Research towards a uniform and integral ESG assessment instrument for investments in real estate projects in The Netherlands

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Preface

Dear reader,

In front of you lies my graduation project, marking the final step of my educational career. A couple of years ago, I started my journey within the built environment to fulfill my dream of becoming an architect. However, after finishing my bachelor at the TU/e, I decided to take a different path and focus on a broader scale and dive into the world of project management and real estate. A step I don't regret as I fully enjoyed this part of the built environment and learned many new things within the two master's I followed.

Approaching my graduation project, I aimed at focusing on a topic closely related to the practical field. Starting my research, the topic of ESG was new to me, challenging myself to learn new things and discover the world of sustainable investments within the built environment. I want to thank PVM, and especially Stephan, for all the support during my graduation project, providing me with lots of insights, tips, and motivation! Combining my research with getting insights into the practical field made the process very dynamic and interesting.

This thesis would not have been possible without the guidance and support of my supervisors. I would like to thank Robert van Dongen, Arghavan Akbarieh, Qi Han and Theo Arentze for their support, advice, enthusiasm, and feedback given over the past months. Furthermore, I want to thank my friends for the unforgettable time at the TU/e, my family for their support and the de-stressing weekends at home, and of course Jorrit, for his unconditional support and help during the whole project!

Sanne
Eindhoven, June 2024

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Summary

In today's world, the urgency of sustainability and sustainable development has surged, driven by challenges like climate change, resource depletion, and environmental degradation. These challenges are particularly pronounced in the built environment, as the building sector contributes significantly to global greenhouse gas emissions and energy consumption. Historically, the concept of sustainability has evolved from early uses in German forestry to its formal recognition in the 1987 Brundtland Report, which emphasized the need to meet present needs without compromising future generations. More recently, the United Nations' Sustainable Development Goals (SDGs) and the widespread adoption of the Environmental, Social, and Governance (ESG) framework and the Sustainable Finance Disclosure Regulation (SFDR) have underscored the global commitment to sustainable practices.

Despite the increased focus on ESG and SFDR, universally accepted definitions and standardized assessment methods remains absent, particularly in the real estate sector. This lack of standardization often leads to inconsistent evaluations of sustainability performance. For instance, ESG ratings for companies can vary widely between different rating agencies, causing confusion and potentially leading to greenwashing—where companies misleadingly present themselves as more environmentally friendly than they actually are.

This research addresses the pressing need for a uniform and comprehensive ESG assessment instrument for real estate investments in the Netherlands, a country that has set ambitious climate goals but struggles to meet them. The study aims to fill gaps in current research, as current research often focuses on organizational or policy levels rather than on the asset level. By developing an ESG assessment tool specifically for real estate assets, this research seeks to provide a reliable and standardized method for evaluating the sustainability performance of investments in real estate projects and align its outcomes with the SFDR articles.

The methodology used in this study involved a systematic literature review to identify relevant ESG criteria, followed by a data collection and analysis through a Best-Worst experiment. This experiment gathered input from experts to rank the importance of the selected ESG criteria. The results indicated that for the environmental factors, the use of sustainable materials and renewable energy, are most important. For the social criteria, provide affordable housing is found to be the most important criterion, and for Governance, the criterion on the compliance with regulations and policies is found to be most important. Least important were the criteria reduce pollution on the construction site, optimize visual comfort for occupants, and the use of technology and digital tools.

After integrating one additional aspect, given by the experts in the experiment, the criteria were integrated into an ESG assessment instrument. This ESG assessment instrument is designed to evaluate real estate projects by using building characteristics and information and calculating a final score. To ensure the instrument's reliability and validity, it was tested through a case study involving different types of real estate projects. The results demonstrated high consistency in the results among participants and aligned the ESG scores with existing standards like BREEAM labels. This validation confirmed the tool's effectiveness in providing accurate and meaningful sustainability assessments.

Moreover, the research identified several limitations, such as the potential loss of detailed information due to the merging of criteria for simplicity and the focus on recent literature, which might overlook older but relevant studies. The context-specific nature of the study means that the findings are particularly relevant to the Netherlands but may need adaptation for other regions. Furthermore, the relatively young and less experienced sample in the Best-Worst experiment suggests that future studies should involve a more diverse respondent group. Finally, the case study's limited scope necessitates further validation with a broader range of projects and participants.

Future research should focus on refining the identified criteria by clearly defining each one individually and developing detailed methods for calculating scores. Emphasis should be placed on measuring actual project performance, potentially replacing policy-based measurements. The interrelations between Environment, Social, and Governance criteria should also be explored to provide a more holistic assessment. Finally, the current focus on the building itself should be expanded to consider the impact of its users as well, especially in cases where external parties occupy the building. For instance, a sustainable building used by a company with environmentally harmful practices might not fully achieve sustainability goals.

The developed ESG assessment instrument offers significant benefits to the real estate industry by providing a consistent and comprehensive tool for evaluating sustainability performances of assets. It minimizes subjective judgments and facilitates reliable comparisons across different assets. This instrument can help investors and building owners identify strengths and weaknesses in their projects, promoting sustainable development and aligning with regulatory requirements, including those of the SFDR. The study's findings and methodology also contribute to the broader effort of standardizing ESG assessments, potentially influencing industry-wide guidelines and practices. Policymakers and regulatory bodies can leverage these insights to establish clearer definitions and standards for ESG and SFDR, supporting the transition towards a more sustainable built environment.

In conclusion, this research presents a robust framework for a uniform and integral ESG assessment instrument tailored to the Dutch real estate market. By suggesting linking the assessment to SFDR compliance, it provides a critical tool for aligning real estate investments with sustainable finance regulations. The study highlights the importance of several key criteria and offers a validated tool for assessing sustainability performance. While further research is needed to refine the criteria and expand the tool's applicability, this study marks a significant step towards standardized and reliable ESG assessments in the real estate sector, enhancing transparency and supporting the industry's commitment to sustainability goals.

Samenvatting

In de huidige wereld is de urgentie van duurzaamheid en duurzame ontwikkeling toegenomen, gedreven door uitdagingen zoals klimaatverandering, uitputting van hulpbronnen en milieuvervuiling. Deze uitdagingen zijn bijzonder uitgesproken in de gebouwde omgeving, aangezien de bouwsector een aanzienlijke bijdrage levert aan de wereldwijde uitstoot van broeikasgassen en het energieverbruik. In het verleden heeft het begrip duurzaamheid een evolutie doorgemaakt, van vroegere toepassingen in de Duitse bosbouw tot de formele erkenning ervan in het Brundtland-rapport van 1987. Dit rapport benadrukte het belang van het vervullen van huidige behoeften zonder daarbij de kansen van toekomstige generaties in gevaar te brengen. Meer recentelijk hebben de Duurzame Ontwikkelingsdoelen (SDG's) van de Verenigde Naties en de brede acceptatie van het Environmental, Social, and Governance (ESG) framework en de SFDR-artikelen het belang van wereldwijde betrokkenheid voor duurzame praktijken benadrukt.

Ondanks de toenemende focus op ESG en SFDR, ontbreken universeel geaccepteerde definities en gestandaardiseerde beoordelingsmethoden in de vastgoedsector. Dit gebrek aan standaardisatie leidt vaak tot inconsistente evaluaties van duurzaamheidsprestaties. ESG-beoordelingen voor bedrijven kunnen bijvoorbeeld sterk variëren tussen verschillende beoordelingsbureaus, wat verwarring veroorzaakt en mogelijk leidt tot greenwashing—waarbij bedrijven zich ten onrechte milieuvriendelijker voordoen dan ze daadwerkelijk zijn.

Dit onderzoek richt zich op de dringende behoefte aan een uniform en integraal ESG-beoordelingsinstrument voor investeringen in vastgoedprojecten in Nederland, een land met ambitieuze klimaatdoelstellingen die echter moeilijk te realiseren zijn. De studie beoogt tekortkomingen in huidig onderzoek aan te vullen, aangezien huidig onderzoek zich vaak focust op organisatorische of beleidsniveaus in plaats van op gebouwniveau. Door een ESG-beoordelingsinstrument specifiek voor vastgoed te ontwikkelen, streeft dit onderzoek naar een betrouwbare en gestandaardiseerde methode voor het evalueren van de duurzaamheidsprestaties van investeringen in vastgoedprojecten en het afstemmen van de uitkomsten op de artikelen van de SFDR.

De methodologie die in deze studie werd gebruikt, omvatte een systematische literatuurreview om relevante ESG-criteria te identificeren, gevolgd door een het verzamelen en analyseren van data via een Best-Worst-experiment. Dit experiment verzamelde input van experts uit de praktijk om de geselecteerde ESG-criteria te rangschikken. De resultaten gaven aan dat voor de Environment het gebruik van duurzame materialen en hernieuwbare energie het belangrijkst zijn. Voor de criteria in Social is het bieden van betaalbare woningen het belangrijkste criterium, en voor Governance is naleving van regelgeving en beleid het belangrijkste. Minst belangrijk waren de criteria voor het verminderen van vervuiling op de bouwplaats, het optimaliseren van visueel comfort voor bewoners en het gebruik van technologie en digitale hulpmiddelen.

Na het integreren van een extra aspect in de criteria, aangedragen door de experts in het experiment, werden de criteria geïntegreerd in een ESG-beoordelingsinstrument. Dit ESG-beoordelingsinstrument is ontworpen om vastgoedprojecten te evalueren door het gebruik van gebouw informatie en het berekenen van een score. Om de betrouwbaarheid en validiteit van het instrument te waarborgen, werd het getest via een casestudie met verschillende typen vastgoedprojecten. De resultaten toonden een hoge consistentie in de resultaten onder de deelnemers, en vergeleek de ESG-scores met bestaande normen zoals BREEAM-labels. Deze

validatie bevestigde de effectiviteit van het instrument in het bieden van nauwkeurige en betekenisvolle duurzaamheidsevaluaties.

Ook identificeerde het onderzoek verschillende beperkingen, zoals het potentiële verlies van gedetailleerde informatie door het samenvoegen van criteria voor eenvoud. Ook de focus op recente literatuur kan gezien worden als een beperking, waar oudere maar relevante studies mogelijk over het hoofd worden gezien. De context specifieke aard van de studie betekent dat de bevindingen vooral relevant zijn voor Nederland, maar mogelijk moeten worden aangepast voor andere regio's. Verder suggereert de relatief jonge en minder ervaren groep respondenten in het Best-Worst-experiment dat toekomstige studies een meer diverse respondentengroep zouden moeten betrekken. Tot slot vereist de beperkte reikwijdte van de casestudie verdere validatie met een breder scala aan projecten.

Toekomstig onderzoek zou zich moeten richten op het verfijnen van de geïdentificeerde criteria door elk afzonderlijk duidelijk te definiëren. Ook zouden gedetailleerde methoden voor het berekenen van scores ontwikkelt moeten worden. Hierbij moet ook worden gelet op het vervangen van beleidsgerichte metingen met het meten van de daadwerkelijke prestaties van projecten. De onderlinge relaties tussen de criteria voor Environment, Social en Governance zouden ook moeten worden onderzocht om een meer holistische beoordeling te bieden. Bovendien zou het ESG-beoordelingsinstrument moeten worden aangepast aan verschillende projecttypen, zoals residentiële, industriële, gezondheidszorg- of onderwijsprojecten, om de toepasbaarheid ervan te verbeteren. Ten slotte moet de huidige focus op het gebouw zelf worden uitgebreid om zo ook de impact van de gebruikers ervan mee te nemen, vooral in gevallen waarin externe partijen het gebouw gebruiken. Een duurzaam gebouw dat wordt gebruikt door een bedrijf met milieuschadelijke praktijken, zou bijvoorbeeld niet volledig de duurzaamheidsdoelen kunnen bereiken.

Het ontwikkelde ESG-beoordelingsinstrument biedt aanzienlijke voordelen voor de vastgoedsector door een consistent en uitgebreid hulpmiddel te bieden voor het evalueren van duurzaamheidsprestaties van gebouwen. Het minimaliseert subjectieve oordelen en faciliteert betrouwbare vergelijkingen tussen verschillende gebouwen. Het ESG-beoordelingsinstrument kan investeerders en gebouweigenaren helpen om sterke en zwakke punten in hun projecten te identificeren, duurzame ontwikkeling te bevorderen en zich te houden aan de regelgeving, inclusief die van de SFDR. De bevindingen en methodologie van de studie dragen ook bij aan de bredere doelen om ESG-beoordelingen te standaardiseren, wat mogelijk invloed heeft op richtlijnen en praktijken in de gehele sector. Beleidsmakers en regelgevende instanties kunnen deze inzichten benutten om duidelijkere definities en normen vast te stellen voor ESG en SFDR, wat de overgang naar een duurzamere gebouwde omgeving ondersteunt.

Samenvattend presenteert dit onderzoek een robuust kader voor een uniform en integraal ESG-beoordelingsinstrument, afgestemd op de Nederlandse vastgoedmarkt. Het benadrukt het cruciale belang van verschillende criteria en biedt een gevalideerd instrument voor het beoordelen van duurzaamheidsprestaties met een suggestie voor de koppeling aan SFDR. Hoewel verder onderzoek nodig is om de criteria te verfijnen en de toepasbaarheid van het instrument uit te breiden, zet deze studie een significante stap naar gestandaardiseerde en betrouwbare ESG-beoordelingen in de vastgoedsector, wat de transparantie vergroot en de inzet van de sector voor duurzaamheidsdoelen ondersteunt.

Abstract

In today's world, the urgency of sustainability and sustainable development is increasingly pronounced, driven by challenges such as climate change, resource depletion, and environmental degradation. The building sector, as a major contributor to global greenhouse gas emissions and energy consumption, is at the forefront of these issues. Despite the global embrace of sustainability principles, as reflected in the United Nations' Sustainable Development Goals (SDGs), there remains a lack of universally accepted definitions and standardized assessment methods for ESG and SFDR, particularly in the real estate sector. Therefore, this research aims to develop a uniform and integral ESG assessment instrument tailored to investments in real estate projects in the Netherlands. By conducting a systematic literature review and conducting a Best-Worst experiment to rank the importance of various ESG criteria, the study proposes a reliable and standardized method for evaluating the sustainability performance of real estate projects. The study also suggests aligning the assessment outcomes with SFDR requirements, providing a crucial link between real estate investments and sustainable finance regulations. Findings highlight that for Environment, the use of sustainable materials has the largest impact on the total ESG score. For Social, providing affordable housing is identified as most important, and for Governance, compliance to regulations and policies is deemed most important. The developed ESG assessment tool was validated through case studies, showing consistency in results and alignment with established standards like BREEAM labels. The results of this study offer significant benefits to the real estate industry. It provides investors and building owners with a means to identify strengths and weaknesses in their projects, promoting sustainable development through consistent and reliable sustainability assessments. The study also contributes to the broader effort to standardize ESG assessments and offers a valuable instrument for evaluating real estate investments. Future research should focus on further defining the identified criteria, expanding the instrument’s applicability, and exploring the impact of building users on sustainability performance. Overall, this research represents a significant step towards establishing standardized and reliable ESG assessments in the real estate sector, enhancing transparency, and supporting the industry's commitment to sustainability goals.

Keywords: *Sustainability; Environment, Social, Governance (ESG); Real Estate Investments; Sustainable Finance Disclosure Regulation (SFDR); Assessment instrument; Best-Worst Experiment*

List of abbreviations

GHG	Greenhouse Gas
SDG	Sustainable Development Goal
UN	United Nations
ESG	Environment, Social, Governance
SFDR	Sustainable Finance Disclosure Regulation
BENG	Bijna energie neutrale gebouwen (Almost energy neutral buildings)
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SRI	Socially Responsible Investment
CSR	Corporate Social Responsibility
LEED	Leadership in Energy and Environmental Design
BREEAM	Building Research Establishment Environmental Assessment Methodology
DGNB	Deutsche Gesellschaft für Nachhaltiges Bauen (German Sustainable Building Council)
CASBEE	Comprehensive Assessment System for Built Environment Efficiency
AEC	Architecture, Engineering, & Construction
HQE	High Environmental Quality
GRESB	Global Real Estate Sustainability Benchmark
AHP	Analytic Hierarchy Process
Bbl	Besluit bouwwerken leefomgeving (Buildings and Living Environment Decree)
RWH	Rainwater harvesting
NTA	Nederlands Technische Afspraak (Dutch Technical Agreement)
NRB	Nederlandse Richtlijn Bodembescherming (Dutch Soil Protection Directive)
BRCL	Bodemrisico-checklist (Soil risk checklist)
MPG	MilieuPrestatie Gebouw (Environmental Performance of Buildings)
LCA	Life Cycle Assessment
BIM	Building Information Modelling
EMS	Environmental Management Systems
BWS	Best-Worst Scaling
BIBD	Balanced Incomplete Block Design

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1. Introduction

The first chapter of this study will cover the background of the research, including an introduction on Environment, Social and Governance (ESG) and its importance related to the Sustainable Finance Disclosure Regulation (SFDR) articles. Furthermore, the problem statement, research questions and research outline are defined, along with the importance and relevance of this study. The chapter will conclude with a reading guide that describes the structure of the remaining part of the study.

1.1 Background

Sustainability and sustainable development have become predominant in today's world due to the pressing challenges facing our planet (UNFCC, 2015). With concerns over climate change, resource exhaustion, and environmental degradation intensifying, sustainable practices have emerged as a critical response. Especially in the built environment, sustainable development is of great importance today since the building sector (directly and indirectly) contributes approximately 36% of greenhouse gas (GHG) emissions globally (Vrensen et al., 2020). Nowadays, the International Energy Agency (2023) indicates that the operational energy use in buildings represents about 30% of the global final energy consumption. Moreover, they indicate that this share jumps to 34% when including the final energy use associated with the production of cement, steel, and aluminum for the construction of buildings. It is expected that the building sector 's energy consumption to increase with 28% by 2050 (Ooi & Dung, 2019).

Although the terms ‘sustainability’ and ‘sustainable’ appeared for the first time in the Oxford English Dictionary during the second half of the 20th century, the equivalent terms in French (durabilité and durable), German (Nachhaltigkeit, literally meaning ‘lastingness’, and nachhaltig) and Dutch (duurzaamheid and duurzaam) have been used for centuries (Zon & Kuipers, 2002). A Study by Du Pisani (2006) gives an overview of the origin of the concept of sustainable development by going far back in history to trace it roots. The study explains that sustainability is a concept which originates from Hans von Carlowitz, while he used the term first in German forestry circles in *Sylvicultura Oeconomica* in 1713. Carlowitz suggested *nachhaltende Nutzung* (sustainable use) of forest resources, which implied maintaining a balance between harvesting old trees and ensuring that there were enough young trees to replace them. The recognition of Hans von Carlowitz his concept of sustainability was further emphasized by the Brundtland report, ‘Our Common Future’, in 1987 (WCED, 1987). It highlighted the importance of sustainable development, defined as:

‘’Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs’’ (WCED, 1987, p. 41).

The study of Pisani (2006) also found that the concept of sustainability can be traced back to ancient times. Pisani (2006) states that population growth, increase in consumption after the Industrial Revolution, and the danger that crucial resources such as wood, coal and oil could be depleted, boosted the awareness of the need to use resources in a sustainable way. Furthermore, it states that fears that future generations might struggle to maintain their quality of life led to new ways of thinking that paved the way for the global acceptance of sustainable development. Besides the historical roots, many other aspects of the concept of sustainable development and sustainability are discussed in literature and studies (Diesendorf, 2000; Du Pisani, 2006; Kuhlman & Farrington, 2010; Purvis et al., 2019).

Following the pressing need of sustainable development in today's world, the United Nations (UN) established the 17 Sustainable Development Goals (SDGs) in 2015 as a universal call-to-action, aiming to harmonize the pursuit of sustainable development (United Nations, 2015). The UN recognizes that ending poverty must go hand-in-hand with a plan that builds economic growth and addresses a range of social needs including education, health, social protection, and job opportunities, while addressing climate change and environmental protection. To enable businesses and investors to pursue the SDGs for a sustainable future, international organizations have been focusing on the implementation of sustainable development frameworks (Muselaers, 2023). Moreover, the Environment, Social and Governance framework (ESG), is most widely recognized for sustainable development, integrating ESG performance into the strategy of organizations or investors (UNEP FI, 2004). Its importance is shown by the Counselors of Real Estate (2021) as well, indicated the increased importance of ESG as it moved from the tenth place in 2020, to the third most influential issue affecting real estate in 2021-22. Within the ESG framework, the 17 SDGs can be aligned into the three aspects (Berenberg, 2018), Figure 1. SDGs that appear more than once are relevant across two or even all three factors. It should be noted that this figure is not focused on real estate or the building sector specifically.

Figure 1: SDGs through the lens of ESG (Berenberg, 2018)

To force companies to be more transparent on their sustainability and report on their policy regarding the ESG measurements, the EU Taxonomy is implemented on the 1st of January 2022. It is a system, or uniform language, which should help to understand if investments contribute to the climate goals of 2050 and should answer questions as 'is an investment really as green as it looks like?' (DGBC, 2022). The European Commission explains that in order to meet the EU's climate and energy targets for 2030 and reach the objectives of the European green deal, it is vital that the EU directs investments towards sustainable projects and activities (European Commission, 2023). To achieve this, a common language, and a clear definition of what is 'sustainable' is needed as shortly discussed above. This is why the action plan on financing sustainable growth called for the creation of a common classification system for sustainable economic activities, or an "EU taxonomy" (European Commission, 2023).

Furthermore, as part of the EU Taxonomy, the European Union requires ESG reporting through the Sustainable Finance Disclosure Regulation (SFDR) since 2021. Research stated that in recent years, sustainable development became a prevailing belief for business and financial actors, raising doubts about the reliability of their sustainability claims, spreading the dangerous phenomenon of greenwashing[1] (Cremasco & Boni, 2022). Therefore, the SFDR aims to improve the transparency for sustainable investment products and thereby prevent greenwashing from happening (Vincent, 2023). The SFDR can be seen as a framework that requires financial operators to declare their products' positioning with respect to the overarching framework of the EU Taxonomy for sustainable activities by using the ESG principles as described above (Cremasco & Boni, 2022). The purpose of the SFDR framework is thus to enable investors to make more informed decisions, contributing to the sustainable transition (Eurosif, 2024), but also to formally declare their degree of compliance to ESG, in an effort to prevent greenwashing from happening (Cremasco & Boni, 2022; Partiti, 2023).

Nowadays, SFDR identifies three different product groups or so called articles (de Wergifosse, 2023). The first article includes products that do not include sustainability characteristics, also labelled as grey products (Article 6). The second article includes products that do have some sustainability characteristics, also called light green products (Article 8). Finally, the third article includes those that have many sustainability characteristics and thereby significantly contribute to sustainability goals, called dark green products (Article 9).

Despite the three articles described above, SFDR currently includes no clear set of criteria and does not use a clear framework to assess the level of sustainability of investments. This absence of a clear labelling system with criteria or thresholds that financial products must meet to receive a 'stamp of approval' of their sustainability credentials within the SFDR articles is problematic (Partiti, 2023). Partiti (2023) stated that stricter criteria would help protect consumers and combat greenwashing, aligning with other EU regulations. He suggested that the SFDR could be improved by introducing elements that would bring it closer to a labelling regime, signaling products with higher sustainability credentials and revise the ambiguous definitions across its three distinct articles. As SFDR currently refers to ESG, using this framework could aim as a starting point to simplify investor decision-making based on sustainability and mitigate the issue of greenwashing.

However, this definition issue is also identified in numerous studies focusing on ESG, highlighting the absence of a universally agreed-upon conceptualization and definition. Studies, for example by Robinson & McIntosh (2022b) and Berg et al. (2020), indicated that ESG remains somewhat difficult to define and that ESG ratings from different providers substantially diverge. Consequently, the lack of a clear-cut definition and standardized metrics leads to varying assessments of the same company's ESG performance, depending on the indicator selection, measurements, and weights applied (Kempeneer et al., 2021). An example of such a varying assessment is the case of Tesla which claimed the top position in the ranking for the automotive sector following the ESG ranking of the rating company MSCI (Hamme, 2019). However, at the same time, Tesla was ranked at the very bottom of the list with another important rating company, FTSE.

The divergence between ESG ratings from various providers result in a situation where the information received by decision-makers from these ESG rating agencies is relatively unreliable (F. Berg et al., 2020; Eccles et al., 2020). The study by Eccles et al. (2020) stated that without a universally accepted definition of ESG metrics, each data vendor developed its own

[1] Greenwashing refers to the deceptive practice where financial market participants falsely portray themselves as responsible and sustainable (Cremasco & Boni, 2022).

methodology for measuring ESG data, and their own set of indicators, to best capture their preferred conceptualization of materiality, which can lead to diversities and disagreements as indicated in the example of Tesla. Eventually, this will lead to greenwashing, meaning that a false impression is given of the environmental impact or benefits of a product, company or building (Europees Parlement, 2024).

Addressing the challenges of formulating a clear framework for the Sustainable Finance Disclosure Regulation (SFDR) could be facilitated by examining clear ESG criteria. ESG is gaining increasing importance and interest (F. Berg et al., 2020), yet it also grapples with the lack of precise definitions and clear criteria as described above. Addressing the fundamental issues within ESG can act as an initial step toward creating a more coherent and effective SFDR framework. This approach not only underscores the connections between ESG and SFDR but also utilizes the ongoing refinement of ESG criteria, potentially paving the way for more robust SFDR standards.

When looking into current research, particularly concerning the implementation, enhancement, and definition of ESG frameworks, studies are predominantly centered on the organizational or policy level (Amir & Serafeim, 2018; Backenroth & Lindqvist, 2021; F. Berg et al., 2020; Cloutier, 2020; Dumrose et al., 2022; Kodaneva, 2021; Liu et al., 2023). This type of research is not only performed in real estate industries but also in other industries or sectors. For instance, a study by Pomè et al. (2023) focused purely on the ESG factors and found that the majority of the ESG factors evaluate the governance impact by concentrating on the organizational level, such as board governance, company policy, and employee satisfaction, while few indicators evaluate the sustainable level of actual products and services.

While the prevailing trend in this field gravitates towards examining ESG at the organizational or policy level as described above, it is noteworthy that some studies propose the exploration of ESG practices at the asset level. Such an approach may uncover even more intriguing and valuable insights. Since the real estate sector is primarily based on physically developing products that humans interact with, the impacts created by the sector should be measured at the product level (Zaccack, 2020). Additionally, a study conducted by Serafeim (2021) underscores the distinction between reporting activities and reporting outcomes in the context of ESG. It states that historically, ESG measurements and emphasizes have been centered around activities rather than outcomes. Only a small portion of ESG metrics entering the evaluation of ESG raters is outcomes but most of them are activities (or inputs, meaning policies, principles, management systems, targets, and disclosures). Furthermore, it suggests that while measuring these activities will generate many activities, it may not necessarily lead to different or improved outcomes (for example actual reduction of emissions). A noteworthy quote mentioned in this study illustrates this point:

> *''Most consumer goods company now have a deforestation policy, but that does not mean the forest is in better shape'' Serafeim (2021, p. 6).*

The quote mentioned above indicates the activity or input as the deforestation policy and the shape of the forest as the outcome. In essence, the study highlights that many companies now have a diversity target and systems included within their ESG report. However, the presence of these elements in the ESG reports does not guarantee that these companies have genuinely achieved greater diversity and inclusivity as a tangible outcome.

As described above, there exist notable research gaps in the domain of defining ESG and SFDR, focusing on the absence of a universally accepted conceptualization for ESG, the lacking focus on assets and thereby the issue of interpreting its relation towards SFDR. These gaps have substantial effects, especially in countries like the Netherlands, where the commitment to sustainability and ambitious climate goals are central to government policy. By 2050, the Dutch Central Government wants to reduce the Netherlands' emissions of greenhouse gases (like carbon dioxide (CO_2)) to zero (Rijksoverheid, 2023a). To encourage builders, clients, and inhabitants to engage in sustainable construction, the Dutch government sets a good example itself. For example, for housing its employees, it now exclusively chooses sustainable offices (Rijksoverheid, 2023b). However, among all EU countries, the Netherlands is still the farthest from achieving their climate goals (NOS, 2019). In the context of the European Union, the Netherlands, traditionally an oil and gas-producing nation, has consistently ranked low in terms of its transition towards renewable energy sources. Alongside France and Ireland, it is furthest from its targets regarding the use of renewable sources (Duurzaam Ondernemen, 2019). Figure 2 shows these results where the green dots indicate the target of 2020, and the dark blue bars indicate the current state. The difference between the actual state (blue bar) and the target (green dot) is the biggest for the Netherlands. These targets are established on a country-by-country basis, taking into account each nation's starting point and economic potential.

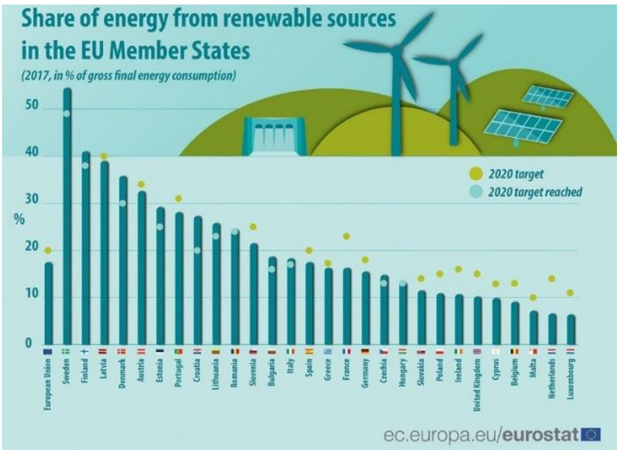


Figure 2: Share of energy from renewable sources in the EU Member States (Duurzaam Ondernemen, 2019)

The above highlights the pressing need for research into effective methods for implementing and utilizing ESG principles for real estate. Developing a clear definition and implementation strategy for ESG principles across the entire real estate sector could be a viable way to tackle and potentially resolve sustainability challenges. Moreover, focusing on a clear method for assessing all types of real estate based on ESG could address the ambiguities in the definitions within the three articles of the SFDR. This clarity would not only promote sustainable development but also help to prevent greenwashing. By concentrating on the Netherlands, it becomes feasible to incorporate its legal framework, regulations, and potential guidelines pertaining to sustainability in the building sector. Examples include bouwbesluit, BENG (Bijna Energie Neutrale Gebouwen), and energy labels (Rijksdienst voor Ondernemend Nederland, 2023). In essence, a thorough examination of the definition of ESG and its potential to clarify the SFDR articles appears intriguing and beneficial.

1.2 Problem definition

While looking at the aforementioned background, it can be concluded that there exist notable research gaps in the domain of ESG, including the absence of a universally accepted conceptualization for ESG, its lack of focus on assets, and its potential to clarify SFDR definitions. At the local level, there is a notable research gap and need concerning ESG practices and their impact on real estate assets in the Netherlands. This means that research into this field, and giving new insights into the defined research gaps, is necessary and valuable for the building sector in the Netherlands but also globally.

Concluding the above, the research problem which will be addressed in this study is the pressing need for research into effective methods for implementing and utilizing ESG principles in real estate, and thereby also addressing the ambiguities within the definition of the three SFDR articles. To address this research problem, the main focus of this study will be on the asset level. Therefore, the proposed research questions and its corresponding sub questions are formulated as follows:

''How can a uniform and integral ESG assessment for investments in real estate projects in the Netherlands be designed?''

a. What is the current state-of-the-art regarding ESG assessment methods for investments in real estate projects in the Netherlands?
b. What aspects and measurements should be considered in an ESG assessment for real estate at the asset level, while also exploring opportunities to incorporate aspects at the policy level?
c. How can we define these ESG measurements in such a way that they are measurable and quantifiable in the final assessment instrument?
d. How can Dutch laws and regulations be effectively integrated when defining measurable and quantifiable ESG measurements?
e. What methods and technology tools are most suitable for designing an efficient and usable ESG assessment instrument?

