the owner of the building will receive the building you have designed and, more importantly, what you have asked for. So a kind of check whether the building was built according to the drawings, so many construction errors are made nowadays. For the existing buildings, the current installations are equipped for the current use of the building. Analyzing, a couple of office cells have been converted into open plan offices, have they also adapted the installation? If there are many more people there than the installations were ever designed for, then the installations have to run very fast, then you will not have the healthy air you would like and at the same time you use a lot of energy to power all those people, but also for adequate ventilation. Managing those installations is an important one for me.'' (interviewee 2)

''What I find very important with existing buildings when it comes to energy is that you do indeed monitor your energy, so that you know what is happening in your building, but also what is going to do with it. So that there is also a plan to know what is happening, this is also inherent to health. Your installations have a great effect on your wellbeing, you can also see that with corona, that many installations are not capable enough for this and that the building actually needs to ventilate a lot more and that the installations cannot cope with that. That combination would be of added value than that of breeam.''(interviewee 5)

Energy saving measures

The inclusion of energy savings measures, such as energy saving lights, looked arbitrary next to the other indicators which address sustainability issues directly. Including this indicator was the result of the literature review on existing certification schemes. Since this measure was mentioned in almost all schemes, it was included in the first selection. Four out eight interviewees selected this indicator during the semi-structured interviews. The interviewees agreed that energy saving lights have an important role in energy savings, however, compared to the other indicators, the role of the measure is less relevant. Some interviewees asked why energy saving lights only where mentioned within the first selection list, and not other relevant energy saving measures. Based on the latter issue, it can be concluded that this indicator confuses the participants. For this reason, this indicator will be left out, and won't be included in the online survey.

5.3.2 Health & Well-being

Eight indicators were identified, of which 7 are selected by the interviewees. One new indicator based on the interview findings will be added to the selection, this indicator (occupant satisfaction) was mentioned 4 times by the interviewees. Several indicators related to different themes detected during the interviews, such as the spatial design qualities and the indoor environment of an office building. According to the interviewees, the inclusion of health and well-being indicators within a sustainability assessment was self-evident. However, a clear explanation why such indicators should be included was not given.

	Indicator	Goal	Measurement	total count
5	daylighting	provide end-users sufficient daylighting	percentage of glass windows	7
6	views	provide end-users views from workplaces	end-users have views (not-disturbed) towards outside	7
7	air quality	enabling a healthy indoor environment	fresh air supply through , humidity level, CO2 emissions (inside)	6
8	light regulation	provision of light control by end-users to their comfort	workplaces contain manual light regulation	4
9	temperature regulation	provision of temperature control by end-users	presence of operable windows, thermostat, mechanic ventilation, per workplace unit	5
10	relaxing spaces	provide end-users sufficient space to take breaks	relaxing spaces inside & outside, sufficient surface	6
11	occupant satisfaction	assess the satisfaction level of indoor environment by users	post occupancy evaluation results	4

table 10: Health category

x = *input for online survey*

x = *(new) proposed indicator based on interview findings*

Spatial design qualities

It is striking that indicators related to spatial design qualities, 'views', 'daylighting' and 'relaxing spaces' were the most frequently selected indicators and appear to be most important within this category. 'Daylighting' was the most frequently chosen indicator within this category. The importance of these indicators is in line with the findings from the literature review. While the importance of sufficient daylighting for health is known for a long period and actually regulated by the law, undisturbed views from workplaces towards outside also contribute to the health and well-being of end-users. Several interviewees stressed the importance for the presence of greenery within buildings, which increases the productivity of end-users. The latter will be included in the indicator 'green facilities' in the category ecology.

Indoor-environment quality & control

In line with the findings from the literature review, the quality of the indoor environment has a huge impact on the health and well-being of end-users, therefore, the indoor 'air quality' of an office building and 'fresh air supply' are selected 6 times by the interviewees. The indoor environment and its quality impacts potentially the comfort of office users, work-related health problems, sickness absence and risk of deteriorated work performance (Carrer & Wolkoff, 2018). The negative impacts are mainly caused by a decreased ventilation and humidity, leading to an increased concentration of indoor pollutants (e.g. CO2), causing building related illnesses and sick building syndrome among the occupants (Allen et al., 2016). The latter issues related to CO2 pollutants and humidity are mentioned by several interviewees as well. The interviewees acknowledged that the aforementioned issues are related to the end-users and not directly to the property owner. As stated by interviewee 6; ''...I can imagine that it is quite interesting for the value of an office, which we already know, but what you see little in the value is that a healthy office is good for the employees. Perhaps we should also define that when is an office healthy, that that is good for the employees, the employees are also less ill, which is good for productivity. and a real estate owner does not benefit much from a healthy office that is really for the tenant who really wants a healthy office. And therefore also benefits .....''

Several interviewees suggested to merge the indicators 'air quality' and 'fresh air supply'. The reason for merging stems from the fact that fresh air supply together with the humidity determine the indoor air quality. Therefore, these indicators will be adjusted in the assessment. Since these indicators will be merged with the humidity level included, as suggested by many interviewees, additional questions about the adjusted indicator 'air quality' will be included in the online survey, to determine its' importance in relation to the health and well-being category.

The provision of control by end-users over ventilation is desired according to the interviewees in several ways. The supply of fresh air through operable windows, which allows the end-user to control the fresh air if needed, is an example. In contrast with earlier mentioned findings on temperature control, several interviewees noted that it's not favorable to enable the control of temperature by the end-users of an office. Next to the difficulty in setting the systems to provide locational temperature control, control by the end-users turns out to be less sustainable for the property. An alternative for cooling during hot periods of summer are low-tech measures, such as sunscreens. Some interviewees positioned temperature and light regulation as an energy saving measure, instead of a measure that enhances the mental health and well-being of end-users.

''...I was auditing at() yesterday. There they have a kind of remote control per 6 workplaces and they are all there to regulate the temperature control light while they are just sitting in an open garden. So that installation does not know what to do at all, it is still generating a lot of cold in the winter for people who are too hot ... that is actually not sustainable at all .. I have never seen it work, people want it, but that is precisely why someone experiences it as hot or cold. You have to make sure that there is 1 temperature and also that you have sun protection, that you are not in the warmth, you know, that way you can make it a bit adaptable... ''(interviewee 4)

''...Whether that is really value enhancement, temperature control. I would say, uh, yes you don't want that at all on an individual level. In breeam, it shows that that is nice, but it is actually super inconvenient. ''(interviewee 3).

While 'acoustic comfort' was an important feature within the IEQ according to the literature review, the interviewees selected this indicator only 3 times. According to the interviewees, the Dutch building code/decree regulates the acoustic comfort of properties. Offices should comply with these regulations, and therefore this indicator was not a concern for the interviewees. However, one interviewee mentioned that with the current garden office trend, the importance of acoustic comfort has increased.

Occupant satisfaction

More than two interviewees suggested other methods of collecting data (for indicators) for assessing the health and well-being of occupants. Consulting measures, such as surveys, could cover the health and well-being indicators by assessing occupant satisfaction on aspects such as the indoor environments etc. This will save time, provide plans for improvement, and could be better interpreted by the assessor.

''...Then instead of asking all the separate questions, just like in the breeam in use, there is a user satisfaction survey containing these kinds of things. Either it is actively measured and monitored whether users are satisfied with the health aspects within the building and the working climate; heat, light as well as fresh air and temp regulation and that sort of thing. They could be more important than all the separate things together. If the building has to be healthy, these are important indicators, but if an appraiser is also allowed to ask that the comfort or health is improved, then you could use such a user satisfaction survey as an indicator. . ''(interviewee 2)

''...I would always start with coarse to fine. So it starts with the experience of the workplace, wherever that is. The net promoter score or something, customer satisfaction, then the actual health of those people, those are both result variables. And the process variables are those things that are below that. Below that are process variables that you will look at if the result variables are not correct, not according to the purpose. So for health I would say WELL as measurement, customer satisfaction, and health (illness fitness, absenteeism, level of fitness of your employees). And then the other things are process variables. . ''(interviewee 8)

5.3.4 Water Category

Altogether, 5 indicators were identified related to the water category, 4 of them are selected by the interviewees. At first glance, the interviewees conveyed the impression that 'water' related issues are not present of great size in the Netherlands due the quality of our public water regulated by the law and its availability. However, after inspecting the indicators, the role of 'water-measures' in climate adaptation was noticed by all interviewees. As stated by interviewee 3; ''...If I take a look at breeam, water is a lot more important abroad, as in well what focuses on health characteristics, where they focus more on the quality of the water. While in the Netherlands the quality of water is quite well regulated, based on the legislation, the water purification plants. Here it is much more about reducing water consumption and reusing water. For example for the green areas, or flushing the toilets. ''

	Indicators	Goal	Measurement	total
12	monitoring water use	gain insight into water consumption of end-users	site & building, per floor level, per large water consumers	5
13	water saving sanitary	reduce use of water (public)	presence of water saving sanitry by dual flush button, flush disruptor	6
14	separate rainwater system	prevent runoff water due to storm	presence of greywater system	7
15	re-use consumed/collected water	reduce use of water (public)	re-use rain&greywater	4

x = input for online survey

x = (new) proposed indicator based on interview findings

table 11: Water category

The importance of 'water' in climate adaptation

At building level, the separation of greywater and stormwater was considered as essential in tackling flood caused by runoff water on the surface since this indicator is selected 7 times. An often-mentioned prerequisite is, next to the separation of stormwater from the sewage system, storing rainwater through the presence of vegetation and/or other water storing facilities. Interviewee 5 stated; ''...I see water as climate adaptive. We are used to looking at the building but what happens around your building because we are dealing with floods. I myself live in (), I don't know where you live, in a heavy rain shower I look outside and I think now that is all tiled, all too much water, water just cannot be carried away. Or too little capacity. Then I think yes, as a building you can do quite a bit with that or as a building owner.''

''...The main kind of water is actually, storm water. So if it rains hard, then, because of our, because we petrify the buildings very much and petrify streets, our sewer cannot handle the water discharge. So it actually starts with, you could call it climate adaptation, but it is actually rainwater discharge. So green roofs and gardens around the buildings. That is where it starts. Suppose you make everything out of stone, but you put a big pipe on it, you still have sewer flooding. So due to climate change we get more and more violent storms, you have to design your building accordingly. For the rest, you do not really have a water issue in the Netherlands, although in recent days with the heat. ''(interviewee 8)

As it became clear from the previous statements, the key issues related to water in the Netherlands arise from the need for climate adaptation. On one hand, we are facing challenges due to floods caused by stormwater, while at the other hand dry periods of summer are becoming more common. Drought in the Netherlands, as a result of climate change, appears for the third summer this year, which is why the application of water saving sanitary becomes more important each year. To optimize the water savings, the collected rainwater or used water could be re-used as proposed by several interviewees. The latter is in relation with the indicator 'reduced use of public water'. Since these two indicators overlap each other in some way, reused water contributes actually to reduced use of the public water, they will be merged within the new version of the assessment. As the presence of saving measures might be arbitrary in the indicators list, which was discussed in the energy section as well, the indicator 'water saving sanitary' won't be left out for the selection. The importance of this indicator is confirmed by most interviewees.

''...Water in an office, water-saving sanitary facilities are very important and measure water consumption with sub-measurement'' (interviewee 2)

''...Water-saving sanitary is becoming more important. We are now, I think it is the 3rd summer that we are entering in which we come up with a considerable water shortage. And, that we really need to be more careful with it. Water companies are really calling on us to shower less. If you can contribute to that as a working environment, it seems very logical to me. So water-saving plumbing seems fine to me. ''(interviewee 6)

''...water-saving sanitary facilities, that is the question for a quick scan, maybe you want to split it up or that you, for example, yes, you could always make it very simple is there a circuit breaker when you continue, that you, volume selector that kind of stuff. Urinal in itself uses less than a regular toilet. Then you could make things easier for the person filling it out. ''(interviewee 7)

Despite of the importance of saving water for business use, an interviewee argued that;''...In the Netherlands, water is not a big issue, the last 2 years you have heard a lot about drought and so on, and there is a lot of maintenance involved if you have a gray water system. I hear and experience that maintaining and adjusting it and everything is much more difficult than in the end it takes more time and energy than it does. ''(interviewee 4)

Although conflicting views on the installment of a greywater system are noticed, the indicator will be included in the online survey, which will reveal the importance of the indicator within the water category.

Monitoring water consumption

The importance of monitoring consumption use was recognized by 5 interviewees; however, different views are noticed While some interviewees stressed the need for sub-monitoring, other interviewees didn't see the added value of sub-monitoring. The reason for sub-monitoring emerges from installation systems present in a building such as ventilation systems or heating systems or large kitchens which consume water as well. Opponents of sub-monitoring argue that the largest water consumers in an average office building are/is the sanitary, monitoring each floor level or even installations might not be relevant. Despite the contrasting views, the importance of monitoring water use is related to motivating a sustainable use of water by its users. For this reason, the question whether sub-monitoring is essential will be included in the online survey.

''...In the Netherlands it is very common to meter water from 1 building, but if you really want to measure and monitor properly, you have to monitor all major water consumers. so for example the water that enters a heat sink, that should also be submeted. Water consumption which goes into ventilation or heating systems, for example, or if you have a large dishwashing kitchen. Breeam in use lists all groups that consume more than 10% of the total water consumption. ''(interviewee 2)

5.3.5 Materials Category

For this category, 5 indicators were identified of which 4 are selected by 5 or more interviewees. In general, the interviewees emphasized the need to distinguish indicators for newly built properties, major renovations and existing constructions. Since existing/older properties are already built, and some indicators are not obliged by the law, the question whether these indicators should be applied to the existing stock remained unanswered. For this reason, additional questions about these indicators will be included in the online survey, to reveal the importance of applying the indicators for existing/ older properties.

Indicators		Goal	Measurement	total count
16	demountable materials	enhancing circularity of materials	non-toxic materials, easily demountable and re-usable	5
17	material passport	enhancing circularity of materials/ details on composition	presence of a passport	7
18	environmental impact materials	reduce negative impacts on the environment	calculation of the environmental impact of materials / compliance	5
19	condition monitoring	obtaining the current technical condition of building for maintenance	carried out/ improvements made check	7

x = *input for online survey*

x = *(new) proposed indicator based on interview findings*

table 12: Materials category

Condition of the materials

Obtaining the current state of the materials (condition monitoring) is often described in relation with maintenance that has to be carried out in the future. An advantage of monitoring the current condition of materials is to schedule or predict when a big maintenance has to be carried out, what the costs would be, and which materials have to be replaced. An interviewee made the comment that the replacement of roofs or other materials is often combined with sustainable measures. When certain materials or parts of a property are still in good condition, sustainable upgrades are often postponed until the time has reached to carry out replacement or maintenance. With monitoring the condition of materials, carrying out sustainable measures can be scheduled.

Additionally, monitoring the condition is regulated by the government by mandatory monitoring. The requirements depend on the present installations, systems and materials. ''...This condition monitoring can predict 5 or 10 years in advance when you need to make your roof more sustainable. The condition assessment is actually the starting point and end point of making buildings more sustainable (interviewee 8).''

Environmental impact

In the Netherlands, the calculation of the environmental impact of materials (hereafter MPG) is compulsory during applications of environmental permits, for new constructions. All interviewees stressed the importance of the MPG calculation since it's a measure to indicate how sustainable the used materials are, mainly for the facades, floors and structures. The Dutch government has set a maximum value of 1 euro per square meters for new offices larger than 100 square meters. Currently, clear requirements for the existing stock do not exist and the process for determining the impact of existing buildings is highly complex. However, despite the lacking guidelines for the existing stock, some interviewees expressed their views on this indicator assessing the existing building stock. Most interviewees acknowledged the importance of this indicator and the complex process to apply it to existing buildings. Unlike the saving measures which received criticism in the previously described categories, this indicator was depicted as very important. For this reason, this indicator will be included in the online survey to gather more expert opinions about the inclusion of this indicator in the final assessment.

''...Yes. I think it's very good that you wrote it down, but I do think that it is difficult for an appraiser to estimate. We're just not that far yet. We have been working on determining an EPC for a building for a long time, since 1995 or something. We have now started determining the environmental impact of buildings when it comes to new construction, not on existing construction at all. The only thing you see visually is, for example, if a lot of wood has been used, then you know that the environmental impact is a bit lower, for example steel really has a higher impact. Perhaps there are a number of materials that have a higher environmental impact, but I don't know .. I find it difficult to say something about values now(interviewee 6).''

Circularity

The indicator 'material passport' has been selected 7 times but received among other indicators within this category the most comments. The indicator 'material passport' was included in the first selection in relation with the theme circularity. Most interviewees acknowledged that a material passport could enhance the circularity of materials of which the property is composed. However, the difficulty in acquiring a material passport for existing buildings lies in the fact that it's already built, information on the materials could be lacking. Obtaining a material passport for new constructions is easier, however, still not implemented on a large scale. For existing properties, it might be interesting to include a material passport for newly added materials in case of major renovations or smaller refurbishment as an example. Next to circular (construction) materials, the suggestion to expand the 'area' of circularity was made by an interviewee. Analysing the different incoming and outgoing streams, including food waste streams, could enhance the circularity of existing properties as well. However, since the latter issue was just mentioned by one interviewee, it won't be included in the online survey.

''...For existing buildings I wonder for a moment whether it is important for the use phase or good to make that inventory. Because we are also looking at what are the important things in circularity in existing buildings, then it is often the flows that goes in and out of an existing building. Food for the canteen, furniture that is replaced every so often (interviewee 7).''

''... If we now start keeping those materials to demolish the building. But the buildings that are not going to be demolished, you really only want to know the systems, you want to know which heaters are in them, what kind of wood is in the frames. But you don't want to know about screws or pipes, you just don't care. So, I think buildings should be mapped but not a materials passport but a building passport (interviewee 8).''

The indicator 'demontable materials' addresses the toxicity of materials, if the connections allow reassembly and reuse. As explained in the previous section about the material passport for existing properties, the same issue applies for this indicator. However, newly added materials should be easily demontable according to several interviewees.

''...I see that as mainly relevant for new construction and renovation projects. Because actually existing buildings, I see buildings that are monumental and have been standing for 20-100 years. They are actually built with materials that cannot be disassembled or are difficult to disassemble. So these demountable materials is important when you add materials to your building that they are demountable. But you can hardly expect a building from 1920 to be demountable, since that was not done at the time

5.3.6 Pollution Category

In total, 4 indicators were identified for this category of which 3 indicators are chosen by at least 5 interviewees. One new indicator (flood measures) is added to the selection since at least 4 interviewees mentioned measures against flood caused by rainwater.

Indicators		Goal	Measurement	total count
20	monitoring emissions	gain insight in emissions emitted by installations, refrigerants,	CO2, NOx, F-gases	5
21	light pollution	to reduce/prevent light pollution that might disturb fauna in the surrounding environment, reduce light disturbane to neighbours	lights are switched of outside office hours, advertising lights switched off	5
22	flood measures	prevent flood and pollution by rainwater	presence of green roofs, or other water-storing measures	5
23	separate waste collection	reduce impact of waste on environment	presence of waste collection area/ waste separation by users	8

x = input for online survey

table 13: Pollution category

x = (new) proposed indicator based on interview findings

Waste

It is noteworthy that all interviewees selected the indicator 'waste separation' in relation with 'waste collection area' while waste can be seen as an outcome product of business activities which has no direct relation with the physical boundaries of the property itself. This confirms earlier findings from literature, our definition of a sustainable property does not only compromise physical aspects but goes beyond the physical boundary of an asset. The importance of waste separation and collection does not only arise from preventing pollution but to limit the use of resources of the earth. In this way, waste can be seen as a potential resource to contribute to sustainability. In order to reduce the impact of waste on the environment, the amount of residual waste should be lowered to 0 kilograms. The list of the first selection included another indicator 'waste separation area', however, in order to allow 'separate waste collection' , sufficient waste collection areas are needed. Thus, these two indicators will be merged and included in the online survey.

''...It is quite easy to scrore on this in the breeam, it literally says there is a large waste space needed to collect waste, but in the end it is a waste collection contract. And if there is also actively directed that building users can collect separated waste on the floors and the cleaners are also instructed to dispose of it again in the correct way (interviewee 2).''

''...So, for example, separated waste is a very important one. Because residual waste is burned or buried under a road, and we will never do anything with it again. Everything where that residual waste ends up is lost forever. So kilos of waste, non-renewable waste, have to go to zero, otherwise we will never become circular. So waste is, is not so much pollution, but more of limiting the use of the earth's resources (interviewee 8).''

Emissions

Emissions such as CO2 was placed under the category pollution, however, several interviewees argued that this indicator could be placed within the category energy as well since the installations of properties emit CO2 as well.

''..Look, refrigerants, CO2 emissions are often referred to as the most important greenhouse gas emissions. But refrigerants contain many harmful substances that are more harmful to the ozone layer or to many other environmental aspects than CO2. It can sometimes be 400x more harmful than CO2. But for smaller buildings, for example, there is no installation with refrigerants. So it depends on what kind of buildings an appraiser assesses (interviewee 3).''

Flood measures

The indicator 'flood measures' is newly added to the selection and proposed by at least 4 interviewees. For this reason, this indicator will be included in the online survey as well. While flood measures could be positioned within the category ecology as well, the main reason for implementing flood measures is to prevent pollution from rainwater flowing into the soil. Examples mentioned by the interviewees are green roofs, the ratio between greenery and pavement on the site, or other water storing measures at the site and property.

''...So when it rains hard, then, because of our, because we petrify buildings very much and petrify streets, our sewers cannot handle the drainage. So it actually starts with, you could call it climate adaptation, but it is actually rainwater discharge. So green roofs and gardens around the buildings. That is where it starts. Suppose you make everything out of stone, but you put a big pipe on it, you still have sewer flooding.'' (interviewee 8).

5.3.7 Ecology Category

Four indicators were identified related to the category ecology, all of them are selected by the interviewees as relevant. Despite the selection of all indicators, some indicators needed to be adjusted based on the difficulty in obtaining required data for the measurement.

Indicators		Goal	Measurement	total count
24	ecological research	enhance the ecological value of the site by assessing whether the property & site do not harm the environment	an ecological research that has been carried out / suggestions are implemented / no harm to the existing flora & fauna	7
25	ecological facilities	enhance the ecological value of the site by placing ecological facilities (based on research)	presence of facilities such as boxes for birds, insects, bats / planting floral species	6
26	green facilities	ensure that site & property contain green facilities /mitigate urban heat-island effect	green facilities inside and outside the property, could be vertical as well	5

x = input for online survey

table 14: Ecology category

x = (new) proposed indicator based on interview findings

To start with, allocating points to the ecological value of the office site is a complex task, especially for the appraiser. If an ecological research has not been carried out, the request for such an report/ research is time consuming. The presence of ecological facilities, such as installed bird, insect and/ or bat boxes and planting floral species that enhances the ecological value of the site is perceived as important within this category by all interviewees. ''...An ecological study may be important, but it does not help him (appraiser). An appraiser should request this, but it is up to the tenant or landlord to really do something with it. So an appraiser can say we have a piece of green with greenery, then the tenant or landlord decides whether he wants to add something. But within urban areas you have almost no green facilities at all, so you can have an ecological study carried out, but I think that will add very little (interviewee 1).''

The aforementioned interviewer pointed out that an ecological research for offices located within dense urban areas might not be relevant. However, if a renovation is planned to be carried out, the property owner is obliged to investigate whether the measures could disturb the flora and fauna within that area. As stated by interviewee 6: ''...ou know, the moment you start renovating, if you don't change anything, it's not that important. If you are going to renovate it is important, because you are not obliged, but it is forbidden to disturb rest and nesting places of the fauna. So the moment you start renovating you have to research bats, other insects, birds, that are currently using the building, all the holes in the building, and I have to make provisions for that. ''

''... If you want a quick quick scan, and you make an investigation mandatory, then it is almost no longer a quick scan." If you like, I'd rather stick with landscaping and ecological facilities. And if you then go deeper, those facilities are placed in a good way, they have ecological value, how does that relate to facilities in the area. Then you go a step deeper. It is very useful, hear an ecological survey, but then again, that is a step further than a faster tool. So it depends on what you want to use it for (interviewee 7).''

The terminology used to define the indicators might have been not clear since ecological facilities overlap the type of green facilities. The definition of green facilities has not been explained to the interviewees, while green facilities might relate to the health category as well. Some interviewees stressed the importance of green facilities, inside and outside, in mitigating the impact of heat stress. The urban heat island effect in the Netherlands causes an increase of approximately 7 degrees Celsius during long hot periods, exposure to heat for a long duration is deathly for vulnerable groups of the society and distorts other functions of human beings (de Nijs et al., 2019). For this reason, green facilities, such as green roofs or lakes, are key in mitigating heat stress. Several interviews referred to this issue by the theme 'climate adaptation'.

''... Heat stress; if you have a green roof, your building absorbs more heat. Our cities are sources of global warming. I think climate adaptivity and heat stress are extremely important. And this is actually part of future-proofing. While those other things are a bit at the bottom of the importance list (interviewee 8).''

The indicator 'reduced light pollution' is mentioned by the interviewees as a measure to not only limit the impact of light on surrounding dwellings but to prevent disturbing fauna as well. Measures to reduce 'light pollution' are switching off lights during closing hours of an office, switching off advertising lights and switching off outdoor lighting. An interesting comment, almost discussion, was made by an interviewee about the contribution of safety by outdoor lightning. As a female, it might not 'feel' safe or comfortable to walk through streets in which lights are switched off, the question here is, what is more important, safety or savings?
''...I think it's important, what they actually have to do is the power of the lighting has to be adjusted to the environment and at 11 o'clock at night it has to be all off. So that it has a timer (interviewee 4).''

5.3.8 Transport Category

In total, 5 indicators were proposed of which 4 are selected by at least 4 interviewees.

Indicators		Goal	Measurement	total count
27	proximity of public transport	reduce carbon footprint of commuting end-users	distance to public transport nodes	7
28	proximity of facilities	to reduce carbon footprint of commuting end-users to facilities	distance to facilities in surrounding neighbourhood / typologie of facilities	5
29	facilities for cyclists	stimulate end-users to commute with bike by provding facilities	presence of showers, bicycle racks / storage / enclosed due to rain	8
30	reduced car/park use	reduce carbon footprint of commuting end-users	implementation of policy by organisation to reduce transport impact (presence) / paid parking	6

x = input for online survey

x = (new) proposed indicator based on interview findings

table 15: Transport category

All interviewees acknowledged the importance of sustainable transport by end-users. Enabling a more sustainable way of transport has a positive impact on the environmental sustainability of a property and site. It is interesting that the indicator 'pedestrians' route' is selected only 4 times while the indicator 'reduce car/park use' has been selected 6 times since the inclusion of the theme 'transport' within sustainability assessments is based on promoting more sustainable ways of transportation. The reason for the latter remark is based on bicycle routes and parking lots that offer pedestrians a safe access into the building as well, according to the interviewees. However, in order to enable safe access for pedestrians and cyclists, separate entrances for vehicles of suppliers is necessary.

''...Eh yes, I just wonder, if you have facilities for cyclists, then the pedestrians will get to the location quite safely. You can always go via a cycle path. I don't know if you need to map everything. I don't think safe routes necessarily make sense. If it comes from BREEAM, for example, sometimes in a parking lot where there is not much driving at all, which is still not sufficient, because it is not a walking path. But when I'm in a parking lot, I never really feel unsafe (interviewee 1).''

''...I would rather say that the supplier entrance should be separated from the main entrance, that's where you have the most risk 'that you have parking in the front and cars motorcycles pedestrians cyclists come, that's fine, but the suppliers just have to come the other way (interviewee 4).''

One interviewee emphasized that it might not be fair to allocate more points in case of a short distance to public transport since the property owner cannot influence locational characteristics of an office. For this reason, the interviewee suggested to not mainly emphasize the distance and measure the distance in big portions? Another remark by interviewee 3; ''...Yet you often see in transport that public transport can have a huge impact on how people travel to work, um, yes, certainly for offices at least. When you talk about distribution centers, they are often in the meadow end of the periphery, so public transport is less important there because only in and supply applies there.''

On the other hand, an interesting remark by interviewee 8 contradicted the aforementioned view on the distance to public transport nods. While it's true that an office owner cannot influence the distance from an office to the public transport since the property already exists, the fact that the large distance forces end-users to commute by car, and thus emit pollutants, cannot be denied.

''...You may ask yourself whether your definition, to what extent it should be the definition of valuers. If I'm going to attribute to the appraisers now, I'm actually writing to the past. So you say this is what an appraiser should measure. Then there will be a list, which in the present time means this questionnaire. With transport it is of course very important that the facilities are there, you have to take them all with you. These are also things, technology can be adjusted once. But if you're not at the station, people are forced to come by car. These location things have much more eternity impact than whether or not you have humidification in the building (interviewee 8).''

During the interviews, an acceptable distance for the indicators 'proximity of public transport' and 'proximity of facilities' was not discussed. For this reason. additional questions for these indicators will be included in the online survey, to determine an 'acceptable' distance for end-users.

5.3.9 Future Category

In total, 4 indicators were identified, 3 of them are selected by the interviewees.

	Indicators	Goal	Measurement	total count
31	integral accessibility	providing access to users with dissabilities	entrances, doorways, corridors do have the needed measures to grant access to weelchairs, blind, deaf dissabled users	8
32	adaptability of structure	the structure and facade can respond to changing user requirements	measurements of structural elements/type of bearing elements	6
33	adaptability of functions (interior)	ensure an extended use of the property by being able to accommodate different functions	multiple entrances, adjustable/ moveable internal walls/ installations can be adjusted easily	6

x = *input for online survey*

x = *(new) proposed indicator based on interview findings*

table 16: Future proof category

Accessibility

Integral accessibility refers to the accessibility of an office by all its users and/or visitors, including people with a disability, varying from visual or auditory disabilities to physical disabilities. According to an interviewee, the Dutch Building Decree already covers these aspects in the regulations, but in practice not all buildings are designed in a way that it allows 'integral' accessibility. Since it is already covered in the Building Decree, the suggestion to include this indicator to answer the question whether an organization made plans to improve accessibility was also made. The 'integral' accessibility does not only refer to the entrances of a property, but also to the internal routes of a building that enables

''...Until now, little attention has been paid to this, but with inclusivity and all those things, more and more demands are made about it, and these too are fairly visible and an appraiser can say about it fairly quickly. Then it is useful to think about what does a disability mean, are you talking about a wheelchair, blind, deaf people. It can happen to anyone, you may have a broken leg and have to go to work in a wheelchair. It is not that people with disabilities only have difficulties, but employees can also have disabilities. It is good to think about this (interviewee 1).''

Adaptability

Most interviewees acknowledged the importance of flexible interior walls. the use columns and less load bearing walls in the adaptability of offices. Some interviewees suggested to include the grid of the columns into the criteria since measurements are important in the flexibility. Next to the walls and structure of a property, installations are decisive as well in determining the capacity of adaptivity.

''... Customizability functionality is a bit similar. Yes well that is also important. That is future-proof, especially the demand for offices. Especially now, now that everyone is working from home, whereby offices will have a different approach. Not as a real workplace, but as meeting spaces, at a safe distance. Then it is better if your ventilation is also adjusted accordingly, as well as your space and your layout'' (interviewee 3). Since new suggestions are made for the indicators in this category, additional questions will be included in the online survey.

5.3.10 Management Category

In total, 1 of the 2 proposed indicators are selected. Four interviewees suggested to add a new indicator called a 'roadmap' towards sustainability, which will be explained below.

Indicators		Goal	Measurement	total count
34	green lease agreement	'solving' the split-incentive issue, stimulating sustainable use of the property	presence of green lease, agreements are fulfilled by both parties	8
35	roadmap towards sustainability	make sure that property owner/ users have action plan to comply with future regulations	presence of plans made by owner and users	4

x = input for online survey

table 17: Management category

x = (new) proposed indicator based on interview findings

Greenlease

The category management consisted of 2 indicators, of which 1 is selected by 4 or more interviewees. The indicator 'green lease' remained after the second selection. The green lease is a term for the rental contract made between the tenant and lessee in which agreements are made about energetic objectives, CSR objectives, but also the costs and benefits of sustainable measures are described and how these are distributed. The green lease also covers agreements concerning the use and management of the property. All interviewees agreed upon the need for clear agreements made between the tenant and lessee since the way a property is used by the end-users is an important aspect in determining sustainability.

However, not all interviewees were convinced of the effectiveness of the green lease. As stated by interviewee 3: ''...Greenlease, there are different experiences with that. One person does not honor his lease, thrown it in the trash, so to speak, or he sees it as a legal instrument that is legally recorded, so those agreements must then be complied with. So there are different experiences with it. It is a good tool to include the tenant in the entire sustainability story..''

Thus, while assessing this indicator, the appraiser should have to check whether a greenlease agreement was made and whether both parties fulfill their duties as stated in the agreement. Other comments made by the interviewees discussed the current view on the green lease and how it is positioned as a special tool, however, such agreements should be included in the rental agreement as a matter of course. Thus, while assessing this indicator, the appraiser should have to check whether a greenlease agreement was made and whether both parties fulfill their duties as stated in the agreement. Other comments made by the interviewees discussed the current view on the green lease and how it is positioned as a special tool, however, such agreements should be included in the rental agreement as a matter of course.

''...The moment you, as a tenant and as a landlord, have laid down agreements about sustainability in a lease or in an extension, that is a big plus. Then you are fully aware that you, as a tenant or landlord, have a role in sustainability. You already asked what is the definition of sustainability, it starts with that, it is not only about the performance of the building, but also about how you deal with the building, so how you use it. So you also have to agree on this in a green lease. A green lease actually almost indicates that it is almost special. I would almost say a rental contract in which agreements about sustainability have been made. I am gradually getting ready for sustainability to be special. This is still special for an appraiser, they have just started doing that. It is all new. But sustainability just has to become normal. With greenlease you say that it is very special while you actually want a rental contract that includes it all (interviewee 6).''

Roadmap towards sustainability

Next to the physical aspects, such as installations, systems, or design qualities, some interviewees suggested incorporating an indicator to check whether clear plans are made to apply sustainable upgrades to the property in order to keep up with the transitions the Netherlands is going through. The energy transition towards 2050, the transition towards circularity and the health transitions. Several reasons for the inclusion are mentioned. A property that is perceived or depicted as 'less' sustainable, let's say with a less green label, might obtain less points on certain areas. However, a property owner could postpone certain investments in sustainable upgrades due to well-grounded reasons, as an example, the heat networks that will be installed in the coming ten years.

''...You have to keep in mind that you have 3 major transitions in NL, you have the energy transition towards 2050, the materials transition to materials passports and to circularity, resource depletion that we must prevent, resources and material use and waste, and the third is the health transition. That's the value of productivity, workplace quality, but that's much more workplace quality. Those are the big transitions at the front. At the back you have climate adaptation, heat resistant, water collection, ecological facilities. You could actually get very far with those four things. So a good energy policy, resilience climate adaptation policy, health of the building. '' (interviewee 2)

''...But also sustainability plan for your real estate. What are your long-term plans, do you have a roadmap for it. This is very important in this. '' (interviewee 5)

''...You could split indicators much easier into; is there an energy policy, which is elaborated in sub measurements with monitoring, it is broken down into an a label, into a roadmap to energy neutral and from gas. That you are going to work with several sub things from the policy. And then that policy must also be present, and of course the energy label.'' (interviewee 2)

5.4 Conclusion & Discussion

Through the findings from the semi-structured interviews, the following sub question can be answered:

Which sustainability indicators should be included in the assessment and how should these be measured?

In total, 37 indicators of the 45 preliminary indicators were selected by at least 4 interviewees. The indicators that are selected less than 4 times were excluded directly. Indicators that were selected 4 times, were first analyzed before a decision was made to include or exclude them. The decision whether to include or exclude the indicators that were selected 4 times, was based on the lack of consensus among the sustainability experts, vagueness within the indicator list such as an overlap in the goals of the indicators and the relevance of the indicator within the category itself.

The indicators that are excluded are: share renewable energy, energy saving lights, energy use of electricity net,use of fossil fuels, type of sustainable sources, acoustic comfort, leak detection, safety measures materials, separate liquids, pedestrians route, urbanization of area and green cleaning. However, some indicators are merged. Altogether, based on the findings from the semi-structured interviews with the sustainability experts, the following indicators should be included in the sustainability assessment for office appraisal;

- Within the energy category, the following indicators are included: EPC, monitoring energy consumption, sustainable energy sources and commissioning. The indicators share renewable energy and types of sustainable energy sources are merged into a new indicator that will be included as 'sustainable energy sources'. The indicators energy use of electricity net and use of fossil fuels will be added to the indicator 'monitoring energy consumption'.

- Within the health and well-being category, the following indicators are included: daylighting, views, air quality, light regulation, temperature regulation, relaxing spaces and occupant satisfaction. the indicator fresh air supply will be merged into the indicator 'air quality'.

- Within the water category the following indicators are included: water saving sanitary, separate rainwater system and re-use consumed/collected water.

- Within the materials category, the following indicators are included: demountable materials, material passport, environmental impact materials and condition monitoring.

- Within the pollution category, the following indicators are included: light pollution, flood measures, separate waste collection and monitoring emissions.

- Within the ecology category, the following indicators are included: ecological research, ecological facilities and green facilities.

- Within the transport category, the following indicators are included: proximity of public transport, proximity of facilities, facilities for cyclists and reduced car & park use.

- Within the future proof category, the following indicators are included: adaptivity of the structure, adaptivity of functions (interior) and integral accessibility.

- Within the management category, the following indicators are included: greenlease, and the newly added indicator 'roadmap towards sustainability'.

The table on the following page depicts the total selection of indicators by the experts together with their criteria and measurement.

	Sustainability indicators		Goal	Criteria - measurement
Energy	1	sustainable energy sources	gaining insight in the energy consumption, stimulating sustainable energy use by monitoring share of renewable energy, check with regulation & optimalisastion of energy performance	% of energy consumption
	2	EPC		compliance with current regulation
	3	monitoring energy use		%renewable energy and %fossil fuels, comparing with EPC
	4	commisioning		energy performance according to design requirements (tested & adjusted)
Health	5	air quality	providing the end-users a healthy and comfortabel indoor work environment by	sufficient fresh air supply, humidity & CO2 emissions monitoring
	6	daylighting		sufficient daylighting through windows at workplaces, compliance regulation
	7	temperature control		provision of temperature control through operable windows, MV/temperature (per workp
	8	relaxing spaces		presence of (sufficient) relaxing spaces for end-users
	9	views from workplaces		undisturbed views towards outside from workplaces
	10	light regulation		provision of light regulation by end-users
	11	occupant satisfaction		measuring satisfaction level of end-users
Materials	12	environmental impact	enabling an extended/longer use of mainly building materials, enhancing the circularity of building materials	(presence of) calculation of MPG of newly added materials
	13	demountable materials		newly added materials are non toxic, easily demountable
	14	material passport		the presence of a material passport for newly added materials
	15	condition monitoring		monitoring the current state of materials
Ecology	16	ecological facilities	enhancing the ecologic value of the site & property, mitigating heat island effect and	presence of boxes for birds, bats, insects & planting floral species
	17	green facilities		presence of green facilities inside & outside (could be verrtical as well)
	18	ecologic value		in case of renovations, suggestions from research are implemented & no flora fauna harmed
Future proof	19	adaptability of functions	(faster) anticipation on changing trends & demands through easily adaptable offices	adjustable interior walls, location & distance of entrances, 'adjustable' installations &
	20	adaptability of structure		structural elements can bear possible addings/ extensions, grid & height allow new interior
	21	integral accessibility		measurements of entrances, internal routes for all users (weelchairs, blind, dissabled)
Manag.	22	roadmap towards sustainability	stimulating a sustainable use of the office by solving the split incentive use and	property owner planned improvements & communicated with end-users
	23	greenlease		presence of green lease & agreements fulfilled by all parties
Transport	24	reduced car park/use	stimulating end-users to commute sustainably (reduce footprint)	paid parking policy, reduced car use by end-users through policy
	25	proximity of public transport		distance to public transport nodes
	26	facilities for cyclists		presence of facilities, sufficient bicycle racks, covered, storage/lockers
	27	proximity of facilities		distance to facilities in area
Pollution	28	separate waste collection	minimizing site & property pollution from installations, climate and business activities	presence of waste separation area / separation by end-users
	29	monitoring emissions		emitted by installations & refrigerants, CO2, NOx and f-gases
	30	light pollution (reduce)		lights switched of during closing hours,
	31	flood measures		presence of flood measures,
Water	32	monitoring water consumption	gaining insight in water consumption... and re-used amount by collected water	sub-monitoring per floor level
	33	water saving sanitary		presence of dual flush, disruptor and automatic sinks
	34	reuse collected water		re-use consumed / collected water
	35	separate grey&stormwater		presence of separate system for..

table 18: overview after interviews and survey)

CH 06 Final selection through online survey

The online survey is the second empirical step of this research. The results from the survey combined with the findings from the semi-structured interviews answer together the following research questions: ''Which sustainability indicators should be assessed'' & ''What are the importance levels of the sustainability indicators?''

6.1 Survey design

The initial goal of the questionnaire and distribution of the survey was to identify and rank the importance of the indicators within the different categories together with the importance of the different categories in total. However, as shortly discussed in the conclusion section of the previous chapter, some data with regard to the measurement of the indicators was still lacking due to conflicting views by the interviewees. To complete the indicator and measurement list, questions concerning the measurements were included in the online survey. Additionally, questions about the inclusion of certain indicators of which the applicability are still uncertain due to legislation, are included to gather the view of experts on these issues. In total, 22 questions were included in the online survey and the questions can be found in appendix D.

In order to identify the importance of the categories together with their indicators, the constant sum method was implemented. The constant sum method, which is basically a point allocation method, is used to collect the expert opinion. The participants were asked to assign 100 points across the indicators within each category, assigning more points to the indicators with more importance and fewer points to indicators of less importance. The same method is applied to identify the importance of the different categories in assessing sustainability. This allows to depict the indicators and categories in descending order, based on the importance (figure 12). By assigning 100 points over the indicators per category, the mean, standard deviation and variance can be calculated. This allows a better interpretation of the gathered data.

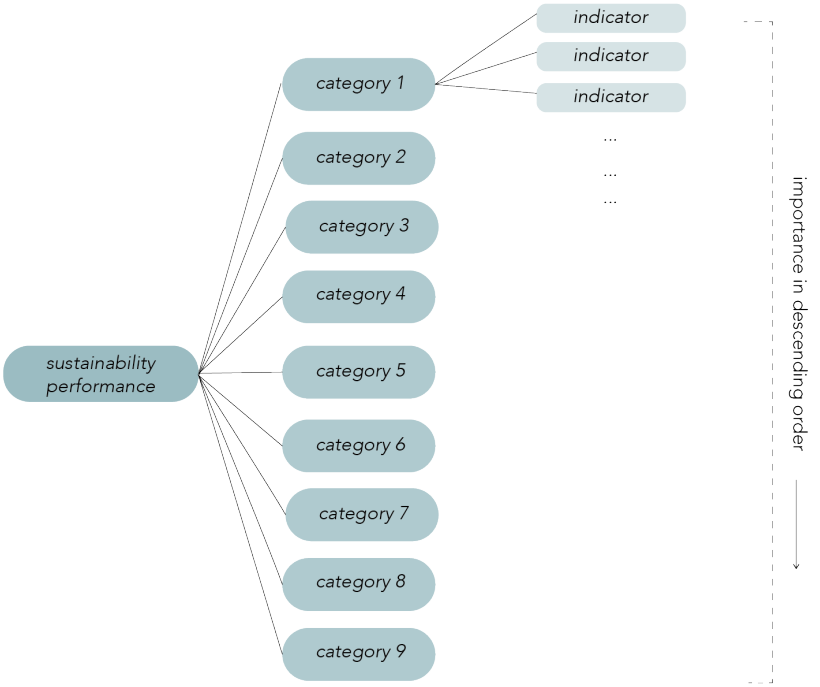

Figure 11: importance of indicators and categories

Additional questions about the indicators are included in the online survey, based on the interview findings. These questions are based on a 4-point Likert scale, to rank expert opinion. By using a 4-point scale, the respondents are forced to form an opinion, since there is no 'neutral' option.

The participants were invited by email to complete the online survey. The selection of the participants was based on the participating experts of the semi-structured interview. The experts were kindly asked to distribute the online survey among colleagues whose expertise would be valuable for the purpose of this research. In total 11 respondents filled in the online survey.

6.2 Results

This section presents the results per category starting with a total overview.

6.2.1 Total overview

Sustainability categories	*Weight (%)*	Sustainability indicators		Weight (%)	Final Weight
Energy	20,3	1	sustainable energy sources	29	5,9
		2	EPC	24,5	5,0
		3	monitoring energy use	24,2	4,9
		4	commisioning	22,4	4,5
Health	18,8	5	air quality	28,9	5,4
		6	daylighting	19,7	3,7
		7	temperature control	14,1	2,7
		8	relaxing spaces	13,9	2,6
		9	views from workplaces	12,7	2,4
		10	light regulation	10,6	2,0
Materials	15,0	11	environmental impact	29,6	4,4
		12	demountable materials	26,4	4,0
		13	material passport	23,8	3,6
		14	condition monitoring	20,2	3,0
Ecology	11,1	15	ecological facilities	35,5	3,9
		16	green facilities	32,6	3,6
		17	ecologic value	31,9	3,5
Future proof	8,5	18	adaptability of functions	37,7	3,2
		19	adaptability of structure	32,9	2,8
		20	integral accessibility	29,4	2,5
Manag.	7,5	21	roadmap towards sustainability	56,7	4,3
		22	greenlease	43,3	3,2
Transport	6,9	23	reduced car park/use	28,6	2,0
		24	proximity of public transport	28,2	1,9
		25	facilities for cyclists	27,7	1,9
		26	proximity of facilities	15,6	1,1
Pollution	6,6	27	separate waste collection	38,5	2,5
		28	monitoring emissions	28,9	1,9
		29	light pollution (reduce)	16,4	1,1
		30	flood measures	16,3	1,1
Water	5,4	31	monitoring water consumption	27,6	1,5
		32	water saving sanitary	26,8	1,4
		33	reuse collected water	23,7	1,3
		34	separate grey&stormwater	21,9	1,2

table 19: total overview of the weights and final weights

6.2.2 Energy Category

Looking at the table with the means of the indicators, it can be said at first glance the means (importance) are close to each other. Surprisingly, the indicator 'sustainable energy sources' has the highest mean (29). While during the interviews the indicator 'type of sustainable sources' was not relevant according to the interviewees, the new merged indicator has received the most points within this category. This can be explained by the importance and interrelated working with the indicator 'monitoring energy use'. While the indicator 'type of sustainable energy sources' addressed only which type of sources and installations, the new indicator 'sustainable energy sources' addresses how much kWh of the monitored energy consumption originates from the sources. Despite the close means, the indicators 'EPC' and 'monitoring energy use' scored the highest variance, which indicates a lack of consensus among the respondents.

Since conflicting views were detected during the interviews about the indicator 'epc' and what information it should provide to the assessor, a question about the measurement and goal was included. The question; How important are the following aspects for the indicator 'EPC' according to your experience/view? was included. As can be seen in the questionnaire in Appendix D , some respondents mentioned 'other' (than proposed) as extremely important. These respondents answered with the following; 'new norm BENG indicators'. 'stimulating the unwilling', 'higher RoR in the long term' and 'mandatory by law '.based on the figure, it seems that comparison with the actual energy consumption is slightly less important than compliance with current regulation. This is in line with the interview findings, consulting the actual energy consumption should be done in order to check whether the theoretical use provided by the label correspondents with the actual use.

During the interviews, conflicting views about the goal and frequency of monitoring energy consumption was noticed as well. Therefore, the online survey included a question about the frequency, whether it should be compared with the epc and how important the share of fossil fuels is, with a reference to the BENG indicators. Four interviewees responded also with 'other': 'measuring consumption per hour', 'shown as presentation to the public', 'measuring continuously', 'measuring consumption more frequently (day/week/month), 'consumption per 15 min', 'compare with similar buildings' and 'compare with benchmark (other companies)' as extremely important.

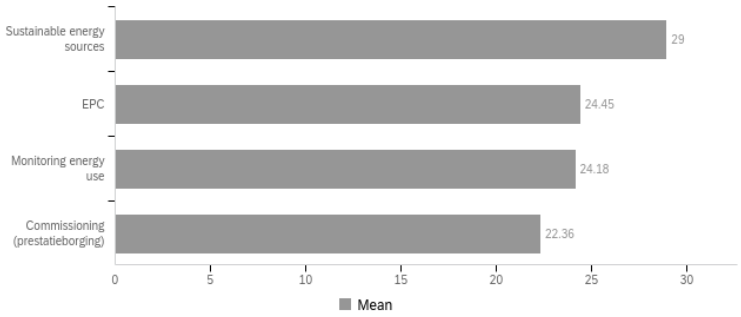

figure 12: means in energy category

6.2.3 Health & Well-being

Within the health category, the air quality of the indoor environment seems to be the most important indicator according to the respondents. This is in line with the findings from the interviews, in which the air quality together with the spatial design qualities were selected 6-7 times. As it became already clear during the interviews, the provision of temperature regulation by users is less important compared to the other indicators. Although, 1-2 interviewees stressed the importance of temperature regulation since individual differences in normal body temperatures exist. However, the results show that the respondents ranked these indicators at the third place. A possible explanation for this difference could be the inclusion of an additional question about this indicator in the online survey which explained which components the indicator was made of. The question addressed issues such as the provision of indoor climate control through windows, MV. Another noticed difference between the interview findings concerns the indicators 'relaxing spaces' and 'views', both indicators related to the spatial design qualities. The selection of these two indicators by all interviewees did not indicate their importance within the health category.

Since the indicator 'air quality' was merged with 'fresh air supply' based on the interview findings, the question: Which of the following aspects determine the indoor air quality and should be included in the assessment of a sustainable office? was included. 56,25% of the respondents answered for 'fresh air supply' with 'extremely important', followed by very important for the level of CO2 emissions inside (40%), and the humidity level inside (--%) (figure x).

Some respondents filled in the text entry 'other' as extremely important and 'very important'. These respondents answered with; 'tegenhouden virussen', 'other air pollutants', 'Ozon, VOC', Policies about air quality (think about smoking, asbestos, green purchasing, chemical storage) and 'outdoor air quality and filtration'. Despite the aforementioned remarks by the respondents, this indicator will be included in the final framework.

The indicator 'temperature regulation' by end-users received different opinions about the inclusion of this indicator and what it should measure. For this reason, the question 'How important are the following aspects in 'temperature regulation' according to your experience/view? Was included in the online survey. Based on the interview findings, the criteria 'operable windows', 'MV control by end-users', 'temperature regulation by end users' and 'control per workplace unit' was added to the answers list. The criteria 'MV control and temperature control by end-users' are extremely important according to 50% of the respondents, followed by 'operable windows' as very important according to 33,33%. 'Control per workplace/unit' won't be included in the assessment as the criteria for the measurement since most respondents indicates that this is slightly important. .