The primary objective of this study is to create a uniform, and integral ESG assessment instrument for investments in real estate projects in the Netherlands. This will be done by defining a clear framework to be able to assess all types of real estate assets on their sustainability performance and thereby also supporting the clarification of the articles within SFDR. The goal of the study is to provide a standardized framework for investors by developing a uniform and integral ESG assessment instrument. This should formally disclose the extent of ESG and SFDR compliance of real estate assets, promoting transparency and consistency in assessing sustainability performances in real estate. The study has a large added value to the limited amount of research performed into the direction of ESG and real estate by giving a thorough examination of the definition of ESG and its potential to clarify the SFDR articles. The results of the study will be valuable for usage not only within scientific research but also in the practical field, which can benefit from the results and apply outcomes to improve the assessment of sustainability, prevent greenwashing and thereby supporting the sustainability goals.

To reach the goals of the study, it will first review and analyze the existing ESG assessment methods and practices in the context of real estate. Subsequently, it will identify and prioritize relevant aspects and measurements for ESG assessments. These identified measurements will be transformed into measurable and quantifiable ESG criteria which can be incorporated into the ESG assessment instrument. Simultaneously, the influence of Dutch laws and regulations as well as the influence of BREEAM on the identification and definition of the measurements will be investigated. In the final phase, the findings will be translated into an assessment instrument which is able to assess all types of real estate.

While this research aims to offer a standardized ESG framework to create a consistent assessment of the sustainability performance of real estate assets in the Netherlands, it's important to recognize some limitations that could impact the study's scope, practicality, and strength. First of all, the study deliberately avoids concentrating on specific real estate types, focusing instead on creating a uniform assessment tool intended for broad application across all real estate categories. This comprehensive approach is intentional, and it's important to consider this wide-ranging applicability when drawing conclusions from the results. Moreover, the study is tailored to the Netherlands, which means that certain findings might not be applicable to other countries or regions as regulations might vary. In addition to its specific focus on the Netherlands, the study primarily centers on the asset level, potentially resulting in a limited emphasis on policy-related aspects. Furthermore, the regulatory landscape for ESG reporting and real estate investments may change during the execution of the research, potentially impacting the relevance of the instrument. Therefore, it is important to keep up to date on the latest developments on this topic during the execution of the study. Finally, involving stakeholders and experts opinions might cause biased results while making a selection of measurements to include in the assessment instrument. Other, more general limitations of the study are the availability of relevant and up-to-date data which might be limited at certain points, as well as the study's timeline which may not allow for in-depth exploration or iterative development.

For the remaining part of the study, PVM will provide support in conducting the research. PVM is a full service consultancy firm in real estate with their main office in Eindhoven (PVM, 2023). The company calls itself full service because they can act and support on almost all aspects of real estate, for example project management during the building period, or asset management of a real estate portfolio. To indicate their broad range of activities: they can act as a party doing property management, but also asset management, contract management, project management, data management or portfolio management. The company can advise different parties on many topics regarding sustainability, (fire) safety or the digitalization of data. Therefore, it is specialized in a wide range of topics, themes, and stakeholders. The company collaborates with governmental entities, educational institutions, investors, housing corporations and other stakeholders. Their large network of stakeholders and experts and their wide knowledge on real estate can help during the research by offering insights into certain topics and providing assistance when challenges arise. Additionally, during the development phase of the assessment instrument, the company can provide a case study to evaluate the instrument’s functionality. Finally, the instrument could be tested by different stakeholders or experts, allowing for the collection of user feedback.

1.3 Research Approach

To achieve the objectives of this research, the following research design is constructed and visualized in Figure 3. It is important to mention that, during the execution of the research, steps or methods may be subject to modification based on new findings.

1. Conduct a systematic literature review and comparative analysis on sustainability criteria in the built environment.
    - Give an overview of the current state-of-the-art of ESG assessment methods for real estate investments in the Netherlands.
    - Make an inventory of potential criteria for the ESG assessment instrument.
    - Analyze Dutch law and regulations regarding sustainability criteria and compare them with international standards.
    - Look into how to quantify the criteria which are potentially used in the ESG assessment instrument.
2. Collect input from experts via a questionnaire and define utility scores of the criteria.
    - Use the Best-Worst Scaling method to collect data
    - Analyze the data by using the Conditional Logit model
3. Develop the ESG assessment instrument tool, including the utility scores defined in step (3).
4. Perform a validation process to ascertain the functionality and accuracy of the instrument by conducting a case study
5. Optimize and validate the final instrument regarding outcomes of the case study and the user feedback.

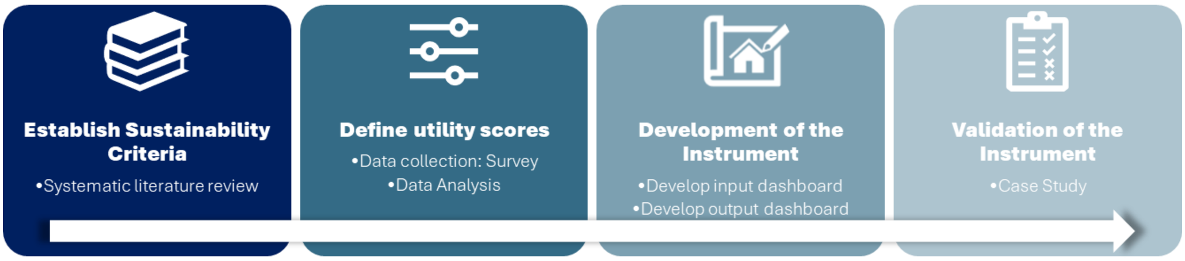


Figure 3: Schematic visualization of the research design

1.4 Importance of the study

This research aims to create a uniform, and integral ESG assessment instrument for investments in real estate projects in the Netherlands by defining a clear framework to assess all types of real estate assets on their sustainability performance and support the clarification of the articles within SFDR. The expected result is a standardized framework for investors by the development of an ESG assessment instrument. It should promote transparency and consistency in assessing sustainability in real estate, support real estate investors and consultants by conducting their analysis on ESG and SFDR, and thereby result in a larger contribution of the real estate sector towards solving the climate challenges.

By finding answers to the aforementioned research question and its sub questions, the study will provide an overview of the current state-of-the-art regarding ESG assessment methods for real estate investments in the Netherlands. This overview will provide a solid base and starting point for the development of the instrument. The study also has a large added value to the limited amount of research performed into the direction of ESG and real estate by giving a thorough examination of its definition. This added value will not only be relevant for usage within scientific research but also in the practical field, which can benefit from the results and apply outcomes to improve the assessment of sustainability.

Since the developed instrument aims to provide more transparent, measurable, comparable, and tangible results to the practical field, it also aims to promote real estate investments to being more (socially) sustainable. The developed instrument should guide towards a more regulated and consistent ESG assessment method, supporting the investments in real estate to be truly sustainable and thus prevent greenwashing from happening.

Additionally, the expected result is not only a practical ESG assessment instrument as the study also wants to highlight its connection towards the SFDR articles. The identification and quantification of several ESG measurements in this study will also support in creating a better understanding and clarification of the SFDR articles. Furthermore, the results of the study should not only support further research into the clarification of SFDR but also help to improve regulations and concepts which aim to reach the sustainability goals set by the European Union. In the end, the ESG assessment instrument will be developed. The instrument can process data imported by the users, which will be transformed into a user interface, designed to visually represent the results and outcomes of the ESG assessment in a user-friendly and easily understandable manner. The dashboard should be capable of presenting individual outcomes regarding the E, S and G aspects separately, while also having the capability to include an overarching outcome or performance which relates back to the SFDR performance of the asset.

To conclude, this study contributes significantly to the limited research on ESG and SFDR in real estate by clarifying its frameworks. Its importance lies not only in advancing scientific knowledge by providing insights into SFDR and ESG in real estate but also in offering practical benefits. By applying the outcomes of this study, the real estate sector can enhance its sustainability assessments and improve its alignment with the European Union's sustainability goals. The findings of this study provide valuable insights into the necessary steps to further develop and refine ESG assessments and clarify SFDR in the real estate sector, extending its applicability beyond the Netherlands by potentially providing guidance to other regions or countries as well. Additionally, the study may highlight specific measurement areas that require improvement to optimize the application and implementation of ESG and SFDR. Finally, the outcomes can support and guide the European Union in continuously evolving its regulatory frameworks and vision to achieve its long-term sustainability objectives.

1.5 Reading guide

The remaining part of this study will describe the process of creating a uniform and integral ESG assessment instrument for investments in real estate projects in the Netherlands. It will follow the steps in the previous shown research design. Chapter 2 will first focus on the literature review and establish a list of sustainability criteria. Next, Chapter 3 will explain the methodology of the remaining part of the research. By using the gathered list of sustainability criteria, Chapter 4 will discuss the data collection, analysis, and results, including the Best-Worst Scaling experiment. The final instrument development, case study and validation will be discussed in Chapter 5. Finally, Chapter 6 will conclude this study by answering the research questions and reflecting on the results and findings. It will include a critical review on the research, describe limitations and include recommendations for further research.

2. Literature Review

This study will start with an elaborated systematic literature review on relevant subjects within the field of the research. The literature review aims to find answers to the questions *'what is the current state-of-the-art regarding ESG assessment methods for real estate?'* and '*what are measurements, scores or indexes which are currently taken into account while looking into sustainability assessments of assets or buildings?'.* To find answers on these questions, the systematic literature review will analyze relevant research papers in a structured way. The findings of this review will be used for the remaining part of the study.

This chapter is divided into two parts, where the first part elaborates on the findings and results of the systematic literature review, concluding with a list of sustainability criteria. The second part dives into more detail regarding the selected sustainability criteria and use the Dutch Laws, regulations, policies and BREEAM as a starting point for the elaboration on definitions and calculation methods.

2.1 Methodology

By using a systematic literature review, the study aims to provide a comprehensive and structured overview of the available literature on the research topic. A systematic literature review is a well-planned review to answer specific research questions by using a systematic and explicit methodology to identify, select, and critically evaluate results of the studies included in the literature review (Rother, 2007). Conducting this systematic literature review will be done by using the PRISMA framework. PRISMA stands for ''Preferred Reporting Items for Systematic Reviews and Meta-Analyses'' (PRISMA, n.d.) and is an evidence-based guide consisting of a checklist and flowchart intended to be used as tools for writing a systematic literature review (Pati & Lorusso, 2018). Furthermore, two different databases are used to create a broad scope and limit the change of missing relevant papers. The databases used in this study are Scopus (Scopus, n.d.) and Web of Science (Web of Science, n.d.).

While using the PRISMA framework, search queries should be formulated which will select papers relevant for reviewing the current state-of-the-art regarding the research topics of ESG and sustainability assessments of buildings. This is done by formulating a list of search concepts and synonyms first, shown in Table 1. This overview shows which elements or topics should be covered in the systematic literature review. In this table, some synonyms include an asterisk (*), indicating that these words can be used as a verb (e.g. assessments) as well, this is called truncation.

Table 1: List of concepts and their synonyms

Concept	ESG	assessment	Asset	Sustainability	Criteria
Synonyms	Environment	Assessment*	Asset*	Sustainability	Indicator*
	Social	Evaluat*	Build*		Criteria
	Governance		Built asset*		Aspect*
	ESG		Built environment		Measurement*
			Real estate		
			Construct*		

After formulating the list of concepts as described above, limitations for the review search are defined. First of all, the literature should not be outdated since the review aims to focus on the current state-of-the-art. This means that studies published in the past 5 years will be included. Furthermore, the language of the papers is set to English which means that papers published in another language will be excluded from the review. Taking the above into account, search queries are written, and papers are extracted from Scopus and Web of Science. The search queries can be found in Appendix A.

The queries are applied to Scopus and Web of Science. After removing the duplicates, papers occurring in both the Scopus outcome and the Web of Science outcome, a total of 599 papers is used for further screening. This process of screening the papers consists of several stages of which an overview can be seen in Figure 4. This figure shows that during the identification phase, two different queries are used, one focusing on the topic of ESG, and one query focusing on sustainable building assessments to broaden the scope of the study and gather all relevant information.

In the initial stage of the systematic literature review, indicated in the PRISMA framework as the screening phase, conference papers, proceeding papers, books, and book chapters are removed. They are removed since these types of papers often undergo a less rigorous peer review. By excluding them, the literature review maintains a high standard of quality control on the information obtained. After this first selection, the remaining papers are screened based on their titles where irrelevant titles are removed from the review. Irrelevant titles are for example titles not including a focus on ESG or a focus on the built environment or sustainability assessment. After this first step, the papers with a relevant title are screened based on reading the abstract. While reading the abstract, it should be clear that the paper is focusing on the keywords indicated in Table 1. Papers which focus on mainly companies outside of the real estate sector (so non-building related), or papers focusing on the financial aspects or performance of a company are excluded. Before going to the last step of the screening phase, it was checked if the remaining papers were available to download. When papers were not accessible, they were removed from the review. Some papers were inaccessible as not all journals or databases are available due to a lack of agreements between the TU/e and these websites. Finally, the last step in the screening phase consists of reading the introduction and conclusion of the remaining papers. The papers which are still relevant are fully read, an overview of these selected papers can be found in Table 47 in Appendix B. By fully reading the articles, a good overview can be found of the current state-of-the-art regarding research towards ESG assessments considered in real estate and sustainability assessments of buildings.

After all the papers from the systematic literature review are analyzed, additional literature will be gathered to elaborate on the findings and help to define clear definitions for all criteria. This additional literature will mainly be documents, policies and other official documents from the Dutch Government or municipalities. Furthermore, BREEAM will be used to elaborate on the findings from the systematic literature review as it might give additional insights into the measurements.

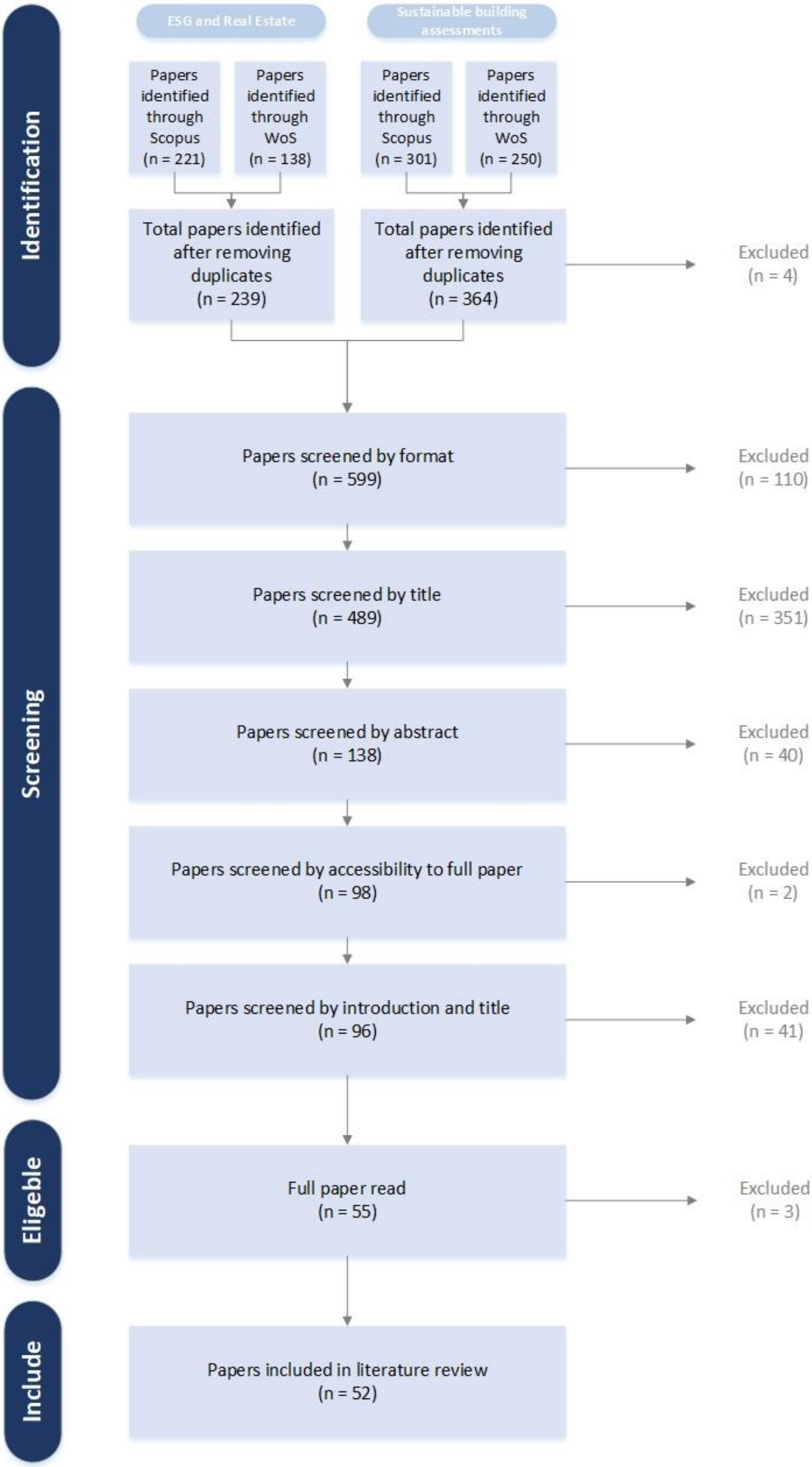


Figure 4: Selection process PRISMA

2.2 Systematic Literature Review

Within this section, the selected papers following from the PRISMA framework are discussed regarding several relevant topics. Several aspects will be discussed regarding the definition of ESG defined in the selected papers, its link towards real estate, the use of existing green rating systems or guidelines used in these studies. Lastly, this section will give an overview of the indicators and criteria used in literature and result in an overview, serving as a starting point for the remaining part of the study.

2.2.1 Definition of ESG

The impact of human-made greenhouse gas (GHG) emissions on climate degradation is noted not only in ecological paradigms but also in the realms of energy and economic development in industrialized nations, which encourages states to constantly work to improve international and national so-called "green" standards (Verstina et al., 2022). In the given context described by Verstina et al. (2022), the principles of ESG are gaining broader acceptance as also stated by (Castro et al., 2020; Kempeneer et al., 2021). Newell et al. (2023) stated that ESG has taken on increased global importance and awareness in recent years for all stakeholders, consumers, community, industry, investors, and governments. Kempeneer et al. (2021) identified a dual purpose in the use of ESG where investors initially focused on the value of ESG issues in and of themselves. However, over time, other investors became interested in ESG from a more financially focused approach where sustainability is taken into account more rationally.

ESG is a term first used by James Gifford in 2004 as part of the UN program for the environment in Geneva and demonstrates the widespread awareness of the importance of sustainability (Battisti, 2023). Morgante et al. (2023) described that the sustainable development concept in the financial world from which ESG criteria were derived, has already received international recognition in Brundtland Report ''Our Common Future'' in 1987 in which sustainable development was defined as a development's ability to meet the needs of present generations without compromising the ability of future generations to meet their own needs.

In a study by Morgante et al. (2023), it was noted that ESG originated as a set of criteria guiding responsible investments and corporate restructuring practices. The intention was to harmonize the dichotomous relationship between ''shareholders' profit'' and ''stakeholder well-being''. Moreover, the study described that global initiatives have reinforced the significance of incorporating ESG factors into sustainable development strategies. These efforts have motivated investors to embrace impact investment approaches, contributing to the increasing utilization of ESG criteria in the real estate market sector (Morgante et al., 2023). Morgante et al. (2023) went into detail on the definition of ESG by describing it as a broad umbrella term, referring to the integration of environmental, social, and governance considerations into investors' portfolio assessments. It defined the environmental dimension 'E' as the assessment of a company's impact on the natural ecosystem and characterized the social dimension 'S' as encompassing the company's relationships with customers, labor, and society. Lastly, the governance dimension 'G' is portrayed as a dimension that refers to the system through which management acts in the best interest of its long-term investors.

The study by Battisti (2023) stated that in the economic or financial sector, the term ESG is employed to indicate the criteria adopted for sustainable responsible investments (SRIs). In other words, sustainable responsible investments are investments in activities that consider environmental, social, or governance aspects. The study further underscored that ESG demonstrates the widespread awareness of the importance of sustainability and that ESG criteria can be primarily described as a series of measurement criteria and standards (in many instances still in the development stage) for environmental, social, and governance activities within an organization, used by investors to evaluate and choose their investments.

The three principal European regulatory measures which were introduced in the last few years, or those which are still under development, have a potential contribution to the growth of the sustainable finance market (Battisti, 2023). Battisti (2023) described that one of them is the Sustainable Finance Disclosure Regulation (SFDR) which authorizes the EU to request financial operators to provide information regarding whether the investment choices and financial products on sale in Europe are integrated in terms of their sustainability and, if so, which form these integrations take. This regulatory Act establishes that financial operators are obliged to disclose information regarding how they integrate ESG risks and how they take into consideration the negative effects their investment policies might have on the environment and social issues.

Besides the definitions of the term ESG as given above, Newell et al. (2023) described four styles of ESG benchmarks and reporting standards, all capturing information at various levels. These levels include (1) real estate fund/asset level, (2) listed real estate level, (3) delivery level and (4) the reporting level. It also described a difference between internal and external benchmarks regarding ESG where internal benchmarks are benchmarks which are created by organizations itself while external benchmarks are not, giving a more consistent and robust methodology.

As outlined in a study by Castro et al. (2020), real estate ESG references and real estate ESG benchmarking address fundamental practices in incorporating sustainability into real estate activities. It stated that their approach provides guidance for helping real estate stakeholders monitor the triple bottom line [2] in the building life cycle and in their investment decision making. In addition, the study indicated that they describe best practices in the building, which commonly are based on some sort of sustainable building rating bodies. The principle of the triple bottom line is further discussed in the study by Paganin (2021). The study indicates that since the mid-90s, the issue of environmental performance communications has introduced the concept of the Triple Bottom Line and has evolved to include governance and decline the sustainability factors in the 4Ps (People, Planet, Prosperity and Principles of Governance).

2.2.2 ESG and real estate

Although the ESG criteria existed before the Agenda 2030 and the Paris Agreement, international efforts have emphasized the significance of integrating ESG factors into sustainable development strategies and encouraged investors to adopt impact investment approaches, leading to a growing use of ESG criteria in the real estate sector (Morgante et al., 2023). Furthermore, the real estate sector is identified as a key contributor to global environmental challenges, including approximately 39% of global CO_2 emissions, and therefore holds the potential for significant positive impacts on the environment, society, and the economy through the adoption of ESG criteria, as emphasized by multiple sources (Battisti, 2023; Newell et al., 2023).

[2] Rivai et al. (2023) indicates that the ''triple bottom line'' is often defined as the three main aspects, or pillars, of sustainability, namely economic, environmental, and social.

Verstina et al. (2022) underscored the increasing recognition of the importance of incorporating ESG risks into decision-making processes by commercial property investors, owners, and corporate tenants. It also suggested that the growing awareness of ESG considerations is serving as a stimulus for real estate companies to integrate sustainability dimensions into their corporate policies and business activities. This incorporation of ESG is also seen in a paper by Castro et al. (2020), which intends to link sustainability, real estate ESG, and sustainable building in order to help companies internalize this concept in all areas of their operations by aligning it with their strategic planning. The study by Kempeneer et al. (2021) went into more detail and focused on how user behavior might affect the ESG value of real estate.

Additionally, the real estate sector is one of the various industrial sectors that contributes to achieving the Sustainable Development Goals (SDGs) and to the development of financing opportunities in sustainable development finance (Battisti, 2023). Morgante et al. (2023) indicated that the relationship between SDGs and the sustainability of projects and interventions in the building and urban field are investigated by several authors, exploring which indicators and criteria can be used for its evaluation. However, Battisti (2023) focused on the link between ESG and SDG and indicated that in the real estate sector, achieving SDG 11 would mean that making cities and human settlements inclusive, safe, long-lasting and sustainable should be its target. This means that if a project meets the ESG requirements, it should be checked to make sure it matches the goals of SDG 11. This check is important for those supporting sustainable development financially to decide if the project qualifies for funding.

Hence, the study by Paganin (2021) indicated that the construction industry, a major recipient of capital investments, needs to understand and apply sustainability criteria in each project. The study stated that the growing attention to ESG in construction arises from its substantial share of capital, with nearly half of the European Union's investments going to buildings or infrastructures. So, by acknowledging the sector's financial importance, incorporating ESG principles is crucial for supporting wider sustainability objectives.

Beyond the real estate sector or construction industry in general, the study by Verstina et al. (2022) looked into industrial facilities[3]. Due to the substantial energy consumption and significant energy losses in industrial operations, caused by potential structural imperfections, wear and tear, and production processes, the author of this study recognized the importance of devising a new method for evaluating the energy efficiency of industrial enterprises. In the end, this new formed approach or method should ensure the possibility of accelerating the transition to ESG principles.

2.2.3 Focus on ESG indicators and criteria.

Currently, the ESG measurement systems present a significant challenge for portfolio investors and management, particularly evident in the real estate sector (Morgante et al., 2023). Key issues identified by Morgante et al. (2023) include the lack of alignment in practices related to comparison metrics, integration of social and governance dimensions with environmental sustainability, and the absence of agreed-upon processes for identifying ESG criteria and

[3] Industrial facilities are defined as an industrial building (structure) or a complex of adjacent buildings (structures) was proposed, including its entire property complex, which has a single engineering infrastructure that ensures production activities as a business entity (Verstina et al., 2022).

indicators in scientific research. This is further emphasized by Castro et al. (2020) which stated that there is a huge variety of sustainability definitions that change over time and between countries and additionally, that there is no one guideline providing a cross-reference between corporate social responsibility (CSR) and green building performance. Paganin (2021) investigated this matter by looking into an analysis of a sample of investors. About half of the respondents of this sample of investors highlighted that it is difficult to integrate ESG information into investment decisions due to the multiplicity of approaches to ESG communication, which makes it also difficult to compare different companies and projects. Finally, it is in many cases still unclear what it means to improve ESG factors in the first place, due to a lacking universal conceptualization and the divergence in measurement practices (Kempeneer et al., 2021).

Furthermore, the lack of a universally accepted meaning for the concept of sustainable finance has led financial institutions and international organizations to structure different definitions based on their specific points of view, sometimes making it difficult to correctly frame the topic of investments in sustainability (Paganin, 2021). Moreover, for the real estate investment market to work efficiently in filtering out assets that perform poorly in terms of ESG metrics, a robust benchmarking framework is necessary (Newell et al., 2023). The lack of a universally accepted meaning or definition, and the absence a robust benchmarking framework results in stakeholders who commonly have different perceptions and cannot determine the true sustainable performance and quality of a sustainable real estate business (Castro et al., 2020).

Besides the absence of clear processes, indicators, and criteria, Kempeneer et al. (2021) indicated the absence of user behavior when looking at reducing the environmental impact of a building. It also concluded that the social dimension of ESG is strongly under conceptualized and should include more elements of user wellbeing.

The study by Verstina et al. (2022) indicated that the catalyst for compliance with ESG principles, including environmental friendliness, is to set up a good system for keeping track of how much energy a company uses and managing the costs, which seems especially important for businesses in the industrial sector. The study also highlighted the importance of evaluating how efficient industrial facilities are in using energy. To do this, the researchers looked into factors that affect the energy efficiency of a building and suggested incorporating their developed system of indicators into national and international standards. This approach aims to provide an effective tool for large-scale monitoring of energy-saving measures, aligning with sustainable development and ESG principles in the global transition to low-carbon energy.

Finally, Battisti (2023) identified questions of scientific interest regarding how to evaluate the performances of ESG projects, such as urban transformation and regeneration and real-estate development, which are intended to collaborate in achieving the SDGs, especially the SDG 11.

2.2.4 ESG and Green rating systems or guidelines

Among the selected papers for this literature review, a notable trend emerged, highlighting that a substantial number of them used existing certificates or rating bodies regarding sustainable development or sustainable buildings. Rating bodies such as Leadership in Energy and Environmental Design (LEED), Building Research Establishment Environmental Assessment Method (BREEAM,) Deutsche Gesellschaft für Nachhaltiges Bauen (DGNB), Comprehensive Assessment System for Built Environment Efficiency (CASBEE) and the Sustainable Development

Goals (SDGs) are used in studies as a reference or for comparison. Paganin (2021) looked at characteristics and indicators taken into account in several rating bodies or assessment systems such as the EU taxonomy, LEED, ISO 21929-1, EU level(s), BREEAM, and DGNB. The study also noted that sustainable finance criteria for evaluating projects and companies do not always align entirely with the numerous building sustainability assessment systems developed within the Architectural Engineering and Construction (AEC) industry (Paganin, 2021).

Another study that delved into these rating bodies was conducted by Castro et al. (2020), where the guidelines and certifications are first divided into two groups: the business dimension and the building dimension. Considering the building dimension, BREEAM, LEED, DGNB, Haute Qualité Environnementale (HQE) and CASBEE are included as well as sustainable building standards such as ISO 15392:2008 (sustainability in building construction – general principles) and ISO21929-1:2011 (sustainability in building construction – sustainability indicators – part 1: Framework for the development of indicators and a core set of indicators for buildings). CASBEE is also discussed in more detail in the study of Hayashi et al. (2021), which focused on the factors taken into account in this specific assessment method only, related to ESG.

Morgante et al. (2023) started by looking into the SDGs and compared a list of indicators formed during the study with a list of indicators given by LEED, BREEAM and Global Real Estate Sustainability Benchmark (GRESB). Battisti (2023) also looked into the SDGs but mainly focused on SDG 11 as a guideline for formulating a list of ESG indicators. The study by Verstina et al. (2022) was the only study not taking into account the SDGs or other rating bodies. This study mainly looked at the level of energy efficiency of the object of assessment, determined based on the characteristics of consumption or the consumption of energy resources (Verstina et al., 2022).

2.2.5 Methods used in literature

Some similarities have also been identified regarding the methodologies in the selected papers. First of all, it was recognized that many studies included a panel of experts or stakeholders to collect feedback on criteria or indicators to evaluate the sustainability of real estate regarding ESG (Battisti, 2023; Morgante et al., 2023; Newell et al., 2023; Verstina et al., 2022). An example of the incorporation of experts is through the use of the Delphi Method, a typical social research methodology that allows information to be acquired from a selected group or panel of experts, who are called to anonymously express their opinions on a specific issue so that some of their opinions can be validated through mutual comparison and progressive sharing (Battisti, 2023). Two studies which used input of a panel also included a specific case study in their analysis, one focusing on the Florance Metropolitan Area and the other on a renovation project in the core of Milan city for residential purposes (Battisti, 2023; Morgante et al., 2023).

Some studies only focused on the evaluation or reflection of existing materials or assessments (Hayashi et al., 2021; Paganin, 2021) and some included a comparative analysis, mostly using the above described rating bodies or certificates (Castro et al., 2020; Verstina et al., 2022). In the study by Verstina et al. (2022), the comparative analysis was used to analyze the correspondence of energy consumption indicators and their indicative values, as well as to formulate proposals for discussion on the ranking of the values of energy efficiency indicators of industrial facilities. Castro et al. (2020) used the comparative analysis for establishing the comprehensive features of the sustainable commercial property and highlights which are the core premises needed to understand the concept of sustainability. One study used the AHP method to focus also on weighting of the criteria for evaluation the sustainability of real estate (Morgante et al., 2023).

2.2.6 Research towards sustainability assessments.

While looking into current research towards sustainability assessments, several criteria and indicators were found, some supporting the criteria mentioned in literature focusing on ESG. It should be noted that several studies selected the criteria in their research by looking into sustainability assessment tools such as BREEAM, LEED or DGNB (Ameen & Mourshed, 2019; Huedo Dorda et al., 2019a; Khan et al., 2021; Olakitan Atanda, 2019; Rodríguez, 2023; Salati et al., 2022; Yadegaridehkordi & Nilashi, 2022), which is also used as a basis for formulating lists of criteria when looking into research focusing on ESG. Furthermore, the concept of the triple bottom line is mentioned and used as a starting point for defining a list of criteria and indicators in numerous studies (Amoako Sarpong et al., 2023; Huedo Dorda et al., 2019b; Jalilibal & Bozorgi-Amiri, 2022; Karji et al., 2019; Khan et al., 2021; Olakitan Atanda, 2019; Rivai et al., 2023; Yuan et al., 2019; Zulkefli et al., 2020). Rivai et al. (2023) indicates that the ''triple bottom line'' is often defined as the three main aspects, or pillars, of sustainability, namely economic, environmental, and social.

Moreover, the studies are diverse in the focus area regarding the specific location used in the study, or the type of buildings used. For example studies focus on the area of Jordan (Alnsour et al., 2023; Mohsen & Matarneh, 2023; Sharif, 2023) , Cyprus (Olukoya & Atanda, 2020), Brazil (Costa et al., 2023a), South Africa (Olawumi & Chan, 2020), Ghana (Agyekum et al., 2022; Amoako Sarpong et al., 2023), China (Chen et al., 2022; Yuan et al., 2019), Malaysia (Yadegaridehkordi & Nilashi, 2022), Iraq (Ameen & Mourshed, 2019), Iran (Zarghami et al., 2019), Sweden (Robling et al., 2023), Pakistan (Khan et al., 2021), India (Francis & Thomas, 2022), Spain (Rodríguez, 2023), Turkey (Akcali & Cahantimur, 2022) and Slovakia (Burdová et al., 2020). This means that these studies take into account specific aspects such as the climate and economic situation while selecting or using criteria and indicators. There also is a great variety regarding the type of buildings which are researched in the selected literature. Studies focus, besides buildings or the construction sector in general, specifically on high rise buildings (Khanapure & Shastri, 2023; Maleki et al., 2022; Tupenaite et al., 2021), health care buildings (Costa et al., 2023b) or elderly homes (Yuan et al., 2019), educational buildings (Alhilli & Burhan, 2021; Chen et al., 2022; Yadegaridehkordi & Nilashi, 2022), social housing (Arukala et al., 2019), farming (Robling et al., 2023), interior design (Mohsen & Matarneh, 2023), or the urban scale (Salati et al., 2022). Finally, one paper focused on residential buildings under pandemic conditions (Tokazhanov et al., 2021). However, unless the specific focus on a country, area or building type, the mentioned criteria or indicators remain similar and therefore can be used in this study.

2.2.7 Criteria used in literature

After combining all the criteria and indicators found in literature focusing on ESG and sustainability assessments in the built environment, an overview is created based on the three categories of ESG. The criteria included can be found in the schematic overview in Figure 5. In Appendix C , tables with a more detailed overview of the criteria can be found, also including the definitions of the criteria found in literature. It should be noted that criteria which were only mentioned in 1 of the 52 papers are removed from this initial framework and thus not included in the overview.

Figure 5: ESG overview resulting from the literature review

2.3 Elaboration on findings

After collecting a list of important criteria based on the systematic literature review, discussed in section 3.1.7, additional literature is found on the criteria to elaborate and find additional information regarding the definitions, calculations, and requirements. The main focus for finding this additional information are the Dutch policies, laws and regulations. However, if not enough information can be found in these sources, additional sources are added to gather missing information and finalize the basis for developing the assessment instrument. Also, BREEAM (BREEAM-NL, 2024j) is used to find methods on calculation or defining criteria. This section will discuss and elaborate on the additional findings and will conclude with a final overview of all criteria including their definition, calculation method and their minimum requirements.

2.3.1 Environment

This section will cover the criteria which are related to the environmental part of the assessment instrument and are discussed per category, Figure 6. Note that there are small changes compared to the overview given in section 2.2 as several criteria are merged together to limit the amount of criteria in the final assessment instrument.

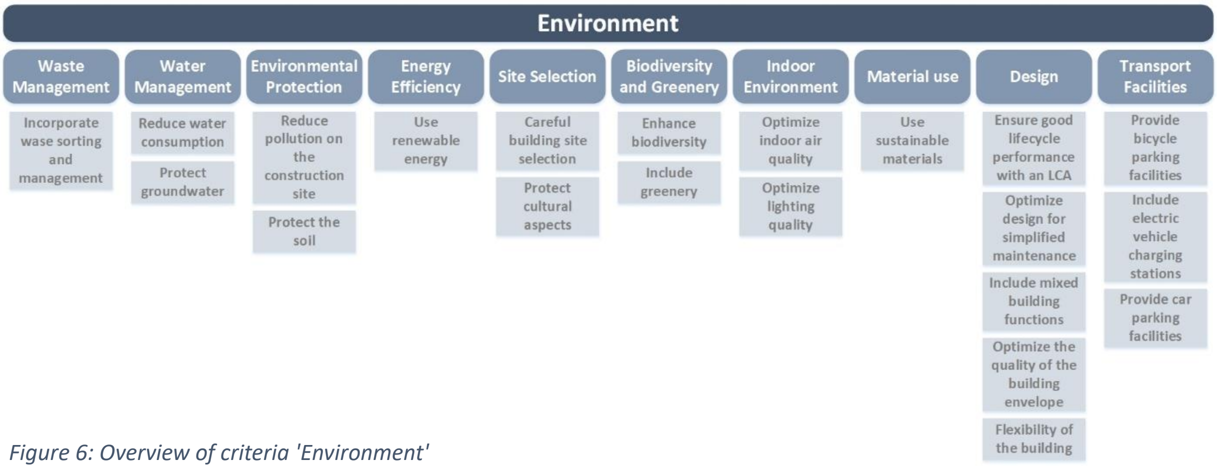


Figure 6: Overview of criteria 'Environment'

Waste Management

The category of waste management has one criterion, focusing on incorporating waste sorting and management, Table 2. As indicated in a study by Montalbán-Domingo et al. (2020), waste plays a significant role in reducing carbon dioxide emissions. The study also stated that proper waste management is essential to guarantee lower rates of sending waste to landfill, placing less strain on nature.

As the definition also focuses on the construction site, 'besluit bouwwerken leefomgeving' (BBL) is checked but does not give specific guidelines on low waste construction sites in general. However, in Chapter 7 'Bouw- en sloopwerkzaamheden', there is a part on waste separation, describing that construction and demolition work should be carried out in such a way that construction and demolition waste released during the execution is properly separated (BRIS, 2024). This article can function as a guideline on defining minimum requirements for the category of waste management. Besides this regulation on waste separation, there is no regulation found on decreasing waste on the construction site. However, as literature supported the statement in the BBL about waste sorting, it suggested that a low waste construction site can be promoted by onsite waste sorting but also by including low waste building technologies such as prefabrication or a modular design (Yu et al., 2021).

Table 2: Details regarding criteria in category 'waste management'.

Category	Criteria	Definition	Input value	Minimum requirement
Waste Management	Incorporate waste sorting and management	Include measures and solutions to facilitate separate waste collection. For example a space destined for recycling containers, differentiating organic waste, packaging, and paper. Also on the construction site.	Amount of measures present	At least one measure is present

Water Management

Water management includes two criteria, focusing on the reduction of water usage and the protection of groundwater, Table 3. Looking into the Dutch laws and regulations, there are no specific guidelines for reducing water usage. However, the guidelines of BREEAM (BREEAM-NL, 2024j) give a lot of indicators and calculation methods regarding water management, these can serve as a basis for formulating the calculation methods and minimum requirements of the criteria in this category. To further explore the data obtained from BREEAM, this study draws upon research conducted by Witteveen+Bos (Inge Phernambucq et al., 2023) on behalf of the Ministry of 'Binnenlandse Zaken en Koninkrijksrelaties', as well as a policy brief authored by the Minister of Infrastructure and Water Management in 2022 (Harbers & Heijnen, 2022).

To protect groundwater on the project site, 'besluit bouwwerken leefomgeving' article 7.16 'grondwaterstand', indicated that dewatering on the construction site should not result in a groundwater level that is dangerous for the safety of neighboring properties or buildings (Overheid.nl, n.d.). To minimize these negative effects, a groundwater investigation can be done and a dewatering or plumping plan can be made. When the project is extracting or infiltrating groundwater, permission may be required from the water board or the province (Rijkswaterstaat, n.d.), therefore, measures should be present and show that groundwater is protected.

In the Netherlands, it is required to include facilities enabling the drainage of domestic wastewater and rainwater without adverse effects on health (Informatiepunt Leefomgeving, 2024c). However, regarding the management or reuse of water, no specific requirements are given. Research conducted by Deltares concluded that rainwater harvesting (RWH) can support the goal of reaching a 20% saving of drinking water (Deltares, n.d.). The research mentioned that collecting rainwater for reuse can be done by integrating water tanks into the project, taking into account paved surfaces or the surfaces of a roof as well.

Finally, there are no specific requirements found regarding the reuse of gray water but the research of Witteveen+Bos (Inge Phernambucq et al., 2023), mentioned the use of gray water as an option to minimize the use of drink water. They stated that graywater systems reuse 'light gray water', which is water from the washing machine, the shower, bath, or sink. This water contains soap residues that need to be removed before it can be reused, which is done by the gray water systems. The study also indicated that the use of these systems is already promoted in some other countries, where the starting point is to use the system safely for the washing machine, the garden, and toilet flushing.

Table 3: Details regarding criteria in category 'water management'.

Categories	Criteria	Definition	Input value	Minimum requirement
Water Management	Reduce water consumption	Reduce the amount of water used in the building by including water efficient components, water recycling systems (such as a graywater system) and monitoring the water usage with technology.	Presence of water efficient components, water recycling systems, and monitoring systems.	At least one measurement is present
			Presence of rainwater tanks (of 5-10m^3 for terraced or single-family houses), connected to paved surfaces (in case of apartments).	A rainwater tank of at least 5m^3 is present and in case of apartments, a tank of 20m^3 is connected to paved surfaces.
			Presence of gray water system	A gray water system is present.
	Protect groundwater	Include measures to minimize the negative impact on ground water such as a groundwater investigation and dewatering or plumping plan.	Presence of measures to protect groundwater.	At least one measurement is present

Energy efficiency

As indicated by (Montalbán-Domingo et al., 2020), improving energy efficiency is important to reduce the dependency on energy imports and to reduce pollution. Measuring the energy efficiency of a project means that a lot of different aspects are taken into account which are combined in one criterion focusing on the use of renewable energy, Table 4.

A study by Chel & Kaushik (2018) stated that modern day buildings are highly energy intensive with a significant consumption of energy right from the construction phase to the operation and maintenance stage. Therefore, renewable energy sources and technologies should be implemented in buildings. Renewable energy originates from ongoing natural processes that are consistently replenished. The various forms of renewable energy are derived directly from the sun, or from heat generated deep within the earth. This definition also encompasses electricity and heat derived from solar, wind, ocean, hydropower, biomass, geothermal resources, as well as biofuels and hydrogen sourced from renewable materials (Chel & Kaushik, 2018). Chel & Kaushik (2018) also stated that the integration of solar and wind energy systems appears to be the most interesting among renewable energy sources for the built environment.

When looking at the requirements in the Netherlands, it is required to have a certain amount of renewable energy after doing an extensive renovation, which means that more than 25% of the building envelope changes (Rijksdienst voor Ondernemend Nederland, 2021). BREEAM uses the NTA 8800, which is an abbreviation for 'Nederlandse Technische Afspraken' (Dutch Technical Agreements) (BREEAM-NL, 2024g). It is a method given by the Dutch government to determine the energy performance of buildings, which can be used to for example demonstrate compliance with the BENG requirements (EPG, n.d.). Within these BENG requirements, three different indicators are included: the energy demand indicator in kWh/m_2 (BENG-1), the primary fossil energy indicator in kWh/m_2 (BENG-2) and the total share of renewable energy in % (BENG-3) (Rijksdienst voor Ondernemend Nederland, 2017a). Furthermore, the energy labels which can be given to buildings give indications on minimum requirements for the energy efficiency criteria (ANWB, 2024). Within this study, the requirements for reaching energy label A are used as guideline.

Table 4: Details regarding criteria in category 'energy efficiency'

Categories	Criteria	Definition	Input value	Minimum requirement
Energy Efficiency	Use of renewable energy	Use energy from renewable sources such as solar panels and thereby promote the building's energy efficiency and reduce the CO_2 emissions of the building.	Energy demand (kWh/m_2) per year.	< 150 kWh/m^2
			Primary fossil energy (kWh/m_2) per year.	< 160 kWh/m^2
			% of total energy (kWh) which is renewable energy	> 50%

Environmental Protection

The construction industry has attracted acute criticism due to its detrimental effects on the natural environment (Agyekum et al., 2022), which means that protecting it is essential. Within this study, two criteria are included in this category, Table 5, focusing on the reduction of pollution on the construction side and the protection of the soil.

First, reduction of pollution on the construction site is included as a criterion. When looking into the Dutch laws and regulations, it is found that chapter 8 of Bouwbesluit (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2024) gives some guidelines and regulations regarding noise pollution, vibration nuisance and dust pollution. A project should report on all these measures in a safety plan, indicating the measures taken to reduce the pollution. Projects also need to include measures to protect the soil from pollution, the Dutch guideline soil protection (NRB, Nederlandse Richtlijn Bodembescherming) stated that for example a soil risk checklist (BRCL, Bodemrisicochecklist) can be used to see whether it is needed to implement any measures, or a soil investigation can be conducted (Ministerie van Infrastructuur en Milieu, 2012). If any risk is present, measures should be taken to prevent soil pollution from happening.

Table 5: Details regarding criteria in category 'Environmental Protection'

Categories	Criteria	Definition	Input value	Minimum requirement
Environmental Protection	Reduce pollution on the construction site	Include measures to reduce inconvenience derived from the construction site, such as noise control systems or measures against dust.	Amount of measures present	At least one measure is present
	Protect the soil	Protect the soil from pollution of physical and chemical environmental stressors and prove this by including soil investigation reports.	Amount of measures present	At least one measure is present

Site Selection

The efficient use of urban land is a predominant issue promoted by sustainability assessment tools (Salati et al., 2022). Choosing a construction site also has a major significance in terms of the integration of buildings into the natural environment, with the aim of ensuring the minimal impact on natural resources and ecosystems (Burdová et al., 2020). Therefore, careful building site selection is needed. This means that it is encouraged to use previously occupied or contaminated land and avoid land which has not been previously disturbed (Lazar & Chithra, 2021). Furthermore, a building should reflect the cultural and ethnic identity of the neighborhood and community (Olakitan Atanda, 2019). Including appropriate historical environment professionals (archaeologist, conservation architect, or historic buildings specialist) on the project team could help to manage and inspect the mitigation effort in construction projects (Montalbán-Domingo et al., 2020). The criteria within this category can be found in Table 6 below.

Within the Dutch laws and regulations, some guidelines can be found on the site selection. Currently, it is preferred to build in urban areas instead of non-urban areas because facilities such as hospitals, schools, public transport stations and shops are used more efficiently (Ministerie van Infrastructuur en Waterstaat, 2004). Another argument given in this policy research is that careful site selection leads to the conservation of the scarce open spaces in the Netherlands. The Nota Ruimte (Ministeries van VROM, LNV, VenW, n.d.) elaborated on these strategic guidelines regarding the vision of the government and describes an outline in which national responsibilities and those of others are clearly distinguished.

Next to the guidelines and visions of the government, there also is a Spatial Planning Act, currently covered within the recently implemented Omgevingswet (Raad van State, 2024). This act includes a plan per municipality and provides a balanced allocation of functions to locations (Informatiepunt Leefomgeving, 2024e). The Omgevingswet also includes the protection of cultural aspects. However, there is a separate Erfgoedwet, which is an act to protect cultural heritage such as monuments (Rijksdienst voor het Cultureel Erfgoed, n.d.). This means that all projects are required to follow both the Omgevingswet and, if applicable, the Erfgoedwet. Furthermore, the guidelines and visions of the government support the findings in literature and are included in the criteria of this category.

Table 6: Details regarding criteria in category 'Site Selection'

Categories	Criteria	Definition	Input value	Minimum requirement
Site Selection	Careful building site selection	Site of the project is carefully selected, and urban lands are not used.	Presence of research done to site selection	Site carefully selected as research is done.
	Protect cultural aspects	Protect the identity, landscape and cultural identity of the area.	Amount of measures present	At least one measure is present

Biodiversity and Greenery

The study by Montalbán-Domingo et al (2020) stated that establishing measures to minimize the effect on natural vegetation is important in the construction industry, as well as protecting nonhazardous trees and native plant communities and planting or replacing vegetation in a way that extends well beyond typical practices. Furthermore, the study stated that the extinction of threatened species needs to be prevented. Besides studies, also the United Nations (United Nations, 2024) mentioned the importance of biodiversity and greenery, covered in SDG 15. It aims to protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

This category includes two criteria, Table 7, focusing on the biodiversity and the greenery in the project and its area. Biodiversity is a scientific term that describes the different varieties of all living organisms from all sources (terrestrial, marina and aquatic) and their ecosystems, encompassing diversity within species, between species and of ecosystems (Agyekum et al., 2022). As a heavy consumer of resources, the construction industry is seen as a significant contributor to biodiversity loss (Agyekum et al., 2022). Therefore, measures should be included in a project to minimize this loss and even enhance the biodiversity. This can be described in a biodiversity policy plan, which is also included as a criterium in BREEAM (BREEAM-NL, 2024i).

To not only measure the policy plan, but also include the actual actions taken by the project, an additional input is used. Within the Omgevingswet, there are some regulations and guidelines described in the legislation for nature conservation (Wetgeving voor Natuurbescherming) (Rijksoverheid, n.d.). It described that projects should look into the effects of their activities on nature and that they have to meet certain conditions to protect the biodiversity. Actual plans and guidelines are given on the local level by the municipalities. An example of a local plan is the 'puntensysteem voor natuurinclusief bouwen', a point system connected to the guidelines 'natuurinclusief bouwen en ontwerpen' and used in the design phase of a project (Gemeente Amsterdam, 2024). This system can be used to evaluate the criterion on greenery.

Table 7: Details regarding criteria in category 'Biodiversity and Greenery'

Categories	Criteria	Definition	Input value	Minimum requirement
Biodiversity and Greenery	Enhance biodiversity	Creating, maintaining, and increasing biodiversity both on building plots and in their environment.	Biodiversity policy plan	A policy plan is present
	Include greenery	Greenery should be included in the project and plot.	Points 'natuurinclusief bouwen'	At least 20% of the points

Indoor Environment

Mohammed (2021) stated that indoor environmental quality is one of the five major elements of a green building design. Focusing on the quality of the indoor environment is needed to eliminate the harmful effects on the health conditions of users (Fatourehchi & Zarghami, 2020). Within this study, there is a subdivision of two criteria, focusing on the indoor air quality and the lighting quality, defined by several input values, Table 8. These criteria should measure if the indoor environment is a healthy and pleasant space for its users by for example preventing the increase of the concentration of dust particles inside a home or using the advantages of good lighting quality such as the psychological benefits for building users (Fatourehchi & Zarghami, 2020).

Regulations for the indoor air quality for new buildings can be found in the BBL (besluit bouwwerken leefomgeving) (Informatiepunt Leefomgeving, 2024d). It stated that every building needs a ventilation possibility which should prevent that the indoor air quality harms the health of its users. It described some basic rules which should be met by every building. BREEAM focused more on the measures taken within a building to optimize the indoor air quality, supporting the standards from the BBL (BREEAM-NL, 2024h). This leads to the given input value and minimum requirement of this criterium being the amount of measures present to optimize the indoor air quality.

Bouwbesluit gave some clear guidance on the amount of daylight surface (windows) which should be present compared to floor area (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, n.d.), as well as BREEAM which used the same calculation method (BREEAM-NL, 2024a). The minimum requirement in Table 8 is at least 10% as indicated in the calculation method from BREEAM. Finally, there should be at least one measure which prevents discomfort due to brightness or glare from natural light.

Table 8: Details regarding criteria in category 'Indoor Environment'

Categories	Criteria	Definition	Input value	Minimum requirement
Indoor Environment	Optimize indoor air quality	Provide healthy indoor air quality through the specification and installation of appropriate ventilation, equipment, and finishes.	Amount of measures present	At least one measure is present
	Optimize lighting quality	Include appropriate levels of daylight but minimize discomfort due to brightness from natural light.	% window area compared to floor area	At least 10%
			Amount of measures present	At least one measure is present

Material Usage

The construction industry is known to have a considerable potential for improving sustainability by adopting measures, such as using renewable materials or reusing recycled and low-impact materials (Salati et al., 2022). This issue is also emphasized by SDG 12, focusing on sustainable production and consumption, with more efficient use of resources, to reduce environmental pressure and lessens dependence on those resources (SDG Nederland, 2024). Within the category material usage, there is one criterion on the use of sustainable materials. This covers several aspects as it includes the use of environmentally friendly materials, but also reuse of materials, and the use of local or certified materials, Table 9 . Together, all these characteristics can be summarized as sustainable materials since they reduce the environmental pressure as described in SDG 12.

When applying for an environmental permit, an MPG (MilieuPrestatie Gebouwen) is required as it describes the environmental impact of the materials used in a building (Rijksdienst voor Ondernemend Nederland, 2017b). BREEAM also uses MPG and stated that a project should have an MPG score which is at least 20% better compared to the reference value (BREEAM-NL, 2024b). These reference values are given in Guidance Note 42 and are comparable with the building regulations but can be stricter as well (BREEAM-NL, 2021). Within this study, the MPG score will be included to define a part of the criterion on the use of sustainable materials.

Recycled and reused materials have been recognized as making an important contribution to reducing landfill and conserving nonrenewable resources (Montalbán-Domingo et al., 2020). A study by Morgante et al. (2023) showed an example on how to measure the reuse of materials where they take the percentage of the amount of materials which is recovered or recycled. They also used percentages to measure the amount of local materials used in the project. As the Dutch laws do not have specific measures for these criteria, the method of using percentages is used. BREEAM gives some guidance on a minimum requirement, which is set on 25% for reused materials (BREEAM-NL, 2014a). For the amount of local materials in a project, no clear numbers were found. However, taking the amount of the reused materials, a guideline can be set for the local materials as well. As the amount of available local materials can be limited, the minimum requirement is set a bit lower compared to the amount of reused materials and set on 20%.

Finally, BREEAM indicated that there should be a sustainable purchasing policy for the project (BREEAM-NL, 2020a). This policy should specify the plan of using certified, responsibly sourced building materials instead of building materials without certification. A similar plan is implemented as a requirement in Table 9 as well.

Table 9: Details regarding criteria in category 'Material Usage'

Categories	Criteria	Definition	Input value	Minimum requirement
Material usage	Use sustainable materials	Use environmentally friendly materials, reuse existing materials, buildings, or construction waste, and use local and certified materials.	MPG score	at least 20% better compared to the reference value
			% of reused materials	At least 25%
			% of local materials	At least 20%
			Sustainable purchasing policy	Policy should be present

Design

Within the category of Design, five criteria are included, all focusing on the building itself, Table 10. The first one focuses on the Life Cycle Assessment (LCA) as considering the life cycle assessment of a building helps in understanding the environmental impact throughout the entire lifespan (Mohsen & Matarneh, 2023). Having a LCA report is not mandatory by the Dutch law, as it uses the MPG score which is discussed earlier (Rijksdienst voor Ondernemend Nederland, 2017b). However, BREEAM uses the LCA as a requirement to show that the lifecycle of the building is optimized (BREEAM-NL, 2014b).

Furthermore, the design should be optimized for simplified maintenance, which means that all technology, such as installations, should be easily accessible. As stated in a study by (Vieira De Castro et al., 2020), the project should optimize and facilitate the maintenance of building materials and systems to create a sustainable building environment. There are no specific regulations on simplified maintenance for the Netherlands, however, BREEAM measures the maintenance procedures by checking if a maintenance guideline or document is present (BREEAM-NL, 2024c).

Table 10: Details regarding criteria in category 'Design'

Categories	Criteria	Definition	Input value	Minimum requirement
Design	Ensure good lifecycle performance with an LCA	Measure the environmental impact of the materials used over the full life cycle of the building by using a Life Cycle Assessment, showing that the building has a good lifecycle performance.	LCA document	LCA document should be present
	Optimize design for simplified maintenance	All technology, installations and other aspects must be easily accessible for maintenance.	Maintenance document	Maintenance document should be present
	Include mixed building functions	Include different functions in the building (such as commercial spaces, office spaces, residential spaces, etc.).	Amount of functions	At least one additional function is present (if allowed)
	Optimize the quality of the building envelope	A well-planned building envelope which means that the exterior walls, roof, foundation, windows, and doors are of good quality with appropriate insulation levels.	R_c-values	At least 10% compared to the reference value
	Flexibility of the building	The building is flexible which means that there is possibility to change function or layout of the building.	Presence of flexible design elements	At least a part of the building has a flexible design

Akcali and Cahantimur (2022) stated that a diversity of functions should be implemented in a project to correspond with the needs of various social groups and consider future requirements. This leads to the third criterion within this category, focusing on the mixed building functions included in the design. Besides the land use plan, which describes the functions allowed on a specific plot (Rijkswaterstaat, 2024), there are no actual regulations in the Netherlands on the amount of different functions in a project. Moreover, BREEAM does not provide specific guidelines regarding the functional mix of a building. Because this criterion is highly dependent on location and must consider various land use plans, it is challenging to establish a fixed percentage of different functions that should be present in the building, as proposed in a study by Morgante et al (2023).

The optimization of the quality of the building envelope is found as one of the important criteria in sustainability assessments by Khanapure & Shastri (2023), as it has a large impact on the energy efficiency of a building. This is further strengthened in a study by Zarghami et al. (2019), which stated that a high efficiency building envelope is required. BREEAM did not give specific requirements or measures on the building envelope. However, the Dutch regulations have some requirements on the quality of the building envelope, stated in the Besluit bouwwerken leefomgeving (BBL). This regulation states that the R_c-value of the floor should be at least 3,7 m^2K/W, 4,7 m^2K/W for the façade and 6,3 m^2K/W for the roof (Rijksdienst voor Ondernemend Nederland, 2024). These are the standard requirements, the minimum requirement within this study will be to improve these minimum values with at least 10%. This is comparable with the method BREEAM uses with the MPG scores, described above.

Finally, the flexibility of the building is measured. It defines the building's adaptability to modify its layout in future scenarios, and thereby prolonging its lifespan. (Velázquez Robles et al., 2022). This criterion should measure the flexibility in the design, allowing for the accommodation of changing needs, functions, and spatial requirements over time (Mohsen & Matarneh, 2023). The Dutch regulations and BREEAM do not have specific requirements or measures on this topic. However, as studies suggested, there should be flexible building elements in the design. This means that for example interior walls can be moved over time, but also installations can be reorganized. The minimum requirement is that at least a part of the building has a flexible design, including these flexible elements.

Transport Facilities

The final category of Environment focuses on the transport facilities of a project and includes 3 different criteria, Table 11. Literature stated that this topic has an important impact on a building's sustainability (Braulio-Gonzalo et al., 2022). The first criterion focuses on the availability of bicycle parking facilities as it states that a project should provide bicycle storage spaces in order to promote their use by building occupants (Braulio-Gonzalo et al., 2022). The Dutch municipalities all have a parking plan or policy, which provides an overview of the requirements regarding the amount of parking facilities for bicycles (Gemeente Almere, n.d.; Gemeente Utrecht, 2021). These requirements are dependent on the building type and function as well as the location of the project and thus can vary for every project. BREEAM also included some measures on the amount of parking spaces for bicycles and states that there should be at least one parking spot per inhabitant of the building (BREEAM-NL, 2023a). BREEAM also includes the availability of additional facilities such as a shower, which can be used by people who arrive by bike.

Besides bicycle parking facilities, the project should also provide electric-vehicle-charging stations to promote the use of green mobility (Rodríguez, 2023). Within the Dutch regulations, there are some rules on the amount of parking places with electric-charging stations describing that for utility buildings with more than 10 parking spots, 1 of 5 should have a pipeline infrastructure to be able to place a charging station if needed (Rijksdienst voor Ondernemend Nederland, 2023). However, BREEAM used a bit more general approach for all types of buildings and stated that every private parking spot should have an electric-vehicle-charging station, or the possibility to add one on existing pipeline infrastructure (BREEAM-NL, 2023b). Furthermore, it stated that in shared parking facilities, at least 10% should have an electric-vehicle-charging station and the remaining 90% should have the infrastructure on which one can connect. The example of BREEAM is used in this study and thus the minimum requirement is that all parking facilities should have the availability to connect to the pipeline infrastructure and 10% should have a charging station.

Finally, a sufficient amount of car parking facilities should be provided, but an over-provision should be prevented (Yadegaridehkordi & Nilashi, 2022). This is summarized in the final criterion and uses BREEAM as a guideline. BREEAM states that the amount of car parking spots should not be higher than 20% of the municipal norm (BREEAM-NL, 2014c).

Table 11: Details regarding criteria in category 'Transport Facilities'

Categories	Criteria	Definition	Input value	Minimum requirement
Transport facilities	Provide bicycle parking facilities	The project provides sufficient amount of safe and accessible bicycle parking facilities within the area of the building.	Amount of parking facilities	The minimum amount of parking facilities is present
	Include electric vehicle charging stations	The project supports the use of green mobility by offering electric-vehicle-charging stations.	Amount of parking facilities connected to pipeline infrastructure	All parking facilities are connected
			Amount of parking facilities with an electric charging station	10% has a charging station
	Provide car parking facilities	The project provides sufficient amount of car parking facilities, but over-provision is prevented.	Amount of car parking facilities	The amount of car parking facilities does not exceed 20% of the municipal norm

2.3.2 Social

This section will cover the criteria which are related to the social part of the assessment instrument and are discussed per category. A summary of all the criteria which will be discussed in this section can be found in Figure 7 below. Note that also in this overview, there are small changes compared to the overview given in section 2.2.

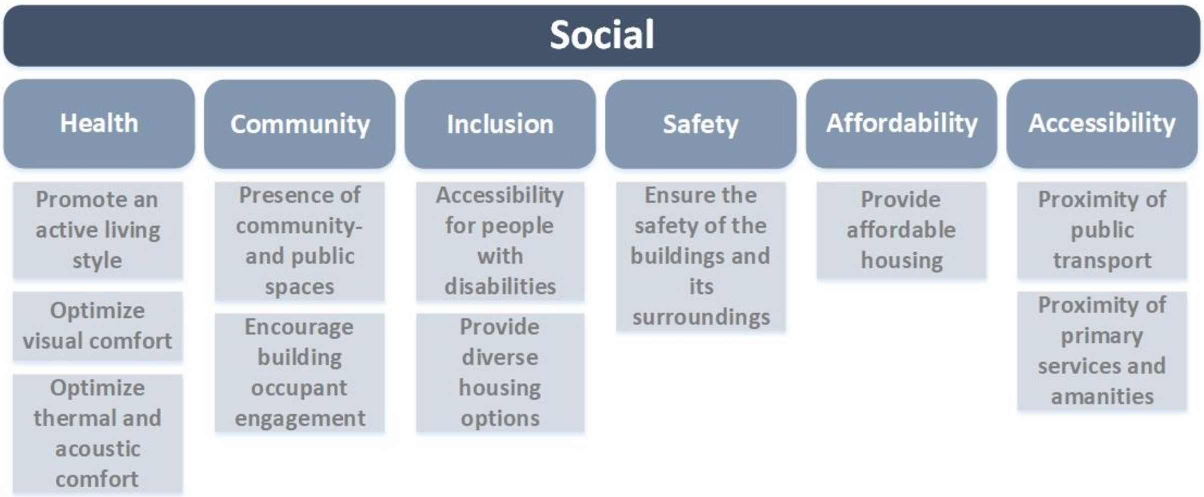


Figure 7: Overview of criteria 'Social'

Health

The first category is focusing on health as sustainable development is characterized as advancement that improves the quality of life and in this manner enables individuals to live in a healthy environment (Olakitan Atanda, 2019). The category includes three different criteria, focusing on active living and the comfort of occupants in the building, Table 12.