A new indicator 'occupant satisfaction' was proposed based on the interview findings. Some interviewees stressed the importance of consulting the end-users for assessing the health and well-being category. Based on the suggestion, the question; 'Would you include an indicator 'post-occupancy evaluation for tenant satisfaction' for the category 'Health & Well-being' in the assessment?' was included. Six respondents answered with 'yes, but the results of the evaluation should only be used for improvements'. For this reason, this indicator won't be included in the assessment framework.

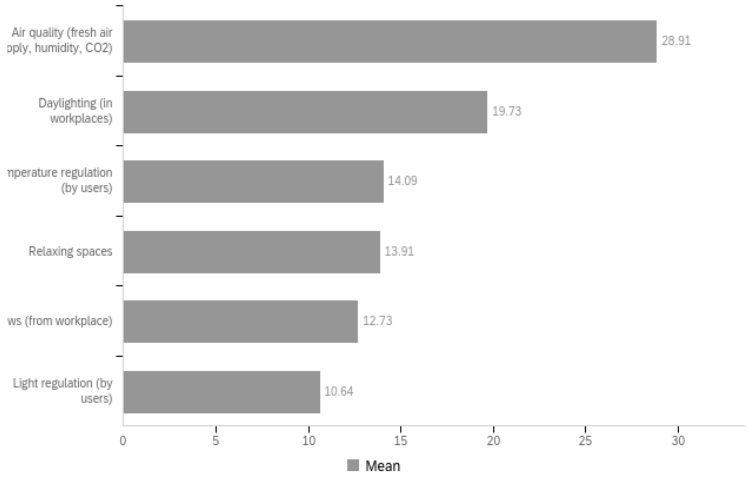

figure 13: means in healthcategory

6.2.4 Water Category

Within the water category, monitoring the water consumption seems to be the most important indicator, which is in conflict with the findings from the interviews. While the presence of a separate grey and rainwater system was the most important indicator according to the interview findings, the survey results indicate differently. The presence of water saving sanitary is the 2nd most important indicator within this category, which is also not in line with the interview findings.

on how often and what should be measured, a question about this indicator was included in the online survey. The respondents were asked to assign the level of importance to the aspects, depicted in figure x. The following question was included: How important are the following aspects/measures for the indicator 'monitoring water consumption' according to your experience/view? Seven of the respondents answered with 'very important' for monitoring the site & property and for sub monitoring the largest users of water. Three respondents answered with 'very important' for; 'monitoring per tenant/user', 'water bottle refiling stations' and 'leak detection'. Keeping in mind the purpose of developing a sustainability assessment framework for appraisers, the criteria for the measurement of this indicator will be included as 'monitoring the site & property' together with sub-monitoring 'largest users of water'.

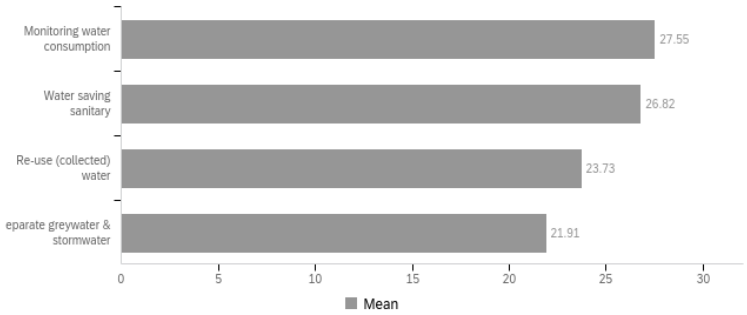

figure 14: means in water category

6.2.5 Materials Category

Surprisingly, the environmental impact (MPG) of building materials scored the highest mean, while the calculation of the environmental impact is not mandatory for existing properties. During the interviews, several interviewees mentioned the growing importance of the circularity of building materials in achieving sustainability. This is confirmed by the results of the online survey, since the indicator 'demountable materials/parts' scored the 2nd highest mean with 26.36 within this category. However, the high variance of this indicator and the minimum and maximum points assigned, reveal that the respondents were not all sharing the same opinion.

Due to the uncertain development of regulations for existing properties, some additional questions about the indicators were included in the online survey. The respondents were asked to give an answer to the following two questions; Currently, the discussion on making a material passport mandatory for new constructions is ongoing in the Netherlands. According to experts and policy makers, a material passport could enhance the circularity of an asset. How do you think that a material passport should be used for the existing building stock? Should this be included in the assessment?

One respondent answered with 'other'; ''The material passport for existing properties should contain information of all parts of the existing buildings that are re-usable''. Other 5 respondents answered with 'yes', which confirms that existing properties should have a material passport as well, in case of renovations in which additional materials are used. However, other 5 respondents selected the answer 'the material passport should contain information of all the existing materials. Based on this given, the criteria for the measurement of this indicator will assess only newly added building materials.

In order to gain expert opinion about the importance of the environmental impact of materials, the following question was included:' The environmental impact of materials (MPG berekening) is mandatory during the application of permits for new constructions. Do you think it should be mandatory for existing buildings as well and therefore included in the assessment?'

The environmental impacts of materials should be calculated for newly added materials during renovations, according to 7 of the 11 respondents. The other 4 respondents selected the answer 'the environmental impact of materials should be calculated for all materials.' Based on this given, the indicator 'environmental impact' will be included in the final assessment framework applicable to newly added materials in case of major renovations or refurbishments.

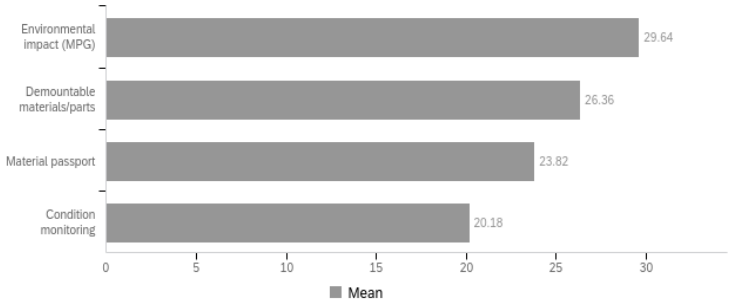

figure 15: means in materials category

6.2.6 Pollution Category

In line with the interview findings, the survey results indicate that the indicator 'separate waste collection' is the most important indicator, with a mean of 38.45, followed by the indicator 'monitoring emissions from installations'. Based on the table, the indicators 'flood measures' and 'light pollution', are according to the respondents, almost equally important. While during the interviews it became clear that flood measures has an important role in climate adaptation, the survey results show that this indicator addressing flood measures is not very important compared to the other indicators. It is no surprise that the indicator 'light pollution' scored the lowest within this category, since the inclusion of this indicator was doubtful according to several interviewees.

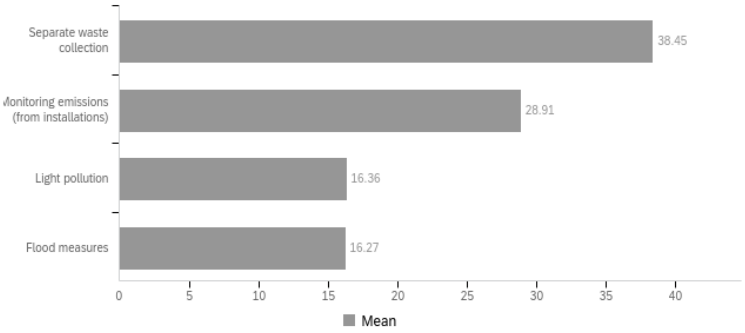

figure 16: means in pollution category

6.2.7 Ecology Category

The indicator 'ecological facilities' that addresses the presence of the facilities on the site of the property, is considered as the most important indicator with a mean of 35.45, followed by green facilities and ecological research. The indicator 'ecological research' has the lowest mean, indicating the lowest importance within this category, which is in line with the interview findings.

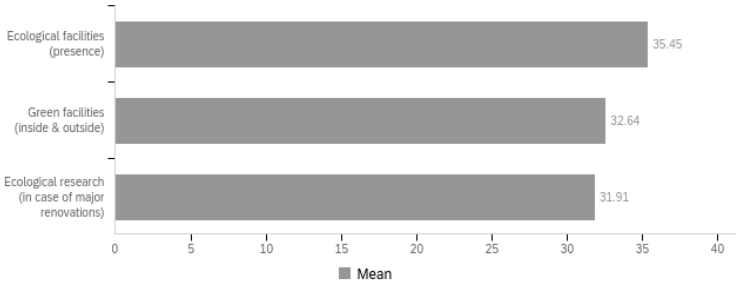

figure 17: means in ecology category

6.2.8 Transport Category

Within the transport category, the indicator 'reduced car park/use' (28.55) and 'proximity of public transport' (28.18) scored the highest, followed by 'facilities for cyclists' and 'proximity of facilities'. Additional questions were asked about the indicators 'proximity of public transport' and 'proximity of facilities to gather opinions about an acceptable distance. The following question was included: 'What is an acceptable walking distance for the following aspects?'.

Distance to public transport - in meters:
Most respondents answered with a distance between 500 and 1000 meters.
Distance to facilities- in meters:
Most respondents answered with a distance of 500, 700 and 1000 meters.

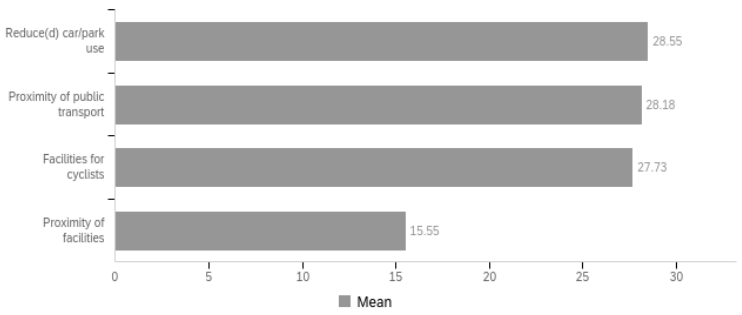

figure 18: means in transport category

6.2.9 Future Category

respondents. This is in line with the interview findings.Since the criteria for the measurement for the indicators within this category was not discussed by all interviewees and the description was not finished, a question about these 2 indicators was included. For the 'adaptability of the structure', the respondents were asked to answer; How important are the following aspects for the indicator 'adaptability of structure', according to your experience/view? (figure x). The possible answers were based on the interview findings. According to 7 respondents (58,33%) adjustable interior walls Is extremely important in adaptability, followed by 'adjustable installations' and 'entrances'. Based on these results, all criteria for the measurements will be included for this indicator in the assessment framework.

A question about the adaptability of the structure was also included in the survey: ' How important are the following aspects for the indicator 'adaptability of structure', according to your experience/view? Based on figure x, 'structural elements can bear possible adding/extensions' is the most important criteria for the indicator 'adaptability of structure'. One respondent answered with 'Open spaces/no internal load bearing walls' as very important. However, since the latter was not discussed during the interviews, and only 1 respondent suggested this measurement, the latter won't be included in the assessment.

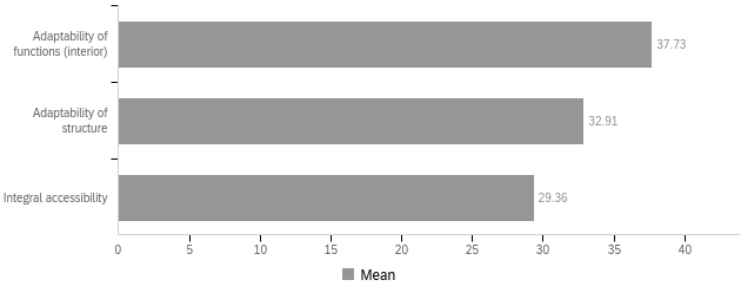

figure 19: means in future proof category

6.2.10 Management Category

According to the respondents, a roadmap towards sustainability in which the property owner made plans for long-term goals and communicated this to the end-users, is the most important indicator. However, the means reveal that the importance of the indicators are very close.

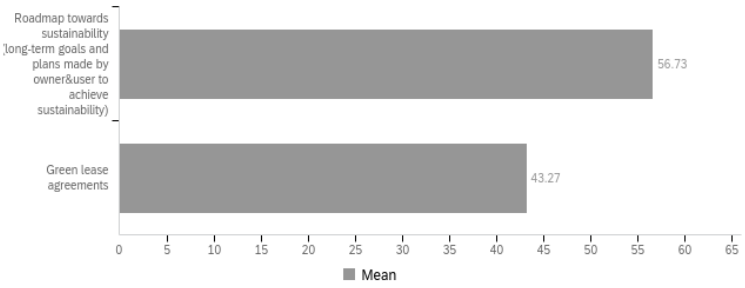

figure 20: means in management proof category

CH 07 Validation of the linkage

The previous empirical steps together with the theoretical framework, provided an overview with the linkage between the selected sustainability indicators and property value. In order to validate the theoretical linkage between the sustainability indicators and property value through the adjustable parameters, an expert interview is conducted with an appraiser.

7.1 Preparation

The expert for the interview was selected based on the expert's local experience in valuations of mainly commercial real estate, his knowledge on the current sustainability discussion within the Netherlands and his contribution to working groups in the Netherlands aiming to make sustainability more present in the valuation profession. The appraiser works for a company operating around the globe, with many clients from different sectors. The identified links are presented and questions were prepared beforehand, see Appendix F for the questions and Appendix G for the links. Questions concerning the future of valuation methods and on the linkage between sustainability indicators were asked during the interview.

7.2 Findings

The discussion on the linkage is divided into the categories of the indicators.

7.2.1 Energy

The appraiser acknowledged the impact of the indicator 'epc' on the property value of offices through three ways. First, an office that will become vacant due to it's unability to comply with the regulations, for example the mandatory energy label C in 2023, will have an impact on the property value. ''If you look purely for an investor with a portfolio, who will say that I am no longer allowed to purchase buildings that do not meet the requirements, then automatically less will be available for your property and your value will decrease'' (appraiser). In other words, an appraiser should apply a correction into the appraisal. ''...So let me put it this way, say you have a building labeled D, and the market value of such a building is a million, but it doesn't meet label C, and it takes a ton to jump and make provisions to satisfy. Then the building is worth a million minus that ton. In fact, that has a direct impact on your value' (appraiser).

Interestingly, the third method of impact is through the comfort of an office which is affected by the the EPC value of a property. The appraiser recognized the effect of a lower epc value on the comfort of the users. ''... The second thing I think is, that is what WELL is headed to, that users will pay more rent depending on the comfort class of the building. The higher your WELL score, the better. I think an old office building with a low EPC value, if your thermal envelope is not good, or you have a very modern office building with a good thermal envelope and insulation, it feels more comfortable than a building that does not have that. Ultimately, all those soft things that are difficult to substantiate, you assume that the user would rather sit in a comfortable building and is willing to pay more than for that other building. So I think in that sense it has an effect on a higher net operating income'' (appraiser). Since tackling the performance gap provides a great opportunity to save energy, the question wether an appraiser would consult the actual energy consumption if it's actively monitored. According to the appraiser, appraisers do not make statements about the actual energy consumptions and do not check whether it correspondends with the energy label.

7.2.2 Health

According to the appraiser, health and well-being related aspects are difficult to quantify and incorporate into the appraisal. However, if there is a high demand for healthy office environments, the impact on property value can be incorporated. ''... In case of a multi tenant office building; suppose that you have to take into account short lease contracts and vacancy periods, suppose that you know that the tenant has canceled it. Then you can estimate that the vacancy period is 6 months, but if you have a very good office building, which is in high demand, then the vacancy period may be 3 months. Then you immediately talk about those corrections in your valuation, and those corrections naturally have an impact on your market value. It is very difficult to prove, but I am convinced that it really works that way, and that it can give a sense of your worth. Then you are talking about direct influence on your value, which you assume that you have lower corrections, higher rent. You can of course also think as an investor optics, this property has little risk, so will probably be prepared to pay more for it'' (appraiser).

However, an appraiser would not take into account organisation aspects such as the productivity level and abseentism of employees. ''... I don't think an appraiser will look into detail, well what is the absenteeism and things like that. I think you should see it more as a big picture, that you will soon be given a certain building score, perhaps it is already in WELL that you have a high comfort class. So suppose you have a high comfort class, probably also with low absenteeism, then it is actually already discounted. I think that will come, yes'' (appraiser).

7.2.3 Materials

The growing importance of the use of materials and their impact on the environment was confirmed through the interviews and surveys, therefore, the appraiser was asked to discuss on possible future regulations on the material passport and environmental impact even though it's currently not mandatory for existing properties. According to the appraiser

''...That is quite difficult to add something to it. You actually have a different concept of value. We are talking about market value, but that is based on the rent and rental value capitalization. Only there you will talk more about the economic value of your building, what you actually see now is that the building itself is not even looked at. We mainly look at the rental contract, how high is the rent multiplied by a number etc.. What kind of building the tenant is in is not considered at all, that is not so decisive in the valuation. With the economic value you are going to look at how resistant such a building is. So if you have materials that can be re-used, I think that will certainly generate value compared to buildings that do not have that and also have a lower residual value. The most important thing is that you start looking at value in a different way, so the economic value of your building'' (appraiser).

The appraiser made an interesting remark about the current methods of valuations. Therefore, the appraiser was asked if according to his view, the current valuation methods are not sufficient to appraise in this case the benefits of circular building components. According to the appraiser, it might be possible to include information about materials and their circularity into the appraisal through the exit value. ''... In year 10 you have your exit value, if you start looking at that, that exit value will be higher than if you have a building that will be fully depreciated in 10 years and without a tenant. If you look purely at the concept of value, which an appraisal actually does, you only look at the rental situation. So empty like a building. Whether in many cases there is a facade of concrete or a most sustainable building, finally returns in the rent or in the yield when an investor buys it. But I don't think that the entire circularity is reflected in that yet. On the other hand, you could say, suppose you have a very circular building that meets all standards. But then the investor is prepared to pay more, for example because he looks to the future and maybe thinks I don't have to change much when another tenant comes in'' (appraiser).

7.2.4 Pollution

According to the appraiser, a discussion is nowadays present, which is about embedding the CO2 emissions of properties expressed per user. ''...So we purely look at how much CO2 you emit per user. And I think that's good because in the end it doesn't matter that much what you do to make your building more sustainable. As long as you ensure that there is a certain level of CO2 emissions, a score that a building user should be allowed to emit, then you should take measures to reduce those CO2 emissions. So then you have the EPC already covered, that's a possible measure'' (appraiser).

''...At the moment I see it going in a direction that it is purely about that CO2, because that is in fact an easy indicator that covers a lot. So now you see it happening a lot on a detailed level, how do you ultimately translate that into a value, I find that very difficult. Now you can say the building has a-label a so it has a higher value than a d-label. But I don't see any concrete references for that. Everyone is like you are on slippery ice. I think there must be a methodology such as CO2 emissions that you can actually measure in a building. If you can really measure something and it is clear what it is, then you can link a value'' (appraiser).

The rising risk of flood in the Netherlands was noticed by the appraiser as well, which might result in higher insurance cost of properties. However, the current method of estimating insurance costs is not based on possible future risks. ''... Now you only have your insurance premium, which is determined based on the percentage of your market rent. There we look at premium, what type of building do you have now, a shopping center etc then you have a different percentage instead of 1 separate shop for example. Insurance premium for your building is per year. Ultimately, you can also see it has an impact on your appraisal because you have higher costs'' (appraiser).

7.2.5 Transport

The appraiser noticed that some office buildings with no parking places at all are perceived as highly attractive among some type of tenants. This is applicable to office locations close to public transport nodes where transportation facilities are in abudance. The fact that some office buildings are rented for high rental prices, without any parking places, confirms that no parking places, which might be a part of a policy to reduce car/park use within an organisation, are perceived as favourable. However, the appraiser emphasized that the type of tenant within the office building together with the location is decisive in assigning a value to the transport facilities.

7.2.6 Future proof

The appraiser was asked to elaborate on the indicators within the future proof category, and whether current methods already cover the adaptability of an office building. The appraiser underpinned the importance of the zoning plan several times in attaching a value to the adaptability of an office and the investment costs of risks attached to adapting an office building.

"... If you look at the corrections, suppose you have an office building, not located at the best place, depending on the market, you see that a lot of people work from home, probably it will be that many people continue to work from home, a lot tenants now rent too much office space. This is also the case on the 'zuidas', but the demand is so great here. Look purely per office location, you may only make offices according to the zoning plan, imagine zoning plan is broader and you can live there, etc., then I would say as an appraiser that is rented out quickly. Then I would say maybe 9 months vacant (vacancy period), but suppose you can also live there, then I will keep 1 month (vacancy period). So that can certainly impact your worth. Which such objects, it may be correct that it has an impact on the discount rate and thus the exit yield. The discount rate is of course also the risk for the investor. A more flexible building means less risk for the future. Suppose that your location is not suitable anymore for offices, it will automatically have an impact on the discounted exit value. (appraiser).

7.2.7 Management

According to the appraiser, the green lease is a clausule in the rental agreement to mainly prevent the split-icentive issue. The appraiser was asked whether an office building which has a green lease agreement, and also fulfilled by both parties, would be considered as a less risky property, and thus have a positive impact on the property value. Based on the responses, it can be said that considering the presence of a green lease as a positive impact on property related risk, would lead to double counting. "... Ultimately, from the perspective of the valuation technique, if you have those solar panels on your roof, and you receive a subsidy for that, your value will go up, because those panels yield extra income. Then you actually have 2 forms of impact, which is solar panels, direct income flow, so a positive correction, the other thing you have, for example, banks that are providing the finance for real estate. When banks look at a sustainable building and see the solar panels, you might be able to claim financing and take out your mortgage for a more favorable interest rate" (appraiser).

7.3 Conslusion & Discussion

Even though not all indicators could be discussed with the appraiser, the covered topics provide the state-of-the-art within the valuation profession. Based on the discussion and provided insights by the appraiser, some barriers for identifying links between the indicators and property value are detected. While existing theory, as discussed in chapter 03 and 04, suggested that the DCF method with the adjustable parameters is a method that can be used to incorporate sustainability, the discussion only validated some theoretical linkages. In table x, the linkage confirmed by the appraiser is depicted. It seems that an appraiser would not easily attach a value or a correction to organisational aspects, related to the user of an office.
Surprisingly, this also applies to property related aspects as mentioned by the appraiser. While the guidelines for the valuation profession proposes a list with property features that an appraiser should take into account, it seems that these are not decisive on the market value. The rental agreement and thus the rental situation has the most impact on the market value. With this given, if an appraiser is not obliged to make an objective estimate on property and ogranizational related features (indicators), these aspects won't be included in the appraisal. Even if the required information is available, the fact that it is not compulsary for appraisers leads to leaving out those aspects.

After reflecting on the expert interview together with the findings from the other empirical steps, it seems that some benefits of sustainability indicators cannot be expressed through the DCF method. Simply because of the time span the method takes into account, namely 10 years. In order to reflect the full potential of certain sustainability indicators, other methods and other definitions of value are needed. For example, installing a separate grey&stormwater system is costly and the price of water is relatively low in the Netherlands. The question to ask here is whether a property owner would consider such measures. Actively monitoring the energy consumption, the water consumption, condition monitoring and commissioning are indicators related to the management of an office to ensure a sustainable use of resources and predicting the performance of materials and installations. One could assume that the performance of properties deteriorates continuously throughout the entire life, and thus making a prediction of the added value for just a few years might be irrelevant. The true added value of those indicators would be effective in the total run, rather than a period of 10 years.

Indicators and parameters

		rent	rental growth	operating costs	occupancy	vacancy	renewal prop.	discount rate	insurance	exit value
	x direct/high impact × indirect/low impact									
1	sustainable energy sources	x	×	x	×	×	x	×		x
2	EPC	x	×	x	x		x	×		x
3	monitoring energy use		×	x						
4	commisioning			x				×	×	×
5	air quality		x		x	x	x			
6	daylighting		x		x	x				
7	temperature control		x		x	x				
8	relaxing spaces		x		x	x				
9	views from workplaces		x		x	x				
10	light regulation		x		x	x				
11	environmental impact materials							×	×	×
12	demountable materials				×	×	×	x		x
13	material passport				×	×		×		×
14	condition monitoring		×	x				x	×	x
15	ecological facilities	x	x		x	x	x			
16	green facilities	×	x		x	x	x			
17	ecologic value	x			x	x				
18	adaptability of functions	x	x		×	x	x	x		x
19	adaptability of structure	x	x		×	x	x	x		x
20	integral accessibility		x		×		x			
21	roadmap towards sustainability	×	×	×	×	×	×			
22	greenlease	×	×	×	×	×				
23	reduced car park/use	×	×		×	×	×			
24	proximity of public transport	×	×		×	×	×	x		x
25	facilities for cyclists	×	×		x	x	x			
26	proximity of facilities	×	×		x	x	x			
27	separate waste collection			x						
28	monitoring emissions		×		×	×	×		×	
29	light pollution (reduce)									
30	flood measures								x	
31	monitoring water consumption			×						
32	water saving sanitary		×	x						
33	reuse collected water		×	x						
34	separate grey&stormwater		×	×					×	

performance & quality indicators — adjustable parameters → — confirmed/acknowledged by appraiser*

table 20: the impact of the selected indicators (chapter 5&6) on adjustable parameters discussed with the appraiser

* some links exist to some extent, but currently still difficult to quantify

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CH 08 Conclusion & Discussion

This chapter summarizes the main findings of this research and discusses the conclusion. First, a brief summary of the problem field will be given followed by the sub research questions which provide together the conclusion for the main research question. The conclusion section is followed by the discussion on the limits of this thesis and suggests some perspectives for further research.