Table 12: Details regarding criteria in category 'Health'

Categories	Criteria	Definition	Input value	Minimum requirement
Health	Promote an active living style	Encouraging active living by the provision and design of activity-programmed spaces like exercise rooms, swimming pools, or multi-purpose rooms that could be designed as venues for physical activity.	Amount of measures present	At least one measure is present
	Optimize visual comfort for occupants	Ensure best practice in visual performance and comfort for building occupants by providing a pleasant view outside.	% of areas with an unobstructed view	At least 75%
	Optimize thermal and acoustic comfort of the building	Ensure that the indoor temperature of the building is pleasant and comfortable and that it meets the appropriate standards regarding its acoustic performance.	Performance regarding NEN 5077	Meet NEN 5077 requirements
			Amount of measures present to regulate temperature	At least one measure is present

Creating spaces that promote physical activity and mental wellbeing can enhance the overall health of occupants (Mohsen & Matarneh, 2023), therefore the criterion on promoting an active living style is included. The Dutch law does not include any rules specifically on the promotion of active living. Also BREEAM does not include any specific measures on the promotion of active living. Kempeneer et al. (2021) stated that including for example an appealing staircase on a convenient location promotes active living as well as the presence activity-programmed spaces. These measures support the promotion of active living and should be present in the project.

The next criterion focuses on the visual comfort of the occupants. This means that the project should for example decrease eyestrain for building occupants by provision of visual connections to the outdoor environment and permitting long-distance views (Yadegaridehkordi & Nilashi, 2022). BREEAM defined this by using the measurement that there should be an unobstructed view towards landscape, city, sky, or surface for at least 75% of the building areas (BREEAM-NL, 2023c). The regulations in the Dutch law mainly focused on the lighting quality which is already covered within Environment and therefore not included in this criterion as it mainly focuses on visual aspects.

The thermal environment of the interior spaces also has physical and psychological effects on its occupants and is of great importance in building design (Costa et al., 2023a). Moreover, Costa et al. (2023a) stated that considering the problems that noise causes in humans, society must be aware and take necessary measures to preserve the health of building occupants. Therefore, the thermal and acoustic comfort of the building should be optimized by providing a pleasant indoor temperature and appropriate acoustic comfort. This means that those responsible for the design should provide acoustic comfort conditions. For both, BREEAM did not give any minimum requirements but indicated that projects should follow the NEN 5077 guidelines for acoustic comfort and should include measures to regulate the temperature (BREEAM-NL, 2023d, 2023e).

Community

Within this category, it is important to elaborate on the fact that a social infrastructure should be designed and managed so that it can adapt to the changing needs of the community (Akcali & Cahantimur, 2022). Providing communal open space areas is important regarding the social sustainability of a project and can be defined as the availability of open spaces that can be accessed and are designed properly for meetings and social interactions and can improve physical health and reduce stress (Rivai et al., 2023). Rivai et al. (2023) also stated that stakeholders' involvement in decision making processes is important to increase their support. Therefore, this category has two criteria, focusing on the presence of community- and public spaces and the occupant engagement, Table 13.

There are no clear regulations in the Netherlands on the provision of community spaces, but BREEAM describes that at least an outdoor communal space should be designed for communal activities for the building occupants (BREEAM-NL, 2023f). The same accounts for the occupant engagement, which does not have a specific regulation but is described by BREEAM. BREEAM described several measures or options on the engagement of occupants in a building which could be implemented in the project (BREEAM-NL, 2024d).

Table 13: Details regarding criteria in category 'Community'

Categories	Criteria	Definition	Input value	Minimum requirement
Community	Presence of community- and public spaces	The project should provide a place to meet, debate and socialize. This could be a common/shared space or room, a garden, play area or a public space.	Amount of community spaces	At least one (outdoor) communal space is present
	Encourage building occupant engagement	The project aims to gather building occupants into the decision-making process and thereby increasing their support.	Amount of measures present	At least one measure is present

Inclusion

Yuan et al. (2019) stated that space accessibility is vital to successfully achieve social sustainability. Also accessibility to diverse living opportunities, such as affordable housing, are part of social sustainability (Stender & Walter, 2019). Both aspects are summarized in Table 14.

The Dutch regulations show some standards regarding the accessibility for people with disabilities which every building needs to meet and can be found in the Besluit bouwwerken leefomgeving (Bbl) (Informatiepunt Leefomgeving, 2024b). BREEAM however includes a specific guideline for the inclusion and accessibility for different users. It stated that an accessibility strategy should be present, including a plan on how different people can access and move through the building (BREEAM-NL, 2020b).

Diverse housing options within a project means that different target groups or different housing types combined. This results in a better social sustainability of the project as described above. This means that projects should include housing which is varying in size, dwelling type, or price range. For example, a project can include housing for starters, but also for families by offering houses in different sizes. This will eventually support greater mobility in the housing system and more efficient use of the existing housing stock (Gilbert et al., 2020).

Table 14: Details regarding criteria in category 'Inclusion'

Categories	Criteria	Definition	Input value	Minimum requirement
Inclusion	Accessibility for people with disabilities	The project should be accessible to everyone and without restrictions on its use, whatever their personal situation. For example by including disabled signage.	accessibility of the project	Project should be at least partly accessible
	Provide diverse housing options	The project should offer a diverse range of housing options, varying in size and price, suitable for different target groups.	Amount of diverse housing options	At least two types of housing are provided

Safety

Space safety and security is defined as another aspect of social sustainability (Yuan et al., 2019) and included within the criteria, Table 15. BREEAM clearly described measures regarding the topic of safety and security of a project (BREEAM-NL, 2023g). It stated that a project should include measures to guarantee the safety of the building and its environment. It should meet the appropriate safety requirements focusing on the building but also the environment. This is summarized by one criterion in the assessment instrument which looks into the amount of safety measures present within the project. This also includes the construction site when present.

Table 15: Details regarding the criteria in category 'Safety'

Categories	Criteria	Definition	Input value	Minimum requirement
Safety	Ensure the safety of the building and its surroundings	Building and its surrounding should be safe and secured by using safety measures, also on the construction site if present.	Amount of measures present	At least one measure is present

Affordability

Lazar & Chithra (2021) stated that experts perceived affordability as an essential aspect for a building to be sustainable, included as a criterion in Table 16. A document from the government, focusing on the program affordable living, stated that affordable rent is defined as a rent lower or equal to €1000 and dwellings with a price equal or lower than €355.000 are defined as affordable as well for the average 2 person household (Ministerie van BZK, 2022). They also defined the ambition to have at least 40% of the rental and owner occupied dwellings within the affordable range. This is included in the criteria as well.

Table 16: Details regarding the criteria in category 'Affordability'

Categories	Criteria	Definition	Input value	Minimum requirement
Affordability	Provide affordable housing	The project should offer enough affordable housing.	% of affordable dwellings	≥ 40% affordable dwellings

Accessibility

Within the category accessibility, there are two criteria included, Table 17. As stated in a study by Salati et al. (2022), the proximity to public transport and the proximity of amenities are objectives which can significantly contribute to achieving sustainability. The Dutch regulations do not give any specific rules on the distances to amenities or public transport, however, there are guidelines and policies formulated by municipalities or provinces in mobility plans, for example in Eindhoven (Gemeente Eindhoven, 2024) and Utrecht (Utrecht, n.d.). BREEAM used a more general approach by calculating an accessibility index based on the distance to public transport stops and the number of different transport options (BREEAM-NL, 2023h). It also described an approach to measure the proximity of primary services and amenities to the project which requires at least 2 amenities within 500 meters of the dwelling (BREEAM-NL, 2024e).

Table 17: Details regarding criteria in category 'Accessibility'

Categories	Criteria	Definition	Input value	Minimum requirement
Accessibility	Proximity of public transport	The distance measured from the project to the nearest stop of each local public transport line.	Accessibility index	At least 1 point on the accessibility index
	Proximity of primary services and amenities	The distance from the project towards primary services and amenities such as grocery stores and schools.	Amount of primary services and amenities within 500 meters of the project	At least 2 primary services or amenities are present

2.3.3 Governance

This section will cover the criteria which are related to the governance part of the assessment instrument and are discussed per category. A summary of all the criteria which will be discussed in this section can be found in Figure 8 below.

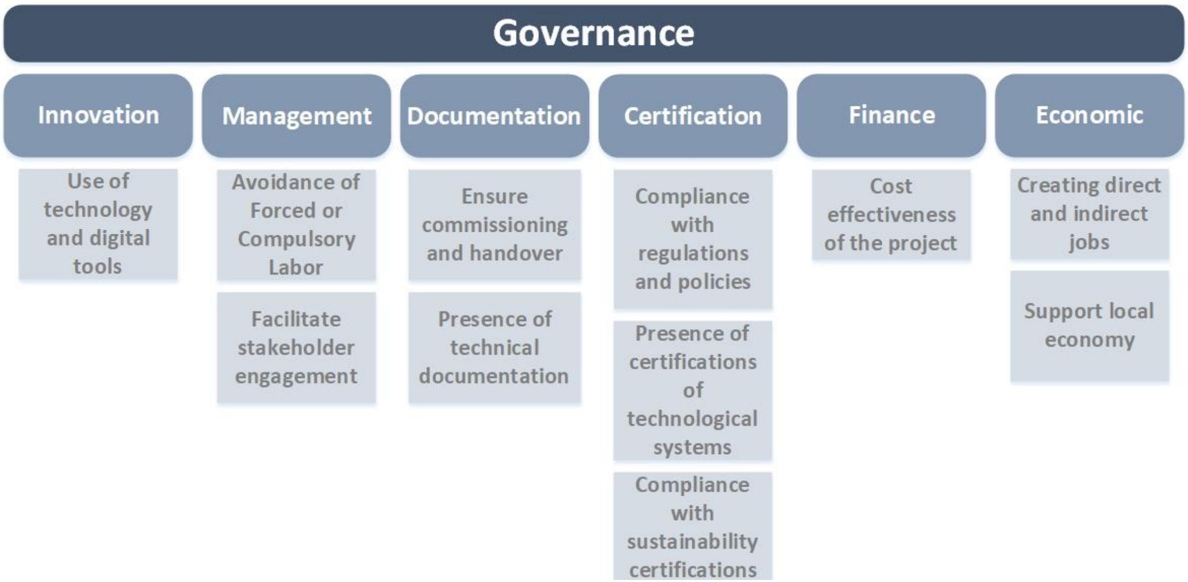


Figure 8: Overview criteria Governance

Innovation

Innovation, or innovative ways of construction, are needed to reduce or eliminate the excessive usage of resources (Amoako Sarpong et al., 2023). A study by Ameen & Mourshed (2019) included criteria such as intelligent buildings, innovative solutions and building information modelling (BIM) in the category focusing on innovation. Also, staying updated on technologies is found to be crucial for driving innovation and thus improve sustainability outcomes of a project (Mohsen & Matarneh, 2023). Therefore, innovative solutions need to be incorporated in projects (Zarghami et al., 2019) as described in Table 18.

As there are no specific regulations within the Netherlands, focusing on the use of these innovative technologies, BREEAM is used and gives a first indication as it measures the presence of smart home systems (BREEAM-NL, 2023i). Within the assessment instrument developed in this study, the presence of technology systems will be used as measure, which means that the use of a smart home system, BIM or other systems is assessed.

Table 18: Details regarding criteria in category 'Innovation'

Categories	Criteria	Definition	Input value	Minimum requirement
Innovation	Use of technology and digital tools	Use technology and digital tools such as innovative design software (BIM, digital twin technologies), Environmental Management Systems (EMS), or technologies for remote control of the building.	Amount of technology systems used in the project	At least one technology system used

Management

Management is another category which is found to be important while assessing projects regarding their sustainability performance (Zarghami et al., 2019), Table 19. A project should for example define workplace health and safety plans and programs according to the characteristics and complexity of the project (Montalbán-Domingo et al., 2020). Another example is given by Braulio-Gonzalo et al. (2022), who indicated that a code of conduct should be present for the contractors in the project.

Within the Netherlands, every employer should follow the Arbowet, which is an Act that describes that employees should work in a safe and healthy environment (Ministerie van Sociale Zaken en Werkgelegenheid, 2024). BREEAM included a measure on responsible construction site management (BREEAM-NL, 2020c), describing that the construction site should have at least 6/10 points for the code of conduct, named ‘Bewuste Bouwers’ (Bewuste Bouwers, 2024). This study also includes the code of conduct for projects including a construction site, where at least 6/10 points should be present.

Besides the healthy and safe working environment, stakeholder consultation is defined as an important aspect of governance and management (Ameen & Mourshed, 2019). Sustainable management, including stakeholder consultation makes sure that sustainability objectives are established and pursued (Lazar & Chithra, 2021). BREEAM and the Dutch law do not give specific measures on this topic, but as literature suggested, there should be some form of stakeholder engagement in the project. Stakeholders in this case are not the building occupants, but focus more on the management parties involved, for example companies or stores located within a building.

Table 19: Details regarding criteria in category 'Management'

Categories	Criteria	Definition	Input value	Minimum requirement
Management	Avoidance of Forced or Compulsory Labor	Ensure good work practices with adequate remuneration. It is expected to prevent and combat all forms of forced or compulsory labor within its activities, being essential to avoid contributing to or becoming linked to the use of forced or compulsory labor through its relationships with suppliers, clients, etc.	Score code of conduct	Score is at least 6/10
	Facilitate stakeholder engagement	Facilitate stakeholder engagement by including them in consultation and participation processes, leading to better-informed and more sustainable outcomes.	Amount of measures present	At least one measure is present

Documentation

As stated by Morgante et al. (2023), the availability of the technical documentation of the components and systems in the building should be part of a sustainability assessment as well and is therefore included in Table 20. Furthermore, Vieira De Castro et al. (2020) stated that a project should aim to a properly planned handover and commissioning process, which ensures the building systems operation and reflects the needs of the building occupants. This is further described in BREEAM, which states that at least a commissioning document and plan should be present (BREEAM-NL, 2023j). To guarantee that all information is available for future usage of the building, the presence of technical documentation is also included.

Table 20: Details regarding criteria in category 'Documentation'

Categories	Criteria	Definition	Input value	Minimum requirement
Documentation	Ensure commissioning and handover procedures	The project aims a properly planned handover and commissioning process, which ensures the building systematic operation and reflect the needs of the building occupants	Presence of handover documents	Document should be present
	Presence of technical documentation	Technical and maintenance documentation of the building should be available.	Presence of documents	Documents should be present

Certification

As mentioned before, there are some Dutch laws and regulations which should be followed by the project. This is also supported by literature (Adamec et al., 2021; Khan et al., 2021; Mohsen & Matarneh, 2023) and BREEAM and therefore included as a specific criterion within the category certification, Table 21. Furthermore, there are no specific laws or regulations on the sustainability certifications of systems in a building. However, BREEAM did specify on the detailed level where for example appliances or the elevators should be sustainable (BREEAM-NL, 2024f). This method used in BREEAM will be implemented in this assessment instrument as well.

Finally, literature suggested that the project should be checked regarding green standards or sustainability standards (such as LEED and BREEAM) (Khan et al., 2021; Tupenaite et al., 2021).

Therefore, the assessment instrument will check whether a project has at least one sustainability certification or green standard.

Table 21: Details regarding criteria in category 'Certification'

Categories	Criteria	Definition	Input value	Minimum requirement
Certification	Compliance with regulations and policies	The building has obtained environmental certifications and is in line with environmental regulations and planning policies.	Compliance with regulations and policies	Project should be in line with regulations and policies
	Presence of certifications of technological systems	Technological systems in the building should have sustainability certifications, such as the HVAC or lighting systems.	Energy labels of systems	The minimum required energy label is present
	Compliance with sustainability certifications	The project must demonstrate compliance with sustainability certifications such as LEED, BREEAM, etc.	Compliance with sustainability certifications	At least one is present

Finance

Within the category Finance, there is only one criterion included, focusing on the cost effectiveness of the project, Table 22. This criterion takes into account the planned costs and the actual costs of a project, as they are found to be important sustainability indicators which should be included in an assessment (Arukala et al., 2019; Costa et al., 2023b; Huedo Dorda et al., 2019a). As there are no specific guidelines or methods given by the government or BREEAM, the cost effectiveness is measured by the difference between the planned and actual costs of the project.

Table 22: Details regarding criteria in category 'Finance'

Categories	Criteria	Definition	Input value	Minimum requirement
Finance	Cost effectiveness of the project	Measuring the actual vs the planned costs regarding the construction, operation, or maintenance of the project.	Actual and planned costs	At least equal

Economic

The final category in this overview is the category focusing on the Economic aspects of the project and includes two different criteria, Table 23. The first one focuses on creating direct and indirect jobs, defined as socioeconomic growth by Jafari et al. (2019). This means that the project should provide local job opportunities (Karji et al., 2019; Rivai et al., 2023), resulting in an increase of vacancies in the near area of the project.

Finally, the last criterion focuses on supporting the local economy by using for example local goods and services during the development of the project, as it contributes to its sustainability performance (Khanapure & Shastri, 2023). The Dutch law and BREEAM do not specify on this topic, but Costa et al. (2023b) stated that hiring local goods and services is an indicator for a sustainable project. As there are no given guidelines found on the minimum requirements or input values, this study states that the amount of local goods, services or employment in the project should be present.

Table 23: Details regarding criteria in category 'Economic'

Categories	Criteria	Definition	Input value	Minimum requirement
Economic	Creating direct and indirect jobs	The project generates direct and indirect jobs during construction or when the project is in use.	Presence of extra generated jobs	Extra jobs are generated
	Support local economy	The project is hiring local goods and services and uses local employment during the development of the project.	Presence of local goods, services, or employment during development	Local goods, services or employment is present

2.3.4 Criteria related to the SDGs

As mentioned in the introduction of this study, the 17 SDGs can be related to ESG (Berenberg, 2018). To check whether the above described criteria are in line with the SGDs set by the European Union and underscore the instrument's ability to measure sustainability in a manner consistent with global standard, this study takes a brief look into how the selected criteria correspond to specific SDGs. By listing the 17 SDGs and define which of the selected criteria are supporting the goals, the study gives an indication on how the selected criteria can be aligned to specific SDGs, Appendix D. Thus, illustrating the extensive coverage of the sustainability aspects as defined by the United Nations within the selected criteria.

The overview indicates that the criteria selected for the instrument not only evaluate the sustainability of real estate assets but also align with a broad range of global sustainability goals, contributing to various aspects of the SDGs. The overview shows that only SDG 5, gender equality, is not covered by the criteria selected for the ESG assessment instrument. The result of the literature study does include a category on inclusion, but the criteria within this category do not specifically focus on gender equality.

2.4 Conclusion

After analyzing all the literature selected from the systematic literature and elaborating on the results by looking into the Dutch laws and policies as well as methods and definitions used in BREEAM, a final overview of criteria and their definitions can be made including a first indication of how the criteria should be measured. The measurements sometimes include policy related input, but it is tried to also include measurements on the actual performance of the policies as well. Furthermore, the input values are kept rather simple to make sure that all users will fill in the correct and same information. Finally, it can be concluded that the Environmental criteria are mainly focusing on the impact of the project on the natural ecosystem. For the Social criteria, it can be concluded that the relationship between the project and its customers, labor and society is described clearly. And finally, the governmental criteria reflect the system in which management acts in the best interest of long-term investors. Overall, the criteria selected for the instrument not only evaluate the sustainability of real estate assets but also align with a broad range of global sustainability goals, contributing to various aspects of the SDGs.

3. Methodology

This chapter will focus on the research methods used for the remaining part of the study. This methodology section outlines the steps within the research which are needed to answer the research questions of this study. As the research design described, shown in the previous chapter, the study started with a systematic literature review. The remaining part of the study will include a data collection and analysis, and the development and validation of the instrument. This chapter will describe all the methods used in the several steps of this study, starting with an elaboration on the Best-Worst Scaling method, followed by the data gathering and analysis. Finally, this chapter will conclude with a description on the instrument development and validation process, included in the case study.

3.1 Best-Worst Scaling

To analyze the importance of the selected criteria, this study uses the best-worst scaling method. The best-worst scaling (BWS) method can be described as a method of data collection, and a theory where respondents provide a top and bottom ranking of items from a list (Flynn & Marley, 1992). The first study which used BWS was conducted by Jordan Louviere, where he examined the degree of concern the general public had for each of a set of food safety goals (Finn & Louviere, 1992). This method is used as the study by Finn & Louviere (1992) stated that rating scales do not force respondents to discriminate between items, allowing them to state that multiple items are of similarly high importance. Within this study on sustainability criteria, it is possible that respondents will rate all criteria as important, which is not giving the desired result. Therefore, implementing the BWS method will force respondents to make a decision and result in usable outcomes.

Within BWS, there are three types or cases which can be distinguished as they differ in complexity: the object case, the profile case, and the multi-profile case. They will all be described briefly by using the example of a car. The object case can be seen as the simplest of the three types of BWS and is particular useful for determining the importance or level of agreement respondents assign to one of a set of statements or objects called attributes (Flynn & Marley, 1992). Within this type of case, the researcher wants to know which attributes are most or least important. In the example of a car, possible attributes are the size, fuel efficiency, comfort, or the towing capacity. The object case compares the attributes regarding their importance but does not consider the levels of the attributes. In other words, how important fuel efficiency is as a feature is judged, the difference of the level of efficiency is not included. An example of this case can be found in Table 24.

Table 24: Example BWS - Object case

Least important	Attribute	Most important
	Size	
	Fuel efficiency	X
	Comfort	
X	Towing capacity	

The profile case is merely the object case with the objects grouped into an attribute and level structure but is unique due to the fact that attribute-levels are only meaningful when forming a profile. As can be seen in the example in Table 25, the profile exists out of a set of attributes (features), including a level. Within this case, the attributes (for example size) always stay the same, however, the value (for example the amount of persons) of the attributes changes.

Table 25: Example BWS - Profile case

Least important	Attribute	Most important
	Size: 5 persons	
	Fuel efficiency: average	X
	Comfort: very comfortable	
X	Towing capacity: < 1000 kg	

The third case is the multi-profile case, which has the most similarities with a discrete choice experiment as it requires respondents to choose the least attractive profile or alternative as well as the most attractive one (Flynn & Marley, 1992). Table 26 provides an example of a multi-profile case, where several profiles of cars are represented. Since this study will probably find many criteria, creating a similar design would result in very large and unclear profiles. Also, the goal of this study is to focus on the attributes itself and not include the levels of them. Therefore, focusing on purely the attributes is sufficient and the object case can be used as a case-type for the BWS method for collecting data.

Table 26: Example BWS - Multi-profile case

Attributes	Car A	Car B	Car C
Size	5 persons	5 persons	7 persons
Fuel efficiency	Average	High	Low
Comfort	Very comfortable	Uncomfortable	Comfortable
Towing capacity	< 1000 kg	2000 – 2500 kg	< 1000 kg
Least preferred			X
Most preferred	X		

3.2 Data gathering

To gather data and perform the Best-Worst scaling experiment, this research will use an online questionnaire, developed in the software named LimeSurvey (LimeSurvey, n.d.) which is made available for students at Eindhoven University of Technology. The questionnaire consists of several parts, focusing on some general characteristics of the respondents, the criteria within Environment, Social, and Governance by using the Best-Worst scaling method, and a final part on the comparison of Environment, Social, and Governance itself. The survey can be found in Appendix E and will be discussed briefly in the sections below.

The first part of this section will discuss the general characteristics included in the survey. Next, the design of the Best-worst scaling method, used in the second part of the survey, is described. And finally, the comparison of Environment, Social and Governance will be discussed.

3.2.1 General characteristics

The first part of the questionnaire consists of questions regarding the characteristics of the respondents. The first set of questions focuses on some demographic characteristics of the respondents, namely age and gender. Research shows that there could be variations in respondents' reactions to sustainability criteria based on their demographic characteristics (Meinzen-Dick et al., 2014; Satinover et al., 2023). Therefore, it might be interesting to incorporate these characteristics to potentially explain specific outcomes during analysis.

After the demographic characteristics, a set of questions on the job profiles are included as well. These questions focus on the specific job type and experience of the respondent as well as the type of company the respondent works at as well as the size of this company. This will generate an overview of the background of the respondents who reacted on the survey, which can be used by analyzing the outcomes as well.

3.2.2 Experimental Design

To incorporate the sustainability criteria in a survey with the aforementioned BWS method, an experiment design is needed to form the sets of these sustainability criteria (attributes) in a systematic way. A study by Orme (2005) provides insights into the reliability and best designs of a survey using the best-worst scaling method and indicates that using four or five attributes per task is optimal as including more than five attributes per task provides little incremental gain. Furthermore, it indicates that for relatively accurate individual-level estimates, each attribute should be displayed three or more times for each respondent. As the study gives a relation between the amount of tasks, the number of attributes per task, the total number of attributes and the reliability, the following formula can be used:

$$\frac{\#\,Tasks\ \ *\ \ \#\,attributes\ per\ task}{Total\ \#\,attributes} > 3$$

Since the amount of attributes in this research will be relatively large, it is decided to use five attributes per task, and as already indicated in the formula, each attribute is shown at least three times per respondent. By filling in the formula and using the total amount of attributes per group, the amount of tasks per group can be defined.

The next step in finalizing this experimental design is to systematically create the tasks of each 5 attributes. Since the balanced incomplete block designs (BIBDs) is the most commonly used design when creating an object case BWS experiment (Cheung et al., 2016), as this proves that it is a useful method, it is used for this design as well. A BIBD ensures that occurrence and co-occurrences of objects is constant, helping minimize the chance that respondents can make unintended assumptions about the objects based on aspects of the design (Flynn & Marley, 1992). To create an optimal design, the BIBD can be constructed by using the software environment R (The R Foundation, n.d.). By using the crossdes package, a BIBD could be constructed for every group with the total amount of attributes per group, the amount of tasks given, as well as using the number of replications of each attribute, summarized in Table 27.

Table 27: BIBD-features

Expression	Definition
v	Total number of attributes
k	Size of a block (number of attributes per questions)
b	Number of blocks (questions)
r	Number of replications of each attribute
λ	Frequency that each pair of attributes appears in the same block (question)

The total number of attributes v and the size of a block k will be fixed values in this study. Furthermore, it is known that r should be larger or equal to three. Finally, there are some requirements that should be met to create a BIBD. First of all, r should be an integer and equal:

$$r = \frac{bk}{v}$$

Furthermore, λ should be an integer as well and equal:

$$\lambda = \frac{r(k-1)}{a-1}$$

By taking these requirements into account, the remaining numbers can be calculated, and a correct design is developed by using the software R.

3.2.3 Point Allocation

For the final question of the survey, a point allocation, also known as constant sum, is used. Point allocation is a commonly used method for assigning numerical judgments (i.e., importance weights) to attributes in order to signify their relative importance (Bottomley et al., 2000). This method is used to find the relative importance of environment, social and governance. Respondents can assign a total of 100 points to the three categories where 100 points are most important, and 0 points are least important. By gathering this information, the analysis can also take into account the difference in importance of Environment, Social, and Governance, which might be useful to incorporate in the calculations of the final instrument.

3.3 Methods for Data Analysis

Once all data is collected, it will be analyzed, beginning with an examination of descriptive statistics. Subsequently, the count analysis and a conditional logit model will be used to elaborate on the results of the Best-Worst experiment. This section will elaborate on the methods used for analyzing the gathered data as well as the process for conducting the case study.

3.3.1 Descriptive Analysis

The first step within the analysis will be to give an overview of the descriptives of the data. This includes an overview of the general characteristics of the respondents and will give an indication of who reacted to the survey and if certain aspects should be taken into account. For instance, when the respondents' average experience level is low or when one particular job type is overrepresented, these factors should be considered during the analysis of the results. The results of the descriptive analysis will be visualized in graphs and charts.

3.3.2 Count Analysis

To provide an insight into the results of the BWS experiment, a count analysis will be performed. It is a descriptive counting analysis and aimed to provide a brief idea of the preferences given by the respondents (Yeh, 2020). To achieve comparability of the results, the average best–worst score and the square root of the quotient of best and worst selections will be calculated as well (Mühlbacher & Kaczynski, 2021). Several statistics can be calculated by using the following formulas (Cheung et al., 2019):

$$(1)\ BW_i = B_i - W_i$$

$$(2)\ std.BW_i = \frac{BW_i}{Nr}$$

$$(3)\ sqrt.BW_i = \sqrt{\frac{B_i}{W_i}}$$

$$(4)\ std.sqrt.BW_i = \frac{sqrt.BW_i}{max.sqrt.BW}$$

BW_i gives the mean score of the criterion *i*, by subtracting the number of times it is chosen as worst (W_i) from the number of times it is chosen as best (B_i). This score can be standardized by dividing the BW_i score by the number of respondents (*N*) times the number of replications of each attribute (*r*). Finally, using the square root ($sqrt.BW_i$) helps to define the relative importance between the criteria.

3.3.3 Conditional Logit Model

Besides the count analysis described in the previous section, a more detailed analysis is performed by using a conditional logit model in the software R. Within this logit model, the following situation is used to understand the respondents' answers (Flynn & Marley, 1992): the model supposes that there are *m* items in a choice set (a question). The number of possible pairs in which item *i* is selected as best and item *j* is selected as the worst (*i ≠ j)* from *m* items is:

$$m * (m - 1)$$

Respondents are assumed to have a utility (*v*) for each item. Further, they are assumed to select item *i* as the best and item *j* as the worst because the difference in the utility between *i* and *j* represents the greatest utility difference (this is referred to as the maxdiff model). Under these assumptions, the probability of selecting item *i* as the best item and item *j* as the worst is expressed as a conditional logit model, where *k* and *l* are indices used to iterate over all items in the choice set, with *l* being different from *k*:

$$Pr(i,j) = \frac{exp\ (v_i - v_j)}{\sum_{k=1}^{m}\sum_{l=1,k\neq 1}^{m} exp\ (v_k - v_l)}$$

A share of preference for item *i* (SP_i) based on the conditional logit model choice rule is as follows, where *T* is the total number of criteria evaluated in the model:

$$SP_i = \frac{\exp\ (v_i)}{\sum_{t=1}^{T}\exp\ (v_t)}$$

3.4 Case Study

After developing the assessment instrument, it requires a brief review to see if it is performing as intended, thereby assessing its suitability for implementation in the practical field or identifying any necessary refinements. A study by Fitzner (2007) gives a brief overview of reliability and validity testing, from the perspective of diabetes education practice. The study also states that by testing for the basic aspects of reliability and validity, a tool may be appropriate for use in practice settings as it reduces the concerns about bias and distortion in measuring outcomes. The assessment instrument will therefore be tested on its reliability and validity. Reliability indicates that something can be measured consistently, which means that you will get similar results each time you test. On the other hand, validity means that you are accurately measuring the thing you want to measure.

This section will discuss the importance of reliability and validity, and outline the methods used to evaluate how well the assessment instrument aligns with various reliability and validity concepts. Finally, the section will discuss the design of the case study, elaborating on the process that will be followed to reach the desired outcomes.

3.4.1 Reliability

As stated before, the reliability of the instrument should be assessed as it shows its suitability for implementation into the practical field by indicating that the instrument measures consistently, meaning that it will get similar results each time a specific project is tested. This means that for example one project is assessed multiple times by different people using the same instrument, resulting in comparable outcomes.

While looking at this concept of reliability, the inter-rater reliability of the instrument will be tested as it indicates how consistent the outcomes are likely to be if one project is assessed by two or more persons (U.S. Department of Labor Employment and Training Administration, 1999). For this test, it is needed to include multiple participants in the case study which can use the ESG assessment instrument. Furthermore, the characteristics of the participants should be sufficiently similar to be able to compare outcomes (U.S. Department of Labor Employment and Training Administration, 1999). This means that participants should for example have comparable job types or experience levels.

3.4.2 Validity

To be sure that the ESG assessment instrument is accurately measuring the thing it should measure, a validity check is included into the study as well. Within this case study, there are two concepts of validity included: face validity and concurrent validity. Face validity includes a subjective judgement of whether the instrument is a good measure or not, testing if it measures what it intended to measure (U.S. Department of Labor Employment and Training Administration, 1999). This can be done by collecting expert feedback on the outcomes of the ESG assessment instrument after they assessed a project. Within this case study, experts are defined as professionals working in the field of the built environment.

Moreover, the concurrent validity of the instrument will be checked as well. A concurrent validity checks if other tools or assessments give similar results compared to the outcomes of the ESG assessment instrument. BREEAM labels are used as the comparable assessment since it is focusing on the sustainability performance of buildings and is a widely known and recognized method (BREEAM-NL, 2024j). Despite the fact that BREEAM is not an ESG assessment instrument, it is still used to look into the concurrent validity within this study, as there is no possibility to use a validated, recognized method for ESG measurements, as this study is first in looking into the design of such an instrument. Therefore, BREEAM is chosen as an alternative as it is a peer-reviewed and widely used method, but also includes measurements on different topics which can be related to Environment, Social and Governance. If the new developed ESG assessment instrument gives similar outcomes compared to the other assessment, the new method has concurrent validity.

3.4.3 Case Study Design

To test the assessment instrument on the specific topics of reliability and validity, five experts from the researcher's professional network were asked to participate in the case study, using the ESG assessment instrument developed in this study. The participants are asked to individually assess the projects and afterwards reflect on the usage of the instrument and the outcomes of it. Furthermore, they are asked to give their opinion on the outcomes of the assessment. Finally, the outcomes of the assessments of both projects are compared and discussed with the participants. Figure 9 gives a short overview of the process of the case study.

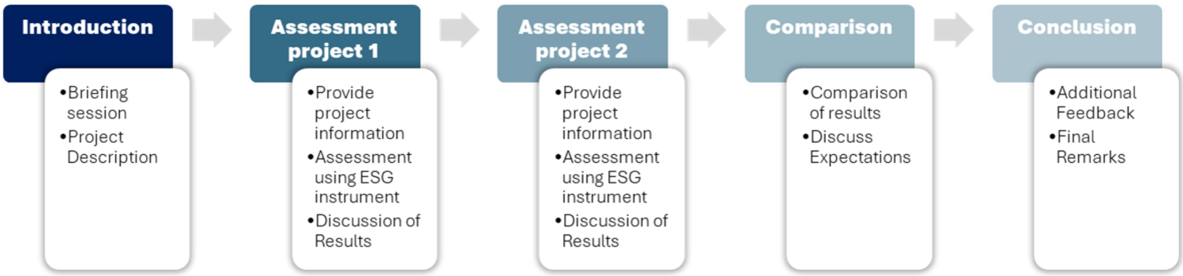


Figure 9: Schematic overview of the Case Study Design.

Within the described case study, two different building projects, provided by PVM (PVM, 2023), are used and assessed by the participants. By specifically choosing projects that differ in function, the reliability and validity of the assessment instrument is tested for different types of building projects. The first project is a residential care project, where living facilities and healthcare are combined in a multifunctional project, focusing on starters and elderly. The second project is a different building, focusing on logistic functions. The project has a small part of offices included in the building, but mainly focuses on industrial functions.

Before starting the case study, participants will receive an introductory briefing from the researcher. This brief session will include an overview of the study's objectives and a background on the development of the ESG assessment instrument. Additionally, the two real estate projects selected for the case study will be described.

After the introduction, participants will be provided with comprehensive information about the first project. This includes relevant documents, floorplans, and detailed descriptions of the building's characteristics. To facilitate the assessment, an Excel document containing the ESG assessment instrument will be supplied. Throughout the assessment process, the researcher will be present to assist with access to the necessary documents and support the participant in using the assessment tool, which is stored on the researcher's laptop.

Upon completion of the assessment of the first case study, the results of the assessment are discussed with the participants by answering some questions. This discussion will focus on analyzing the results of the assessment, particularly evaluating its accuracy and realism. Feedback will be asked on both the overall score and the individual scores of the ESG categories. Participants will also be encouraged to reflect on whether the outcomes met their initial expectations.

After finalizing the first case study and discussing the results, the participants will proceed to the next case study. As with the first project, detailed information will be provided, including documents, floorplans, and the building's characteristics. A new Excel document will be supplied to perform the second assessment. The participants will again complete filing in the required fields in the ESG assessment instrument. Following this, another discussion will take place to review the results. This discussion will mirror the structure of the first project, focusing on the analysis of the scores and feedback on their accuracy and realism. The participants will be asked to share their insights on both the total and category-specific scores, and to comment on any unexpected results.

Once both projects have been assessed and discussed, the participants are asked to compare both projects and their outcomes. The participants are asked to indicate if the comparison is in line with their expectations by looking at possible differences between the projects. Finally, the participants are asked if they have any other remarks regarding the outcomes of the assessments or on the ESG assessment instrument itself.

3.5 Conclusion

The research methodology in this study is designed to develop and validate a robust ESG assessment instrument tailored for investments in real estate projects. The primary aim is to create a standardized framework that evaluates real estate assets based on their sustainability performance and suggest that these assessments can be aligned with the requirements of the SFDR articles. The expected outcome is an ESG assessment tool that enhances transparency, consistency, and comparability in evaluating the sustainability credentials of real estate assets.

The research begins with a comprehensive literature review to understand the current state-of-the-art in ESG practices and sustainability assessment methods within the real estate sector. This review will inform the initial compilation of potential criteria for the ESG assessment instrument. These criteria will be derived from recent literature and compared with those used in established sustainability frameworks such as BREEAM. This elaborated analysis aims to identify relevant criteria and their definitions or calculation methods, ensuring the developed instrument is grounded in best practices.

Following the identification of potential criteria, the next step involves a detailed analysis of Dutch laws and regulations related to sustainability. This analysis will determine whether local rules, laws, or guidelines can facilitate the quantification of the selected criteria. It is essential to also consider international standards and regulations during this process, as they may provide additional criteria that need to be incorporated. If certain criteria prove to be difficult to quantify, they may be redefined to become measurable or removed from the list. Additionally, overlapping criteria may be consolidated to streamline the assessment process.

To prioritize the identified criteria, a Best-Worst experiment will be conducted, soliciting input from experts on the relative importance of each criterion. This experiment will produce utility scores that reflect the significance of each criterion, influencing their utility score in the overall assessment of real estate assets.

With the criteria and their utility scores established, the last step is to develop the ESG assessment instrument. This tool will be designed to generate detailed outcomes based on the defined criteria, providing a comprehensive assessment of the sustainability performance of real estate assets. Upon development, the instrument will undergo a validation process, including a case study to evaluate its functionality and accuracy in a real-world context. This will allow for the identification and implementation of any necessary modifications and optimizations. Expert validation within the relevant field will further assess the instrument's practicality and validity, offering valuable insights for finalizing the tool or guiding future research.

Thus, it can be concluded that the methodology used in this study is essential for developing a comprehensive and effective ESG assessment instrument for the investments in real estate projects. By grounding the criteria in contemporary literature and aligning them with established sustainability frameworks such as BREEAM, the research ensures the instrument reflects best practices. Incorporating Dutch and international regulations provides legal and practical relevance, while integrating insights from the SFDR addresses transparency and greenwashing concerns. The use of a Best-Worst experiment allows for the prioritization of these criteria based on expert input, ensuring the instrument reflects the most critical aspects of ESG performance. This process, combined with validation through case studies and expert feedback, ensures the final tool is both functional and credible. The approach not only supports investor decision-making and promotes more sustainable real estate investments but also contributes significantly to advancing transparency and preventing greenwashing within the sector.

4. Results & Analysis

Within this chapter, the results and analysis of the data collected by the survey will be described, starting with the demographic descriptives, giving an overview of the respondents who participated. Afterwards, the results of the Best-Worst experiment are discussed by first looking into the count analysis, followed by the conditional logit model. Finally, some additional insights of the survey will be discussed such as the input of the respondents to add or remove certain criteria from the assessment instrument. The chapter will conclude with an overview of the final outcomes, including the utility scores that will be implemented in the assessment instrument.

4.1 Demographic Descriptives

The survey was distributed with the target group, defined as people working within the built environment, in April 2024 by email, WhatsApp, and LinkedIn. In total, the survey is opened 171 times of which 85 respondents filled in the environmental part, and a total of 74 respondents filled in the all the best-worst questions. However, 72 completed the survey by also filling in the final question on the point allocation. The 74 respondents that completed all the best-worst questions in the survey will be used for the main analysis and thus their demographic descriptives will be described. As the point allocation question can be treated as a separate part of the analysis, and the difference is only 2 respondents, this question will be analyzed with the total of 72.

When analyzing the gender of the respondent, Figure 10, it can be seen that a very large number of males filled in the survey. As the survey was focused on experts within the field of the built environment, it can be explained that the majority is male as this sector tends to have a disbalance between the amount of male and female (Cushman & Wakefield, 2019).

Secondly, the age of the respondents is described in Figure 10, where the age group of >60 and 45-60 are combined since the group of > 60 only contained 5 respondents. The three age groups are quite evenly distributed, although there is a slightly larger group of respondents in the 28 to 44 years age range. Also, as the group of respondents below 28 years is 33%, a significant amount can be identified as young people. This can be due to the network in which the survey is shared, which contains a lot of young people who recently started working.

While looking into the experience level of the respondents, Figure 10, it appears that 60% has less than five years of experience within their current function. This can be explained by the fact that a large amount of the respondents is of a young age, indicating that they just started with a job, resulting in a lower experience level. Besides the large group of less experienced respondents, the other levels, containing more experienced respondents, are all represented.

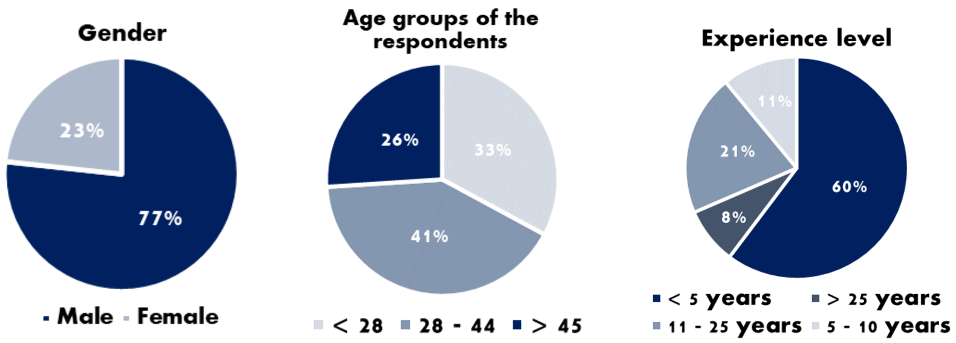
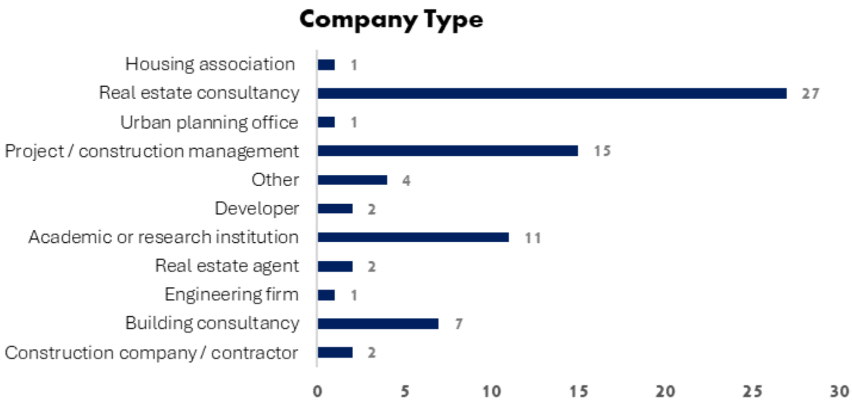


Figure 10: Demographic characteristics

Finally, some demographic information focusing on the job and company of the respondent are described. First, the different company types and sizes can be found in Figure 11. It shows that most of the respondents are working at a real estate consultancy firm, project or construction management firm or an academic/research institution. These large groups of respondents in these groups might be caused due to sharing the survey within PVM, which is a real estate consultancy firm, the university, and a lot of project and construction management firms within the network of the researcher. Furthermore, most respondents work at a larger company, as the amount of medium and large sized companies are the biggest.



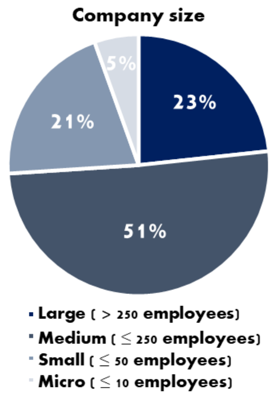


Figure 11: Demographic analysis - Company characteristics

The last demographic characteristic which is analyzed is the job function of the respondent. As Figure 12 shows, it is in line with the findings of the company type, as most of the jobs indicated are real estate advisors or project managers. Furthermore, there is a large number indicating other, within this group, a lot of directors, or board members are found as well as a significant amount of teachers.

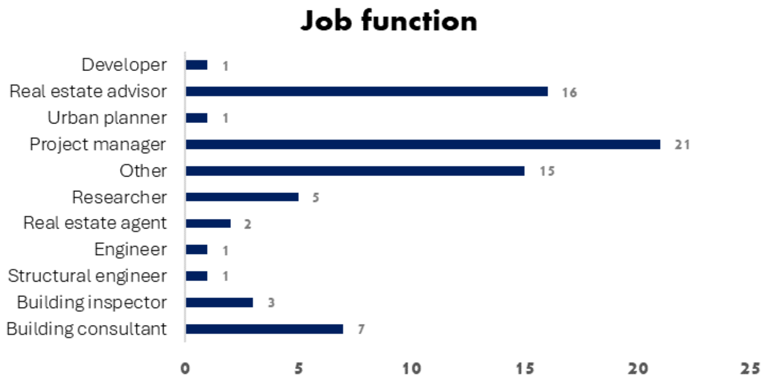


Figure 12: Demographic analysis - Job function

4.2 Point Allocation ESG

Before diving into the importance of the separate criteria within ESG, the importance of the Environment, Social and Governance is analyzed separately. This is done by using a point allocation question in the survey as described in section 3.1.4. The results of the point allocation can be seen in Figure 13. It shows that Environment is clearly found to be the most important one with 46%. Social and Governance are both relatively seen less significant with respect to Environment, where Social received 31% of the points compared to the 23% for Governance.

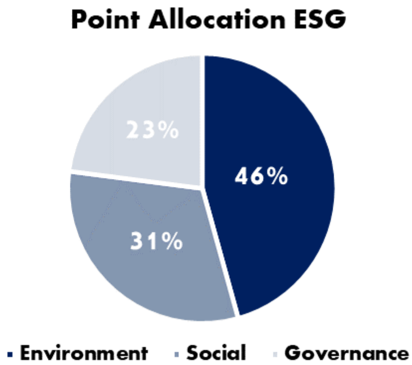


Figure 13: Results Point Allocation ESG

4.3 Best-Worst experiment

The sections below will describe the results of the best-worst experiment by first discussing the results of the count analysis, followed by the results of the logit model. Since the survey contains three separate best-worst sets, the results are also divided into three sections where each section contains a separate analysis of that part. Section 4.3.1 will look into the analysis of the part focusing on Environment, followed by section 4.3.2 focusing on Social, and section 4.3.3 focusing on Governance. Finally, some additional insights are given in section 4.3.4 regarding the input of the respondents on adding or removing criteria.

4.3.1 Design

As described in Chapter 3, the Best-Worst experiment needs a BIBD design which can be generated by using the software R. Table 28 shows the results for a BIBD design for the criteria within Environment. As there are several combinations possible for creating a BIBD design, two values close to the number of criteria are used which did meet all the requirements. However, it is still possible that the values which fulfill the requirements, still not form a correct BIBD. To check whether the values form a correct design, the software program R is used as it has a function to check on this. It is found that option (1), including 21 criteria, is a correct balanced design for the Environment category.

Table 28: BIBD Design - Environment

Expression	Environment	
	(1)	(2)
v (Total number of attributes)	**21**	25
k (Size of a block)	**5**	5
b (Number of blocks)	**21**	30
r (Number of replications of each attribute)	**5**	6
λ (Frequency that each pair of attributes appears in the same block)	**1**	1

For the criteria within the category social, two possible outcomes were found as well, summarized in Table 29. By testing both outcomes in R, it is found that only option (2) is a correct balanced design. This means that the design will be made with 11 criteria included. As the number of criteria found for governance were found to be 11 as well, the correct balanced design generated for the category social can be used.

Table 29: BIBD Design – Social and Governance

Expression	Social	
	(1)	**(2)**
v (Total number of attributes)	15	**11**
k (Size of a block)	5	**5**
b (Number of blocks)	21	**11**
r (Number of replications of each attribute)	7	**5**
λ (Frequency that each pair of attributes appears in the same block)	2	**2**

With all the necessary numbers for creating a correct Balanced Incomplete Block Design (BIBD) determined, they can be implemented in the software R using the crossdes package to generate a matrix. This matrix produces a block design, an example of which is shown in Figure 14. The example matrix contains 11 different attributes (or criteria), each appearing five times across blocks of five. In this instance, with λ set to two, every combination of attributes occurs twice. For example, the combination of attributes 9 and 11 appearing together in one set of five attributes occurs twice, as highlighted in the figure.

Figure 14: Example of a BIBD Matrix

4.3.2 Environment

After collecting the data, the 74 respondents who filled in the best-worst experiment are analyzed, focusing on the questions related to Environment. Using the R-package support.bws results in the count analysis for the criteria within the Environmental part and can be found in Table 30. Here, the B column shows the number of times a criterion is chosen as best, or in this case as most important. The W-column counts the number of times a criterion is chosen as worst, or in this case as least important. The other scores are calculated by the formulas explained in section 3.2.2. The final column gives the ranking of the criteria based on the results of the count analysis, where use of sustainable materials is found to be the most important criterion and reduce pollution on the construction site as least important.

Table 30: Count analysis - Environment

Criteria	B	W	BW	stdBW	sqrtBW	Std.sqrtBW	Rank
Use sustainable materials	176	11	165	0.446	4.000	1.000	1
Use renewable energy	165	14	151	0.408	3.433	0.858	2
Ensure good lifecycle performance with an LCA	166	35	131	0.354	2.178	0.544	3
Careful building site selection	125	30	95	0.257	2.041	0.510	4
Optimize quality of the building envelope	109	30	79	0.214	1.906	0.477	5
Flexibility of the building	100	50	50	0.135	1.414	0.354	6
Protect groundwater	79	30	49	0.132	1.623	0.406	7
Include greenery	79	45	34	0.092	1.325	0.331	8
Protect the soil	60	28	32	0.086	1.464	0.366	9
Enhance biodiversity	78	47	31	0.084	1.288	0.322	10
Optimize design for simplified maintenance	91	60	31	0.084	1.232	0.308	11
Optimize indoor air quality	69	53	16	0.043	1.141	0.285	12
Reduce water consumption	44	53	-9	-0.024	0.911	0.228	13
Include mixed building functions	46	106	-60	-0.162	0.659	0.165	14
Protect cultural aspects	50	113	-63	-0.170	0.665	0.166	15
Provide bicycle parking facilities	26	96	-70	-0.189	0.520	0.130	16
Include electric-vehicle-charging stations	25	97	-72	-0.195	0.508	0.127	17
Incorporate waste sorting and management	23	110	-87	-0.235	0.457	0.114	18
Provide car parking facilities	24	153	-129	-0.349	0.396	0.099	19
Optimize lighting quality	8	151	-143	-0.386	0.230	0.058	20
Reduce pollution on construction site	11	242	-231	-0.624	0.213	0.053	21

After applying the count analysis, a modeling approach is used as well to find more insights into the results. To use this modeling approach, a reference attribute should be selected. This attribute must be the criterion with the most average score, as it will serve as the normalized criterion in the model. For environment, this would be the criterion *reduce water consumption*. The outcomes of this modeling approach are described in Table 31, where the coef is the estimated coefficient, exp(coef) is the exponential transformation of the coefficient and se(coef) is the standard error. Furthermore, the last two columns include the z-value and the p-value. The p-value shows that only the criterion *optimize indoor air quality* does not significantly differ in importance with the reference criterion *reduce water consumption* as the p-value is above 0.05. According to the model, all the criteria with a positive coefficient (coef) are significantly more important than *reduce water consumption* and all the criteria with a negative coefficient are significantly less important.

Table 31: Conditional Logit Model - Environment

Criteria	coef	exp(coef)	se(coef)	z	p
Use sustainable materials	1.395	4.035	0.130	10.710	< 2e-16
Use renewable energy	1.282	3.603	0.130	9.850	< 2e-16
Ensure good lifecycle performance with an LCA	1.107	3.026	0.129	8.596	< 2e-16
Careful building site selection	0.863	2.371	0.130	6.649	0.000
Optimize quality of the building envelope	0.720	2.054	0.127	5.673	0.000
Flexibility of the building	0.544	1.723	0.129	4.234	0.000
Protect groundwater	0.464	1.591	0.127	3.655	0.000
Include greenery	0.395	1.484	0.128	3.091	0.002
Enhance biodiversity	0.368	1.445	0.130	2.825	0.005
Protect the soil	0.338	1.403	0.129	2.617	0.009
Optimize design for simplified maintenance	0.327	1.387	0.129	2.543	0.011
Optimize indoor air quality	0.198	1.219	0.128	1.545	0.122
Reduce water consumption	0.000	-	-	-	-
Protect cultural aspects	-0.345	0.709	0.126	-2.727	0.006
Include mixed building functions	-0.408	0.665	0.129	-3.164	0.002
Provide bicycle parking facilities	-0.422	0.656	0.126	-3.354	0.001
Include electric-vehicle-charging stations	-0.506	0.603	0.129	-3.919	0.000
Incorporate waste sorting and management	-0.611	0.543	0.130	-4.686	0.000
Provide car parking facilities	-0.990	0.372	0.128	-7.712	0.000
Optimize lighting quality	-1.031	0.357	0.128	-8.054	0.000
Reduce pollution on construction site	-1.816	0.163	0.136	-13.330	< 2e-16

Finally, the shares of preference, in this study also called the shares of importance, are calculated for each item and can be found in Table 32. It shows that the *use of sustainable materials* is the most important criterion with a share of 0.133 (13.27%) and *reduce pollution on the construction site* is found as the least important criterion with a share of 0.005.

Table 32: Share of Preference - Environment

Criteria	value	percentage
Use sustainable materials	0.133	13.27%
Use renewable energy	0.118	11.85%
Ensure good lifecycle performance with an LCA	0.100	9.95%
Careful building site selection	0.078	7.80%
Optimize quality of the building envelope	0.068	6.76%
Flexibility of the building	0.057	5.67%
Protect groundwater	0.052	5.23%
Include greenery	0.049	4.88%
Enhance biodiversity	0.048	4.75%
Protect the soil	0.046	4.61%
Optimize design for simplified maintenance	0.046	4.56%
Optimize indoor air quality	0.040	4.01%
Reduce water consumption	0.033	3.29%
Protect cultural aspects	0.023	2.33%
Include mixed building functions	0.022	2.19%
Provide bicycle parking facilities	0.022	2.16%
Include electric-vehicle-charging stations	0.020	1.98%
Incorporate waste sorting and management	0.018	1.79%
Provide car parking facilities	0.012	1.22%
Optimize lighting quality	0.012	1.17%
Reduce pollution on construction site	0.005	0.54%

The outcomes of the counting approach and the modeling approach are compared to test the relation between the best-worst score of the count analysis (stdBW) and the score of the conditional logit model (coef). This comparison is done by using the program SPSS and the results can be seen in Table 33. As the scores are normally distributed (Appendix F), the Pearson correlation value is used and indicates a correlation of 0.999. This high value indicates that there is a strong relationship between the two different analyses, strengthening the outcomes discussed above.

Table 33: Correlation between Conditional logit model and Count analysis - Environment

		coef	stdBW
coef	Pearson Correlation	1	0.999**
	Sig. (2-tailed)		<0.001
	N	21	21
stdBW	Pearson Correlation	0.999**	1
	Sig. (2-tailed)	<0.001	
	N	21	21

**. Correlation is significant at the 0.01 level (2-tailed).

4.3.3 Social

While looking at the social criteria, the R-package support.bws is used again and the results of the count analysis can be found in Table 34. The final column gives the ranking of the criteria based on the results of the count analysis, where providing affordable housing is found to be the most important criterion and reduce pollution on the construction site as least important.

Table 34: Count analysis - Social

Criteria	B	W	BW	stdBW	sqrtBW	Std.sqrtBW	Rank
Provide affordable housing	152	20	132	0.357	2.757	1.000	1
Ensure the safety of the building and its surroundings	124	30	94	0.254	2.033	0.737	2
Optimize thermal and acoustic comfort of the building	105	26	79	0.214	2.010	0.729	3
Proximity of primary services and amenities	93	43	50	0.135	1.471	0.533	4
Proximity to public transport	59	33	26	0.070	1.337	0.485	5
Provide diverse housing options	89	72	17	0.046	1.112	0.403	6
Accessibility for people with disabilities	40	30	10	0.034	1.155	0.419	7
Presence of community- and public spaces	30	99	-69	-0.186	0.550	0.200	8
Promote active living	47	122	-75	-0.203	0.621	0.225	9
Encourage building occupant engagement	57	188	-131	-0.295	0.551	0.200	10
Optimize visual comfort for occupants	18	151	-133	-0.359	0.345	0.125	11

To find more insights in the results, the modeling approach is also used for this set of criteria and the criterion *accessibility for people with disabilities* is used as the reference attribute. The outcomes of this modeling approach are described in Table 35. The p-value of this model shows that the criteria *proximity to public transport* and *provide diverse housing* options do not significantly differ in importance with the reference criterion *reduce water consumption* as the p-value is above 0.05. According to the model, all the criteria with a positive coefficient (coef) are significantly more important than *accessibility for people with disabilities* and all the criteria with a negative coefficient are significantly less important.

Table 35: Conditional Logit Model - Social

Criteria	coef	exp(coef)	se(coef)	z	p
Provide affordable housing	0.861	2.366	0.131	6.595	4.25E-11
Ensure the safety of the building and its surroundings	0.606	1.832	0.130	4.644	3.42E-06
Optimize thermal and acoustic comfort of the building	0.514	1.673	0.127	4.041	5.33E-05
Proximity of primary services and amenities	0.325	1.385	0.126	2.575	0.010
Proximity to public transport	0.140	1.150	0.126	1.108	0.268
Provide diverse housing options	0.063	1.065	0.124	0.508	0.611
Accessibility for people with disabilities	0.000	-	-	-	-
Presence of community- and public spaces	-0.568	0.566	0.129	-4.414	1.02E-05
Promote active living	-0.604	0.547	0.129	-4.679	2.89E-06
Encourage building occupant engagement	-0.804	0.447	0.122	-6.601	4.09E-11
Optimize visual comfort for occupants	-0.953	0.386	0.126	-7.576	3.56E-14

As shown in Table 36, the results of the share of preference are comparable with the outcomes shown above. It shows that *provide affordable housing* is by far the most important criterion with a value of 0.191, followed by *ensure the safety of the building and its surrounding* with a value of 0.148. Furthermore, *encourage building occupant engagement* and *optimize visual comfort for occupants* are found to be the criteria with the least share of preference.

Table 36: Share of Preference - Social

Criteria	value	percentage
Provide affordable housing	0.191	19.05%
Ensure the safety of the building and its surroundings	0.148	14.76%
Optimize thermal and acoustic comfort of the building	0.135	13.47%
Proximity of primary services and amenities	0.112	11.15%
Proximity to public transport	0.093	9.26%
Provide diverse housing options	0.086	8.58%
Accessibility for people with disabilities	0.081	8.05%
Presence of community- and public spaces	0.046	4.56%
Promote active living	0.044	4.40%
Encourage building occupant engagement	0.036	3.60%
Optimize visual comfort for occupants	0.031	3.11%

Finally, the outcomes of the counting approach and the modeling approach are compared to test the relation between the best-worst score of the count analysis (stdBW) and the score of the conditional logit model (coef). As the scores are not-normally distributed (Appendix F), the Pearson correlation value is calculated, Table 37. The value of 0.999 indicates that there is an almost perfect relation between the two models, strengthening the outcomes discussed above.

Table 37: Correlation between Conditional logit model and Count analysis - Social

		coef	stdBW
coef	Pearson Correlation	1	0.999**
	Sig. (2-tailed)		<0.001
	N	11	11
stdBW	Pearson Correlation	0.999**	1
	Sig. (2-tailed)	<0.001	
	N	11	11

**. Correlation is significant at the 0.01 level (2-tailed).

4.3.4 Governance

Finally, the last analysis with the R-package support.bws is done with the criteria regarding Governance, Table 38. As indicated in the final column of the count analysis, *compliance with regulations and policies* is found to be the most important criterion and *use of technology and digital tools* as least important.

Table 38: Count analysis - Governance

Criteria	B	W	BW	stdBW	sqrtBW	Std.sqrtBW	Rank
Compliance with regulations and policies	122	19	103	0.348	2.534	1.000	1
Compliance with sustainability certifiations	127	41	86	0.232	1.760	0.695	2
Avoidance of forced or compulsory labor	129	62	67	0.181	1.442	0.569	3
Cost effectiveness of the project	97	52	45	0.122	1.366	0.539	4
Facilitate stakeholder engagement	70	67	3	0.008	1.022	0.403	5
Support local economy	79	82	-3	-0.008	0.982	0.387	6
Presence of certifications of technological systems	39	63	-24	-0.065	0.787	0.310	7
Ensure commissioning and handover procedures	53	78	-25	-0.056	0.824	0.325	8
Presence of technical documentation	28	85	-57	-0.154	0.574	0.226	9
Create direct and indirect jobs	42	133	-91	-0.246	0.562	0.222	10
Use of technology and digital tools	28	132	-104	-0.281	0.461	0.182	11

Next, the modeling approach is used to find the coefficients of the criteria where *support local economy* is used as the reference attribute. Note that it was also possible to use *facilitate stakeholder engagement* as the reference attribute as they both have an equal distance to zero. The results of the modeling approach, Table 39, show a similar outcome compared to the count analysis. However, the p-value of criterion *ensure commissioning and handover procedures* is above 0.05, indicating that this criterion is not significant.