8.1 Conclusion

The purpose of this research was to develop a sustainability assessment framework that would help assist appraisers in the process of assigning a value to sustainability characteristics. Literature and practise show that appraisers face practical challenges when clients ask how sustainable their property is and whether the sustainability characteristics yield added value. Appraisers are not able to provide an answer to this question. First, no consensus within the valuation profession is reached on which sustainability characteristics should be considered in the appraisal. Next, the benefits that could result in added value for owners along with the measurement of the sustainability characteristics remains unclear up until now. These issues result in the lack of simplified tools that capture relevant aspects of sustainability for office appraisal in the Netherlands. Therefore, the main research question of this research was as follows;

In which way can an appraiser assess the sustainability performance of an office in a comprehensive but manageable way?

The use of the Discounted Cash Flow method

The findings of the literature review discussed in chapter 03 and 04 suggest that the benefits of sustainability characteristics can be integrated in the existing valuation techniques. It became clear that the discounted cash flow method is the most suitable method for incorporating sustainability characteristics of a property into the appraisal. By making adjustments to the single value parameters, an appraiser can translate the sustainability performance of an office and communicate the added value to the clients. These value parameters entail estimations made by the appraiser on how the market responds (market players) to the appraised property. Parameters such as the vacancy periods between terminated contracts, occupancy, depict how the market responds. Other parameters address property specific risks and risks associated with the current market cycle, like the depreciation, discount rate and exit yield. This approach is proposed by many authors, since the transparency increases when adjustments are justified separately. An increased transparency does not only lead to objectivity, which is very crucial for the valuation profession, it will emit the signal towards other users within the real estate profession when sustainability becomes the norm in appraisals.

Sustainability indicators and their importance

The certification schemes that are providing an objective evaluation of the sustainability performance are often developed and designed by design professionals with indicators often differentiating from what appraisers and other decision-makers in the real estate profession are considering as sustainable. The consultation of literature and existing green rating tools made it possible to make a preliminary selection of sustainability indicators. Through semi-structured interviews(CH05), a reduction from 43 to 34 indicators was made. Chapter 07 made clear which sustainability indicators are of high importance. The category energy showed up as the most significant category with 4 indicators. Despite the growing importance of other categories in sustainability assessments, energy related issues seem to be still of great importance according to the sustainability experts. Moreover, the 'health & well-being' category sees itself ranked the second most relevant category with 7 indicators. This category highlights the understanding of health impacts (indoor air quality, spatial design) on the end-users, confirming the growing recognition that social aspects affects sustainability performance. Another noticeable aspect of the results is that the categories 'management' (sixth) and 'transport' (seventh), received a higher rank than the categories 'pollution' and 'water'. With this given, it can be concluded that aspects related to behavior, tracking progress and ultimately plans or roadmaps established by owners and tenants are determinants of the sustainability performance as well.

The linkage between sustainability indicators and appraisal
Chapter 3 and 4 demonstrated that sustainability can be an influencing factor on the market value of offices through the adjustment of several economic parameters. It is proposed to extend the appraisers' market analysis and assess the sustainability indicators and the impact on the value systems of various stakeholders. These value systems are shaped by the preferences of market players, the current market cycle, demand and supply and regulations. By understanding the impact of sustainability indicators and their criteria on the marketability, adaptability, resiliency, durability of the property, an appraiser can make the adjustments. The linkage between organizational related aspects, such as the 'greenlease', 'a roadmap' agreed by both parties, 'separate waste', 'monitoring emissions' , 'condition monitoring' and' consumption', and office appraisal is less convenient according to literature and the expert interview with the appraiser. As it became clear from the interviews with the sustainability experts, these indicators contribute to an extended lifetime of the property, and logically also compliance with regulation and thus a reduced risk to become less marketable. These organizational indicators depict the fitness for use of a property and can predict when maintenance has to be carried out which can be incorporated in the DCF model. However, the interview with the appraiser (Ch.8) gave an impression of current practices. It seems that only compliance with regulations, addressing the energy labels, is of concern for the valuation profession. More focus should be placed on the performance of the sustainability indicators and their relation to value creation and risk mitigation rather than solely focussing on the rental agreements and specifications between a property owner and occupier.

The proposed framework shows that the 'true' financial impact of sustainability goes beyond the energy and operating costs. Some sustainability indicators can indeed have a direct impact the different value systems and thus be linked to the market value while other indicators cannot be directly linked, but through factors such as image gains and marketability. Appraisers can consult the proposed framework in order to form an objective estimation of the added value.

8.2 Discussion

Expectations of the research
The main contribution of this research is the identification and development of sustainability indicators that are relevant within the Netherlands and their integration into the appraisal. However, the focus of this thesis has been mainly on the process towards the development of such a framework, rather than producing. The framework can be consulted to explore possible benefits, but assessing an office based on the indicators in this framework is not sufficient for making reliable assumptions by an appraiser on the possible economic impact. First, base values are missing which is needed to reduce subjectivity. Next, as the valuation profession acknowledges as well, more evidence on sustainability aspects mainly related to the social benefits is needed. The interview with the appraiser made clear that evidence, which can be transaction references, are still lacking and not frequently available. Additionally, the problem statement in this thesis highlighted the need for a 'manageable' but comprehensible tool for the valuation profession. However, assessing 20-30 indicators and estimating the economic impact of these indicators might not be manageable by an appraiser. Even if appraisers have time for assessing these indicators, an understanding of the technical and functional performance of sustainability is needed which requires an educational background in this area.

Limitations

- Basevalues for the indicators

Since it is the task for an appraiser to provide an objective estimation, subjectivity should be minimized, which is why a base value for the indicators is needed. For some indicators is was clear from the start what the base value should be, regulated by governments, such as the compulsory label A. However, for the majority of the indicators, future research could complement the base value before testing such a tool.

- further development and adjustments of the indicators:

Our definition of a sustainability office keeps evolving due to the development of technologies, adaptations in regulations, this means frameworks like in this thesis should be continuously evaluated as well.

- (De)valuing effect

Some sustainability indicators in the framework might lead to a decreased value because of a base value. The question is whether appraisers would consult the framework and the base value and decide to make 'negative corrections'. Aspects such as extended or shortened vacancy periods, market rent, insurance, have generally less impact on the market value than the discount rate. If the indicators cause a negative effect on these parameters, properties will be devalued compared to properties that score higher Questions that arise here is whether clients would still favour carrying out a sustainability if this means more indicators causing a negative effect on the adjusted parameters and thus a lower value. However, neglecting the negative impacts of sustainability indicators and their performance might lead to overestimations or underestimations. With the regulations that are becoming more strict, we need to become more strict as well in attaching a value to offices that will not comply.

- Identified (theoretical) linkage

The identified links between the sustainability indicators are not validated by multiple appraisers, but only discussed with one appraiser. The links are based on existing theory and are assumptions which might not be applicable in the Dutch context. In order to make links between indicators and parameters, local market conditions need to be considered. Furthermore, the assumptions on the social benefits such as the health, productivity and tenant satisfaction are based on available research. It is expected that in the future more evidence will become available.

- The shifting role of the appraiser & sustainability advice

A critical question, or thought, is whether it is the role of the appraiser to assess an office on sustainability indicators. The discussion on how to embed sustainability into valuation models is ongoing for almost 2 decades. According to guidelines, it is not the duty of the appraiser, however, vague suggestions and recommendations are made to 'consider'. Valuation profession seems reluctant. Making a sustainability an assessment mandatory would break through the ongoing discussion.

- Stakeholder involvement

Probably, stakeholder involvement will take place in the future to support appraisers in assessing sustainability. The certification schemes are often designed by designers and design professionals, leading to the question whether designers should communicate the sustainability characteristics of their materials, layout, etc.

- Sustainability perceived as a financial asset creating short-term values

The DCF method generally takes into account 10 years (rental agreements are most of the times for 10 years), however, some benefits detected in this thesis occur at a longer span, and might not be visible in 10 years. This might create a discussion on whether we should consider a different time span.

- Institutional investors and owner-investors

Institutional investors might perceive sustainability as a medium to create long-term value while an investor-owner (private/small) considers the effect of sustainability on the short term. Thus, carrying out a sustainability assessment for the appraisal might not be favored since it is time consuming.

- Covid-19

The impact of the pandemic caused by Covid-19 reveals now, more than ever, that the office sector is very vulnerable. Health issues, such as the indoor air quality, commissioning to make sure installations such as ventilation are optimized, have become more important. Thus, it is expected that sustainability will become the focus point for organizations and hopefully in the appraisal as well.

8.3 Reflection

Research methods

In this section, a brief reflection on the different research methods will be presented followed by the overall experience.

- Literature review

The topic and research question of my thesis changed a few times until my P2 moment, and even until the retake of my P2. Due to the changing topic and research question of my thesis, I couldn't finalize my theoretical background at the time my retake P2 took place. A huge 'barrier' I experienced (I was convinced that it was a barrier) during the literature review shortly after my P2, was without finalizing my literature review, proceeding with the interviews. At that time I thought it was not a good idea to proceed without 'completing' the literature review. Of course, I came at some point in time to the realization that that isn't true, however, at that moment I couldn't get rid of that thought. At the end, conducting a literature review / consulting existing theory did not take place at one phase in the research process, but took place throughout the entire process. After each realization moment, reflection moment, learning moment, literature was consulted to confirm and complement findings.

- Semi-structured Interviews

The interviews held with sustainability experts confirmed my early 'findings' or 'views' on sustainability indicators that should be included in the assessment. I managed to conduct 8 interviews; however, I was aiming at 10. Altogether, arranging interviews, rescheduling interviews, transcribing the interviews and re-reading the interviews took me almost 2-3 months. There was a moment of time I regretted conducting interviews with experts to validate the preliminary selection of sustainability indicators, since I already made a selection based on the literature review. I thought: 'Why didn't I validate the indicators through an online survey? However, I am glad I conducted 8 interviews instead of an online survey (in this phase). Being able to discuss the indicators with experts has led to interesting findings, such as conflicting views among the participants and understanding that some indicators are interrelated and that it doesn't make sense to exclude some. The sustainability experts also asked me relevant questions and provided interesting suggestions which were very valuable for me since it allowed some time for reflection. Transcribing the interviews took a lot of time but enabled a better understanding of what was said and helped me to navigate quickly through the transcripts when I had to prepare the questions for the online survey. It also allowed me to better understand the possible link between valuation models and the sustainability indicators since the interviewees also explained why certain indicators are so important and how it affects the property, the users and ultimately the value it holds. I calculated enough time (but also due to the extended period) between analysing the interview findings, typing the findings in the report and distributing the online survey. Additionally, the preliminary selection of indicators was based on a mix of green rating tools adopted around the globe. Through interviews with Dutch experts, I wanted to collect relevant indicators within the Dutch context (regulations, views).

- Survey

Feeling confident about my interview findings didn't apply for the survey results. Because I transcribed the interviews, I could make an overview with missing data that was relevant for assessing the indicators and include additional questions about missing data within the online survey. However, while preparing the questionnaire, many questions to include came across my mind. My first draft of the online survey with questions was exhaustive. Since the initial aim of the survey was to rank the indicators according to their importance by allocating points among the indicators, adding many questions would not be feasible (for the interviewees). The online survey provided me with the relevance of each indicator and the answers to my additional questions. However, the reason for this ranking was to develop a tool rather than a framework and test the applicability of such a tool through a case study. Due to the lack of time, perhaps motivation, the course of my research changed slightly. While I wanted to test a 'tool' and appraise an office building based on the scoring, I ended up with a list of indicators, their measurability and importance. Reflecting on the process, if I had known earlier that it was not feasible to also perform a case study and valuation of a property, I would have conducted a survey among appraisers instead. On the other hand, through distributing the online survey among the interviewees, the selected indicators could be validated and confirmed.

- Expert interview

The expert interview with the appraiser took place between my P4 and P5 and provided me the opportunity to get an insight in the current process of integrating sustainability and to compare theory with practice. It would have been interesting to organize an expert panel with members from different companies to see whether different approaches are adopted. However, due to a time schedule, one interview is conducted.

Ethical issues

No ethical issues and dilemmas have occured during my graduation process. The decision to anonimize the participants and their contribution to this research was made in advance to prevent any issues that might occur during conducting interivews and distributing the survey. The conditions of the interviews were made clear in the informed consent from and sent prior to the meetings to the particpants, asking them to sign the form and send them back. It was clearly stated that the participants' privacy would be guaranteed. Some interviewees actually mentioned during the interviews that they won't mind if their personal information such as their names would be written in the thesis. I was thankful for the interviewees who mentioned that I could write down their names, since this indicated that they felt comfortable in sharing information. However, since I already made a decision to anonimize, I didn't see a point in writing down names of the interviewees while the other participants would be referred with a number.

Reliability and validity

Reliability is concerned with the consistency of measures and the question whether the research results are repeatable (Bryman, 2016). External reliability is difficult to meet in qualitative research since it is not possible to 'freeze' a social setting and the conditions, every setting is unique (LeCompte & Goetz, 1982). However, in order to ensure the replicability to a certain degree, several measures have been adopted. From the start of this research, the different steps in each research methodology was explained to increase transparency for the reader to be able to see clearly how the interpretation was derived from the data. This process started during the literature review while selecting the sources for the first selection of indicators to present to the interview participants, followed by the explanation how to reduce this extensive set. The interview findings and the decisions made based on the findings are elaborated and described in each category section as well. The documentation of the different steps can be consulted in the appendices. Validity concerns the integrity of the conclusions that are generated from the research (Bryman, 2016). The internal validity or credibility of the research results in this thesis is ensured by triangulation. A limitation in the internal validity can be traced to the findings from the structured interviews. Due to a graduation schedule the choice was made to not ask the interview participants to validate, or confirm, my interpretated findings from the selection of indicators. However, since the same participants were asked to fil in the survey, the indicators resulting from the analysis could be presented. Another limitation related to the external validity, which refers to the possibility to generalize the results of this study beyond the research context, is attributed to the (theoretical) linkage between the sustainability indicators and the link between the appraisal. Since the linkage was discussed with only 1 appraiser, it is not possible to draw conclusions to generalize. Despite the limitations, the combination of research methods has lead to interesting insights in the gap between theory and practice and the multiple linkages between sustainability indicators and appraisal which could be further explored in the future.

Personal reflection on the process

Writing this thesis was a long journey for me with many moments of doubt. It feels like that on 'paper' everything is possible, however practice shows different. Integrating sustainability into appraisals is very complex because of the reliance of the valuation profession on evidence and transcations. Many ideas have emerged the past years on this topic, however, no standard tool or methods have been developed. There was a moment in time I asked myself if it made sense what I was researching, since I am defintely not the first one to do research about this topic. What will my contribution be as a 'newbie' to valuations, was also a frequent occuring thought. However, any action is better than no action at all.

References

Abergel, T., Dean, B., & Dulac, J. (2017). Towards a zero-emission, efficient, and resilient buildings and construction sector: Global Status Report 2017. UN Environment and International Energy Agency: Paris, France, 22.

Allen, J. G., MacNaughton, P., Satish, U., Santanam, S., Vallarino, J., & Spengler, J. D. (2016). Associations of cognitive function scores with carbon dioxide, ventilation, and volatile organic compound exposures in office workers: a controlled exposure study of green and conventional office environments. Environmental health perspectives, 124(6), 805-812.

Banfield, A. (2014). A Valuer's Guide to the RICS Red Book 2014: Revised for the January 2014 Edition of RICS Valuation-Professional Standards. Royal Institution of Chartered Surveyors (RICS).

Bienert, S., Shutzenhofer, C., Leopoldsberger, G., Bobsin, K., Leutgob, K., Huttler, W., ... & Edvardsen, D. (2010). Integration of energy performance and life-cycle costing into property valuation practice.

Bendewald, M., Miller, D., & Muldavin, S. (2015). How to Calculate and Present Deep Retrofit Value: A Guide for Investors. Rocky Mountain Institute, Boulder, CO.

Bernardi, E., Carlucci, S., Cornaro, C., & Bohne, R. A. (2017). An analysis of the most adopted rating systems for assessing the environmental impact of buildings. Sustainability, 9(7), 1226.

Bowman, R., & Wills, J. (2008). Valuing green: How green buildings affect property values and getting the valuation method right. *Green Building Council of Australia, Sydney*.

Bozorgi, A. (2015). Integrating value and uncertainty in the energy retrofit analysis in real estate investment—next generation of energy efficiency assessment tools. Energy Efficiency, 8(5), 1015-1034.

BREEAM-NL In-Use Keurmerk voor bestaande duurzame vastgoedobjecten. Beoordelingsrichtlijn 2016 versie 1.0

Brown, B. J., Hanson, M. E., Liverman, D. M., & Merideth, R. W. (1987). Global sustainability: toward definition. *Environmental management*, *11*(6), 713-719.

Bryman, A. (2016). *Social research methods*. Oxford university press.

Bullen, P. A. (2007). Adaptive reuse and sustainability of commercial buildings. *Facilities*.

Buskermolen, W. TENANTS'WILLINGNESS TO PAY FOR HEALTHY OFFICE WORKPLACE ASPECTS.2019

Carrer, P., & Wolkoff, P. (2018). Assessment of indoor air quality problems in office-like environments: Role of occupational health services. International journal of environmental research and public health, 15(4), 741.

Carroll, A. B. (2016). Carroll's pyramid of CSR: taking another look. International journal of corporate social responsibility, 1(1), 1-8.

Ciora, C., Maier, G., & Anghel, I. (2016). Is the higher value of green buildings reflected in current valuation practices?. Accounting & Management Information Systems/Contabilitate si Informatica de Gestiune, 15(1).

Cole, R. J. (2005). Building environmental assessment methods: redefining intentions and roles. Building Research & Information, 33(5), 455-467.

de Nijs, T., Bosch, P., Brand, E., Heusinkveld, B., van der Hoeven, F., Jacobs, C., ... & van Nieuwaal, K. (2019). Ontwikkeling standaard stresstest hitte.

Dixon, T., McNamara, P., Lorenz, D., & Lützkendorf, T. (2008). Sustainability in property valuation: theory and practice. Journal of Property Investment & Finance.

Dixon, T., Ennis-Reynolds, G., Roberts, C., & Sims, S. (2009). Is there a demand for sustainable offices? An analysis of UK business occupier moves (2006–2008). Journal of Property Research, 26(1), 61-85.

Eichholtz, P., Kok, N., & Quigley, J. M. (2010a). Doing well by doing good? Green office buildings. American Economic Review, 100(5), 2492-2509.

Eichholtz, P., Kok, N., & Yonder, E. (2012). Portfolio greenness and the financial performance of REITs. Journal of International Money and Finance, 31(7), 1911-1929.

Feige, A., Wallbaum, H., Janser, M., & Windlinger, L. (2013). Impact of sustainable office buildings on occupant's comfort and productivity. *Journal of Corporate Real Estate, 15*(1), 7-34.

French, N., & Gabrielli, L. (2005). Discounted cash flow: accounting for uncertainty. Journal of Property

Investment & Finance, 23(1), 75–89.

French, N., & Gabrielli, L. (2018). Pricing to market: Property valuation revisited: The hierarchy of valuation approaches, methods and models. Journal of Property Investment & Finance, 36(4), 391-396.

Fuerst, F., & McAllister, P. (2011). The impact of Energy Performance Certificates on the rental and capital values of commercial property assets. Energy policy, 39(10), 6608-6614.

Gluszak, M., & Zięba, M. (2016). Using the means-ends approach to understand the value of sustainability on the property market. In Smart City 360° (pp. 738-749). Springer, Cham.

Goubran, S., Masson, T., & Caycedo, M. (2019). Evolutions in Sustainability and Sustainable Real Estate. In Sustainable Real Estate (pp. 11-31). Palgrave Macmillan, Cham.

Goubran, S. (2019). On the Role of Construction in Achieving the SDGs. Journal of Sustainability Research, 1(2).

Green Star Performance: Summary of Categories and Credits.

Hüttler, W., Leutgöb, K., & Bienert, S. (2011). Integrating energy efficiency and other sustainability aspects into property valuation–methodologies, barriers, impacts; Paper für die eceee Summer Study 2011.

Jailani, J., Reed, R., & James, K. (2015). Examining the perception of tenants in sustainable office buildings. Property Management.

Krysiak, F. C. (2009). Risk management as a tool for sustainability. Journal of business ethics, 85(3), 483.

Kubbinga, B., Bamberger, M., van Noort, E., van den Reek, D., Blok, M., Roemers, G., ..., & Faes, K. (2018). A framework for circular buildings: indicators for possible inclusion in BREEAM. Circle Economy, DGBC, Metabolic, SGS Search.

LaSalle, J. L. (2013). Occupier Special Sustainability, 12. Geraadpleegd van http://www.joneslanglasalle. nl/ResearchLevel1/JLL_Occupier_Special_Sustainability_ duurzaamheid_2013. pdf.

LeCompte, M. D., & Goetz, J. P. (1982). Problems of reliability and validity in ethnographic research. *Review of educational research*, 52(1), 31-60.

LEED v4 for BUILDING OPERATIONS AND MAINTENANCE

Livingstone, N., & Ferm, J. (2017). Occupier responses to sustainable real estate: what's next?. Journal of Corporate Real Estate.

López, C. D., Carpio, M., Martín-Morales, M., & Zamorano, M. (2019). A comparative analysis of sustainable building assessment methods. Sustainable Cities and Society, 49, 101611.

Lorenz, D., Trück, S., & Lützkendorf, T. (2006). Addressing risk and uncertainty in property valuations: a viewpoint from Germany. Journal of property investment & finance.

Lorenz, D. P., Trück, S., & Lützkendorf, T. (2007a). Exploring the relationship between the sustainability of construction and market value. Property Management.

Lützkendorf, T., & Lorenz, D. (2007b). Integrating sustainability into property risk assessments for market transformation. Building Research & Information, 35(6), 644-661.

Lorenz, D., & Lützkendorf, T. (2011). Sustainability and property valuation: Systematisation of existing approaches and recommendations for future action. Journal of Property Investment and Finance, 29(6), 644-676.

Lützkendorf, T., & Lorenz, D. (2011). Capturing sustainability-related information for property valuation. *Building Research & Information*, 39(3), 256-273.

Lowe, C., & Ponce, A. (2010). UNEP-FI/SBCI'S financial & sustainability metrics report. An international review of sustainable building performance indicators & benchmarks.

Lützkendorf, T., & Lorenz, D. (2014). Sustainability Metrics–Translation and impact on property investment and management. United Nations Environment Programme (UNEP), Finance Initiative. Draft version, 1.

Manganelli, B. (2014). Real estate investing: Market analysis, valuation techniques, and risk management. Springer.

Marchese, D., Reynolds, E., Bates, M. E., Morgan, H., Clark, S. S., & Linkov, I. (2018). Resilience and sustainability: Similarities and differences in environmental management applications. Science of the total environment, 613, 1275-1283.

Meins, E., Wallbaum, H., Hardziewski, R., & Feige, A. (2010). Sustainability and property valuation: a risk-based approach. Building Research & Information, 38(3), 280-300.

Menkveld, M. (2016). Energiemanagementsystemen in de utiliteitsbouw (No. ECN-N--16-003). ECN.

Mills, E. (2011). Building commissioning: a golden opportunity for reducing energy costs and greenhouse gas emissions in the United States. Energy Efficiency, 4(2), 145-173.

Michl, P., Lorenz, D., Lützkendorf, T., & Sayce, S. (2016). Reflecting sustainability in property valuation–a progress report. Journal of Property Investment & Finance.

Myers, G., Reed, R., & Robinson, J. (2007). The relationship between sustainability and the value of office buildings. In PRRES 2007: Proceedings of the 13th Annual Conference of the Pacific Rim Real Estate Society (pp. 1-22). Pacific Rim Real Estate Society.

Nappi-Choulet, I., & Decamps, A. (2013). Can sustainability enhance business district attractiveness? A survey of corporate property decisions in France. Urban Studies, 50(16), 3283-3304.

Nurick, S., Le Jeune, K., Dawber, E., Flowers, R., & Wilkinson, J. (2015). Incorporating green building features and initiatives into commercial property valuation. *Journal of Sustainable Real Estate*, *7*(1), 21-40.

Ornetzeder, M., Wicher, M., & Suschek-Berger, J. (2016). User satisfaction and well-being in energy efficient office buildings: Evidence from cutting-edge projects in Austria. Energy and Buildings, 118, 18-26.

Oyedokun, T. B. (2017). Green premium as a driver of green-labelled commercial buildings in the developing countries: Lessons from the UK and US. *International Journal of Sustainable Built Environment*, *6*(2), 723-733.

Pike, A., Dawley, S., & Tomaney, J. (2010). Resilience, adaptation and adaptability. *Cambridge journal of regions, economy and society*, *3*(1), 59-70.

Pivo, G., & Fisher, J. (2010). Income, value, and returns in socially responsible office properties. Journal of real Estate research, 32(3), 243-270.

Pope, J., Annandale, D., & Morrison-Saunders, A. (2004). Conceptualising sustainability assessment. Environmental impact assessment review, 24(6), 595-616.

Rodi, W. N. W., Ani, A. I. C., Tawil, N. M., Ting, K. H., & Mahamood, N. M. (2017). A preliminary study on the relevancy of sustainable building design to commercial property depreciation. Journal of Fundamental and Applied Sciences, 9(6S), 162-183.

Ross, B. E., Chen, D. A., Conejos, S., & Khademi, A. (2016). Enabling adaptable buildings: Results of a preliminary expert survey. *Procedia Engineering*, *145*(Supplement C), 420-427.

Royal Institution of Chartered Surveyors (RICS). (2009). Sustainability and Commercial Property Valuation. Valuation Information Paper, (13).

Runde, T. P. (2015). Net Zero Energy Buildings: An introduction for Valuation Professionals. Appraisal Journal, 83(2).