Table 39: Conditional Logit Model - Governance

Criteria	coef	exp(coef)	se(coef)	z	p
Compliance with regulations and policies	0.861	2.366	0.124	6.970	3.17E-12
Compliance with sustainability certifications	0.530	1.699	0.115	4.591	4.40E-06
Avoidance of forced or compulsory labor	0.457	1.579	0.116	3.935	8.34E-05
Cost effectiveness of the project	0.265	1.303	0.116	2.282	2.25E-02
Facilitate stakeholder engagement	0.039	1.040	0.115	0.338	7.35E-01
Support local economy	0.000	-	-	-	-
Ensure commissioning and handover procedures	-0.149	0.861	0.112	-1.329	0.184
Presence of certifications of technological systems	-0.152	0.859	0.117	-1.292	1.96E-01
Presence of technical documentation	-0.413	0.662	0.117	-3.540	0.000
Create direct and indirect jobs	-0.597	0.551	0.117	-5.083	3.72E-07
Use of technology and digital tools	-0.724	0.485	0.117	-6.187	6.14E-10

To conclude the analysis of the criteria related to governance, the share of preference is calculated based on the previous shown conditional logit model, Table 40. Again, these results are comparable with the previous outcomes. It shows that *compliance with regulations and policies* is the criterion with the largest share, having a value of 0.191, followed by *compliance with sustainability certifications* with a value of 0.137. *Use of technology and digital tools* is again indicated at the bottom of the list with a value of 0.039.

Table 40: Share of Preference - Governance

Criteria	value	percentage
Compliance with regulations and policies	0.191	19.07%
Compliance with sustainability certifications	0.137	13.70%
Avoidance of forced or compulsory labor	0.127	12.73%
Cost effectiveness of the project	0.105	10.51%
Facilitate stakeholder engagement	0.084	8.38%
Support local economy	0.081	8.06%
Ensure commissioning and handover procedures	0.069	6.94%
Presence of certifications of technological systems	0.069	6.93%
Presence of technical documentation	0.053	5.34%
Create direct and indirect jobs	0.044	4.44%
Use of technology and digital tools	0.039	3.91%

For this final analysis, the correlation of the models is checked by using the program SPSS. The results of both analyses were again normally distributed (Appendix F) which means that the Pearson correlation value is taken, Table 41. The value of 0.999 indicates a strong correlation between the two analysis methods which is supporting the outcomes described above.

Table 41: Correlation between Conditional logit model and Count analysis - Governance

		coef	stdBW
coef	Pearson Correlation	1	0.999**
	Sig. (2-tailed)		<0.001
	N	11	11
stdBW	Pearson Correlation	0.999**	1
	Sig. (2-tailed)	<0.001	
	N	11	11

**. Correlation is significant at the 0.01 level (2-tailed).

4.4 Additional insights

Additionally to the best-worst experiment, respondents of the survey were able to indicate if they would like to remove or add certain criteria from or to the overview. This section will shortly describe the outcomes of this part of the survey by discussing the additions and suggested removals given by the respondents, Table 42. For the suggestions to remove certain criteria, a selection is made which only includes the suggestions made a significant amount of times. This means that suggestions which were made only once are not included and thus not discussed. The suggestions on the additional criteria are also filtered on criteria which were not already included in the assessment instrument yet.

Table 42: Suggestions made on removing or adding criteria

Suggestions to remove	Suggestions to add
Reduce pollution on construction site	Use of air conditioning and heating
Provide car parking facilities	Facilities for safe and comfortable walking
Protect cultural aspects	Use of subsidies

First, the suggestions on the removal of certain criteria will be discussed. Here, the three criteria which were indicated most frequently are included. Reduce pollution on construction site was mentioned most often (17 times), which is in line with the results of the Best-Worst experiment as the results showed that this is indeed the least important criterion for Environment. However, as described in section 2.3.1, the environment needs to be protected carefully against pollutions coming from the built environment, also including the construction site. Furthermore, the presence of several regulations in the Netherlands on minimizing pollution on the construction site indicates its importance. However, the instrument will not include this criterion when no construction site is present, for example when assessing an existing project which is already built.

The next suggestion is on the removal of the criterion on providing car parking facilities (11 times). While looking at the outcomes of the analysis, this was not the criterion which was the least important after the one focusing on the reduction of pollution on the construction site. There was one criterion in between these two. As it is still one of the least important criteria, it is likely that it is indicated to be removed by a certain amount of respondents. This might be due to the fact that respondents link car usage as something that is not sustainable, as it is often mentioned that car usage should be lowered to reduce CO_2 emissions (Milieu Centraal, 2024) . However, the criterion within this assessment does not promote the usage of the car, it indicates that a project should not overrepresent the presence of the car and is therefore not removed from the assessment.

Finally, the last suggestion on removing a criterion is regarding the protection of cultural aspects (8 times). This criterion is indicated as a suggestion to remove but is found as an average important criterion in the outcomes of the analysis. Combined with the explanation given in section 2.3.1 which states that there are several regulations in the Netherlands to protect cultural elements as they can be limited, it is decided to not remove this criterion.

The suggestions made regarding the addition of criteria resulted in three potential new criteria, or elaborations. First, the use of air conditioning and heating was suggested once, this topic is not mentioned separately in the assessment instrument yet but can be found within other criteria such as the optimization of the indoor air temperature. Therefore, it is not included as a separate criterion since this would lead to a very extensive list of very detailed criteria.

The suggestion on safe and comfortable walking is given once in the experiment but might be supported by three other additions focusing on distances to facilities and transport. As the tool already includes criteria which measure distances to these (transport) facilities, there is no additional criterion for this topic. However, unless the fact that the suggestion on safe and comfortable walking is only mentioned once in the experiment, the suggestion is incorporated within the criteria that are focusing on measuring distances. This suggestion might be a valuable addition, supported by its inclusion within the BREEAM framework as well (BREEAM-NL, 2024e). The suggestion is included by measuring the distance in the assessment instrument as a walking distance which is safe and comfortable, meaning that it should be separated from other forms of traffic, have safe road crossings, and is accessible for all pedestrians.

The final suggestion, focusing on the use of subsidies is only mentioned once and therefore not implemented as a new criterion as it is not seen as a significant indicated missing criterion. Furthermore, this study argues that subsidies are not directly related to the sustainability of the project but might be used to create extra possibilities to invest in sustainable improvements of the project. These improvements can be measured by the instrument, but as the subsides itself do not have a direct effect on the sustainability of the building, it is not separately included. Therefore, the study suggests that including subsidies can eventually result in greenwashing, where the ESG score can be improved by a project receiving subsidies without actually measuring the impact or result of the subsidies.

4.5 Conclusion

After finding all the results of the different analyses which are performed, it can be concluded that the outcomes can be used as they mainly show significant outcomes and are supported by the high correlation values between the different tests. Furthermore, the amount of respondents is sufficient and diverse regarding their job type, age, and experience level. This means that there is not one specific group overrepresented and influencing the outcomes of the analysis.

Regarding the analysis of the importance of the criteria for Environment, use of sustainable materials and use renewable energy are found as the two most important criteria. These findings can be supported by the findings of the systematic literature as it was found that studies highlighted the importance of material use and the use of renewable energy as well as its importance found in the regulations and policies of the Dutch Government. However, the literature study also found a relative importance regarding water efficiency. As reduce water efficiency was found to be not at the top of the list regarding its importance, the results of the experiment differ on this topic compared to literature findings. Finally, the criterion reduce pollution on the construction site was found to be the least important criterion within Environment, which might be due to the fact that this criterion is only looking into a short term effect, namely during the construction process. The other criteria are looking into an effect which will make impact for a longer period of time, for example the whole lifespan of the building.

For the importance of the criteria focusing on the Social part, provide affordable housing was found to be the most important criterion which is supported by the findings of the literature study as it stated that not only literature, but also governmental policies and BREEAM indicate its importance. Ensure the safety of the building and its surroundings is also found to be one of the most important criteria by the experiment. However, the literature study showed a limited importance of this criterion as only literature mentioned its importance which was not elaborated further by regulations of the Dutch Government. Finally, optimize visual comfort for occupants is found to be the least important in this Best-Worst analysis. This might be due to the fact that visual comfort is hard to measure compared to for example the amount of renewable energy used in a project. There are no direct (financial) benefits which follow from better visual comfort. This might cause that respondents are indicating the criterion as least important.

Finally, compliance with regulations and policies is found to be the most important criterion within Governance. This might be caused by the fact that the compliance with regulations and policies is easily measurable and therefore easy to understand for respondents. Furthermore, it might have consequences when projects are not in line with the regulations and policies as they might not receive subsidies for sustainable investments or are not allowed to proceed with the building process. Literature did not show the relative importance of this criterion as it was not clearly stated in studies. However, the compliance with sustainability certifications was a criterion indicated by multiple studies to be important. This criterion is found to be second important in the Best-Worst experiment, in line with the findings in the literature study. The least important criterion within this Best-Worst analysis was the use of technology and digital tools, which might be a surprising outcome as nowadays, technology is often used to achieve sustainable developments. The literature study indicated multiple studies suggesting the importance of these digital technologies, however the Dutch government does not focus on this topic with their regulations and policies.

After analyzing and interpreting the results of the best-worst experiment, the experiment concludes with the final utility scores which are based on the share of preferences given in the sections above. The percentages given by this analysis will be used to calculate the amount of points which will be allocated to the criteria. For example, there are 100 points to divide over the criteria within Environment, the criterion on use of sustainable materials will thus get 13,27% of the 100 points, is 13,27 points. An overview of the utility scores and the points for all the criteria can be found in Appendix F, where the total amount of points for Environment, Social and Governance is based on the results of the point allocation experiment.

5. ESG assessment instrument

After collecting the criteria needed in an ESG assessment instrument and analyzing the importance of these criteria, all the components are brought together in a final ESG assessment instrument which is able to assess a building project on its sustainability performance. This section will describe the development of the instrument itself and the results of the validity and reliability tests.

5.1 ESG Instrument and its development

The ESG assessment instrument will be described in three different parts, based on the steps that will be taken by the instrument itself to come to the final outcome. First, the input section of the tool will be described, followed by an elaboration on the calculations made by the instrument which includes the utility scores defined in chapter 4. Finally, the output of the tool will be discussed, including an elaboration on the suggested relation of the ESG score with the SFDR articles as well.

5.1.1 Input

To be able to calculate the ESG performance of a building project, several input values must be entered into the assessment instrument, divided over 4 input sections, Figure 15. Most of the information will be entered within the General input section of the assessment instrument. This includes general information on the type of project, the amount of functions, parking places or apartments present or the energy usage. All the information filled in within this section will be used to define most of the input values within the next sections regarding environment, social and governance. For example, by filling in the floor area in square meter present in the project, and the window area in square meter, the instrument will automatically fill in the value for one of the criteria within the category for indoor environment. This means that no data has to be filled in twice. After filling in the general input section, the remaining sections must be checked as well to see if there is still information which is missing.

Figure 15: Input sections within the ESG assessment instrument

Finally, to be able to assess different types of projects, certain criteria must be removed from the assessment if they are not assessed. By including some general questions about the project in the general input section, the tool will automatically remove criteria which are not relevant. This means for example that a project without a construction site will indicate this within the general input, resulting in a utility score of 0 and a maximum amount of points of 0 for the criterion *reduce pollution on the construction site* as well as a reduction of the maximum of the total points of the whole assessment. By including this, it is possible to assess different project without having to change the calculations by hand.

5.1.2 Calculations

After all the input values are entered, the assessment instrument will automatically calculate the scores of all the criteria, resulting in combined scores per category, a score for E, S and G, and an overall score. As the criteria all get different types of input values, such as square meters, percentages, the amount of facilities or the presence of a certain document, the input values are rescaled to a point system where the lowest score is 0, and the highest score is 4. For now, the points between 0 and 4 are called Points *(P)*. As some criteria are measured by multiple input values, the total points per criterion (P_t) must be calculated as well. Calculating P_t is done by dividing the sum of the points (P) by the maximum amount of points which can be gathered for the criterion (P_{max}).

By calculating the total points per criterion (P_t), all the criteria are rescaled to a value between 0 and 1. After rescaling the points of the criteria, it is possible to add the utility scores as explained in section 4.5. By multiplying the total points (P_t) with the utility score (U), the final score (S) of a criterion is calculated. Applying these utility scores to the points means that certain criteria will have more impact on the final score compared to others. To get a good overview of the performance of the project on different categories, the percentages of the final scores are calculated. This is done by dividing the sum of all scores within a category (S_t) by the sum of all the utility scores within a category (U_t). The utility score is also the maximum score which can be reached as P_t has a maximum score of 1. An overview of all variables and their calculations can be found in Appendix H.

Table 43: Variables used in calculations

Variable	Definition	Formula	Minimum	Maximum
Points (P)	The points gathered by a certain input value.	-	0	4
Maximum Points (P_{max})	The maximum amount of points which can be reached for a criterion.	-	0	4*(amount of input values for the criterion)
Total Points (P_t)	The total points gathered by a criterion	P / P_{max}	0	1
Utility (U)	The utility score of the criterion	-	Fixed score	
Total utility (U_t)	The total utility score of a category	Sum of U	Fixed score	
Final score (S)	The final score of the criterion	$P_t * U$	0	U
Total score (S_t)	The total score of a category	Sum of S	0	U_t

To explain the process described above, an example from the assessment instrument will be taken and discussed. The criterion *include electric vehicle charging stations* is used as it includes two input values which are combined to one single score. The example can be found in Table 44.

Table 44: Example instrument calculations per criteria

Criteria	Information required	Input	Points (P)	Total points (P_t)	Utility (U)	Score (S)
Include electric vehicle charging stations	Parking facilities are connected to pipeline infrastructure	No	0	0,375	1,82	0,683
	Amount of parking facilities with an electric charging station	21%	3			

Finally, the score of this criterion is combined with the outcomes of all the criteria within the category Transport Facilities. In this last step, the effect of the utility scores becomes visible as certain criteria within this selection will have a higher utility score compared to others. This final step is shown in Table 45, where it is shown that 56,8% of the points within this category are collected.

Table 45: Example tool calculations per category

Category	Criteria	Total points (P_t)	Utility (U)	Score (S)	%
Transport Facilities	Provide bicycle parking facilities	0,500	1,98	0,990	56,8%
	Include electric vehicle charging stations	0,375	1,82	0,683	
	Provide car parking facilities	1,000	1,12	1,120	

5.1.3 Output

After all project information is included into the assessment instrument and when the automated calculations are made, the instrument generates several levels of output scores. At the highest level, it provides a total ESG score, which reflects the overall sustainability performance of the project across various criteria. This total score offers a comprehensive view of the project's sustainability in terms of Environment, Social, and Governance aspects.

Looking into more detail, the instrument also presents scores specific to each of ESG dimension, allowing stakeholders to pinpoint strengths and weaknesses in each area. Furthermore, the instrument breaks down these scores into individual categories within each dimension, offering detailed insights into specific performance aspects that may require attention or commendation. Figure 16 visualizes these different levels of detail.

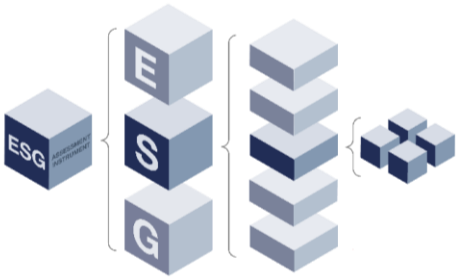


Figure 16: Levels of detail in the ESG assessment instrument

Beyond identifying a project's strengths and weaknesses, the goal of the ESG assessment instrument also is to align its outcomes with SFDR articles 6, 8, and 9, which categorize financial products based on their sustainability characteristics (AFM, 2021). As previously discussed in this study, the SFDR articles distinguish between products that do not include sustainability characteristics (Article 6), those with some sustainability characteristics (Article 8), and those that actively focus on sustainability characteristics (Article 9) (de Wergifosse, 2023), Figure 17.

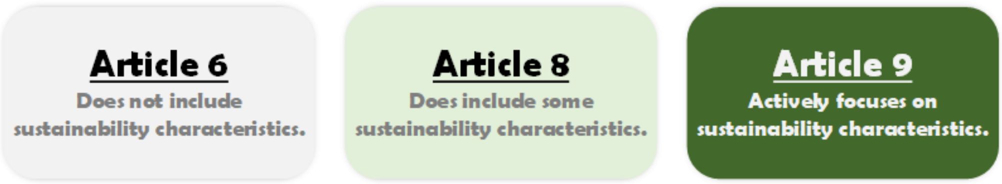


Figure 17: Overview SFDR articles

The link between the outcomes derived from the ESG assessment instrument developed in this study and the SFDR articles is crucial for advancing transparency and sustainability in real estate investments as well as supporting the development of clearly defined articles, improving the currently ambiguous descriptions used to distinguish the different levels of sustainability. In this study, the ESG assessment instrument serves as a framework for measuring and disclosing the sustainability performance of real estate assets. This instrument not only aids in assessing the sustainability credentials of investments in real estate projects but might also support the objectives of the SFDR by providing clear, measurable outcomes on ESG criteria.

To support the clarification and improved implications of the SFDR articles, this study suggests linking specific percentage ranges of the ESG outcomes to the three SFDR articles. This study uses the percentage ranges within the labeling system of BREEAM as this existing labeling system offers a widely recognized framework for assessing the sustainability performance of buildings across Europe (BREEAM-NL, 2024e) and is therefore seen as a suitable starting point for defining the percentage ranges of the ESG scores. The different labels used in BREEAM can be found in Figure 18, where a percentage below 30% does not receive a label, and a percentage above 85% receives the highest label.

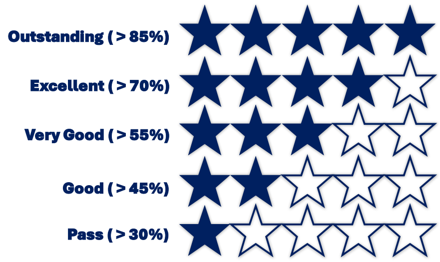


Figure 18: BREEAM-NL rating labels (De Groene Jongens, 2024)

The second BREEAM label indicates a good performance when the percentage is above 45%. Therefore, this study suggests that scores of the ESG assessment instrument below 45% should be aligned with Article 6 as this article is indicating minimal sustainability characteristics. Furthermore, the study suggests that ESG scores between 45% and 70% should be aligned with Article 8, showing substantial sustainability characteristics. Finally, the study suggests that scores above 70% should be aligned to Article 9, representing excellent performance with robust sustainability characteristics.

Additionally, when managing multiple assets within a fund, the ESG scores of these assets can be used to provide an overview of its overall performance. This overall performance can be discussed by using the SFDR articles outlined earlier. For instance, if all assets in a fund score above the threshold for Article 8 (which in this study is suggested to be at 45%), investors can classify their fund as having a "light green" profile based on these aggregated ESG scores. This approach allows stakeholders to identify underperforming assets that may lower the fund's average score. For example, if four out of five assets meet or exceed the criteria for Article 9, but one asset falls short, the fund as a whole cannot be categorized under Article 9. This insight enables investors to pinpoint specific assets that need improvement to achieve compliance with the SFDR articles. Figure 19 illustrates an example where a fund is labeled as Article 9. Notably, asset 3 nearly approaches the criteria for Article 9, highlighting an area for potential improvement.

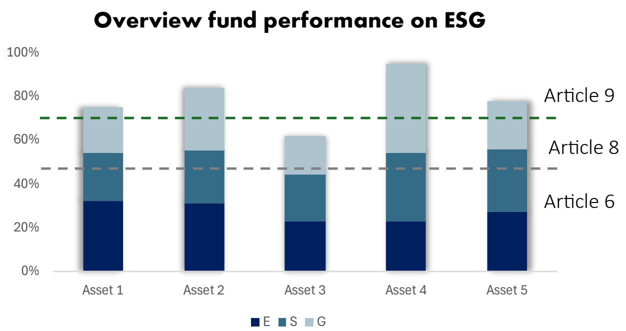


Figure 19: Example of a fund performance on ESG

The link between the ESG scores and the SFDR articles which is suggested by this study provides investors with a clear indication of how the ESG performance of real estate assets translates into SFDR categories, enabling them to make informed decisions aligned with their sustainability objectives. By enhancing transparency and supporting a standardized ESG assessment, this approach not only supports compliance with SFDR but also facilitates the broader goal of promoting sustainable investments in the real estate sector.

Finally, the outcomes of the ESG assessment instrument are visualized by using a dashboard developed in PowerBI (Microsoft, 2024). This dashboard visualizes the total score of an asset, but also provides the possibility to include scores of other assets to generate an overview as shown in Figure 19 above. Furthermore, the dashboard has different taps focusing on Environment, Social and Governance outcomes. These overviews show the scores per category and per criterion. Furthermore, it gives suggestions improvements of the ESG score by listing the criteria which can be improved and make the biggest difference on the total score. The visualizations of the dashboard are added in Appendix I.

5.2 Case Study

As outlined in Section 3.4, it's essential to evaluate the instrument's reliability and validity to determine its suitability for practical use. In order to assess the instrument's reliability and validity, two case studies were conducted involving five participants, all recognized as experts in the built environment. These participants were all asked to assess the sustainability performance of two different building projects by using the ESG assessment tool developed in this study. A comprehensive profile of these participants is presented in Table 46, detailing their years of experience in the built environment and their familiarity with ESG assessments. Their experience levels are categorized as limited, medium, or extensive.

Table 46: Profiles of the participants of the case study

Participant	Level of experience	Job type	Experience with ESG assessments
1	11 – 25 years	Consultant	Lots of experience
2	< 5 years	Consultant	Limited experience
3	11 – 25 years	Consultant	Lots of experience
4	5 – 10 years	Consultant	Limited experience
5	< 5 years	Consultant	Medium experience

Following the initial case studies, two additional projects were analyzed by the researcher to provide a broader perspective on the findings as the initial evaluations, conducted by the participants, resulted in similar sustainability scores for both projects. To test the ESG assessment instrument across a wider range of sustainability performances, two additional projects are selected and assessed. These additional cases were chosen specifically because they represent more extreme values: one project had a notably low sustainability rating according to BREEAM, and the other had a very high rating. This contrast allows for a more comprehensive assessment of the instrument’s effectiveness in evaluating projects with varying degrees of sustainability performance.

Finally, this section will discuss the reliability and validity of the ESG assessment tool by utilizing the results from the case studies and draw conclusions about its effectiveness in practical applications. By examining the outcomes from both the participant-assessed projects and the additional cases, it will be evaluated whether the tool consistently and accurately measures the sustainability level across a diverse range of real estate projects.

5.2.1 Case 1: Logistic asset

The first case study evaluated by the participants focuses on a logistic building located in an industrial area. This building, encompassing a gross floor area of nearly 70,000 m², serving both logistic and office functions. Notably, the building has already achieved a BREEAM rating of 'Very Good' with a score of 57%, signifying a substantial level of sustainability. Additionally, it holds an energy label of A+++, reinforcing its standing as a well-performing asset in terms of energy efficiency. These certifications suggest that the building should perform well in an ESG assessment. However, the building's location within an industrial area presents potential challenges. It is somewhat isolated from other facilities and transportation networks, which could adversely impact the social and environmental dimensions of its ESG assessment. This context is crucial for understanding the potential implications on the overall sustainability evaluation of the project.

To evaluate the building's sustainability, five expert participants from the field of the built environment used the developed ESG assessment tool to assess the building's performance across the three ESG dimensions. Each participant was provided with the assessment instrument along with comprehensive project documentation and relevant information about the building. This enabled them to thoroughly assess the building's performance across the three ESG dimensions. Once the participants completed the assessment by entering the necessary project information into the instrument, they were asked some additional questions to discuss the findings and results of the assessment.

After using the assessment instrument and filling in the required information of the logistic building, the outcomes of the assessment can be discussed. The scores given by the participants are summarized in Table 47, which reveals that the building's overall ESG score ranged from 58% to 64%. This range aligns closely with the building's existing BREEAM score of 57%. Notably, the largest variation among the scores was observed in the Governance category, indicating that governance-related aspects might be perceived differently by various experts. For a more detailed breakdown of the scores across the different ESG categories, please refer to Appendix J.

Table 47: Results case study 1 - Logistic building

Topics	Participants				
	1	2	3	4	5
Overall ESG score (utility score)	**61%**	**62%**	**60%**	**58%**	**64%**
Environment (46%)	65%	62%	59%	56%	65%
Social (31%)	54%	56%	50%	49%	53%
Governance (23%)	61%	69%	73%	69%	73%

After completing the ESG assessment of the logistic building, participants provided feedback on the results. They were asked to consider the type of project they evaluated and the information they entered into the assessment tool. Specifically, they were questioned on the accuracy and realism of the resulting scores and whether they anticipated different outcomes in any of the ESG categories.

Participants generally agreed with the assessment outcomes. They felt that the tool accurately reflected the building's strengths and weaknesses across the various ESG dimensions. Participants confirmed that the scores were realistic and appropriate, suggesting that the ESG assessment tool provides a fair representation of the building's sustainability performance.

When discussing the different ESG categories, participants noted that the building's higher score in the Environmental category aligned well with its high energy efficiency and BREEAM rating, supporting the tool’s accuracy in assessing environmental performance. Conversely, participants agreed that the lower score in the Social category was fitting, given the building’s industrial location and limited social connectivity. However, some participants expected slightly larger variations in the scores as they suggested that the difference between the Environmental score and the Social score could be somewhat larger.

5.2.2 Case 2: Residential asset

The second case study evaluated by the participants is a residential building complex designed to accommodate both elderly residents and young starters. This building complex offers a variety of amenities, including healthcare facilities tailored for the elderly, sports facilities, childcare services, restaurants, and extensive green spaces, including rooftop gardens. The project's location near a major city in the Netherlands ensures convenient access to public transportation facilities. Despite its good connection towards infrastructure and comprehensive amenities, the building holds an energy label of A+, indicating good but not optimal energy efficiency. The use of renewable energy sources in this project is limited, which may impact its overall sustainability performance in an ESG assessment. The combination of residential features and diverse amenities underscores the building's potential for a balanced assessment across environmental, social, and governance dimensions. However, the energy efficiency aspect presents a notable consideration that could influence its sustainability score.

Also for this case study, the five expert participants from the built environment sector used the developed ESG assessment tool to evaluate the building’s sustainability across the three ESG dimensions. Each participant received the assessment instrument along with comprehensive project documentation and relevant building information. After completing the assessment of the building, participants were asked some additional questions to review and interpret the assessment outcomes of the second case study as well.

In this second case study, the overall ESG score ranges between 60% and 62%, Table 48, showing slightly less variation compared to the first case study. Participants’ assessments of the Environment, Social, and Governance aspects were more closely aligned in this instance. The project demonstrates strong performance in the Social aspect, likely influenced by its inclusion of care facilities within the complex. However, shortcomings in energy efficiency contribute to a lower score in the Environment category. The utility score, impacted by energy efficiency and material usage, significantly influences the project's overall score. Despite these challenges, the assessment suggests considerable potential for achieving a higher overall score with improvements in these areas. A detailed breakdown of scores across different ESG categories of this case study can be found in Appendix J as well.

Table 48: Results case study 2 - Residential building

Topics	Participants				
	1	2	3	4	5
Overall ESG score (utility score)	**62%**	**60%**	**62%**	**62%**	**61%**
Environment (46%)	52%	50%	57%	55%	52%
Social (31%)	71%	71%	69%	70%	70%
Governance (23%)	69%	64%	64%	64%	69%

Following the completion of the ESG assessment of the residential building complex, participants provided valuable feedback on the assessment outcomes by answering some questions on the accuracy and realism of the results. Participants largely agreed with the outcomes of the assessment and confirmed that the instrument effectively identified the building complex's strengths and weaknesses across the ESG dimensions, suggesting that the scores accurately represented the project's overall sustainability performance. In particular, participants noted the project's notable strength in the Social category. The inclusion of healthcare facilities and amenities tailored for both elderly residents and young starters resonated well with the participants, contributing to a higher score in this dimension.

Participants' insights underscored the complex's unique concept and its deliberate focus on enhancing social connectivity and community amenities. While acknowledging the project's strong social performance, participants also recognized room for improvement in environmental sustainability practices. They suggested that optimizing energy efficiency and incorporating more sustainable materials could enhance the project's overall sustainability score.

Overall, participants' feedback aligned with the assessment scores generated by the tool, emphasizing the project's strengths in social sustainability while highlighting opportunities for enhancing environmental sustainability practices.

5.2.3 Comparison of the two cases

As a final step, participants were asked to compare the scores of both projects to evaluate their relevance. Despite the overall similarity in final scores, participants focused on comparing the Environment, Social, and Governance aspects between the two projects. They confirmed that these outcomes were consistent with their expectations.

Specifically, participants noted that the first case study performed significantly better in the Environment category compared to the second case study. Conversely, the second case study excelled in the Social category, reflecting its strong emphasis on social aspects such as community amenities and healthcare facilities. This difference was strongly agreed by the participants as the second case study has a very strong concept and is mainly focusing on this social aspect, also due to its function as a residential project.

Furthermore, participants shared that they found the assessment tool to be robust. They observed that minor changes or variations in input values, due to the scoring system (0 to 4 points), did not significantly alter the final outcomes. This stability was viewed positively, ensuring that slight discrepancies in input values from different assessors would not lead to substantial differences in final scores. However, participants acknowledged that criteria with higher utility scores had a more pronounced impact on the overall score. Thus, minor variations in these criteria could result in slightly larger differences in final scores. Regarding the realism of the assessment and its associated scores in depicting project performance, participants generally found the scores to be realistic and reflective of the projects' sustainability attributes.

5.2.4 Two additional cases

Following the average scores observed in the two initial case studies discussed above, two additional cases are assessed to explore the impact of projects with significantly high or low BREEAM scores. These additional cases were conducted independently as the reliability and validity is established through the initial projects with the participants. The aim of the additional cases is to further verify the assessment instrument's performance across extreme ends of the sustainability spectrum. Due to the unavailability of poor or exceptionally well-performing projects within the database of PVM, project data from BREEAM (BREEAM-NL, 2024k) is used. While these projects provide valuable insights, the limited available information necessitates making estimations based on available knowledge and online project details.

The first additional case study focuses on an office building located in Arnhem, which achieved a BREEAM score of approximately 27% (BREEAM-NL, 2024m). The office building is located near the train station and is one of the highest buildings in Arnhem. Within the BREEAM score, it can be seen that the building performs well on transport, but is lacking behind on water, biodiversity and pollution. As there is limited information known on the project, estimations are made based on information available online. Using the gathered information, the ESG assessment instrument yielded a total score of 31% for the project, Table 49. This discrepancy highlights a slightly higher score using the ESG assessment instrument compared to the BREEAM score, a trend also observed in the assessment of the logistic project in the first case study. However, it's important to note that this score is predominantly based on estimations due to limited available information.

The second additional case study involves a renovated office building in Rotterdam, which achieved a BREEAM score of nearly 82% (BREEAM-NL, 2024l). The original structure underwent extensive renovation to meet future sustainability goals, including improvements in insulation, installation of larger windows, and integration of green spaces. The BREEAM certificate highlights excellent performance across various criteria, particularly in waste management and pollution control. After gathering the available information of the project, the ESG assessment instrument is used, resulting in a score of 77%, Table 49. While this score shows a slight variation from the BREEAM rating, it still reflects the building's high sustainability performance. Appendix J shows the detailed scores of the projects on the different categories within ESG.