Sayce, S., Walker, A., & McIntosh, A. (2004). Building sustainability in the balance: Promoting stakeholder dialogue. Estates Gazette.

Sayce, S., & Ellison, L. (2006). The sustainable property appraisal project. Kingston University.

Ellison, L., & Sayce, S. (2007). Assessing sustainability in the existing commercial property stock. *Property Management*.

Santamouris, M. (2020). Recent progress on urban overheating and heat island research. Integrated assessment of the energy, environmental, vulnerability and health impact. Synergies with the global climate change. *Energy and Buildings*, 207, 109482.

Sayce, S., Smith, J., Cooper, R., & Venmore-Rowland, P. (2009). Real Estate Appraisal: from value to worth. John Wiley & Sons.

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

Scheurwater, S. (2017). The Future of Valuations-The relevance of real estate valuations for institutional investors and banks–views from a European expert group. Report of Royal Institution of Charter Surveyors(RICS).

Shapiro, E., Mackmin, D., & Sams, G. (2019). Modern methods of valuation. Taylor & Francis.

Sipma, J. M., Kremer, A., & Vroom, J. (2017). Energielabels en het daadwerkelijk energieverbruik van kantoren.

Slaughter, E. S. (2001). Design strategies to increase building flexibility. *Building Research & Information*, 29(3), 208-217.

Schmidt III, R., & Austin, S. (2016). *Adaptable architecture: Theory and practice*. Routledge.

Spindler, E. A. (2013). The History of Sustainability the origins and effects of a popular concept. In Sustainability in tourism (pp. 9-31). Springer Gabler, Wiesbaden.

Tarigan, J., & Stacia, L. (2019). Corporate social responsibility policies and value creation: does corporate governance and profitability mediate that relationship?. Investment Management & Financial Innovations, 16(2), 270.

Vale, L. J., & Campanella, T. J. (2005). *The resilient city: How modern cities recover from disaster*. Oxford University Press.

Varma, C. S., & Palaniappan, S. (2019). Comparison of green building rating schemes used in North America, Europe and Asia. Habitat International, 89, 101989.

Warren, C. M., Bienert, S., & Warren-Myers, G. (2009). Valuation and sustainability are rating tools enough?.

Warren-Myers, G. (2013). Is the valuer the barrier to identifying the value of sustainability?. Journal of Property Investment & Finance.

Warren-Myers, G. (2016). Sustainability evolution in the Australian property market: Examining valuers' comprehension, knowledge and value. Journal of Property Investment & Finance, 34(6), 578-601.

Walker, T., Krosinsky, C., Hasan, L. N., & Kibsey, S. D. (Eds.). (2018). Sustainable Real Estate: Multidisciplinary Approaches to an Evolving System. Springer.

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Appendix A

Meins et al. (2010)	Indicator/Critera	Meins	Sayce & Ellison	BREEAM Asset	BREEAM USE	BREEAM Management	GreenStar	LEED BC+D	LEED O+M		frequency
flexibility and polyvalence	flexibility of use	x	x	x							
	adaptability to users	x	x	x							
energy & water	energy demand	x	x	x	x	x	x	x	x		8
	production	x	x	x	x	x	x	x	x		8
	water use	x	x	x	x	x	x	x	x		8
	water disposal	x	x	x	x	x	x	x	x		8
accessibility and mobility	public transport	x	x	x	x	x		x	x		7
	pedestrians and non-	x	x	x	x	x		x	x		7
	motor vehicles	x	x	x	x	x			x		6
	accessibility	x	x	x	x	x		x	x		7
safety & security	location natural hazards	x					x				
	building safety -	x									
	security measures	x		x							
health & comfort	inside air quality	x	x	x	x	x	x	x	x		8
	noise	x	x								
	daylight	x	x	x	x	x	x	x	x		8
	radiation	x	x								
	ecological materials	x		x	x			x			
Sayce & Ellison											
operational energy efficiency	modern building management system		x	x		x	x		x		5
	movement sensitive/auto-off lighting		x	x	x	x			x		5
	low energy lighting	x	x	x	x	x		x	x		7
	access to renewable energy source	x	x	x	x		x	x	x		7
	CHP plant		x								
climate control	AC < 5 years old		x								
	AC 5-9 years old		x								
	AC >9 years old		x								
	mechanical ventilation <5 years old		x								
	mechanical ventilation >5 years old		x								
	natural ventilation	x	x	x		x	x	x	x		7
	capacity for alternative cooling system		x	x	x						
pollution	presence of contamination	x	x	x		x		x	x		6
	power to prevent contamination	x	x	x		x		x	x		6
	liability insurance - risk		x								
adaptability	regular footprint		x								
	plan depth 15-18m		x								
	column grid >7,5m		x								
	floor ceiling hight >2,7m		x								
	raised floors		x								
	VAV, fan coil/no AC		x								
	adaptable across use	x	x	x		x					
waste management	access to waste storage		x	x	x		x		x		5
	adequate waste storage		x	x	x		x		x		5

Materials	condition measurement			x							
	security advisories implementation			x							
	intrusion alarm system			x							
	alarm system and fire routing			x			x				
	natural disasters			x							
	future adaptability	x	x	x							
	protected measures against damage			x							
	enviromental impact of materials			x				x	x		
Waste	facilities for separated waste			x				x	x		
Land use and ecology	surface with green facilities			x			x	x	x		
	ecological facilities for animals			x							
Pollution	Liquid separators (grease and oil)			x							
	flood asset			x							
	measured to reduce rainwater runoff			x							
	impact of coolers			x							
	automatic leak detection coolers	x		x		x					
	Nox emission	x		x			x				
BREEAM NL- in Use											
Management	environmental procedures				x	x	x	x	x		5
	scope of environmental policy				x	x	x	x	x		5
	enviromental policy implemention				x	x	x	x	x		5
	environmental objectives, achieved results				x			x			
	assessment of environmental performance of organization				x						
	sustainability report				x						
	green lease				x						
	agreements for building and dismantling exhibition				x						
Well-being and health	Users satisfaction survey				x	x	x		x		
	Users satisfaction survey, responses and actions				x	x	x		x		
	view from workplace to outside		x		x		x	x	x		5
	shared relaxing facilities			x	x						
Energy	energy policy	x	x	x	x	x	x	x	x		8
	energy measures from policy	x	x	x	x	x	x	x	x		8
	monitoring energy use	x	x	x	x	x	x	x	x		8
	achieved energy objectives	x	x	x	x	x	x	x	x		8
	energy savings per year in kwh/m2	x	x	x	x	x	x		x		7
Transport	Transport, reduction/ registration environmental impact				x	x			x		
	Transport management, policy				x		x				
	Local amenities, publication	x			x						
	Transport policy, results				x			x			
	Commuting distances employees				x						
	Environmental impact transport operations (transport employees)				x	x					
	Environmental impact transportation of goods				x			x			
Water	Limiting water consumption	x	x	x	x	x	x		x		7
	Implementation and monitoring of water policy				x						
	Water policy, results				x						
	Water use last year				x						
Materials	Sustainable procurement materials				x		x				
	Sustainable procurement materials, implementation				x						
	Selection of suppliers				x		x	x	x		

	centralised recycling service		x		x				x	
water management	low volume flush toilets	x	x	x	x	x			x	6
	dual flush toilets	x	x	x	x	x			x	6
	controlled taps	x	x	x	x	x			x	6
	controllerd flush urinals	x	x	x	x	x			x	6
	washroom control system		x							
	rainwater harvesting	x	x	x	x		x	x	x	7
	greywater recycling	x	x	x			x	x	x	6
accessibility	car access	x	x	x	x		x		x	6
	local/national train network	x	x	x	x		x	x	x	7
	bus	x	x	x	x		x	x	x	7
	subway	x	x	x	x		x	x	x	7
	foot	x	x	x	x		x	x	x	7
	bicycle	x	x	x	x		x	x	x	7
BREEAM-NL Asset										
well-being and health	percentage glass in facade			x				x		
	preventing light disturbance	x		x		x	x	x	x	6
	temperature regulation		x	x			x	x	x	5
	ventilation, control by users		x	x			x	x	x	5
	microbiological contamination			x					x	
	availability of drinkwater			x						
	availability of relaxingrooms			x	x					
	lighting levels inside and outside	x	x	x	x			x		5
	lighting regulation	x	x	x	x			x		5
	design for people with disabilities			x						
	air supply points	x	x	x	x		x	x	x	7
	high frequency lighting			x						
Energy	EPC			x						
	Air permeability measurement and thermographic examination			x						
	share of locally generated renewables	x	x	x				x	x	5
	outdoor lighting - parking lights			x						
	Energy-efficient escalators and moving walkways			x						
Transport	facilities for bicycles	x	x	x	x	x		x	x	7
	Proximity to public transport (OV)	x	x	x	x	x		x	x	7
	Near basics			x						
	Veiligheid fietsers en voetgangers i.v.m. leveringen			x				x		
	Restrict parking			x				x		
	alternative transport	x	x	x	x	x		x	x	7
Water	metering water consumption	x	x	x	x	x	x	x	x	8
	water-saving plumbing	x		x						
	water-saving urinoiurs			x						
	water-saving sinks			x						
	water saving showers			x						
	percentage of white goods with low water consumption			x						
	leak detection central water supply			x		x				
	self closing taps water supply			x						
	percentage of equipment with shut-off valves			x						
	restrict water use of public water net			x				x	x	
	storage tank for grey water and rainwater		x	x				x	x	

	Supplier criteria rate quality				x		x	x	x		
	Supplier criteria environmental management				x		x	x			
	Results material procurement objectives				x			x			
Waste	Waste prevention measures		x	x	x		x	x	x		6
	Waste prevention, control		x	x	x		x	x	x		6
	Waste separate collection		x	x	x		x	x	x		6
	Waste separate, registration volumes		x	x	x		x		x		5
	Waste separate, active prevention		x	x	x		x	x	x		6
	Storing recyclable waste		x	x	x		x	x	x		6
	Waste performance monitoring frequency		x		x			x	x		
	Waste management, performance targets		x		x		x	x	x		5
	Amount of waste to landfill				x						
	Amount of waste reused-recycled				x	x					
	Amount of waste used for energy fuel				x						
Land-use & ecology	Sponsorship and active support				x						
Pollution	Environmental use of the asset				x	x	x				
	Measures to reduce pollution and nuisances				x	x	x	x			
	Reducing pollution: objectives		x		x	x		x			
	Reducing pollution: measures		x		x	x	x	x			5
BREEAM-NL Management											
Management	Users manual					x					
	Provision of information to users - sustainability					x					
	Maintenance and user manual					x					
	Maintenance policy				x	x	x				
	Environmental management system				x	x	x		x		
	Environmental policy and goals				x	x	x	x	x		5
	Procedures for energy savings	x	x		x	x		x	x		6
	Leak testing			x		x	x	x			
	Agreement with users - Greenlease					x					
	Periodic control building management system					x					
	Adaptation strategy		x			x					
Well-being and health	measurment of air supply			x		x	x	x	x		5
	meausurement of indoor climate: exceedance hours					x		x	x		
	intern air quality monitoring, CO,CO2, Nox	x		x		x	x	x	x		6
	protection of employees during working hours					x					
	volatile organic compounds					x					
	indoor climate: local exhaust ventilation					x		x	x		
	Acoustics research					x	x		x		
	Cleaning, deep cleaning					x	x				
	Microbiological contamination, procedures and processes		x	x		x					
	Users satisfaction survey				x	x	x				
	Users satisfaction survey, responses and actions				x	x	x				
Energy	Monitoring energy use	x	x	x	x	x	x	x	x		8
	Use of information on energy consumption	x	x	x	x	x	x	x	x		8
	Annual consumption of energy per type of user			x	x	x					
	Energy savings research				x	x	x				
	Prestation of installations					x					
Water	Metering water consumption	x	x	x	x	x	x	x	x		8
	Policy monitoring water consumption					x					

	Water savings	x	x	x	x	x	x	x	x		8
	Maintenance policy for water systems					x					
	Percentage reused water	x			x	x	x				
	Groundwater extraction					x					
Pollution	Limiting air-light pollution	x			x	x	x	x	x		6
	Chemical storage					x					
	Periodic inspection of chemical storage					x					
	Maintenance policy liquid separators			x		x					
	Replacement refrigerants					x	x		x		
	Research soil pollution plot		x		x	x	x	x	x		6
	Procedure pollution incidents					x					
	Complaints light and noise pollution					x					
Land-use and ecology	Ecological research and implementation	x		x		x	x	x	x		6
	Ecological policy			x		x	x		x		
	Ecological management			x		x	x	x	x		5
GreenStar											
Managament	greenstar accredited profession						x				
	building information						x				
	ongoing monitoring and metering			x		x	x	x	x		5
	tuning and commissioning			x		x	x	x	x		5
	environmental management	x	x		x	x	x	x	x		7
	green cleaning						x		x		
	commitment to performance						x				
Indoor quality	quality of indoor air	x	x	x		x	x	x	x		7
	hazardous materials			x	x	x	x				
	daylight & views		x	x	x		x	x	x		6
	lighting comfort		x	x			x	x	x		5
	thermal comfort	x	x	x	x	x	x	x	x		8
	acoustics comfort	x				x	x		x		
	occupant comfort and satisfaction				x	x	x	x			
Energy	greenhouse gas emissions	x		x			x	x	x		5
	peak elektricity demand	x					x		x		
	alternative transport program	x	x	x	x		x	x	x		7
	transport modes survey						x				
Water	potable water						x				
	fire protection testing water	x	x	x		x	x				5
Materials	procurement and purchasing				x		x	x	x		
	waste from operations		x	x	x		x	x	x		6
	waste from refurbishments						x	x			
Land use and ecology	ecological value	x		x		x	x				
	groundskeeping practices				x	x	x				
	stormwater		x	x			x	x	x		5
Emissions	light pollution	x			x	x	x	x	x		6
	impacts from refrigeration			x		x	x	x	x		5
Innovation	innovation						x	x	x		
LEED BC+D (2019)											
location & transportation	LEED for Neighborhood Development Location							x			
	Sensitive Land Protection			x				x			
	High Priority Site							x			

	Surrounding Density and Diverse Uses							x			
	Access to Quality Transit	x	x	x	x		x	x			6
	Bicycle Facilities	x	x	x			x	x			5
	Reduced Parking Footprint	x		x	x			x			
	Green Vehicles	x						x			
Sustainable sites	Construction Activity Pollution Prevention			x	x	x		x			
	Site Assessment		x		x	x		x			
	Site Development - Protect or Restore Habitat			x		x	x	x			
	Open Space				x			x			
	Rainwater Management	x	x	x			x	x			5
	Heat Island Reduction						x	x			
	Light Pollution Reduction	x		x	x	x	x	x			6
water efficiency	Outdoor Water Use Reduction	x	x	x		x	x	x			6
	Indoor Water Use Reduction	x	x	x	x	x	x	x			7
	Building-Level Water Metering	x	x	x	x	x	x	x			8
	Outdoor Water Use Reduction	x	x	x		x	x	x			7
	Indoor Water Use Reduction	x	x	x	x	x	x	x	x		8
	Cooling Tower Water Use						x	x	x		
	Water Metering	x	x	x	x	x	x	x	x		8
energy & atmosphere	Fundamental Commissioning and Verification						x	x			
	Minimum Energy Performance		x	x		x	x	x			5
	Building-Level Energy Metering		x	x	x	x	x	x			6
	Fundamental Refrigerant Management			x		x	x	x			
	Enhanced Commissioning						x	x			
	Optimize Energy Performance			x	x	x	x	x			5
	Advanced Energy Metering				x		x	x			
	Demand Response	x	x	x	x	x	x	x			8
	Renewable Energy Production	x	x	x			x	x			5
	Enhanced Refrigerant Management			x		x		x			
	Green Power and Carbon Offsets	x	x					x			
materials & resources	Storage and Collection of Recyclables				x			x			
	Construction and Demolition Waste Management Planning				x		x	x			
	Building Life-Cycle Impact Reduction							x			
	Building Product Disclosure and Optimization - Environmental Product Declarations							x			
	Building Product Disclosure and Optimization - Sourcing of Raw Materials							x			
	Building Product Disclosure and Optimization - Material Ingredients							x			
indoor environmental quality	Minimum Indoor Air Quality Performance	x	x				x	x			
	Environmental Tobacco Smoke Control						x	x			
	Enhanced Indoor Air Quality Strategies	x				x	x	x			
	Low-Emitting Materials	x	x	x	x	x		x			6
	Construction Indoor Air Quality Management Plan					x		x			
	Indoor Air Quality Assessment			x	x	x	x	x			5
	Thermal Comfort	x		x			x	x			
	Interior Lighting	x	x	x	x		x	x			6
	Daylight	x	x	x	x		x	x			6
	Quality Views	x	x	x	x		x	x			6
	Acoustic Performance					x		x			

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location & transportation	Alternative Transportation	x	x	x	x		x	x	x		7
sustainable sites	Site Management Policy				x	x			x		
	Site Development-Protect or Restore Habitat							x	x		
	Rainwater Management		x	x				x	x		
	Heat Island Reduction							x	x		
	Light Pollution Reduction	x			x	x	x	x	x		6
	Site Management				x	x			x		
	Site Improvement Plan								x		
water efficiency	Building-Level Water Metering					x	x	x	x		
	Outdoor Water Use Reduction	x		x				x	x		
	Indoor Water Use Reduction	x	x	x	x	x	x	x	x		8
	Cooling Tower Water Use							x	x		
	Water Metering	x	x	x	x	x	x	x	x		8
energy & atmosphere	Energy Efficiency Best Management Practices								x		
	Minimum Energy Performance				x	x		x	x		
	Building-Level Energy Metering	x	x	x	x	x	x	x	x		8
	Fundamental Refrigerant Management							x	x		
	Existing Building Commissioning— Analysis								x		
	Existing Building Commissioning—Implementation								x		
	Ongoing Commissioning							x	x		
	Optimize Energy Performance							x	x		
	Advanced Energy Metering							x	x		
	Demand Response	x					x	x	x		
	Renewable Energy and Carbon Offsets	x	x	x		x		x	x		6
	Enhanced Refrigerant Management							x	x		
materials & resources	Ongoing Purchasing and Waste Policy								x		
	Facility Maintenance and Renovations Policy								x		
	Purchasing- Ongoing								x		
	Purchasing- Lamps								x		
	Purchasing- Facility Maintenance and Renovation								x		
	Solid Waste Management- Ongoing				x		x		x		
	Solid Waste Management- Facility Maintenance and Renovation				x		x		x		
indoor environmental quality	Minimum Indoor Air Quality Performance equipment							x	x		
	Environmental Tobacco Smoke Control							x	x		
	Green Cleaning Policy								x		
	Indoor Air Quality Management Program				x	x		x	x		
	Enhanced Indoor Air Quality Strategies							x	x		
	Thermal Comfort	x		x		x	x	x	x		6
	Interior Lighting		x	x			x	x	x		5
	Daylight and Quality Views		x	x	x		x	x	x		6
	Green Cleaning- Custodial Effectiveness Assessment								x		
	Green Cleaning- Products and Materials								x		
	Green Cleaning- Equipment								x		
	Integrated Pest Management								x		
	Occupant Comfort Survey				x	x			x		

Appendix B interview question list

Voorstelronde

1 Kunt u in het kort vertellen wat uw functie is binnen *bedrijf* ?
2 In welk vakgebied bent u gespecialiseerd binnen het vastgoed?
3 Speelt duurzaamheid een rol in uw dagelijkse werkzaamheden? Indien ja, hoe?

Duurzaamheid

4 Kunt u vertellen wat u verstaat onder 'duurzaamheid' in de gebouwde omgeving?
5 Wat zijn volgens u typische kenmerken van een duurzaam kantoor?

Assessment tools

Op dit moment bestaat er een overvloed aan duurzaamheidstools om de duurzaamheid van een pand in kaart te brengen, denk bijv. aan BREEAM, WELL, etc.
Zoals ik al eerder heb aangegeven wil ik onderzoeken of een versimpelde duurzaamheidstool door taxateurs gebruikt kan worden om 1) de duurzaamheid van een kantoorpand middels een score kunnen uitdrukken en 2) of een versimpelde tool kan bijdragen aan het bepalen van de meerwaarde van duurzaamheid in taxaties.

6 Denkt u dat de verschillende scores die te behalen zijn (met certificeringsschema's) een goede weerspiegeling zijn van het begrip duurzaamheid?
7 Hoe denkt u over de (toepasbaarheid van de) verschillende certificeringsschema's?
8 Denkt u dat een versimpelde assessment tool / gebruiksvriendelijke tool voor taxaties door de markt geaccepteerd zou worden ?
- indien ja/nee, waarom wel/niet?

Thema's /indicatoren

Voor het eerste gedeelte van mijn onderzoek heb ik de meest voorkomende indicatoren uit de literatuur samengevat in een schema* .. voornamelijk gebaseerd op de bekende certificeringsschema's en andere auteurs die veel hebben bijgedragen aan dit onderwerp.

9 Denkt u dat deze (versimpelde/korte) lijst aan indicatoren een goede indicatie weergeeft van wat een duurzaam kantoor zou moeten zijn?
10 Kunt u, gebaseerd/aan de hand van uw ervaring, vertellen welke indicatoren het meest relevant zijn per sub-categorie?
11 Hoe zou u deze indicatoren meten?
12 Zijn er andere indicatoren die u zou toevoegen aan de sub-categorieën?
13 Vindt u dat alle thema's (met de bijbehore indicatoren) even belangrijk zijn dus even zwaar moeten wegen in een assessment (duurzaamheidsscore)?
14* Ziet u (andere) belemmeringen in de implementatie van zo een (versimpelde) tool, zo ja, welke?

Afsluiting

15 Heeft u nog vragen over mijn onderzoek en over het gebruik van uw gegevens? etc etc

Appendix C

Original transcript of the quotes in Dutch

Definition of sustainability

''...Wetgeving is voor achterblijvers, dat wil ik je wel meegeven. (interviewee 6)

''...Echt duurzaam zijn de gebouwen nooit, ze gebruiken altijd energie, materiaal en water. Wat je dan kan doen is beter maken dan de standaard. (interviewee 1)

''...We willen aan onze behoeftes voldoen als mens, maar niet alleen nu, maar ook later, niet alleen hier maar ook op een andere plek. (interviewee 7)

Energy category

''... energielabel zou ik eigenlijk niet hanteren.. dat is steeds meer dat je hoort, dat het een papieren oefening is dan dat het iets zegt over de praktijk.''(interviewee 4)

''...Bij energie, is het belangrijk om de werkelijke CO2 uitstoot van het actuele energieverbruik te meten. Dus 3, de werkelijke CO2 uitstoot, en dan ook met de bijbehorende mix van energie. Dus je hebt werkelijke co2 uitstoot en werkelijke energieverbruik. Het werkelijke energieverbruik in kwh, van gas elektra en warmte. CO2 uitstoot is van, wat hoort bij 5, daarvan de werkelijke CO2 uitstoot. Maar is wel een aparte, geloof niet dat die erbij stond. 5 is werkelijk energieverbruik en dan is, 8 is werkelijke co2 uitstoot van dat energieverbruik.En dan 2 heb je al te pakken, en 1 die zou ik tijdelijk blijven meten. Die zou ik een tijdje meten. totdat we 5 en anders gaan doen, 8, is het energielabel de enige meting die we hebben. Dus 1, 5, en 8, dat is energieverbruik monitoren. ''(interviewee 8)

''...het goede aan de labels is, dat het eigenlijk recepten zijn hoe je je gebouw kunt verbeteren om minder impact te hebben op je omgeving en een goed gebouw voor de gebruikers. Maar wat er aan mist is hoe je een gebouw circulair maakt namelijk dat het nog bijv 100 jaar meegaat.'' (interviewee 8)

''...Maar als je het hebt over een taxateur, en wat verschil zal uitmaken, de energielabel is er al. Dat betekent dat de categorie energie al redelijk goed ingevuld zou moeten zijn. '' (interviewee 1)

''...En ik zie bij energie, heb je epc incl de beng, maar daarnaast ook nog energie aandeel.. en energieverbruik en elektriciteitsnet, terwijl als je met de beng gaat werken, beng bestaat uit drie delen en beng is ook aandeel energie opgewekt. Dus dan zou ik voor 1 epc label gaan en werkelijke energieverbruik gaan als ze beschikbaar zijn, en actief met elkaar monitoren. Tegenwoordig zijn er steeds meer systemen die dat kunnen, sluit het werkelijke energieverbruik van het pand aan op het energieverbruik wat je zou verwachten op basis van label. en daar een analyse van, dat zou moeten bijdragen aan, dat heeft te maken met energie prestatie boring, heeft allemaal met elkaar te maken die 3 dingen. Hier zit wel veel dubbel in in dit lijstje, misschien kan je dit terugbrengen naar 1/2/3...Dan zou ik zeggen energie prestatie gebouw en combinatie energieverbruik, en daarbij de energiezuinige buitenverlichting. De rest zit in de epc allemaal, als je met BENG werkt, dan zit aandeel en duurzame energiebronnen daarin hoef je niet allemaal apart te nemen. '' (interviewee 2)

''Prestatieborging uit management categorie, dit is eentje die ook in de bestaande bouw toegepast kan worden en er kan zo veel mee bespaard worden. Die zou je ook onder energie kunnen plaatsen, onder het monitoren van werkelijk energieverbruik. Krijgt de eigenaar van het gebouw na oplevering wel het gebouw wat je ontworpen hebt en sterker nog wat je gevraagd hebt. Dus een soort check of het gebouw is gebouwd volgens de tekeningen, er worden zo veel bouwfouten gemaakt. Voor de bestaande bouw geldt zijn de huidige installaties wel toegerust op het huidige gebruik van het gebouw. Analyseren van, stel kantoorcellen zijn omgebouwd naar kantoortuinen, hebben ze dan de installatie ook aangepast? Als daar veel meer mensen zitten dan de installaties ooit voor ontworpen waren, dan moeten de installaties keihard draaien, dan heb je dus niet de gezonde lucht die je zou willen en tegelijkertijd gebruik je heel veel energie om de stroom voor al die mensen, maar ook voor voldoende ventilatie te voldoen. Het managen van die installaties is wat mij betreft wel een belangrijke.'' (interviewee 2)

''Prestatieborging uit management categorie, dit is eentje die ook in de bestaande bouw toegepast kan worden en er kan zo veel mee bespaard worden. Die zou je ook onder energie kunnen plaatsen, onder het monitoren van werkelijk energieverbruik. Krijgt de eigenaar van het gebouw na oplevering wel het gebouw wat je ontworpen hebt en sterker nog wat je gevraagd hebt. Dus een soort check of het gebouw is gebouwd volgens de tekeningen, er worden zo veel bouwfouten gemaakt. Voor de bestaande bouw geldt zijn de huidige installaties wel toegerust op het huidige gebruik van het gebouw. Analyseren van, stel kantoorcellen zijn omgebouwd naar kantoortuinen, hebben ze dan de installatie ook aangepast? Als daar veel meer mensen zitten dan de installaties ooit voor ontworpen waren, dan moeten de installaties keihard draaien, dan heb je dus niet de gezonde lucht die je zou

willen en tegelijkertijd gebruik je heel veel energie om de stroom voor al die mensen, maar ook voor voldoende ventilatie te voldoen. Het managen van die installaties is wat mij betreft wel een belangrijke.''

Health & Well-being category

As stated by interviewee 6; ''...Ik kan me voorstellen dat het voor de waarde van een kantoor best interessant is, wat we al weten, maar wat je weinig terugziet in de waarde is dat een gezond kantoor goed is voor de medewerkers. Misschien moeten we dat ook definiëren wanneer is een kantoor gezond, dat dat goed is voor de medewerkers, zijn de medewerkers ook weer minder ziek wat goed is voor de productiviteit. en vastgoedeigenaar heeft niet veel aan een gezond kantoor dat is echt voor de huurder die echt een gezond kantoor wilt. En daar dan dus ook baat bij heeft....''

''Ik was gisteren een audit aan het doen bij (). Daar hebben ze dus een soort afstandsbediening per 6 werkplekken en daar zitten ze allemaal mee de temperatuurregeling licht te regelen terwijl ze gewoon in een open tuin zitten. Dus die installatie weet helemaal niet wat hij moet doen, die zit in de winter nog heel veel kou op te wekken voor mensen die het te warm hebben.. dat is eigenlijk helemaal niet duurzaam.. Ik heb nog nooit gezien dat het werkt, mensen willen het graag, maar juist daardoor ervaart iemand het als warm of koud. Je moet ervoor zorgen dat er 1 temperatuur is en verder dat je zonwering hebt, dat je niet in de warme zit weetjewel, zo kan je het een beetje aanpasbaar maken. ''(interviewee 4)

''...Of dat nou echt waardevermeerdering is, temperatuurregeling. daarvan zo ik zeggen, eh, ja dat wil je helemaal niet op individueel niveau. In breeam komt dat wel naar voren dat dat fijn is, maar eigenlijk is dat super onhandig. ''(interviewee 3).

''...Dan zou je ipv alle losse vragen kunnen vragen net zoals in de breeam in use is er een gebruikerstevredenheid onderzoek waar dit soort dingen in staan. Ofwel wordt er actief gemeten en gemonitord of gebruikers tevreden zijn over de gezondheidsaspecten binnen het gebouw en het werkklimaat; zowel warmte, licht als verse lucht en temp regeling en dat soort zaken. Die zouden best belangrijker kunnen zijn dan alle losse dingen samen. Als het gebouw gezond moet zijn dan zijn dit wel belangrijke indicatoren, maar als een taxateur ook mag vragen wordt er gestuurd of verbeteren van het comfort, van gezondheid, dan zou je meer zo een gebruikerstevredenheidsonderzoek als indicator kunnen stellen. ''(interviewee 2)

''...Ik zou steeds beginnen met grof naar fijn. Dus het begint met de beleving van de werkplek, waar dat ook is. De net promoter score of iets, klanttevredenheid, vervolgens met de feitelijke gezondheid van die mensen, dat zijn allebei resultaat variabelen. En de procesvariabelen zijn die dingen die daaronder staan. Wat daaronder staat zijn procesvariabelen waarnaar je gaat kijken als de resultaat variabelen niet kloppen, niet volgens het doel. Dus ik zou bij gezondheid zeggen, WELL als meting, klanttevredenheid, en gezondheid (ziekte fitheid, ziekteverzuim, mate van fitheid van je medewerkers). En dan zijn de andere dingen, process variabelen. ''(interviewee 8)

Water category

As stated by interviewee 3; ''...Als ik even naar breeam kijk, is water in het buitenland een stuk belangrijker, zoals in well wat zich op gezondheidskenmerken richt, daar richten zij meer op kwaliteit van het water. Terwijl in Nederland de kwaliteit van water best goed geregeld is, vanuit de wetgeving, de waterzuiveringsinstallaties Hier gaat het veel meer over het verminderen van waterverbruik en hergebruik van water. Voor bijv. de groenvoorzieningen, of de toiletten doorspoelen. ''

Interviewee 5 stated; ''...Water zie ik als klimaatadaptief. We zijn gewend om naar het gebouw te kijken maar wat gebeurd er dan om je gebouw heen want we hebben te maken met overstromingen. Ik woon zelf in (), ik weet niet waar jij woont, bij een harde regenbui kijk ik naar buiten en denk ik nou dat is allemaal betegeld, allemaal te veel water, water kan gewoon niet weggevoerd worden. Of te weinig capaciteit. Dan denk ik ja, als gebouw kun je daar best wel wat mee doen of als gebouweigenaar.''

''...De belangrijkste soort van water is eigenlijk, stormwater. Dus als het hard regent, dan, door onze, omdat we de gebouwen heel erg verstenen en straten verstenen kan onze riool de waterafvoer niet aan. Dus het begint eigenlijk met, je zou het klimaatadaptatie kunnen noemen, maar het is eigenlijk hemelwaterafvoer. Dus groene daken, en tuinen rondom de gebouwen heen. Daar begint het mee. Stel dat je alles van steen maakt, maar je doet er een grote pijp aan, heb je nog steeds riool overstroming. Dus door de klimaatverandering krijgen we steeds meer heftige stormen, je moet je gebouw daarop inrichten. Voor de rest heb je in Nederland niet echt een watervraagstuk, alhoewel de afgelopen dagen met de warmte wel. ''(interviewee 8)

‘’...Water in een kantoor, waterbesparend sanitair is heel belangrijk en waterverbruik meten met submeting. ‘’ (interviewee 2)

‘’...Waterbesparend sanitair begint belangrijker te worden. We zitten nu weer, volgens mij is het de 3e zomer dat we ingaan waarin we met een flink watertekort opkomen. En, dat we er echt wel zuiniger mee om moeten gaan. Waterbedrijven echt roepen ons op om minder lang te douchen. Als je daar als werkomgeving aan kunt bijdragen dan lijkt me dat heel logisch. Dus waterbesparend sanitair lijkt me echt prima. ‘’(interviewee 6)

‘’...waterbesparend sanitair, dat is even de vraag voor een quickscan, misschien wil je het dan opsplitsen of dat je bijv, ja, zou altijd heel simpel kunnen maken is er een stroomonderbreker als je doortrekt, dat je, volume keuzeknop dat soort dingen. Urinoir op zich gebruikt minder dan een gewoon toilet. Dan zou je wat, makkelijker te maken voor diegene die het invult. ‘’(interviewee 7)

‘’...In Nederland is water niet een groot issue, laatste 2 jaar hoor je wel veel over droogte enzovoort, er komt meteen een heleboel onderhoud bij kijken als je een grijswatersysteem hebt. Ik hoor en ervaar dat het onderhouden en inregelen daarvan en alles veel lastiger is dan uiteindelijk het meer tijd en energie kost dan dat het gwn.. ja.. heeft niet veel zin.. Is meer een hele zichtbare maatregel dan dat het echt duurzaamheidswinst geeft. ‘’(interviewee 4)

‘’...In Nederland is het heel gebruikelijk om water te bemeteren van 1 gebouw maar als je echt goed wilt meteren en kunnen monitoren moet je alle grote waterverbruikers monitoren. dus bijv het water wat een wko ingaat, dat zou ook gesubmeterd moeten worden. Waterverbruik wat ventilatie of verwarmingssystemen in gaat bijv, of als je een grote spoelkeuken hebt. In Breeam in use staat alle groepen die meer dan 10% van het totale waterverbruik. ‘’(interviewee 2)

Materials

‘’...Die conditiemeting kan jou 5 of 10 jaar van tevoren voorspellen wanneer je jouw dak moet verduurzamen. De conditiemeting is eigenlijk het beginpunt en eindpunt van de verduurzaming van gebouwen (interviewee 8).’’

‘’...Ja. Ik vind het heel goed dat je het hebt opgeschreven, maar, ik denk wel dat dat voor een taxateur lastig is om in te schatten. We zijn gewoon nog niet zo ver. Het bepalen van een EPC van een gebouw daar zijn we al heel lang mee bezig, al sinds 1995 ofzo. Het bepalen van de milieu impact van gebouwen, daar zijn we nu mee begonnen als het gaat over nieuwbouw, Helemaal niet over bestaande bouw. Het enige wat je visueel ziet is bijv. als er veel hout is gebruikt, dan weet je dat de milieu impact wat lager is, staal heeft bijv echt een hoger impact. Misschien zijn er een aantal materialen die een hoger milieu impact hebben maar ik weet nou niet.. ik vind het lastig om daar nu al iets over te zeggen over waardes (interviewee 6).’’

‘’...Voor bestaande bouw vraag ik me even af of het voor de gebruiksfase of het dan goed belangrijk is om die inventarisatie te maken. Want we zijn ook aan het kijken wat zijn de belangrijke dingen in circulariteit bij bestaande gebouwen, dan zijn het toch vaak de stromen die in en uitgaan in een bestaand gebouw. Voedsel voor de kantine, meubilair die om de zoveel tijd vervangen wordt(interviewee 7).’’

‘’...Als we nu die materialen gaan bijhouden om het gebouw een keer te gaan slopen. Maar de gebouwen die niet gesloopt gaan worden, daar wil je eigenlijk alleen de systemen kennen, je wilt weten welke verwarmingen er in zit, wat voor hout in de kozijnen zit. Maar je wilt niet weten over en schroeven of pijpen inzitten, dat boeit je gewoon niet. Dus, ik denk dat gebouwen in kaart gebracht moeten worden maar niet een materialenpaspoort maar dat het een gebouwenpaspoort moet zijn (interviewee 8).’’

‘’...ik zie dat voornamelijk relevant voor nieuwbouw en renovatieprojecten. Want eigenlijk bestaande bouw, ik zie gebouwen die monumentaal zijn en al 20-100 jaar staan. Die zijn eigenlijk gebouwd met materialen die niet demontabel zijn of lastig te demonteren. Dus deze demontabele materialen is belangrijk als je materialen toevoegt aan je gebouw, dat ze demontabel zijn. Maar je kan lastig van een pand uit 1920 verwachten dat het demontabel is, aangezien in die tijd dat niet werd gedaan.’’ (interviewee 3).

Pollution

‘’...Er wordt in de breeam vrij makkelijk gehaald, daar staat letterlijk is er een afvalruimte groot nodig om afval te verzamelen, maar uiteindelijk gaat het erom is er een afvalverzamel contract. En wordt er actief op gestuurd dat gebouwgebruikers op de verdiepingen gescheiden afval kunnen inzamelen en krijgen de schoonmakers ook de opdracht om dat op de juiste manier weer kwijt kunnen (interviewee 2).’’

''...Dus bijv, gescheiden afval is een hele belangrijke. Want restafval wordt verbrand of onder een weg begraven, en daar gaan we nooit meer wat mee doen. Alles waar die restafval terecht komt, is voor eeuwig verloren. Dus kilo's afval, niet hernieuwbare afval, moeten naar nul toe, anders worden we nooit circulair. Dus afval is, is niet zo zeer vervuiling, maar meer het beperken van het gebruik van de grondstoffen van de aarde (interviewee 8).''

''..Kijk. koudemiddelen, men heeft het snel over co2 uitstoot als belangrijkste broeikasgasemissies. Maar koudemiddelen bevatten veel schadelijke stoffen die schadelijker zijn voor de ozonlaag of voor allerlei andere milieukundige aspecten dan CO2. Kan soms wel 400x zo schadelijk zijn dan CO2. Maar bijvoorbeeld bij kleinere gebouwen komt een installatie met koudemiddelen niet voor. Dus ligt aan wat voor gebouwen een taxateur beoordeeld (interviewee 3).''

''...Dus als het hard regent, dan, door onze, omdat we de gebouwen heel erg verstenen en straten verstenen kan onze riool de waterafvoer niet aan. Dus het begint eigenlijk met, je zou het klimaatadaptatie kunnen noemen, maar het is eigenlijk hemelwaterafvoer. Dus groene daken, en tuinen rondom de gebouwen heen. Daar begint het mee. Stel dat je alles van steen maakt, maar je doet er een grote pijp aan, heb je nog steeds riool overstroming.'' (interviewee 8).

Ecology

'...Een ecologisch onderzoek kan wel van belang zijn maar daar heeft hij niet veel mee. Dat zou een taxateur moeten opvragen, maar om daar echt wat mee te doen, is aan de huurder of verhuurder. Dus een taxateur kan zeggen we hebben een stuk groen met groenvoorzieningen, dan bepaalt de huurder of verhuurder of hij wat wilt toevoegen. Maar binnen stedelijke gebieden heb je bijna helemaal geen groenvoorzieningen, dan kun je wel een ecologisch onderzoek laten uitvoeren, maar dat voegt dan denk ik toch vrij weinig toe (interviewee 1).''

As stated by interviewee 6: ''...Weetje, op het moment dat je gaat verbouwen, als je niks verandert is het niet zo belangrijk. Als je gaat verbouwen is het wel belangrijk, je bent namelijk niet verplicht, maar het is verboden om rust en nestplaatsen van de fauna te verstoren. Dus op het moment dat jij gaat renoveren moet je onderzoek doen naar zijn er vleermuizen, andere insecten vogels, die op dit moment gebruik maken van het gebouw, alle gaatjes van het gebouw, en moet ik daarvoor voorzieningen voor treffen. ''

''...Als je een snelle quickscan wilt, en je stelt een onderzoek verplicht, dan is het bijna geen quickscan meer. Als je, ik zou het eerder houden op zijn er groenvoorzieningen en ecologische voorzieningen. En als je dan meer diep ingaat zijn die voorzieningen op een goede manier geplaatst hebben ze ecologische waarde, hoe verhoudt dat zich tot voorzieningen in de omgeving. Dan ga je al een stap dieper. Het is wel heel nuttig hoor een ecologisch onderzoek maar dan ga ja alweer, dat is een stap verder dan een snellere tool. Dus het hangt even vanaf waarvoor je het wilt gebruiken (interviewee 7).''

''...Hittestress; als je een groene dak hebt, absorbeert je gebouw meer warmte. Onze steden zijn bronnen van de opwarming van de aarde. Ik denk dat klimaat adaptiviteit en hittestress extreem belangrijk zijn En dit hoort eigenlijk bij toekomstbestendigheid. Terwijl die andere dingen een beetje onderaan de belangrijkheid lijst staan (interviewee 8).''

''...Ik vind het wel belangrijk, wat ze eigenlijk moeten doen, is de kracht van de verlichting moet afgestemd zijn op de omgeving en om 11 uur s avonds moet het allemaal uit. Dus dat er een tijdklok op zit (interviewee 4).''

Transport

''...Eh ja ik vraag me alleen af, als je voorzieningen hebt voor fietsers, dan komen de voetgangers ook wel redelijk veilig op locatie. Je kan altijd via een fietspad gaan. Ik weet niet of je alles in kaart moet brengen. Veilige routes vind ik niet per se zinvol. Als deze uit BREEAM komt bijv, soms op een parkeerterrein waar helemaal niet zoveel gereden wordt, die toch niet voldoet, omdat het geen wandelpad is. Maar als ik op een parkeerterrein sta voel ik me eigenlijk nooit onveilig (interviewee 1).''

''...Ik zou eerder zeggen dat de leveranciersingang gescheiden moet zijn van de hoofdingang, daar heb je de meeste risico' dat je aan de voorkant parkeerplaatsen hebt en auto's motoren voetgangers fietsers komen dat is prima, maar de leveranciers moeten gewoon aan de andere kant komen (interviewee 4).''

Another remark by interviewee 3; ''...Toch zie je snel bij transport dat ov enorme impact kan hebben op hoe mensen naar werk toe reizen, ehm, ja zeker voor kantoren dan tenminste,. Als je het hebt over distributiecentra, die liggen vaak in de weid einde periferie, dus daar is OV juist minder belangrijk omdat daar alleen in en aanvoer van toepassing is.''

''...Je kan je afvragen of jouw definitie, in welke mate de definitie van taxateurs moet zijn. Als ik nu naar de taxateurs ga toeschrijven, dan schrijf ik eigenlijk naar het verleden. Dus je zegt dit is wat een taxateur zou moeten meten. Dan komt er een lijstje, in de huidige tijd betekent dat deze vragenlijst. Bij transport is het natuurlijk super belangrijk dat er, de faciliteiten er zijn, deze moet je allemaal meenemen. Dit zijn ook dingen, techniek kan je wel een keer aanpassen. Maar als jij niet bij het station zit, zijn mensen gedwongen om met de auto te komen. Deze locatie dingen hebben veel meer eeuwigheid impact dan of je wel of geen luchtbevochtiging hebt in het gebouw (interviewee 8).''

Future

''...Tot nu toe werd daar weinig aandacht aan besteed, maar met inclusiviteit en al die dingen wordt daar steeds meer naar gevraagd, en ook deze zijn redelijk goed zichtbaar en kan een taxateur redelijk snel over zeggen. Dan is het wel handig om na te denken over wat betekent een beperking dan, heb je het over een rolstoel, blinde, dove mensen. Het kan iedereen gebeuren, dat je een gebroken been hebt en met een rolstoel naar werk moet. Het is niet dat mensen met een beperking alleen moeite hebben maar werknemers kunnen ook een beperking hebben. Het is wel goed om hierover na te denken (interviewee 1).''

''... Customizability functionality is a bit similar. Yes well that is also important. That is future-proof, especially the demand for offices. Especially now, now that everyone is working from home, whereby offices will have a different approach. Not as a real workplace, but as meeting spaces, at a safe distance. Then it is better if your ventilation is also adjusted accordingly, as well as your space and your layout'' (interviewee 3).

Management

. As stated by interviewee 3: ''...Greenlease, daar zijn verschillende ervaringen mee. De ene komt zijn lease niet na, in de prullenbak gegooid bij wijze van spreke, of die ziet het dan als een juridisch instrument wat juridisch is vastgelegd, dus die afspraken moeten dan wel nageleefd worden. Dus er zijn verschillende ervaringen mee. Het is wel een goed instrument om de huurder mee te nemen in het hele duurzaamheids verhaal.''

''...Op het moment dat jij dus als huurder en als verhuurder afspraken over verduurzaming hebt vastgelegd in een huurovereenkomst of in een allonge dan is dat een dikke plus. Dan ben je er gwn van bewust dat je zowel als huurder of verhuurder een rol hebt in verduurzamen. Je vroeg al wat is de definitie van duurzaamheid, daar begint het al bij, het gaat niet alleen over de prestatie van het gebouw, Maar ook over hoe je met het gebouw omgaat dus hoe je het gebruikt. Dat moet je dus ook in een greenlease afspreken. Een greenlease geeft eigenlijk bijna aan dat het bijna bijzonder is. Ik zou bijna zeggen een huurcontract waarin afspraken rondom duurzaamheid zijn gemaakt. Ik ben langzamerhand een beetje toe aan dat duurzaam bijzonder is. Voor een taxateur is dat nog wel bijzonder, die zijn net begonnen daarmee. Het is nieuw allemaal. Maar duurzaamheid moet gewoon normaal worden. Met greenlease zeg je dat het heel bijzonder is terwijl je eigenlijk een huurcontract wil hebben waar het allemaal in staat (interviewee 6).''

''...Je moet in de gaten houden dat je in NL 3 grote transities hebt, je hebt de energietransitie naar 2050 toe, de materialen transitie naar materialen paspoorten naar circulariteit, grondstofuitputting die we moeten voorkomen, resources en materiaal gebruik en afval, en derde is de gezondheidstransitie,. Dat is de waarde van productiviteit, kwaliteit op de werkplek, maar dat is veel meer werkplek kwaliteit. Dat zijn de grote transities aan de voorkant. Aan de achterkant heb je klimaatadaptatie, hittebestendig, wateropvang, ecologische voorzieningen. Met die vier dingen zou je eigenlijk al heel ver kunnen komen. Dus een goed energiebeleid, resilience klimaatadaptatie beleid, gezondheid vh gebouw. '' (interviewee 2)

''...Maar ook verduurzamingsplan van je vastgoed. Wat zijn je plannen op lange termijn, heb je er een routekaart voor. Dit Is heel belangrijk hierin. '' (interviewee 5)

''...Je zou indicatoren veel makkelijker kunnen opsplitsen in; is er een energiebeleid, is dat uitgewerkt in sub metingen met monitoring, is dat uitgesplitst in een a label, in een routekaart naar energieneutraal en van gas af. Dat je met meerdere sub dingen gaat werken uit het beleid. En dan moet dat beleid ook aanwezig zijn, En natuurlijk het energielabel.'' (interviewee 2)

Appendix D

Sustainability assessment

August 27th 2020, 9:11 am MDT

Q - What is your current role/position?

What is your current role/position?
[redacted]
[redacted]
[redacted]
[redacted]
[redacted]
[redacted]
[redacted]
[redacted]
[redacted]
[redacted]
[redacted]

*answers are left out for privacy concerns and company sensitive information

Q - How many years of experience do you have with sustainability?

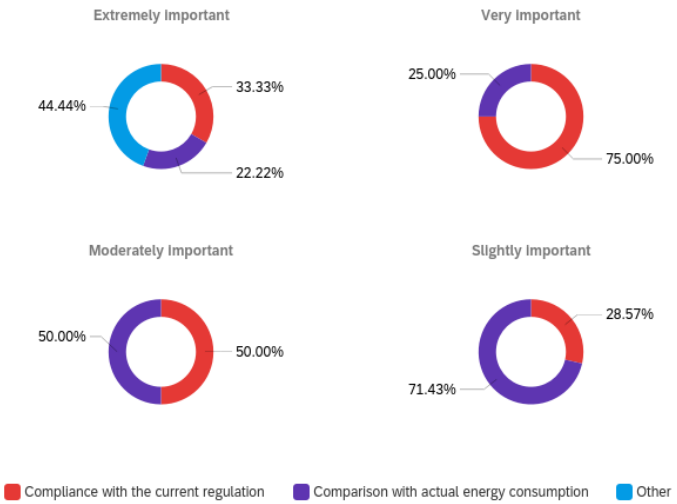
How many years of experience do you have with sustainability?
5
20
20
12
15
24
12
5 years
30
3
5
11

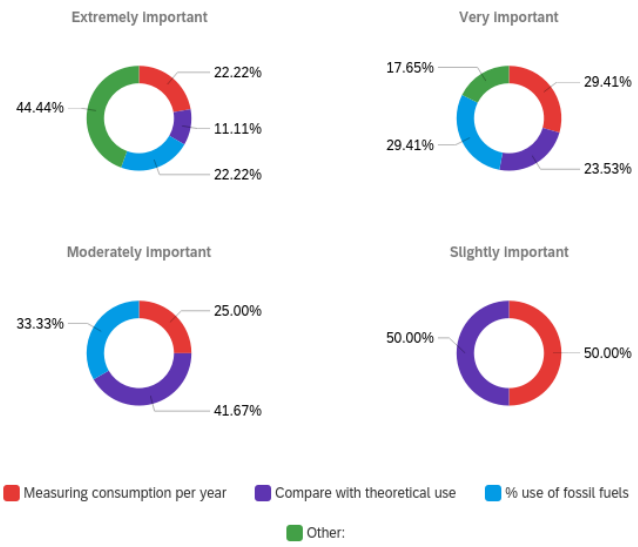
Q1 - ENERGY How important are the following indicators within the category 'Energy' for sustainable offices, according to your experience/view? Please divide a total of 100 points. If an indicator has no importance, you can assign 0 points.