Table 49: Results additional case studies

Topics	Additional cases	
	Office building (Arnhem)	Office building (Rotterdam)
Overall ESG score (utility score)	**31%**	**77%**
Environment (46%)	14%	82%
Social (31%)	43%	74%
Governance (23%)	53%	70%

The aim of the additional cases was to evaluate whether the ESG assessment instrument could effectively analyze projects with significantly high or low sustainability scores. Despite the challenges posed by limited data availability, the results indicated that the ESG assessment instrument generally mirrored the assessments provided by BREEAM. This validation underscores the instrument's capability to evaluate sustainability across a spectrum of performance levels, affirming its robustness and applicability in diverse real estate contexts.

5.2.5 Reliability

The reliability of the ESG assessment instrument was evaluated through the performance of two case studies, with a primary focus on its inter-rater reliability. Inter-rater reliability measures how consistently different evaluators produce similar results when assessing the same project.

In this study, five participants, defined as experts within the built environment, were asked to assess two different building projects by using the ESG assessment tool developed in this study.

Despite the slightly diverse backgrounds and varying levels of experience with ESG assessments among the participants, the results of the case studies showed remarkable consistency. Each participant independently applied the ESG assessment instrument to the projects, and the resulting scores exhibited minimal discrepancies. For instance, the assessments of the logistic building resulted in ESG scores ranging from 58% to 64%, while the residential complex scores varied between 60% and 62%. These limited variations indicate that the tool reliably produces consistent results, regardless of who is conducting the assessment.

Furthermore, the alignment in the scores for different ESG dimensions across all participants reinforces the instrument's reliability. For the logistic asset, all participants noted a higher Environmental performance compared to Social and Governance aspects. Similarly, in the residential case study, the high Social scores and comparatively lower Environmental scores were consistently observed by all evaluators. This pattern of consistent scoring across different dimensions further validates the tool's reliability.

The consistency of these results across different evaluators and project types suggests that the ESG assessment instrument has strong inter-rater reliability. This robustness is critical for practical applications, ensuring that the tool can be confidently used to assess sustainability performance across a variety of real estate projects, irrespective of who is performing the assessment.

5.2.6 Validity

The validity of the ESG assessment instrument was checked through both concepts of face validity and concurrent validity, both determining if the instrument accurately measures sustainability performance as intended.

The face validity of the instrument was confirmed through expert feedback, collected by the performance of the two case studies. The five participants, experienced professionals in the built environment, were asked to evaluate whether the ESG assessment instrument effectively measured what it was designed to measure. They unanimously agreed that the ESG assessment instrument provided results that accurately reflected the expected sustainability characteristics of the assessed projects. This agreement among experts indicates strong face validity, affirming that the instrument appears to measure sustainability performances, and thus ESG characteristic, correctly.

Furthermore, the concurrent validity was specifically evaluated by comparing the ESG assessment outcomes with the BREEAM rating of the logistic project, the only project among the two case studies with an established BREEAM label. The logistic building received a BREEAM score of 57%, and the ESG assessment scores for this project closely aligned with this benchmark, ranging narrowly around 58% to 64%. This alignment demonstrates that the ESG assessment instrument produces results that are comparable to the recognized BREEAM standard, confirming its concurrent validity.

In the additional case studies, the tool's ability to accurately assess projects with extreme BREEAM scores was further validated, supporting the concurrent validity discussed above. The office building located in Arnhem, with a low BREEAM score of 27%, received a slightly higher ESG score of 31%, reflecting its limited sustainability features accurately. Conversely, the office building in Rotterdam, with a high BREEAM score of 82%, was assessed with an ESG score of 77%, underscoring its robust sustainability performance. These results reinforce the instrument's effectiveness in evaluating a wide range of sustainability performance levels.

5.3 Conclusion

In conclusion, this chapter focused on the development and validation of the ESG assessment instrument. The developed instrument aims to provide a clear framework to assess real estate assets on their sustainability performance and supports the clarification of the articles within SFDR. The ESG assessment instrument was created to tackle the complex aspects of sustainability assessments in building projects. It uses a systematic method to gather detailed project information, which is sorted into four main areas: general input, environmental input, social input, and governance input. This organized, data-focused approach ensures that the instrument can be applied to different types of projects and can adapt to their unique features, offering a precise evaluation for all building types.

The main function of the assessment instrument is its ability to calculate the sustainability level of a real estate asset based on different input values regarding ESG. The instrument translates the input values into a uniform point system, incorporating utility scores to reflect the relative importance of each sustainability criterion. The point system, translating the input values into an integer between 0 and 4, is found to be a good method, supported by the feedback of the participants of the case study. The participants indicated that the instrument is robust as they observed that minor changes or variations in input values did not significantly alter the final outcomes. This ensures that slight discrepancies in input values from different assessors would not lead to substantial differences in final scores.

Moreover, the instrument aligns its outputs with the SFDR articles, further enhancing its added value and relevance for investors and stakeholders. By redefining the ambiguous definitions of the three SFDR articles through the use of the clearly defined framework of the ESG assessment instrument and the existing BREEAM labels, it introduces a transparent labeling system. This alignment serves as a suggestion which could streamline investor decision-making on sustainability issues and possibly solves concerns related to greenwashing.

To validate the ESG assessment instrument's practical viability, two primary case studies and two additional case studies were conducted. The two primary case studies involved 5 participants who used the instrument to evaluate two different building projects: a logistic building and a residential building. The results from these case studies indicated that the ESG assessment instrument reliably produced consistent scores, regardless of the participants' slightly varying backgrounds and levels of experience with ESG assessments. Participants' feedback further reinforced the instrument's reliability and validity. Despite slight variations in input values, the scores remained stable, suggesting a strong inter-rater reliability. This consistency is crucial for ensuring that the instrument can be confidently used across different projects and by different assessors.

In addition to the primary case studies, the instrument was tested on two additional projects representing extreme sustainability performances: an office building in Arnhem with a low BREEAM score and a renovated office building in Rotterdam with a high BREEAM score. These tests aimed to evaluate the instrument's effectiveness in assessing projects at both ends of the sustainability spectrum. The results of the additional case studies showed that the ESG assessment instrument closely mirrored the BREEAM scores.

The instrument's face validity was confirmed through expert feedback, with participants agreeing that the instrument effectively measured the intended sustainability characteristics of the projects. Concurrent validity was suggested by comparing the ESG scores with BREEAM ratings, demonstrating close alignment and confirming the instrument's ability to produce comparable assessments to recognized standards.

Overall, the development and validation of the ESG assessment instrument represents a significant step in addressing the need for effective methods to implement ESG principles in real estate. Focused on clarifying SFDR article definitions, this instrument aims to enhance transparency and consistency in assessing sustainability in Dutch building projects. Its structured approach to data collection, scoring, and alignment with regulatory frameworks like SFDR simplifies investor decision-making and reduces the risk of greenwashing. Future enhancements will need to further refine its metrics, ensuring its ongoing relevance in promoting sustainable real estate development and investment.

6. Conclusion & Discussion

Within this last chapter, the main contributions of the study are described as well as some discussion points, implications for the industry and some recommendations for further research.

6.1 Main contributions

The aim of this research was to create a uniform, and integral ESG assessment instrument for investments in real estate projects in the Netherlands by defining a clear framework to assess all types of real estate assets on their sustainability performance and thereby also supporting the clarification of the articles within SFDR. By developing this standardized framework, the research addresses the pressing need for transparency and consistency in ESG and SFDR compliance assessments. This contribution is particularly significant given the limited existing research into ESG assessments specifically tailored for the Dutch real estate sector. The final outcomes and main contributions of this study will be discussed by reflecting on the aim of the study and answering the main research question:

''How can a uniform and integral ESG assessment for investments in real estate projects in the Netherlands be designed?''

Starting with an extensive literature review on the topics of ESG and sustainable building assessment, the study gives an overview of many criteria which should be taken into account when assessing a building or asset on its sustainability performance. This in-depth analysis enriches the current state of research and lays a solid foundation for the practical application of ESG assessments in real estate. The criteria found to be essential for assessing the sustainability level of a building are categorized in different categories and divided on the topics of Environment, Social and Governance. Due to the number of different criteria which were found during this literature study, some are merged into one criterion to keep the experiment from becoming too long, while maintaining a valid research design. The defined list of criteria is studied in more detail by looking into their definitions, methods to measure the performance of the building or asset, and input from laws, regulations, or policies in the Netherlands. Within this step, BREEAM is also used as a guidance on formulating definitions and measurement methods of the criteria. After defining the criteria, the outcomes are compared with the 17 SDGs, suggesting that the selected criteria are almost fully covering the definition of sustainability as stated by the United Nations.

The focus of the study was on the asset level, which means that the study suggested that policy related activities should be measured on the asset level and not on the presence of the policy only. It is found that the presence of policies is sometimes still used as a measurement method in this study. However, this is often in combination with using actual measurements of the project as well. An example can be found in the category *Biodiversity and Greenery*, where the presence of a biodiversity policy is checked, but also the presence of diverse green implementations by looking into the points gathered for 'building nature inclusive' (natuurinclusief bouwen).

After the selected criteria are defined, professionals in the working field are asked to give input on the importance of the selected criteria to find out which criteria should have a higher or lower impact on the sustainability score of an asset. This is done by performing a Best-Worst experiment where respondents are asked to indicate what they consider the most and least important criteria. Here, the criteria for Environment, Social, and Governance are showed separately which means that the outcomes only give a ranking within every group, so one ranking for the criteria within Environment, one for the criteria within Social, and one for Governance. The count analysis and conditional logit model used to analyze the gathered data are compared and tend to have a high correlation factor, indicating the strengths of the outcomes.

The outcomes of the experiment suggest that for Environment, *use of sustainable materials* is clearly the most important. The least important criterion is found to be *reduce pollution on construction site*. For Social, the outcomes suggest that *provide affordable housing* is the most important criterion. *Optimize visual comfort for occupants* is found to be the least important criterion. Finally, the experiment suggests that for Governance, *compliance with regulations and policies* is seen as most important, and *use of technology and digital tools* as least important.

Besides the Best-Worst experiment, the experts also gave some input on the importance of Environment, Social and Governance itself. The experts suggested that Environment should be most important as it gets on average 46 points out of 100, followed by Social (31 out of 100) and Governance (23 out of 100). Also, some recommendations are given on adding or removing criteria from the assessment instrument. This resulted into one addition to the assessment instrument, focusing on safe and comfortable walking. This addition is merged into criteria which include distances measured towards for example facilities or transport locations. The criteria now state that all distances to locations should be measured as a safe and comfortable walking distance, accessible for everyone.

The findings of the systematic literature review and the outcomes of the experiment are combined in an ESG assessment instrument designed for assessing the sustainability level of real estate assets. The instrument aims to provide a structured framework that categorizes project information into environmental, social, and governance dimensions, offering a comprehensive and adaptable evaluation for all building types. By suggesting its alignment with the articles of the SFDR and integrating clear, detailed metrics, the instrument enhances transparency. The study suggests the use of a uniform scoring approach, which makes it easier to compare different project types and understand their sustainability impact. Additionally, this systematic approach not only promotes clarity and consistency in sustainability assessments but also helps mitigate the risks of greenwashing and helps mitigate the risks associated with greenwashing.

To validate the ESG assessment instrument, two primary case studies and two additional ones were conducted. In the primary case studies, five participants assessed a logistic building and a residential building using the instrument developed in this study. The results showed consistent ESG scores, demonstrating its inter-rater reliability. Expert feedback affirmed the instrument's face validity, and the comparison with BREEAM ratings suggested its concurrent validity, showing its practical viability and alignment with recognized sustainability standards. For further evaluation, the instrument was tested on two additional projects at the extremes of sustainability: an office building with a low BREEAM score and a renovated office building with a high BREEAM score. These tests further confirmed the instrument’s effectiveness, as its ESG scores closely matched the BREEAM ratings.

In conclusion, the development of the ESG assessment instrument represents a significant advancement in the field of real estate sustainability. It provides a much-needed, standardized approach to implementing ESG principles, and suggests a clear focus on clarifying SFDR article definitions. This enhancement in transparency and consistency is pivotal for investors, aiding in more accurate and reliable sustainability evaluations. The instrument's structured data collection and scoring system align closely with regulatory frameworks, offering a streamlined process that mitigates the risk of greenwashing. The study's contributions extend beyond immediate practical applications; they set a foundation for future research and improvements in ESG assessments, potentially influencing both Dutch and international standards. This instrument is a crucial step towards a more sustainable real estate sector, supporting broader climate goals and regulatory compliance efforts.

6.2 Limitations and recommendations

The systematic literature of this study resulted in an extensive list of criteria which should be taken into account when assessing a building on its sustainability performance. These selected criteria are merged into different categories. Within these categories, several criteria are merged into one criterion to keep the experiment from becoming too long, while maintaining a valid research design. This means that there could be a loss of information when combining criteria. Furthermore, the study focused particularly on recent literature, which means that relevant information in studies outside the range of publication date is not included. Moreover, the study is tailored to the Netherlands by using its policies and regulations. This should be taken into account when implementing or using the results of the study. Further research might look at the use of international regulations during the development of an ESG assessment instrument. Where on the other hand, international standards could be derived from the results of this study by using its outcomes as a first suggestion.

Next, the study performed a Best-Worst experiment where it is found that the respondents are relatively young and have a limited amount of experience. This should be taken into account when using the results of the study as it might have influenced the outcomes of the experiment. Moreover, one could argue that experts within the built environment are not the ideal target group for this study, where policy makers might be a more suitable target group as they are experienced in formulating sustainability guidelines and standards. Besides this, a larger sample size could increase the flexibility in selecting experimental methods and designs. With more respondents, it becomes feasible to use more advanced statistical techniques, which can allow for a comprehensive comparison of criteria across different dimensions. Instead of only comparing criteria within the same category—such as Environmental (E), Social (S), or Governance (G)—other experimental designs might enable the comparison of criteria between these categories. This broader analysis provides deeper insights into the relative importance and interactions of ESG factors, enhancing the robustness of the assessment.

After defining the criteria and performing the Best-Worst experiment, a case study is performed to test the reliability and validity of the developed ESG assessment instrument. This case study used two different real estate projects within the Netherlands, one logistic project and one residential project, both assessed by five professionals in the working field. As the two initial case studies both showed average scores, two additional cases are assessed by the researcher to explore the impact of projects with significantly high or low BREEAM scores. The aim of the additional cases was to further verify the assessment instrument's performance across extreme ends of the sustainability spectrum. As PVM did not have projects available which could verify the instruments performance across the extreme ends of the sustainability spectrum, the additional cases were gathered from the BREEAM database. This resulted in limited available information, necessitating the making of estimations based on available knowledge and online project details. Furthermore, the experiment only included a limited number of participants and projects. Both can be increased to improve the robustness of the outcomes of the experiment. Finally, the additional cases are not assessed by the participants, giving no possibilities to use these results for reliability and validity checks as well.

During the case study, the reliability of the ESG assessment instrument is checked to show its suitability for implementation into the practical field. The reliability check should indicate that the instrument measures consistently, meaning that it will get similar results each time a specific project is tested. Within this study, the inter-rater reliability of the instrument is tested to show its consistency when one project is assessed by multiple assessors. The results of the case studies showed remarkable consistency in the scores of the projects generated by the five participants. The limited variations indicate that the tool reliably produces consistent results, regardless of who is conducting the assessment. To further test the reliability of the instrument, the profiles of the participants could be varied slightly to see whether these differences, for example in job type, would influence the comparability of the outcomes. Moreover, the amount of projects and participants could be increased to further support the suggested reliability of the instrument.

Besides the reliability, the validity of the instrument is checked to be sure that the ESG assessment instrument is accurately measuring the thing it should measure. This study focused on two different types of validity: face validity and concurrent validity. First, the face validity included a subjective judgement of whether the instrument is a good measure or not. This is done by collecting expert feedback on the outcomes of the ESG assessment instrument after they assessed a project. A limitation of this study could be that there is limited experience with ESG among the participants as well as their diverse level of experience within the practical field. This could limit the trustworthiness of their judgements which should be taken into account when deciding on the instrument's validity. Furthermore, including a larger number of participants in the case study would lead to more representative and robust findings, reducing the impact of outliers and individual biases.

The study also included a check on the concurrent validity of the instrument. Concurrent validity checks if other tools or assessments give similar results compared to the outcomes of the ESG assessment instrument developed. Within this study, BREEAM is used as the comparable assessment as it is a widely known and recognized method within the real estate sector. However, as BREEAM is not an assessment method with a focus on ESG criteria specifically, its ability to function as a comparable assessment could be limited. It should be noted that BREEAM does include similar criteria which are located within the Environmental, Social and Governance parts of the developed instrument, indicating that there is a slight overlap. Moreover, calculation methods or utility scores used in the BREEAM assessment are not fully comparable with the methods and utility scores of the developed instrument. The above mentioned limitations could lead to misleading differences or similarities in the outcomes of the assessments. Results may appear comparable or non-comparable not because of actual differences in the data, but because of the distinct processes used to analyze them. Despite the limitations, BREEAM was used to assess the concurrent validity. As this study is first in developing an ESG assessment instrument, there were no comparable ESG assessment instruments available. Using BREEAM provides a necessary benchmark to evaluate the instrument's performance, even though it may not be ideally comparable. This approach allows to establish a preliminary understanding of how well the instrument aligns with current standards and practices.

Finally, the study looked into the potential to clarify SFDR definitions by using the developed ESG assessment instrument. The study used the labeling system of BREEAM as it is defined as a widely recognized framework for assessing the sustainability performance of buildings across Europe. However, as described above, Using BREEAM as a starting point for creating the benchmarks of the ESG assessment instrument related to the SFDR articles may contain limitations. It should be considered that again, there exists a notable difference in both assessment instruments which potentially influences the comparison of the outcomes. Moreover, the suggested benchmarks for the three SFDR articles should be critically reviewed and further defined.

Zooming out to the main focus of this study, aiming to create a uniform, and integral ESG assessment instrument for investments in real estate projects in the Netherlands by defining a clear framework to assess real estate assets on their sustainability performance and thereby also supporting the clarification of the articles within SFDR. The study suggests that further research might look detailed into the large amount of criteria selected in the literature review. This elaboration should result in more detailed information on the individual criteria, their definition and calculation methods. This also enables the possibility to closely look detailed into the minimum requirements of the criteria. Gathering more insights into the criteria will further improve the quality of the instrument, resulting in outcomes better representing the actual sustainability of real estate assets and thereby also preventing the occurrence of greenwashing.

Furthermore, the study would suggest future research to look into the inclusion of building users of the assessed building in the ESG assessment instrument. As this study primarily focused on the asset level, it limited its focus on the possible effect of building users. The study wants to highlight that a sustainable building should also be used for sustainable activities. For example, a sustainable building only supports the climate goals by also including sustainable users. This means that polluting activities hosted in sustainable buildings might influence the total ESG score of an asset. To get more insights into this relation and its effect, future research should elaborate on a possible inclusion of building users in an ESG assessment instrument.

To conclude, this study offered a clear framework to evaluate the sustainability performance of real estate assets and thereby also elaborated on the clarification of the SFDR article definitions. It recommenders developing an ESG assessment consisting of a simple input section and a clear output interface as it supports the transparency and consistency of ESG and SFDR assessments and thereby prevents greenwashing, relating to a better contribution to the climate goals.

6.3 Implications for the industry

The ESG assessment instrument developed in this study offers a robust and comprehensive tool for evaluating the sustainability level of real estate assets in the practical field. It is built on systematic literature review and validated through case studies, demonstrating its reliability and validity. One of its key strengths is its reduction of subjective biases, ensuring that the variations in outcomes are minimized and that the ESG scores remain stable despite minor differences in input data.

By utilizing this instrument, investors and real estate owners can assess both new and existing buildings to identify their strengths and weaknesses in terms of Environmental, Social, and Governance performance. For those managing or owning multiple properties, the instrument provides an initial suggestion of how their assets or funds align with the Sustainable Finance Disclosure Regulation (SFDR) articles. Furthermore, this instrument's design enables meaningful comparisons across different assets by suggesting a uniform methodology which can be used for multiple types of real estate. This approach can prevent inconsistencies like those highlighted in the Tesla example discussed in the study's introduction, where varied assessment methods lead to incomparable outcomes.

The findings and insights from this research could have significant implications for policies and regulatory frameworks as they can guide governmental bodies in establishing future guidelines or regulations on sustainable investments and developments. The study also suggests the implication of a single, mandatory ESG assessment method to standardize the evaluation process across all assets. This uniformity would enhance the comparability of ESG scores and facilitate more transparent and equitable assessments, eventually minimizing the occurrence of greenwashing.

Moreover, the outcomes of this research could assist the European Union in refining the concept of ESG into a more precise and actionable framework. The study could serve as a foundational reference for creating clear definitions and standards in sustainable development, for example by further defining the SFDR articles. Future research should further elaborate on the specific criteria and requirements within the ESG assessment instrument. However, the study already underscores the potential for this instrument to contribute to the establishment of a mandatory minimum ESG score, promoting a more consistent and fair assessment of sustainability across the real estate sector.

Overall, the study supports the move towards standardized and transparent assessments in the industry, aligning closely with global sustainability goals and regulatory expectations. By providing a clear and consistent framework, it empowers stakeholders to make more informed decisions and encourages the development of a more sustainable built environment. The instrument's comprehensive coverage and methodical approach ensures that it can serve as a reliable foundation for future advancements in ESG and SFDR evaluations and contribute significantly to sustainable development initiatives.

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Appendix A

Below describes the queries used in the systematic literature review for Scopus and Web of Science. Two pairs of search queries are used, one focusing on ESG (Equation 1 and Equation 2) and one focusing on sustainable building assessments (Equation 3 and Equation 4). Each pair consists out of two search queries, one for Scopus and one for Web of Science. Due to different input requirements, the queries are slightly different for the two databases.

Equation 1: Search query for Scopus, focusing on ESG

((TITLE-ABS-KEY ("ESG") AND TITLE-ABS-KEY ("social" OR "environment" OR "governance") AND TITLE-ABS-KEY ("assessment*" OR "evaluat*") AND TITLE-ABS-KEY ("asset*" OR "build*" OR "built asset*" OR "built environment" OR "real estate" OR "construct*")) AND LANGUAGE (English)) AND PUBYEAR > 2018 AND PUBYEAR < 2024*

Equation 2: Search query for Web of Science, focusing on ESG

(((TS=(ESG)) AND TS=(social OR environment OR governance) AND TS=(assessment* OR evaluat*) AND TS=(asset* OR build* OR "built asset*" OR "built environment" OR "real estate" OR construct*)) AND LA=(English)) AND PY=(2019-2023)*

Equation 3: Search query for Scopus, focusing on sustainable building assessments

TITLE-ABS-KEY (social OR environment OR governance) AND TITLE-ABS-KEY ("sustainability indicator" OR "sustainability aspect*" OR "sustainability criteria" OR "sustainability measurement*") AND TITLE-ABS-KEY (assessment* OR evaluat*) AND TITLE-ABS-KEY ("asset*" OR "build*" OR "built asset*" OR "built environment" OR "real estate" OR "construct*") AND PUBYEAR > 2018 AND PUBYEAR < 2024 AND (LIMIT-TO (LANGUAGE , "English"))*

Equation 4: Search query for Web of Science, focusing on sustainable building assessments

TS=(social OR environment OR governance) AND TS=("sustainability indicator" OR "sustainability aspect*" OR "sustainability criteria" OR "sustainability measurement*") AND TS=(assessment* OR evaluat*) AND TS=("asset*" OR "building*" OR "built asset*" OR "built environment" OR "real estate" OR "construct*") AND PY=(2019-2023) AND LA=(English)*

Appendix B

The table below shows an overview of all the 52 selected papers, included in the systematic literature. This table includes the author, title, and the publication year.

Table 50: Overview of literature used in systematic literature review

Author	Title	Year
	ESG in real estate	
Castro et al.	Holistic Approach to the sustainable commercial property business: analysis of the main existing sustainability certifications	2020
Hayashi et al.	CASBEE-Wellness Office: An objective measure of the building potential for a healthily built environment	2021
F. Battisti	SDGs and ESG criteria in housing: defining local evaluation criteria and indicators for verifying project sustainability using Florence Metropolitan Area as a case study	2023
Morgante et al.	How to invest in the ''Market of Sustainability'': evaluating the impacts of a real estate investment across ESG criteria	2023
Newell et al.	Improving the benchmarking of ESG in real estate investment	2023
G. Paganin	Sustainable finance and the construction industry: new paradigms for design development	2021
Verstina et al.	A new approach to assessing the energy efficiency of industrial facilities	2022
Kempeneer et al.	Bringing the user back in the building: An analysis of ESG in real estate and a behavioral framework to guide future research	2021
	Sustainable building assessment	
Costa et al.	Methodology to Identify and Prioritize the Sustainability Aspects to Be Considered in the Design of Brazilian Healthcare Buildings	2023
Alhilli et al.	Developing a system for assessing the sustainability in school building projects	2021
Montalbán-Domingo et al.	Study of social and environmental needs for the selection of sustainable criteria in the procurement of public works	2020
Díaz López et al.	A comparative analysis of sustainable building assessment methods	2019
Mohammed A.B.	Sustainable design strategy optimizing green architecture path based on sustainability	2021
Braulio-Gonzalo et al.	Relationship between green public procurement criteria and sustainability assessment tools applied to office buildings	2020
Burdová et al.	Evaluation of family houses in Slovakia using a building environmental assessment system	2020
Olukoya et al.	Assessing the social sustainability indicators in vernacular architecture—application of a green building assessment approach	2020
Tupenaite et al.	Sustainability assessment of modern high-rise timber buildings	2021
Velázquez Robles et al.	Environmental performance assessment: A comparison and improvement of three existing social housing projects	2022
Arukala et al.	Evaluation of Sustainable Performance Indicators for the Built Environment Using AHP Approach	2019
Stender et al.	The role of social sustainability in building assessment	2019
Lazar et al.	Evaluation of sustainability criteria for residential buildings of tropical climate: The stakeholder perspective	2021
Adamec et al.	How to measure sustainable housing: A proposal for an indicator-based assessment tool	2021
Qtaishat et al.	Eco-Cultural Design Assessment Framework and Tool for Sustainable Housing Schemes	2020
Rivai et al.	Assessment of social sustainability performance for residential building	2023
Zulkefli et al.	Preliminary review of sustainability indicators to greening existing building based on lcsa components	2020
Karji et al.	Assessment of Social Sustainability Indicators in Mass Housing Construction: A Case Study of Mehr Housing Project	2019
Fatourehchi et al.	Social sustainability assessment framework for managing sustainable construction in residential buildings	2020
Jagatramka et al.	Sustainability Indicators for Vernacular Architecture in India	2020
Olawumi et al.	Application of generalized Choquet fuzzy integral method in the sustainability rating of green buildings based on the BSAM scheme	2020
Sharif A.A.	A framework for social sustainability on the building level: a contextual approach	2023
Huedo Dorda et al.	Analysis of sustainable building rating systems in relation to CEN/TC 350 standards	2019
Ameen et al.	Urban sustainability assessment framework development: The ranking and weighting of sustainability indicators using analytic hierarchy process	2019
Olakitan Atanda J.	Developing a social sustainability assessment framework	2019
Jalilibal et al.	A Hybrid Grounded Theory, Fuzzy DEMATEL and ISM Method for Assessment of Sustainability Criteria for Project Portfolio Selection Problems	2022

Hussain et al.	Sustainability assessment for construction projects: A cost-sustainability tradeoff approach	2023
Maleki et al.	Sustainability assessment in residential high-rise building design: state of the art	2022
Mohsen et al.	Exploring the Interior Designers' Attitudes toward Sustainable Interior Design Practices: The Case of Jordan	2023
Francis et al.	A framework for dynamic life cycle sustainability assessment and policy analysis of built environment through a system dynamics approach	2022
Robling et al.	Measuring sustainability at farm level – A critical view on data and indicators	2023
Rodríguez J.F.F.	Sustainable Design Protocol in BIM Environments: Case Study of 3D Virtual Models of a Building in Seville (Spain) Based on BREEAM Method	2023
Braulio-Gonzalo et al.	How are indicators in Green Building Rating Systems addressing sustainability dimensions and life cycle frameworks in residential buildings?	2022
Ghaleb et al.	Assessing the impact of maintenance practices on asset's sustainability	2022
Khanapure et al.	A sustainability assessment framework for high-rise residential projects: a case of India	2023
Agyekum et al.	Environmental performance indicators for assessing sustainability of projects in the Ghanaian construction industry	2022
Khan, et al.	A Framework for Developing Green Building Rating Tools Based on Pakistan's Local Context	2021
Akcali, et al.	The Pentagon Model of Urban Social Sustainability: An Assessment of Sociospatial Aspects, Comparing Two Neighborhoods	2022
Chen, et al.	Integrating Sustainability and Users' Demands in the Retrofit of a University Campus in China	2022
Amoako Sarponget al.	Establishing the Economic Sustainability Criteria for Assessing Tenders in the Procurement of Building Works	2023
Salati et al.	Sustainability Assessment on an Urban Scale: Context, Challenges, and Most Relevant Indicators	2022
Jafari et al.	Identification of Social Sustainability Criteria in Building Energy Retrofit Projects	2019
Yuan et al.	Examining sustainability indicators of space management in elderly Facilities—a case study in China	2019
Yadegaridehkordi, et al.	Moving towards green university: a method of analysis based on multi-criteria decision-making approach to assess sustainability indicators	2022

Appendix C

Table 51: Overview criteria 'Environment'

Categories	Criteria	Definition
Waste Management	Reduce waste on construction site	Include measures and solutions to reduce the waste on the construction site.
	Incorporate waste sorting and management	Include measures and solutions to facilitate separate waste collection. For example a space destined for recycling containers, differentiating organic waste, packaging, and paper.
Water Management	Reduce Water consumption	Reduce the amount of water used in the building by including water efficient components, water recycling systems, and monitoring the water usage with technology.
	Protect groundwater	Include measures to minimize the negative impact on ground water such as a groundwater investigation and dewatering or plumping plan.
	Reuse water	Include rainwater tanks in the project and in case of apartments, integrate the paved surfaces to the tanks (for example parking lots are used). Also, integrate a graywater system.
Energy Efficiency	Reduce energy consumption	Include measure to promote the building's energy efficiency by implementing energy efficient building solutions, systems, and equipment such as solar panels, suitable energy labels and EPC scores and thereby saving energy costs.
	Reduce carbon emissions	Measuring the CO2 emissions and consumption of the building.
	Use renewable energy sources	Use of energy from renewable sources such as solar panels.
Environment Protection	Reduce pollution on the construction site	Include measures to reduce of inconvenience derived from the construction site, such as noise control systems or measures against dust.
	Protection of the soil	Protect the soil from pollution of physical and chemical environmental stressors and prove this by including soil investigation reports.
Site Selection	Careful site selection	Site of the project is carefully selected, greenfield or brownfield, but preferably brownfield. Try to keep non-urban lands.
	Protect cultural aspects	Protect the identity, landscape and cultural identity of the area. Cultural heritage is not used for the generation of renewable energy.
Biodiversity and Greenery	Enhance biodiversity	Creating, maintaining, and increasing biodiversity both on building plots themselves and in their environment.
	Include greenery	Greenery should be included in the project and plot to for example minimize the Urban Heat Island Effect.
Indoor environment	Optimize indoor air quality	Provide healthy indoor air quality through the specification and installation of appropriate ventilation, equipment, and finishes.
	Optimize lighting quality	Include appropriate levels of daylight but minimize discomfort due to brightness from natural light.
Material use	Use sustainable materials	Use environmentally friendly materials, reuse existing materials, buildings, or construction waste, and use local and certified materials.
Design	Include building life cycle assessment	Measure the environmental impact of the materials used over the full life cycle of the building by using a Life Cycle Assessment, showing that the building has a good lifecycle performance.
	Optimize for simplified maintenance	All technology, installations and other aspects must be easily accessible for maintenance.
	Include mixed building functions	Include different functions in the building (such as commercial spaces, office spaces, residential spaces, etc.).