#	Field	Minimum	Maximum	Mean	Count
1	EPC	5.00	50.00	24.45	11
2	Monitoring energy use	10.00	50.00	24.18	11
3	Sustainable energy sources	20.00	39.00	29.00	11
4	Commissioning (prestatieborging)	5.00	35.00	22.36	11

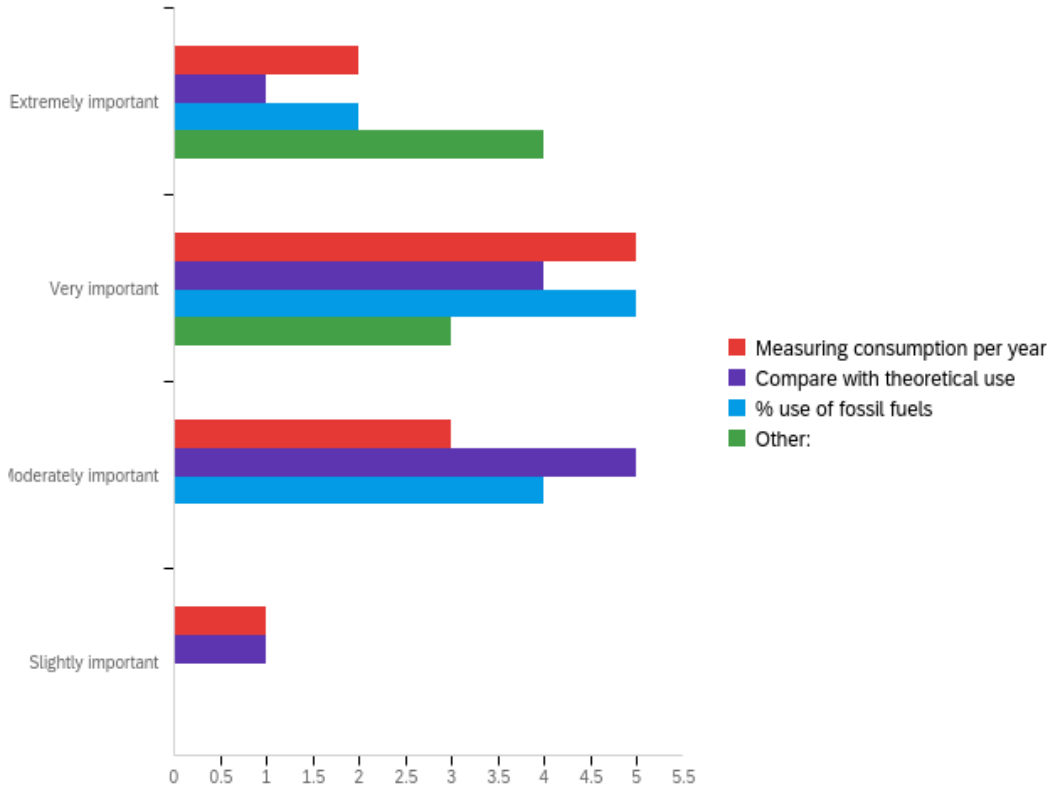
#	Field	Minimum	Maximum	Mean	Count
1	Compliance with the current regulation	1.00	4.00	2.36	11
2	Comparison with actual energy consumption	1.00	4.00	3.00	11
3	Other	1.00	1.00	1.00	4

#	Question	Extremely important		Very important		Moderately important		Slightly important		Total
1	Compliance with the current regulation	27.27%	3.00	27.27%	3.00	27.27%	3.00	18.18%	2.00	11.00
2	Comparison with actual energy consumption	18.18%	2.00	9.09%	1.00	27.27%	3.00	45.45%	5.00	11.00
3	Other	100.00%	4.00	0.00%	0	0.00%	0	0.00%	0	4.00



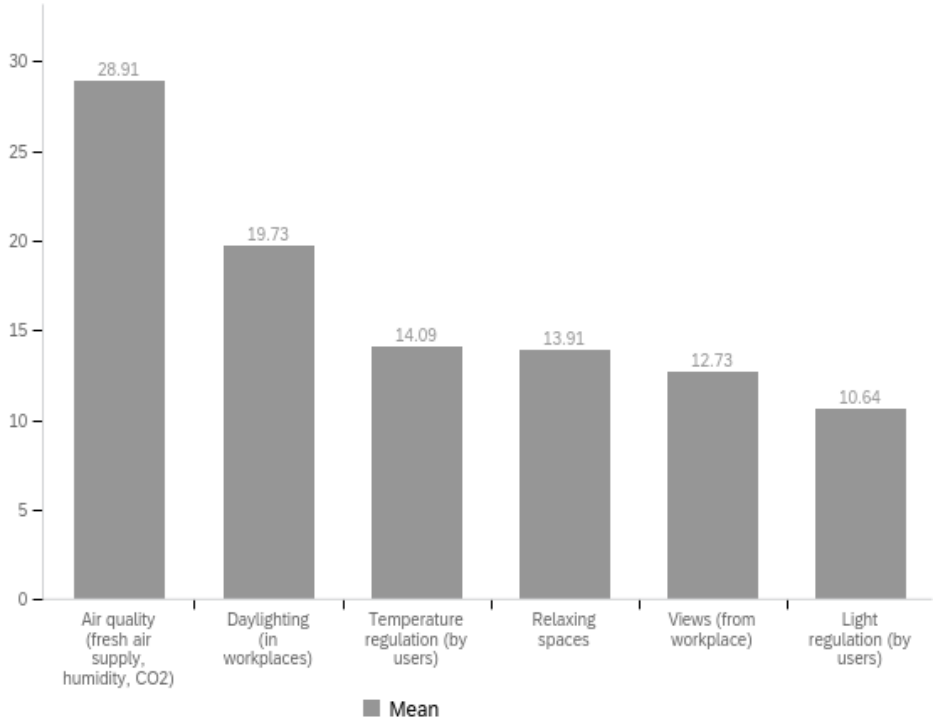


Q3 - How important are the following aspects for the indicator 'monitoring energy use' according to your experience/view?



#	Question	Extremely important		Very important		Moderately important		Slightly important		Total
1	Measuring consumption per year	18.18%	2.00	45.45%	5.00	27.27%	3.00	9.09%	1.00	11.00
2	Compare with theoretical use	9.09%	1.00	36.36%	4.00	45.45%	5.00	9.09%	1.00	11.00
3	% use of fossil fuels	18.18%	2.00	45.45%	5.00	36.36%	4.00	0.00%	0	11.00
4	Other:	57.14%	4.00	42.86%	3.00	0.00%	0	0.00%	0	7.00

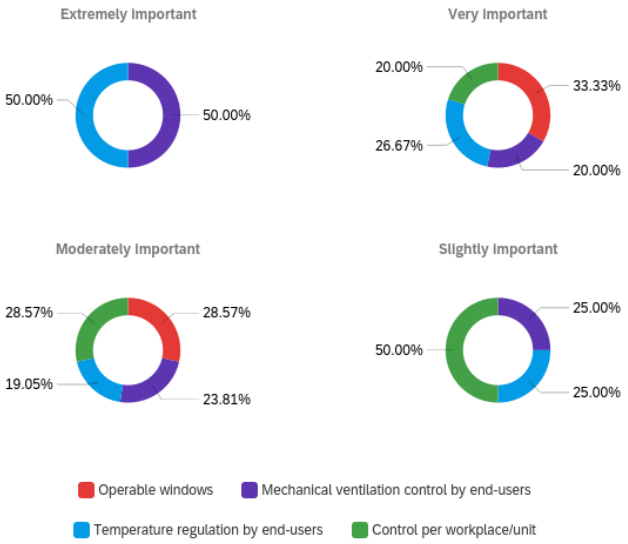
Q4 - HEALTH & WELL-BEING How important are the following indicators within the category 'Health & Well-being' for sustainable offices, according to your experience/view? Please divide a total of 100 points.



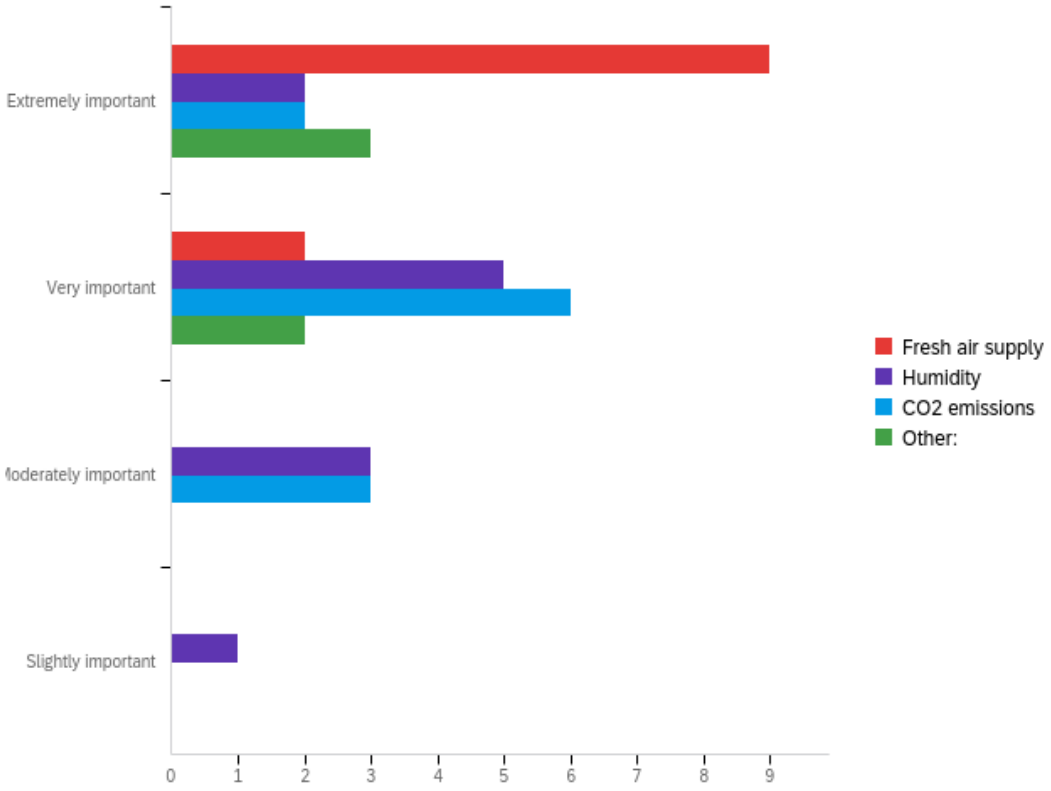
Q5 - How important are the following aspects in 'temperature regulation' according to your experience/view?

#	Field	Minimum	Maximum	Mean	Count
1	Operable windows	2.00	3.00	2.55	11
2	Mechanical ventilation control by end-users	1.00	4.00	2.45	11
3	Temperature regulation by end-users	1.00	4.00	2.36	11
4	Control per workplace/unit	2.00	4.00	2.91	11

#	Question	Extremely important		Very important		Moderately important		Slightly important		Total
1	Operable windows	0.00%	0	45.45%	5.00	54.55%	6.00	0.00%	0	11.00
2	Mechanical ventilation control by end-users	18.18%	2.00	27.27%	3.00	45.45%	5.00	9.09%	1.00	11.00
3	Temperature regulation by end-users	18.18%	2.00	36.36%	4.00	36.36%	4.00	9.09%	1.00	11.00
4	Control per workplace/unit	0.00%	0	27.27%	3.00	54.55%	6.00	18.18%	2.00	11.00

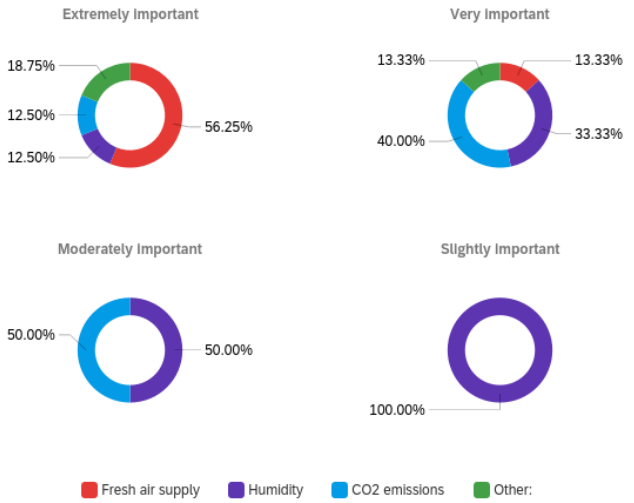

Extremely Important
50.00%
50.00%
Very Important
20.00%
33.33%
26.67%
20.00%
Moderately Important
28.57%
28.57%
19.05%
23.81%
Slightly Important
25.00%
50.00%
25.00%
Operable windows
Mechanical ventilation control by end-users
Temperature regulation by end-users
Control per workplace/unit

Q6 - Which of the following aspects determine the indoor air quality and should be included in the assessment of a sustainable office?

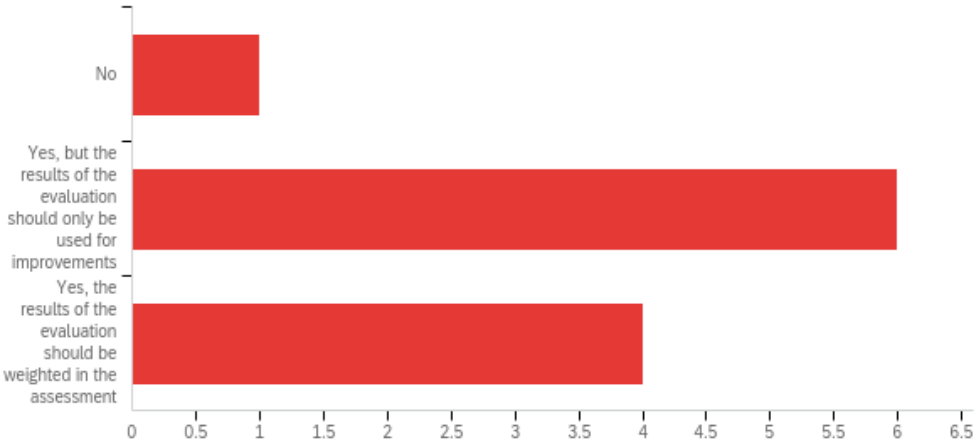


#	Field	Minimum	Maximum	Mean	Count
1	Fresh air supply	1.00	2.00	1.18	11
2	Humidity	1.00	4.00	2.27	11
3	CO2 emissions	1.00	3.00	2.09	11
4	Other:	1.00	2.00	1.40	5

#	Question	Extremely important		Very important		Moderately important		Slightly important		Total
1	Fresh air supply	81.82%	9.00	18.18%	2.00	0.00%	0	0.00%	0	11.00
2	Humidity	18.18%	2.00	45.45%	5.00	27.27%	3.00	9.09%	1.00	11.00
3	CO2 emissions	18.18%	2.00	54.55%	6.00	27.27%	3.00	0.00%	0	11.00
4	Other:	60.00%	3.00	40.00%	2.00	0.00%	0	0.00%	0	5.00

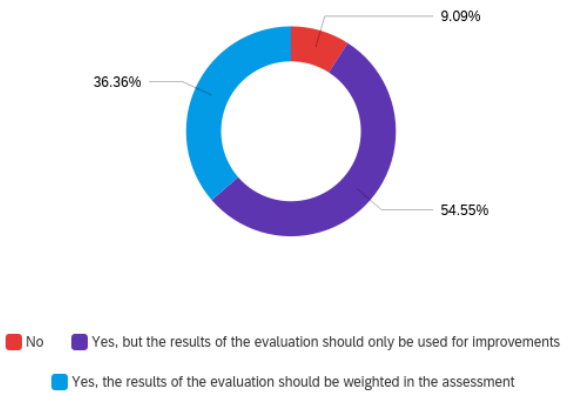


Q7 - Would you include an indicator 'post-occupancy evaluation for tenant satisfaction' for the category 'Health & Well-being' in the assessment?

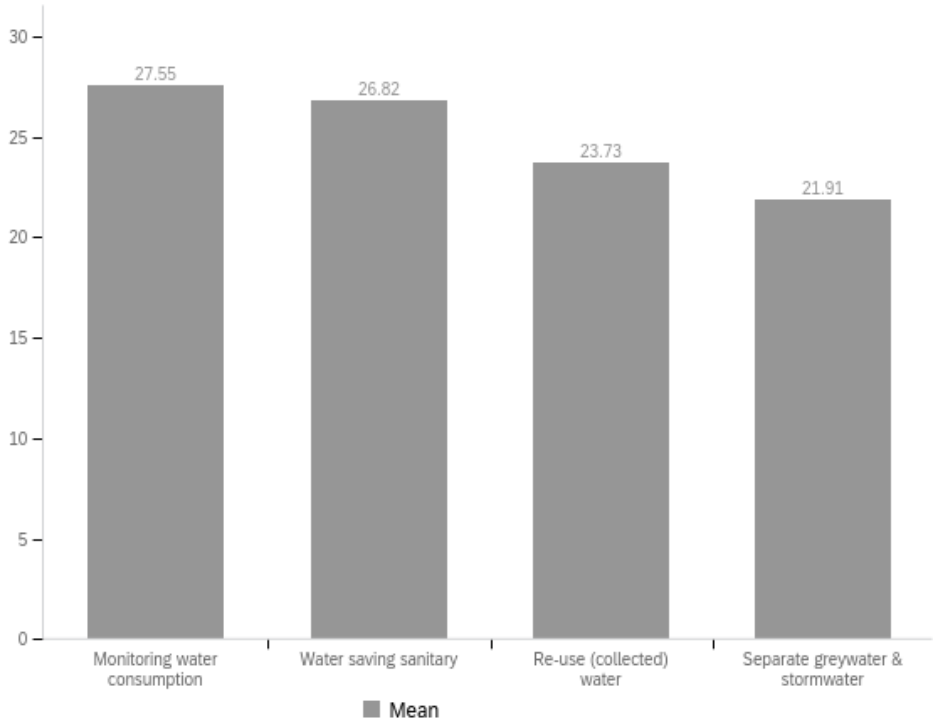


#	Field	Minimum	Maximum	Mean	Count
1	Would you include an indicator 'post-occupancy evaluation for tenant satisfaction' for the category 'Health & Well-being' in the assessment?	1.00	3.00	2.27	11

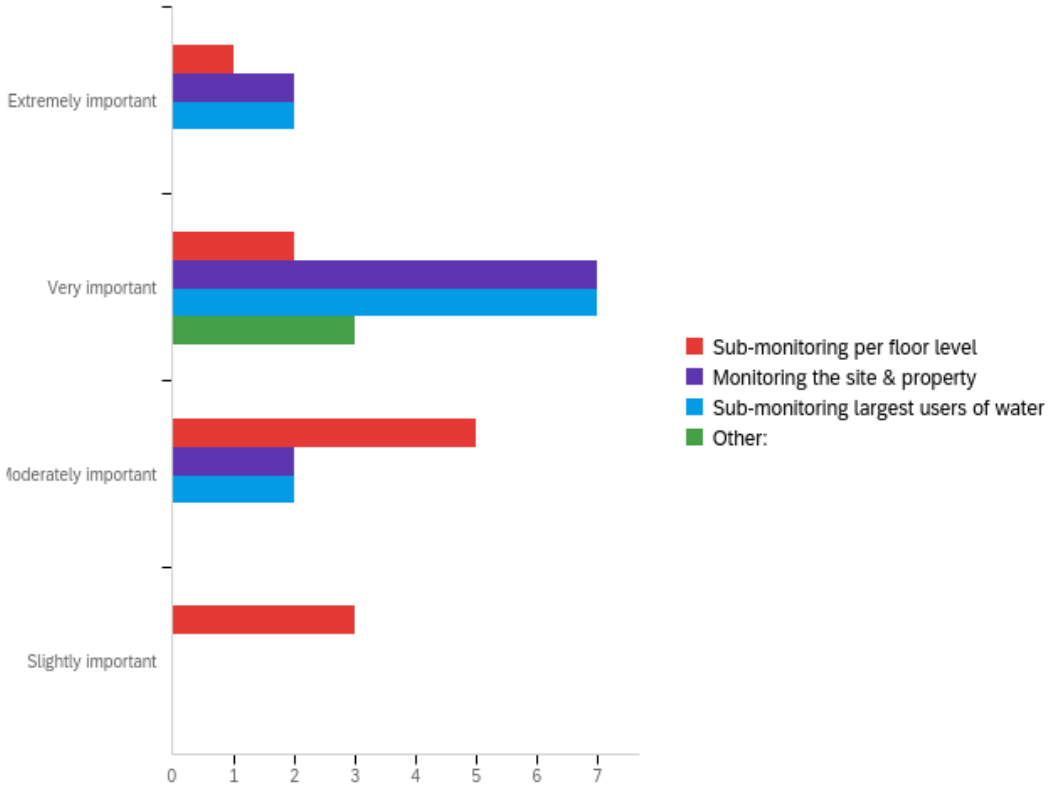
#	Answer	%	Count
1	No	9.09%	1.00
2	Yes, but the results of the evaluation should only be used for improvements	54.55%	6.00
3	Yes, the results of the evaluation should be weighted in the assessment	36.36%	4.00
	Total	100%	11.00



Q8 - WATER How important are the following indicators within the category 'Water' for sustainable offices, according to your experience/view? Please divide a total of 100 points.



Q9 - How important are the following aspects/measures for the indicator 'monitoring water consumption' according to your experience/view?



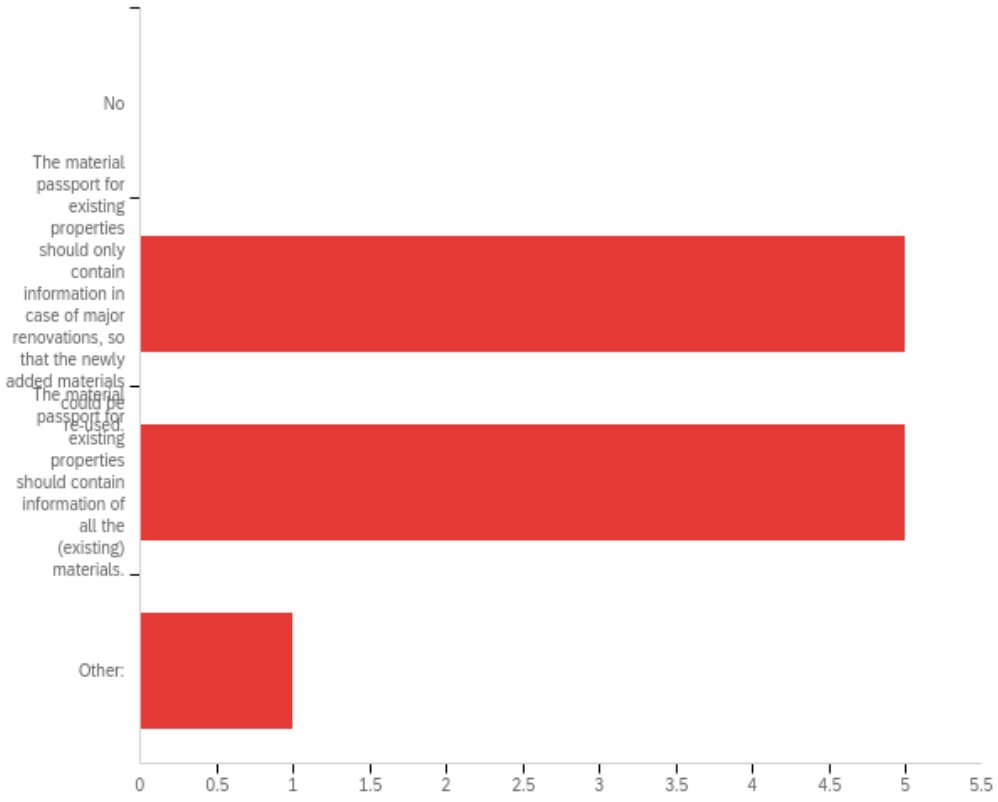
#	Field	Minimum	Maximum	Mean	Count
1	Sub-monitoring per floor level	1.00	4.00	2.91	11
2	Monitoring the site & property	1.00	3.00	2.00	11
3	Sub-monitoring largest users of water	1.00	3.00	2.00	11
4	Other:	2.00	2.00	2.00	3

#	Question	Extremely important		Very important		Moderately important		Slightly important		Total
1	Sub-monitoring per floor level	9.09%	1.00	18.18%	2.00	45.45%	5.00	27.27%	3.00	11.00
2	Monitoring the site & property	18.18%	2.00	63.64%	7.00	18.18%	2.00	0.00%	0	11.00
3	Sub-monitoring largest users of water	18.18%	2.00	63.64%	7.00	18.18%	2.00	0.00%	0	11.00
4	Other:	0.00%	0	100.00%	3.00	0.00%	0	0.00%	0	3.00

Q10 - MATERIALS How important are the following indicators within the category 'Materials' for sustainable offices, according to your experience/view? Please divide a total of 100 points.

#	Field	Minimum	Maximum	Mean	Count
1	Material passport	10.00	40.00	23.82	11
2	Environmental impact (MPG)	14.00	47.00	29.64	11
3	Condition monitoring	10.00	43.00	20.18	11
4	Demountable materials/parts	5.00	50.00	26.36	11

Q11 - Currently, the discussion on making a material passport mandatory for new constructions is ongoing in the Netherlands. According to experts and policy makers, a material passport could enhance the circularity of an asset. How do you think that a material passport should be used for the existing building stock? Should this be included in the assessment?



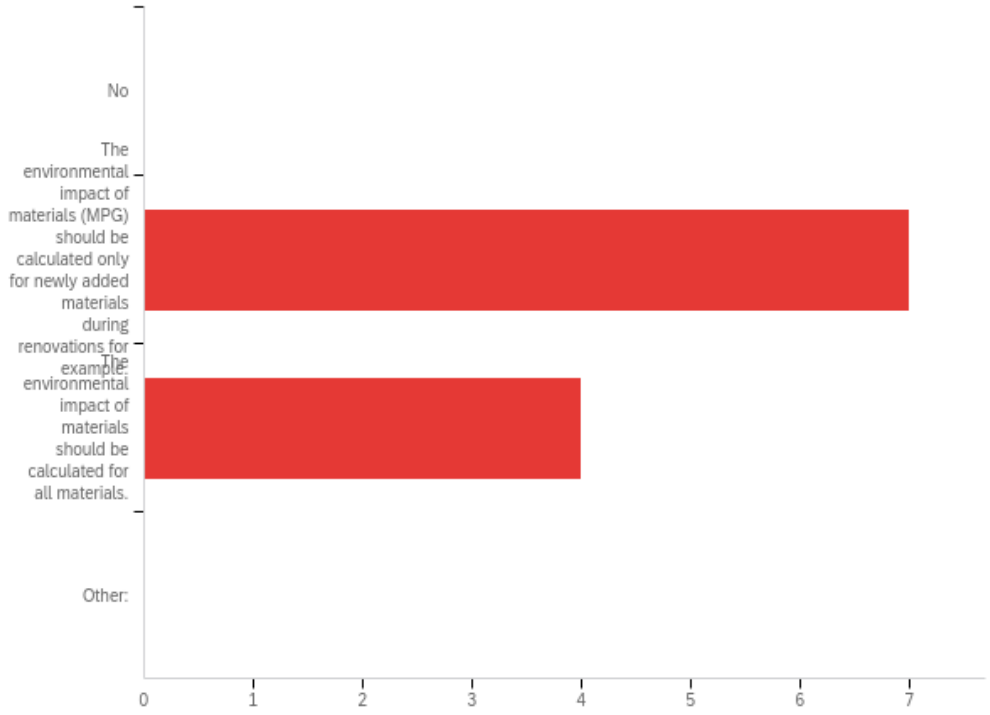
#	Field	Minimum	Maximum	Mean	Count
1	Currently, the discussion on making a material passport mandatory for new constructions is ongoing in the Netherlands. According to experts and policy makers, a material passport could enhance the circularity of an asset. How do you think that a material passport should be used for the existing building stock? Should this be included in the assessment? - Selected Choice	2.00	4.00	2.64	11

Q11_4_TEXT - Other:

Other: - Text

The material passport for existing properties should contain information of all parts of the existing buildings that are re usable.

Q12 - The environmental impact of materials (MPG berekening) is mandatory during the application of permits for new constructions. Do you think it should be mandatory for existing buildings as well and therefore included in the assessment?



#	Field	Minimum	Maximum	Mean	Count
1	The environmental impact of materials (MPG berekening) is mandatory during the application of permits for new constructions. Do you think it should be mandatory for existing buildings as well and therefore included in the assessment? - Selected Choice	2.00	3.00	2.36	11

#	Answer	%	Count
1	No	0.00%	0.00
2	The environmental impact of materials (MPG) should be calculated only for newly added materials during renovations for example.	63.64%	7.00
3	The environmental impact of materials should be calculated for all materials.	36.36%	4.00

Q13 - POLLUTION How important are the following indicators within the category 'Pollution' for sustainable offices, according to your experience/view? Please divide a total of 100 points.

#	Field	Minimum	Maximum	Mean	Count
1	Monitoring emissions (from installations)	5.00	52.00	28.91	11
2	Separate waste collection	14.00	60.00	38.45	11
3	Flood measures	0.00	30.00	16.27	11
4	Light pollution	5.00	27.00	16.36	11

Q14 - ECOLOGY How important are the following indicators within the category 'Ecology', according to your experience/view? Please divide a total of 100 points.

#	Field	Minimum	Maximum	Mean	Count
1	Ecological research (in case of major renovations)	10.00	50.00	31.91	11
2	Ecological facilities (presence)	25.00	70.00	35.45	11
3	Green facilities (inside & outside)	20.00	50.00	32.64	11

Q15 - TRANSPORT How important are the following indicators within the category 'Transport' for sustainable offices according to your experience/view? Please divide a total of 100 points.

#	Field	Minimum	Maximum	Mean	Count
1	Proximity of public transport	10.00	46.00	28.18	11
2	Proximity of facilities	3.00	27.00	15.55	11
3	Facilities for cyclists	10.00	40.00	27.73	11
4	Reduce(d) car/park use	13.00	40.00	28.55	11

Q16 - What is an acceptable walking distance for the following aspects?

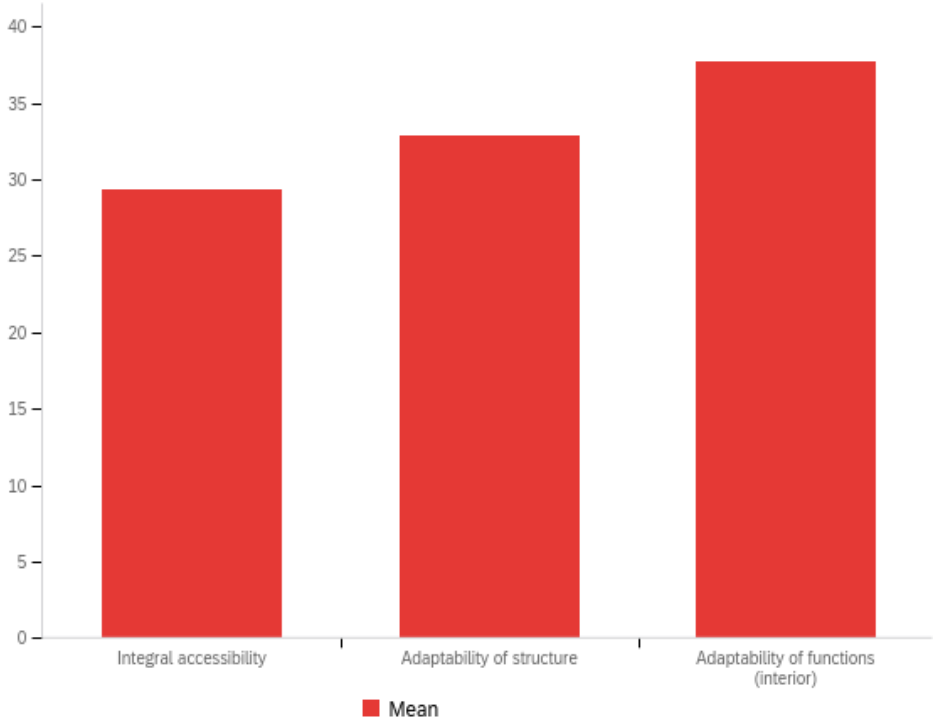
Q16_4_1 - Distance to public transport - in meters

Distance to public transport - in meters
500
750
700
500
500
1000
1000
250
1000
1000
500

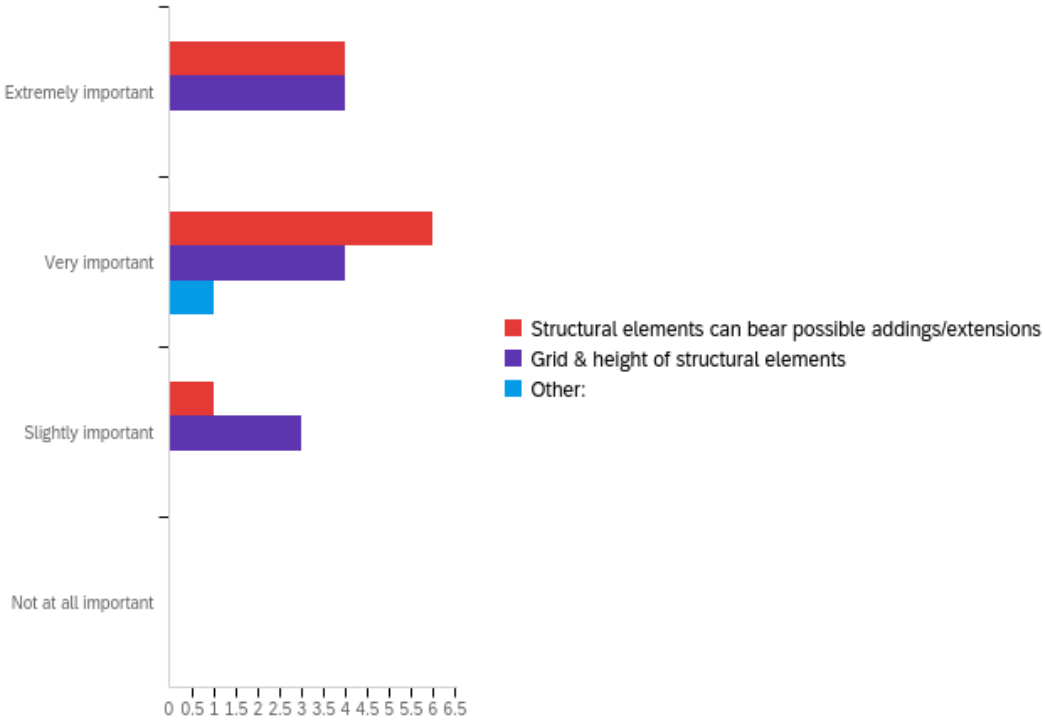
Q16_5_1 - Distance to facilities - in meters

Distance to facilities - in meters
700
500
700
250
500
1000
500
100
1000
750
500

Q17 - FUTURE PROOFNESS How important are the following indicators within the category 'Future proofness' for sustainable offices, according to your experience/view? Please divide a total of 100 points.



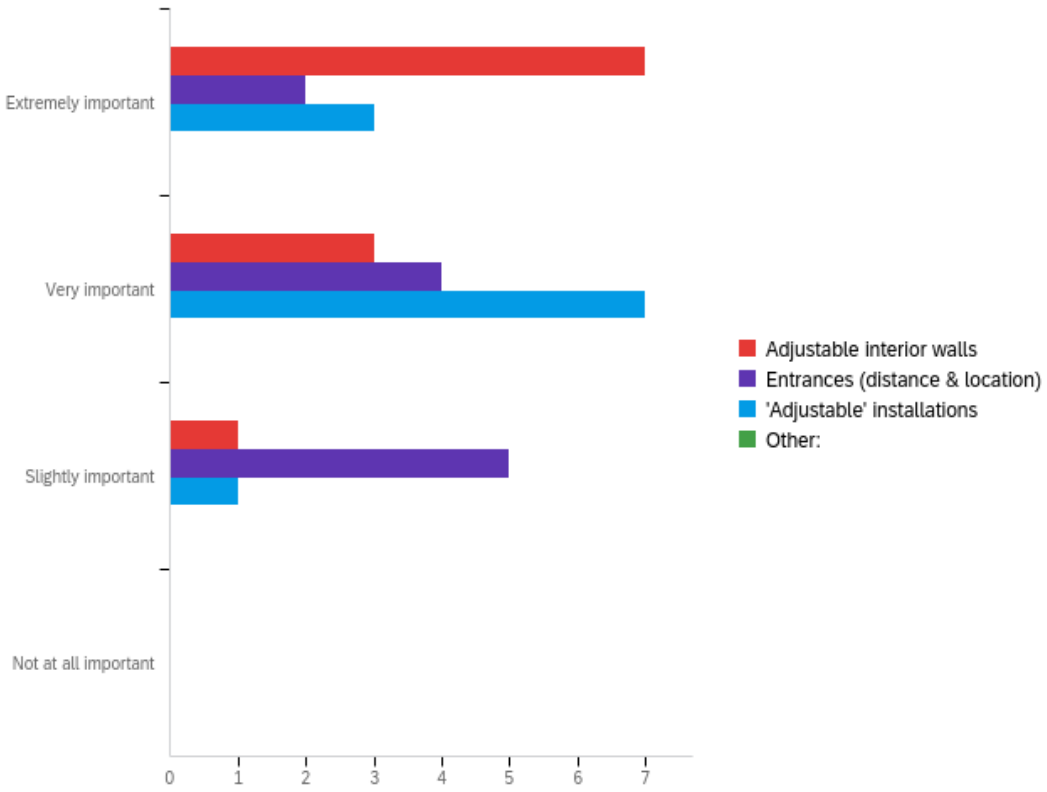
Q18 - How important are the following aspects for the indicator 'adaptability of structure', according to your experience/view?



#	Field	Minimum	Maximum	Mean	Count
1	Structural elements can bear possible addings/extensions	50.00	52.00	50.73	11
2	Grid & height of structural elements	50.00	52.00	50.91	11
3	Other:	51.00	51.00	51.00	1

#	Question	Extremely important		Very important		Slightly important		Not at all important		Total
1	Structural elements can bear possible addings/extensions	36.36%	4.00	54.55%	6.00	9.09%	1.00	0.00%	0	11.00
2	Grid & height of structural elements	36.36%	4.00	36.36%	4.00	27.27%	3.00	0.00%	0	11.00
3	Other:	0.00%	0	100.00%	1.00	0.00%	0	0.00%	0	1.00

Q19 - How important are the following aspects for the indicator 'adaptability of functions', according to your experience/view?



#	Field	Minimum	Maximum	Mean	Count
1	Adjustable interior walls	20.00	22.00	20.45	11
2	Entrances (distance & location)	20.00	22.00	21.27	11
3	'Adjustable' installations	20.00	22.00	20.82	11
4	Other:	0.00	0.00	0.00	0

#	Question	Extremely important		Very important		Slightly important		Not at all important		Total
1	Adjustable interior walls	63.64%	7.00	27.27%	3.00	9.09%	1.00	0.00%	0	11.00
2	Entrances (distance & location)	18.18%	2.00	36.36%	4.00	45.45%	5.00	0.00%	0	11.00
3	'Adjustable' installations	27.27%	3.00	63.64%	7.00	9.09%	1.00	0.00%	0	11.00
4	Other:	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00

Q20 - MANAGEMENT How important are the following indicators within the category 'Management for sustainable offices, according to your experience/view? Please divide a total of 100 points.

#	Field	Minimum	Maximum	Mean	Count
1	Green lease agreements	22.00	70.00	43.27	11
2	Roadmap towards sustainability (long-term goals and plans made by owner&user to achieve sustainability)	30.00	78.00	56.73	11

Q21 - Based on the previous questions about the indicators, how important are the following categories according to your experience/view? Please divide a total of 100 points.

#	Field	Minimum	Maximum	Mean	Count
1	Energy	15.00	32.00	20.27	11
2	Health & Well-being	10.00	40.00	18.82	11
3	Water	2.00	10.00	5.36	11
4	Materials	5.00	20.00	15.00	11
5	Pollution	0.00	10.00	6.64	11
6	Ecology	5.00	19.00	11.09	11
7	Transport	0.00	18.00	6.91	11
8	Future proof	0.00	13.00	8.45	11
9	Management	0.00	20.00	7.45	11

Appendix E
Theoretical linkage by other authors

The overview (table x) depicts the link between the characteristics and performance of sustainable offices and the resulting economic and financial influences on property value and which parameters are adjustable to reflect the economic impact on the value, by an appraiser. The categories are based on the same categories in which the sustainability indicators are placed derived from the review of green rating tools. It should be noted that this is just to order the existing theoretical linkage.

- Attempt by other authors -

Category	Sayce & Ellison (2006)	Ratcliffe et al. (2009)	Meins et al. (2010)
energy efficiency	achieve CSR, reduced running costs & tenant demand • *rental growth* • *risk premium*	lower capital costs, occupant benefits & lower energy costs • operating costs • development costs • occupancy • improved churn	reduced dependency on non-renewable sources reduces risk for future cost rises; • discount rate
water consumption	refurbishment costs • *rental growth* • *cash flow* • *depreciation*	lower water consumption. costs impact; • operating costs	lower water consumption & collecting rainwater; • discount rate
health & well-being IEQ control	climate control impacts depreciation through • *depreciation rate* • pollution risk/insurance • *rental growth* • *risk premium*	increased occupant satisfaction, employee productivity; • marketability • faster sell and lease • vacancy • occupancy	design with sufficient daylight; • electricity costs • discount rate
materials		longer building lifecycle, lower maintenance costs; • depreciation • operating costs • maintenance costs	use of eco-materials; • discount rate
pollution & contamination	pollution risk/insurance premium • *rental growth* • *risk premium* *waste disposal* • *rental growth*	*indoor pollutants control increased productivity;* • *greater marketability* • *faster sell and lease* • *risk reduction* • *occupancy* • *vacancy*	*protection against flood increase in property value through;* • *discount rate*
flexibility & adaptability	accommodating changing requirements • *risk premium* • *cash flow* • *rental growth* • *occupancy*	*longer building lifecycle;* • *depreciation*	response to future development by use flexibility and user flexibility • *discount rate*
ecology		improved site aesthetics, • marketability	reduced damage from expected extreme weather conditions • discount rate

* other sustainability aspects not fitting into 1 category
x- some authors make a distinction between direct and indirect impact

table x: translation of sustainability characteristics into financial performance.
different authors

Appendix E
Theoretical linkage by other authors

- Attempt by other authors -

Category	Muldavin (2010)	Lorenz & Lutzkendorf (2005)	Lorenz & Lutzkendorf (2014)
energy efficiency	energy savings/costs • operating costs • discount rate • insurance	reduction of risks through changes in energy prices, improved marketability • operating costs • cap/discount rate • rent projection	• rent • rental growth • occupancy • capital growth • operating costs
water consumption	water savings/costs • operating costs • insurance	reduction of risks through changes in water prices, improved marketability • operating costs • cap/discount rate • rent projection	• occupancy • operating costs
health & well-being IEQ control	lower emissions and reduction in carbon footprint; • operating costs • maintenance • insurance	*reduction of vacancy risks and losing tenant, improved marketabillity* • *cap/discount rate* • *market rent*	• rent • *rental growth* • occupancy • *capital growth*
materials		use of eco friendly/healthy materials leads to improved marketability, reduction of ligitation risk, - cap/discount rate	• refurbishment costs
pollution & contamination	reduction in waste; • operating costs	reduced impacts on the local and global environment leads to image and reputation gains for owners & users • cap/discount rate	• rental growth • occupancy • capital growth • operating costs (waste)
flexibility & adaptability	reduced risk of not operating as designed; • discount rate • sale price • renewal probability • occupancy	reduction of risks through changes in market participants' preferences (obsolescence), longer economic life, stable cash flow • cap/discount rate • rent projection	• rent • rental growth • occupancy • capital growth • operating costs • refurbishment costs
ecology			• rental growth • occupancy • capital growth
transport & accessiblity			• rent • rental growth • occpancy • capital growth

* other sustainability aspects not fitting into 1 category

x- some authors make a distinction between direct and indirect impact

table x: translation of sustainability characteristics into financial performance.
different authors

Appendix F

Interview question list with expert (appraiser)

Questions

Energy
- Would you consider the energy label/BENG indicators (future) in the valuation of offices?
- would you 'devalue' offices that do not comply with the current legislation or coming 5-10 years?
- energy performance gap, risk factor if not monitored?
- impact on MV?

Health & Well-being
- Would you consider design qualities of an office that enhances the health of employees and satisfaction of tenants in the valuation?
- if not, what's needed? And do you think it should be incorporated into the appraisal?

Materials
- Would you consider the characteristics of materials and the possibility for demontage into the appraisal?
- future legislation on environmental impact and material passport
- impact on MV?

Ecology
- Would you consider green & ecologic facilities within an office and on the site in the appraisal?
- Ecologic value:
- impact on MV?

Future proof
- Would you consider the adaptability of an office in the appraisal?
- impact on MV?

Management
- Would you consider 'planned sustainable upgrades' in the appraisal?
- Do you think green lease should be incorporated in the appraisal?

Transport
- Would you consider organisational aspects (users' behaviour) in the appraisal?
- Do you think organisational aspects should be incorporated into the appraisal?
- Conflicting views, reduced car/park?

Pollution
- Would you consider organisational aspects (users' behaviour) in the appraisal?
- Would you consider legal aspects, emissions from installations?
- Do you think organisational aspects should be incorporated into the appraisal?

Appendix G Proposed Framework

	Sustainability indicators		% Weight*	Final weight	Goal	Criteria - measurement
Energy	1	sustainable energy sources	29	5,9	gaining insight in the energy consumption, stimulating sustainable energy use by monitoring share of renewable energy, check with regulation & optimalisastion of energy performance	% of energy consumption
	2	EPC	24,5	5,0		compliance with current regulation
	3	monitoring energy use	24,2	4,9		%renewable energy and %fossil fuels, comparing with EPC
	4	commisioning	22,4	4,5		energy performance according to design requirements (tested & adjusted)
Health	5	air quality	28,9	5,4	providing the end-users a healthy and comfortabel indoor work environment by	sufficient fresh air supply, humidity & CO2 emissions monitoring
	6	daylighting	19,7	3,7		sufficient daylighting through windows at workplaces, compliance regulation
	7	temperature control	14,1	2,7		provision of temperature control through operable windows, MV/temperature control (per workplace)
	8	relaxing spaces	13,9	2,6		presence of (sufficient) relaxing spaces for end-users
	9	views from workplaces	12,7	2,4		undisturbed views towards outside from workplaces
	10	light regulation	10,6	2,0		provision of light regulation by end-users
Materials	11	environmental impact	29,6	4,4	enabling an extended/longer use of mainly building materials, enhancing the circularity of building materials	(presence of) calculation of MPG of newly added materials
	12	demountable materials	26,4	4,0		newly added materials are non toxic, easily demountable
	13	material passport	23,8	3,6		the presence of a material passport for newly added materials
	14	condition monitoring	20,2	3,0		monitoring the current state of materials
Ecology	15	ecological facilities	35,5	3,9	enhancing the ecologic value of the site & property, mitigating heat island effect and	presence of boxes for birds, bats, insects & planting floral species
	16	green facilities	32,6	3,6		presence of green facilities inside & outside (could be verrtical as well)
	17	ecologic value	31,9	3,5		in case of renovations, suggestions from research are implemented & no flora fauna harmed
Future proof	18	adaptability of functions	37,7	3,2	(faster) anticipation on changing trends & demands through easily adaptable offices	adjustable interior walls, location & distance of entrances, 'adjustable' installations &
	19	adaptability of structure	32,9	2,8		structural elements can bear possible addings/ extensions, grid & height allow new interior design
	20	integral accessibility	43,3	2,5		measurements of entrances, internal routes for all users (weelchairs, blind, disabled)
Manag.	21	roadmap towards sustainability	56,7	4,3	stimulating a sustainable use of the office by solving the split incentive use and	property owner planned improvements & communicated with end-users
	22	greenlease	43,3	3,2		presence of green lease & agreements fulfilled by all parties
Transport	23	reduced car park/use	28,6	2,0	stimulating end-users to commute sustainably (reduce footprint)	paid parking policy, reduced car use by end-users through policy
	24	proximity of public transport	28,2	1,9		distance to public transport nodes 500-1000m
	25	facilities for cyclists	27,7	1,9		presence of facilities, sufficient bicycle racks, covered, storage/lockers
	26	proximity of facilities	15,6	1,1		distance to facilities in area 500-1000m
Pollution	27	separate waste collection	38,5	2,5	minimizing site & property pollution from installations, climate and business activities	presence of waste separation area / separation by end-users
	28	monitoring emissions	28,9	1,9		emitted by installations & refrigerants, CO2, NOx and f-gases
	29	light pollution (reduce)	16,4	1,1		lights switched of during closing hours,
	30	flood measures	16,3	1,1		presence of flood measures,

Appendix G

Proposed Framework

	Sustainability indicators		Green impact	Market impact	Valuation impact
Energy	1	sustainable energy sources	• lower energy costs • lower operating costs • longer lifecycle • improved CSR/image gains	• increased demand • reduced vacancy risk • occupancy • rental growth • market rent • marketability	• possible higher NOI • less depreciation • discount rate • exit value • maintenance costs
	2	EPC			
	3	monitoring energy use			
	4	commisioning			
Health	5	air quality	• healthy work environment • improved tenant satisfaction • productivity/abseentism • CSR/image gains • lower operating costs • compliance • energy performance	• increased demand • reduced vacancy risk • occupancy • rental growth • market rent • marketability	• possible higher NOI • discount rate • exit value
	6	daylighting			
	7	temperature control			
	8	relaxing spaces			
	9	views from workplaces			
	10	light regulation			
Materials	11	environmental impact	• greater design flexibility • lower cost of repair/ replacement • longer lifecycle • compliance with future regulation • CSR/image gains	• increased demand • reduced vacancy risk •	• less depreciation • discount rate • exit value • maintenance costs
	12	demountable materials			
	13	material passport			
	14	condition monitoring			
Ecology	15	ecological facilities	• longer lifecycle of property • durability/resilience against extreme weather conditions • insurance costs	• increased demand • marketability	• less depreciation • discount rate • exit value • possible higher NOI
	16	green facilities			
	17	ecologic value			
Future proof	18	adaptability of functions	• design flexibility • adaptability • fast anticipation • tenant satisfaction • lower cost of replacement and refurbishing • serviceability • longer lifecycle	• increased/retained demand of property • reduced vacancy risk (obsol.) • marketability • rental growth	• exit value • discount rate • possible higher NOI • maintenance costs
	19	adaptability of structure			
	20	integral accessibility			
Manag.	21	roadmap towards sustainability	• durability • marketability • compliance with future legislation • longer lifecycle	• increased/retained demand • reduced vacancy risk • marketability • rental growth	• exit value • discount rate • possible higher NOI • maintenance costs
	22	greenlease			
Transport	23	reduced car park/use	• CSR/image gains • reduced carbon footprint • longer lifecycle	• increased demand • reduced vacancy risk • occupancy • rental growth	• possible higher NOI • exit value • discount rate
	24	proximity of public transport			
	25	facilities for cyclists			
	26	proximity of facilities			
Pollution	27	separate waste collection	• lower operating costs • longer lifecycle • environmental • resilience, less prone to weather risks	• marketability • reduced vacancy risk • occupancy • increased demand	• exit value • discount rate • possible higher NOI • maintenance cost
	28	monitoring emissions			
	29	light pollution (reduce)			
	30	flood measures			
Water	31	monitoring water consumption	• healthy indoor environment • lower operating costs • CSR/image gains	• increased demand • reduced vacancy • insurance? • marketability • occupancy	• less depreciation • possible higher NOI
	32	water saving sanitary			
	33	reuse collected water			
	34	separate grey&stormwater			