	Flexibility of the building layout	The building is flexible which means that there is possibility to change function or layout of the building.
	Optimize the quality of the building envelope	A well-planned building envelope which means that the exterior walls, roof, foundation, windows, and doors are of good quality with appropriate insulation levels.
Transport facilities	Provide bicycle parking facilities	The project provides sufficient amount of safe and accessible bicycle parking facilities within the areas of the building. However, too many parking places will have a negative effect on the score.
	Provide car parking facilities	The project provides sufficient amount of car parking facilities, but keeping in mind a maximum parking capacity which should not be exceeded.
	Include electric vehicle charging stations	The project supports the use of green mobility by offering electric-vehicle-charging stations.
	Proximity to transport facilities	The proximity of the project to transport facilities (such as road networks and public transport facilities) within a radius of 15 min. (considering an average speed of 5 km/h)

Table 52: Overview criteria 'Social'

Categories	Criteria	Definition
Health	Promote active living	Encouraging active living by the provision and design of activity-programmed spaces like exercise rooms, swimming pools, or multi-purpose rooms that could be designed as venues for physical activity.
	Optimize visual comfort for occupants	Ensure best practice in visual performance and comfort for building occupants, the design is considering daylight aspects as well as providing a pleasant view outside.
	Optimize thermal comfort of the building	Ensure that the indoor temperature of the building is pleasant and comfortable.
	Optimize acoustic comfort of the building	Ensure the building's acoustic performance meets the appropriate standards, including measures for noise protection.
Community	Presence of community spaces	The project should provide a place to meet, debate and socialize. This could be a common/shared space or room, a garden or play area.
	Presence of public spaces	The project includes external and internal surfaces prepared for public use.
	Encourage building occupant engagement	The project aims to gather building occupants into the decision-making process and thereby increasing their support.
Inclusion	Accessibility for people with disabilities	The project should be accessible to everyone and without restrictions on its use, whatever their personal situation. For example by including disabled signage.
	Provide diverse housing options	The project should offer a diverse range of housing options, varying in size and price, suitable for different target groups.
Safety	Safety of the building and surroundings	Building and area should be safe and secured by using safety measures and equipment such as cameras or alarm systems.
	Safety conditions on construction site	The company should specify how occupational health and safety risks are identified and managed to prevent incidents, injuries, or deaths in the workplace.
Affordability	Provide affordable housing	The project should offer enough affordable housing.
Accessibility	Proximity to public transport	The distance measured from the project to the nearest stop of each local public transport line.
	Proximity of primary services and amenities	The distance from the project towards primary services and amenities such as grocery stores and schools.

Table 53: Overview criteria 'Governance'

Categories	Criteria	Definition
Innovation	Use of technology and digital tools	Use technology and digital tools such as innovative design software (BIM, digital twin technologies), but also Environmental Management Systems (EMS), and technologies for remote control of the building.
Management	Facilitate stakeholder engagement	Facilitate stakeholder engagement by including them in consultation and participation processes, leading to better-informed and more sustainable outcomes.
	Avoidance of forced or compulsory labor	Ensure good work practices with adequate remuneration. It is expected to prevent and combat all forms of forced or compulsory labor within its activities, being essential to avoid contributing to or becoming linked to the use of forced or compulsory labor through its relationships with suppliers, clients, etc.
Documentation	Presence of technical documentation	Technical and maintenance documentation of the building should be available.
	Ensure commissioning and handover procedures	The project aims a properly planned handover and commissioning process, which ensures the building systematic operation and reflect the needs of the building occupants
Certification	Compliance with regulations and policies	The building has obtained environmental certifications and is in line with environmental regulations and planning policies.
	Presence of certifications of technological systems	Technological systems in the building should have sustainability certifications, such as the HVAC or lighting systems.
	Compliance with sustainability certifications	The project must demonstrate compliance with sustainability certifications such as LEED, BREEAM, etc.
Finance	Cost effectiveness of the project	Measuring the actual vs the planned costs regarding the construction, operation, or maintenance of the project.
Economic	Create direct and indirect jobs	The number of direct and indirect jobs following the from the project.
	Support local economy	The project is hiring local goods and services and uses local employment.

Appendix D

Table 54: Overview of the 17 SDGs and the selected criteria related to it.

SDGs	Criteria	Explanation
1. No Poverty	Provide affordable housing	Directly addresses housing affordability, which is critical in reducing poverty.
	Create direct and indirect jobs	Employment opportunities can alleviate poverty.
2. Zero Hunger	Support local economy	Promoting local economies can enhance food security and access
	Proximity of primary services and amenities	Ensures access to local food markets, contributing to food security.
3. Good Health and Well-being	Optimize indoor air quality	Improves the health of the indoor environment and thereby also the health of occupants.
	Optimize thermal and acoustic comfort of the building	Enhances good living and working conditions, and thereby ensures the health and wellbeing of occupants.
	Ensure the safety of the building and its surroundings	Critical for occupant safety and well-being.
	Optimize lighting quality	Affects mental and physical health positively.
	Promote active living	Encourages physical activity, improving health outcomes.
4. Quality Education	Proximity to primary services and amenities	Includes access to educational facilities.
5. Gender Equality	-	-
6. Clean Water and Sanitation	Reduce water consumption	Ensures sustainable water use.
	Protect groundwater	Prevents contamination and preserves water resources.
7. Affordable and Clean Energy	Use renewable energy	Directly promotes clean energy use.
	Include electric-vehicle-charging stations	Supports the transition to clean energy for transportation.
8. Decent Work and Economic Growth	Create direct and indirect jobs	Contributes to economic growth and employment.
	Support local economy	Strengthens economic resilience and growth.
	Cost-effectiveness of the project	Ensures economic viability and supports local job markets.
9. Industry, Innovation, and Infrastructure	Use of technology and digital tools	Promotes innovative practices in building management.
10. Reduced Inequality	Provide diverse housing options	Addresses housing inequality.
	Proximity of primary services and amenities	Ensures equitable access to essential services.
	Proximity to public transport	Enhances accessibility and mobility for all.
	Accessibility for people with disabilities	Promotes inclusive environments benefiting all occupants.
11. Sustainable Cities and Communities	Careful building site selection	Promotes sustainable urban development.
	Protect cultural aspects	Preserves cultural heritage and community identity.
	Presence of community- and public spaces	Encourages community cohesion and social interaction.
12. Responsible Consumption and Production	Use sustainable materials	Reduces environmental impact through responsible sourcing.
	Ensure good lifecycle performance with an LCA	Promotes sustainable production and consumption practices.

13. Climate Action	Incorporate waste sorting and management	Encourages recycling and waste reduction.
	Reduce pollution on construction site	Minimizes environmental impact during construction.
	Include greenery	Mitigates climate change impacts and enhances environmental quality.
	Enhance biodiversity	Supports ecosystems and resilience against climate change.
14. Life Below Water	Protect groundwater	Maintains clean water sources, indirectly benefiting aquatic ecosystems.
15. Life on Land	Enhance biodiversity	Protects and restores terrestrial ecosystems.
	Protect the soil	Prevents soil degradation and promotes land health.
	Include greenery	Supports biodiversity and enhances ecological value.
16. Peace, Justice, and Strong Institutions	Compliance with regulations and policies	Ensures adherence to fair and just standards.
	Avoidance of forced or compulsory labor	Promotes human rights and fair labor practices.
	Facilitate stakeholder engagement	Encourages inclusive decision-making and governance.
17. Partnerships for the Goals	Compliance with sustainability certifications	Encourages collaboration for sustainable development.
	Presence of technical documentation	Supports transparency and shared knowledge.
	Presence of certifications of technological systems	Promotes standardized and collaborative approaches to sustainability.

Appendix E

Importance of sustainability criteria in ESG for assessing real estate investments.

Question 1a

Which category below includes your age?

- ☐ < 28
- ☐ 28 – 44
- ☐ 45 – 60
- ☐ > 60
- ☐ I don’t want to say

Question 1b

What is your gender?

- ☐ Female
- ☐ Male
- ☐ Other

Question 1c

What type of company are you working?

- ☐ Architectural firm
- ☐ Construction company / contractor
- ☐ building consultancy
- ☐ Engineering firm
- ☐ Real estate agent
- ☐ Research institution
- ☐ Developer
- ☐ Project/construction management
- ☐ Urban planning office
- ☐ Real estate consultancy
- ☐ Housing association
- ☐ Other: …

Question 1d

What is the size of the company you are working?

- ☐ Micro (≤ 10 employees)
- ☐ Small (≤ 50 employees)
- ☐ Medium (≤ 250 employees)
- ☐ Large (> 250 employees)

Question 1e

What is your **primary** job responsibility?

- ☐ Contractor
- ☐ Architect
- ☐ Building consultant
- ☐ Building inspector
- ☐ Architectural drafter
- ☐ Structural engineer
- ☐ Engineer
- ☐ Real estate agent
- ☐ Researcher
- ☐ Project manager
- ☐ Urban planner
- ☐ Real estate advisor
- ☐ Developer
- ☐ Other: …

Question 1f

How many years of experience do you have in the position you filled in the previous question?

- ☐ < 5 years
- ☐ 5 – 10 years
- ☐ 11 – 25 years
- ☐ > 25 years

PART 1 – ENVIRONMENT

Question 2a:

Most Important	Criteria	Least Important
	Reduce pollution on construction site	
	Protect cultural aspects	
	Optimize indoor air quality	
	Optimize lighting quality	
	Provide bicycle parking facilities	

Question 2b:

Most Important	Criteria	Least Important
	Reduce water consumption	
	Optimize design for simplified maintenance	
	Flexibility of the building	
	Provide bicycle parking facilities	
	Ensure good lifecycle performance with a LCA	

Question 2c:

Most Important	Criteria	Least Important
	Protect groundwater	
	Enhance biodiversity	
	Optimize lighting quality	
	Optimize design for simplified maintenance	
	Optimize quality of the building envelope	

Question 2d:

Most Important	Criteria	Least Important
	Reduce water consumption	
	Use renewable energy	
	Protect the soil	
	Careful building site selection	
	Optimize lighting quality	

Question 2e:

Most Important	Criteria	Least Important
	Incorporate waste sorting and management	
	Use renewable energy	
	Enhance biodiversity	
	Include mixed building functions	
	Provide bicycle parking facilities	

Question 2f:

Most Important	Criteria	Least Important
	Incorporate waste sorting and management	
	Protect the soil	
	Protect cultural aspects	
	Optimize design for simplified maintenance	
	Provide car parking facilities	

Question 2g:

Most Important	Criteria	Least Important
	Protect groundwater	
	Protect the soil	
	Optimize indoor air quality	
	Include mixed building functions	
	Flexibility of the building	

Question 2h:

Most Important	Criteria	Least Important
	Incorporate waste sorting and management	
	Reduce water consumption	
	Protect groundwater	
	Reduce pollution on construction site	
	Include greenery	

Question 2i:

Most Important	Criteria	Least Important
	Use renewable energy	
	Include greenery	
	Optimize indoor air quality	
	Optimize design for simplified maintenance	
	Include electric-vehicle-charging stations	

Question 2j:

Most Important	Criteria	Least Important
	Reduce water consumption	
	Enhance biodiversity	
	Optimize indoor air quality	
	Use sustainable materials	
	Provide car parking facilities	

Question 2k:

Most Important	Criteria	Least Important
	Careful building site selection	
	Protect cultural aspects	
	Enhance biodiversity	
	Include greenery	
	Flexibility of the building	

Question 2l:

Most Important	Criteria	Least Important
	Reduce water consumption	
	Protect cultural aspects	
	Include mixed building functions	
	Optimize quality of the building envelope	
	Include electric-vehicle-charging stations	

Question 2m:

Most Important	Criteria	Least Important
	Incorporate waste sorting and management	
	Optimize lighting quality	
	Use sustainable materials	
	Flexibility of the building	
	Include electric-vehicle-charging stations	

Question 2n:

Most Important	Criteria	Least Important
	Include greenery	
	Optimize lighting quality	
	Include mixed building functions	
	Provide car parking facilities	
	Ensure good lifecycle performance with a LCA	

Question 2o:

Most Important	Criteria	Least Important
	Protect the soil	
	Include greenery	
	Use sustainable materials	
	Optimize quality of the building envelope	
	Provide bicycle parking facilities	

Question 2p:

Most Important	Criteria	Least Important
	Protect groundwater	
	Use renewable energy	
	Protect cultural aspects	
	Use sustainable materials	
	Ensure good lifecycle performance with an LCA	

Question 2q:

Most Important	Criteria	Least Important
	Incorporate waste sorting and management	
	Careful building site selection	
	Optimize indoor air quality	
	Optimize quality of the building envelope	
	Ensure good lifecycle performance with an LCA	

Question 2r:

Most Important	Criteria	Least Important
	Reduce pollution on construction site	
	Careful building site selection	
	Use sustainable materials	
	Optimize design for simplified maintenance	
	Include mixed building functions	

Question 2s:

Most Important	Criteria	Least Important
	Use renewable energy	
	Reduce pollution on construction site	
	Flexibility of the building	
	Optimize quality of the building envelope	
	Provide car parking facilities	

Question 2t:

Most Important	Criteria	Least Important
	Protect groundwater	
	Careful building site selection	
	Provide bicycle parking facilities	
	Provide car parking facilities	
	Include electric-vehicle-charging stations	

Question 2u:

Most Important	Criteria	Least Important
	Reduce pollution on construction site	
	Protect the soil	
	Enhance biodiversity	
	Include electric-vehicle-charging stations	
	Ensure good lifecycle performance with an LCA	

Question 2v:

Do you want to remove a criterion from the given list above, if yes, which one?

- ☐ No
- ☐ Yes, …

Question 2w:

Do you want to add a criterion to the given list above, if yes, which one?

- ☐ No
- ☐ Yes, …

PART 2 – SOCIAL

Question 3a:

Most important	Criteria	Least important
	Promote active living	
	Optimize visual comfort for occupants	
	Encourage building occupant engagement	
	Accessibility for people with disabilities	
	Provide diverse housing options	

Question 3b:

Most important	Criteria	Least important
	Promote active living	
	Optimize thermal and acoustic comfort of the building	
	Provide diverse housing options	
	Provide affordable housing	
	Proximity of primary services and amenities	

Question 3c:

Most important	Criteria	Least important
	Presence of community- and public spaces	
	Accessibility for people with disabilities	
	Provide diverse housing options	
	Proximity to public transport	
	Proximity of primary services and amenities	

Question 3d:

Most important	Criteria	Least important
	Promote active living	
	Encourage building occupant engagement	
	Ensure the safety of the building and its surroundings	
	Proximity to public transport	
	Proximity of primary services and amenities	

Question 3e:

Most important	Criteria	Least important
	Promote active living	
	Optimize visual comfort for occupants	
	Optimize thermal and acoustic comfort of the building	
	Presence of community- and public spaces	
	Proximity to public transport	

Question 3f:

Most important	Criteria	Least important
	Promote active living	
	Presence of community- and public spaces	
	Encourage building occupant engagement	
	Ensure the safety of the building and its surroundings	
	Provide affordable housing	

Question 3g:

Most important	Criteria	Least important
	Optimize visual comfort for occupants	
	Optimize thermal and acoustic comfort of the building	
	Accessibility for people with disabilities	
	Ensure the safety of the building and its surroundings	
	Proximity of primary services and amenities	

Question 3h:

Most important	Criteria	Least important
	Optimize thermal and acoustic comfort of the building	
	Encourage building occupant engagement	
	Accessibility for people with disabilities	
	Provide affordable housing	
	Proximity to public transport	

Question 3i:

Most important	Criteria	Least important
	Optimize visual comfort for occupants	
	Provide diverse housing options	
	Ensure the safety of the building and its surroundings	
	Provide affordable housing	
	Proximity to public transport	

Question 3j:

Most important	Criteria	Least important
	Optimize visual comfort for occupants	
	Presence of community- and public spaces	
	Encourage building occupant engagement	
	Provide affordable housing	
	Proximity of primary services and amenities	

Question 3k:

Most important	Criteria	Least important
	Optimize thermal and acoustic comfort of the building	
	Presence of community- and public spaces	
	Encourage building occupant engagement	
	Provide diverse housing options	
	Ensure the safety of the building and its surroundings	

Question 3l:

Do you want to remove a criterion from the given list above, if yes, which one?

- ☐ No
- ☐ Yes, …

Question 3m:

Do you want to add a criterion to the given list above, if yes, which one?

- ☐ No
- ☐ Yes, …

PART 3 – GOVERNANCE

Question 4a:

Most important	Criteria	Least important
	Use of technology and digital tools	
	Facilitate stakeholder engagement	
	Ensure commissioning and handover procedures	
	Compliance with regulations and policies	
	Presence of certifications of technological systems	

Question 4b:

Most important	Criteria	Least important
	Use of technology and digital tools	
	Avoidance of forced or compulsory labor	
	Presence of certifications of technological systems	
	Cost effectiveness of the project	
	Support local economy	

Question 4c:

Most important	Criteria	Least important
	Presence of technical documentation	
	Compliance with regulations and policies	
	Presence of certifications of technological systems	
	Create direct and indirect jobs	
	Support local economy	

Question 4d:

Most important	Criteria	Least important
	Use of technology and digital tools	
	Ensure commissioning and handover procedures	
	Compliance with sustainability certifications	
	Create direct and indirect jobs	
	Support local economy	

Question 4e:

Most important	Criteria	Least important
	Use of technology and digital tools	
	Facilitate stakeholder engagement	
	Avoidance of forced or compulsory labor	
	Presence of technical documentation	
	Create direct and indirect jobs	

Question 4f:

Most important	Criteria	Least important
	Use of technology and digital tools	
	Presence of technical documentation	
	Ensure commissioning and handover procedures	
	Compliance with sustainability certifications	
	Cost effectiveness of the project	

Question 4g:

Most important	Criteria	Least important
	Facilitate stakeholder engagement	
	Avoidance of forced or compulsory labor	
	Compliance with regulations and policies	
	Compliance with sustainability certifications	
	Support local economy	

Question 4h:

Most important	Criteria	Least important
	Avoidance of forced or compulsory labor	
	Ensure commissioning and handover procedures	
	Compliance with regulations and policies	
	Cost effectiveness of the project	
	Create direct and indirect jobs	

Question 4i:

Most important	Criteria	Least important
	Facilitate stakeholder engagement	
	Presence of certifications of technological systems	
	Compliance with sustainability certifications	
	Cost effectiveness of the project	
	Create direct and indirect jobs	

Question 4j:

Most important	Criteria	Least important
	Facilitate stakeholder engagement	
	Presence of technical documentation	
	Ensure commissioning and handover procedures	
	Cost effectiveness of the project	
	Support local economy	

Question 4k:

Most important	Criteria	Least important
	Avoidance of forced or compulsory labor	
	Presence of technical documentation	
	Ensure commissioning and handover procedures	
	Presence of certifications of technological systems	
	Compliance with sustainability certifications	

Question 4l:

Do you want to remove a criterion from the given list above, if yes, which one?

- ☐ No
- ☐ Yes, …

Question 4m:

Do you want to add a criterion to the given list above, if yes, which one?

- ☐ No
- ☐ Yes, …

Question 5:

Can you divide 100 points to Environment, Social and Governance where 0 points means ‘least important’ and 100 points means ‘most important.

Environment	*slider from 0 to 100*
Social	*slider from 0 to 100*
Governance	*slider from 0 to 100*

Total: 0
Left: 100

Appendix F

This appendix shows the distribution of the data gathered from the Best-Worst experiment . As a small sample size is analyzed, the Shapiro-Wilk significance is used to see whether data is normally, or non-normally distributed. For Environment, Social and Governance it is found that all data is normally disturbed as the Sig. of the Shapiro-Wilk is > 0.05 (R. G. van den Berg, 2024). The tables including the results can be found below.

Tests of Normality - Environment

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Clogit_E	.138	21	.200*	.970	21	.725
stdBW_E	.144	21	.200*	.969	21	.711

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Tests of Normality – Social

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
coef_S	.171	11	.200*	.942	11	.541
stdBW_S	.183	11	.200*	.948	11	.621

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Tests of Normality - Governance

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
coef_G	.113	11	.200*	.977	11	.948
stdBW_G	.135	11	.200*	.972	11	.903

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Appendix G

Table 55: Final utility scores and points for all ESG criteria

Environment	percentage	Points
Use sustainable materials	13.27%	12.21
Use renewable energy	11.85%	10.90
Ensure good lifecycle performance with an LCA	9.95%	9.16
Careful building site selection	7.80%	7.17
Optimize quality of the building envelope	6.76%	6.21
Flexibility of the building	5.67%	5.21
Protect groundwater	5.23%	4.81
Include greenery	4.88%	4.49
Enhance biodiversity	4.75%	4.37
Protect the soil	4.61%	4.24
Optimize design for simplified maintenance	4.56%	4.20
Optimize indoor air quality	4.01%	3.69
Reduce water consumption	3.29%	3.03
Protect cultural aspects	2.33%	2.14
Include mixed building functions	2.19%	2.01
Provide bicycle parking facilities	2.16%	1.98
Include electric-vehicle-charging stations	1.98%	1.82
Incorporate waste sorting and management	1.79%	1.64
Provide car parking facilities	1.22%	1.12
Optimize lighting quality	1.17%	1.08
Reduce pollution on construction site	0.54%	0.49
Social	**Percentage**	**Points**
Provide affordable housing	19.05%	11.81
Ensure the safety of the building and its surroundings	14.76%	9.15
Optimize thermal and acoustic comfort of the building	13.47%	8.35
Proximity of primary services and amenities	11.15%	6.91
Proximity to public transport	9.26%	5.74
Provide diverse housing options	8.58%	5.32
Accessibility for people with disabilities	8.05%	4.99
Presence of community- and public spaces	4.56%	2.83
Promote active living	4.40%	2.73
Encourage building occupant engagement	3.60%	2.23
Optimize visual comfort for occupants	3.11%	1.93
Governance	**Percentage**	**Points**
Compliance with regulations and policies	19.07%	8.77
Compliance with sustainability certifications	13.70%	6.30
Avoidance of forced or compulsory labor	12.73%	5.85
Cost effectiveness of the project	10.51%	4.83
Facilitate stakeholder engagement	8.38%	3.86
Support local economy	8.06%	3.71
Ensure commissioning and handover procedures	6.94%	3.19
Presence of certifications of technological systems	6.93%	3.19
Presence of technical documentation	5.34%	2.45
Create direct and indirect jobs	4.44%	2.04
Use of technology and digital tools	3.91%	1.80

Appendix H

This Appendix will show the points which can be scored for every criterion of the ESG assessment instrument developed in this study. Starting with the overview of the criteria within Environment, Table 56. Within Environment, a couple of criteria is divided into 0, 2 or 4 points, where 0 points are given if no measures are present, 2 points are given when there is one measure present and 4 points if multiple measures are present. Some criteria only check on one specific aspect which means that the option for multiple is not possible. For these criteria, 0 or 4 points that can be gathered. Furthermore, the criteria which are tested on the amount of measures present start with 0 points if no measures are present and go slightly up to 7 or more measures present for 4 points.

Energy efficiency is the first category which has a different approach, using the input of the amount of kWh/m^2 used in the project and the total % of renewable energy. The steps for fossil energy are defined by looking into the energy labels for dwellings, which state that the minimum for an energy label A is 160 kWh/m^2 (ANWB, 2024), for the remaining steps, the steps taken to get higher energy labels are used as an indication as well. The steps for the energy demand are related to the fossil energy but also take into account the guidelines given for BENG 1 (HBA, 2024).

For biodiversity, the points on the system called 'natuurinclusief bouwen' are used, where a minimum of 20% should be gathered as this is the minimum for a tender process described by Gemeente Amsterdam (2024), the remaining points are divided by going slightly upwards with the percentage. Looking into the percentage of the window areas, the starting point for receiving one point is set at 10% as described in section 3.2.1. The remaining points are going up by 5% for each step as this step size is also used in the BREEAM example.

Material usage has several percentages involved in the calculation, where the MPG score is at least improved by 20% compared to its reference value to receive one point, described in section 3.2.1. The remaining percentages go slightly up with steps of 10%. For the reuse of materials and the local materials, the input from BREEAM is used again as a starting point to set a minimum to the first point which can be given. The remaining points are again slightly increasing the percentage, where the criterion on local materials is increasing less compared to the reused materials as this percentage might be harder to reach as described earlier in the study.

Finally, for the transport facilities, the amount of parking facilities for bikes should at least meet the guidelines for the location to receive 1 point and will increase which means that a project will receive more points if it offers more bicycle parking facilities. The same accounts for the amount of parking facilities with an electric charging station, however, this percentage starts lower as it only indicates a part of the total amount. The amount of car parking facilities should not exceed the guidelines for the location and will receive more points if it offers less parking places.

Table 56: Overview of points per criterion - Environment

Category	Criteria	Definition	Input	Points 0	1	2	3	4
Waste management	Incorporate waste sorting and management	Presence of measures to facilitate separate waste collection	No/Yes/ Multiple	No	-	Yes	-	Multiple
Water Management	Reduce water consumption	Presence of water efficient components, water recycling systems, and/or monitoring systems.	No/Yes/ Multiple	No	-	Yes	-	Multiple
		Presence of rainwater tanks	No/Yes	No	-	-	-	Yes
		Presence of gray water systems	No/Yes	No	-	-	-	Yes
	Protect groundwater	Presence of measures to protect groundwater	No/Yes	No	-	-	-	Yes
Energy efficiency	Use of renewable energy	Energy demand per year	kWh/m2	>150	149- 125	124-100	99- 75	<75
		Primary fossil energy per year	kWh/m2	>160	160- 105	104- 75	74- 50	<50
		% of total energy which is renewable	%	<50%	50%-60%	61%-75%	76%-99%	≥100%
Environmental protection	Reduce pollution on the construction site	Amount of measures present to reduce pollution on the construction site	#	0	1 or 2	3 or 4	5 or 6	≥ 7
	Protect the soil	Presence of measures to protect the soil	No/Yes	No	-	-	-	Yes
Site selection	Careful building site selection	Presence of research done to site selection	No/Yes	No	-	-	-	Yes
	Protect cultural aspects	Amount of measures present to protect cultural aspects	#	0	1 or 2	3 or 4	5 or 6	≥ 7
Biodiversity and Greenery	Enhance biodiversity	Presence of a biodiversity policy plan	No/Yes	No	-	-	-	Yes
	Include greenery	Amount of points 'Natuurinclusief bouwen'	%	< 20%	20%-40%	41%-60%	61%-80%	≥ 81%
Indoor Environment	Optimize indoor air quality	Presence of measures to optimize indoor air quality	No/Yes/ Multiple	No	-	Yes	-	Multiple
	Optimize lighting quality	% window area compared to floor area	%	< 10%	10%-15%	15%-20%	25%-30%	≥ 30%
		Presence of measures to optimize lighting quality	No/Yes/ Multiple	No	-	Yes	-	Multiple
Material Usage	Use sustainable materials	MPG score	%	< 20%	20%-39%	40%-49%	50%-59%	≥ 60%
		% of reused materials	%	< 25%	50%-60%	61%-75%	76%-99%	≥100%
		% of local materials	%	< 20%	20%- 30%	31%-40%	40%-50%	> 50%
		Presence of a sustainable purchasing policy	No/Yes	No	-	-	-	Yes
Design	Ensure good lifecycle performance with an LCA	Presence of an LCA document	No/Yes	No	-	-	-	Yes
	Optimize design for simplified maintenance	Presence of a maintenance document	No/Yes	No	-	-	-	Yes
	Include mixed building functions	Amount of functions in the building	#	≤1	2 or 3	4 or 5	6 or 7	> 7
	Optimize the quality of the building envelope	Rc- values of the building envelope	Value	No	-	Referenc e value	-	Improved

	Flexibility of the building	Presence of flexible design elements	No/Yes	No	-	-	-	Yes
Transport facilities	Provide bicycle parking facilities	Amount of bicycle parking facilities	%	<100%	100%-110%	111%-120%	121%-130%	>130%
	Include electric vehicle charging stations	parking facilities connected to pipeline infrastructure	No/Yes	No	-	-	-	Yes
		Amount of parking facilities with an electric charging station	%	<10%	10 %-15%	15%-20%	25%-30%	≥30%
	Provide car parking facilities	Amount of car parking facilities	%	>120%	120%-116%	115%-111%	110%-100%	≤99%

For the criteria within social, Table 57, similarities occur compared to the criteria within environment, for example by assessing the presence of measures. However, some calculations also include percentages or numbers of measures or facilities present. First, the percentage for the areas with an unobstructed view is defined, where a minimum of 75% should be scored to receive one point. The remaining steps for receiving more points are going slightly upwards as no guidance is given on this level. Next, the amount of places to meet, debate or socialize should at least be one. To gather more points, extra places should be present and therefore, the values rise with an integer number. This same method is used for the diverse amount of housing options which should be provided by the project.

The accessibility index is already divided into several steps, which are also taken to divide the 0 to 4 points which can be gathered in this assessment tool. The first point of the accessibility index can be score when there is a connection to public transport within 1 to 3 kilometers of the project with a frequency of 30 minutes. Next, two points can be scored when the distance is the same, but the frequency increases and is 15 minutes. Three points are given when the distance to public transport is less than 1km with a frequency of 30 minutes. Finally, 4 points are scored when the distance is less than 500 meters, and the frequency is 30 minutes or less. All the distances which are measured here, should take into account a safe and accessible walking route.

Finally, the amount of services or amenities are calculated in the same way as the amount of places to meet, debate, or socialize, but start with a minimum of two.

Table 57: Overview of points per criterion - Social

Category	Criteria	Definition	Input	Points				
				0	1	2	3	4
Health	Promote active living	Amount of measures present to promote active living	No/Yes/ Multiple	No	-	Yes	-	Multiple
	Optimize visual comfort for occupants	% of areas with an unobstructed view	%	< 75%	75%-80%	81%-85%	86%-90%	≥ 90%
	Optimize thermal and acoustic comfort of the building	Project meets NEN5077 requirements	No/Yes	No	-	-	-	Yes
		Amount of measures present to regulate temperature	No/Yes/ Multiple	No	-	Yes	-	Multiple
Community	Presence of community- and public spaces	Amount of places to meet, debate or socialize	#	0	1	2	3	≥ 4

	Encourage building occupant engagement	Amount of measures present to encourage occupant engagement	No/Yes/ Multiple	No	-	Yes	-	Multiple
Inclusion	Accessibility for people with disabilities	Presence of an accessibility strategy	No/Yes	No	-	-	-	Yes
	Provide diverse housing options	Diverse housing options	#	0	1	2	3	≥ 4
Safety	Ensure the safety of the building and its surroundings	Presence of measures to ensure the safety of the building and its surroundings	No/Yes/ Multiple	No	-	Yes	-	Multiple
Affordability	Provide affordable housing	% of affordable dwellings	%	< 40%	40%-45%	46%-50%	51%-60%	≥ 61%
Accessibility	Proximity of public transport	Accessibility index	#	0	1	2	3	4
	Proximity of primary services and amenities	Amount of primary services and amenities within 500m of the project	#	< 2	2	3	4	≥ 5

Finally, the points for the criteria for governance are shown in Table 58. It starts with the amount of technology systems used in the project, which is an integer slightly increasing as the amount of points are increasing. These small steps are taken as it is hard to include many different systems of tools in one project. Next, the score of the code of conduct should be sufficient, which means at least a 6. The other steps increase slightly with integers as the previous criterion did as well as a higher score automatically relates to better performance on this criterion.

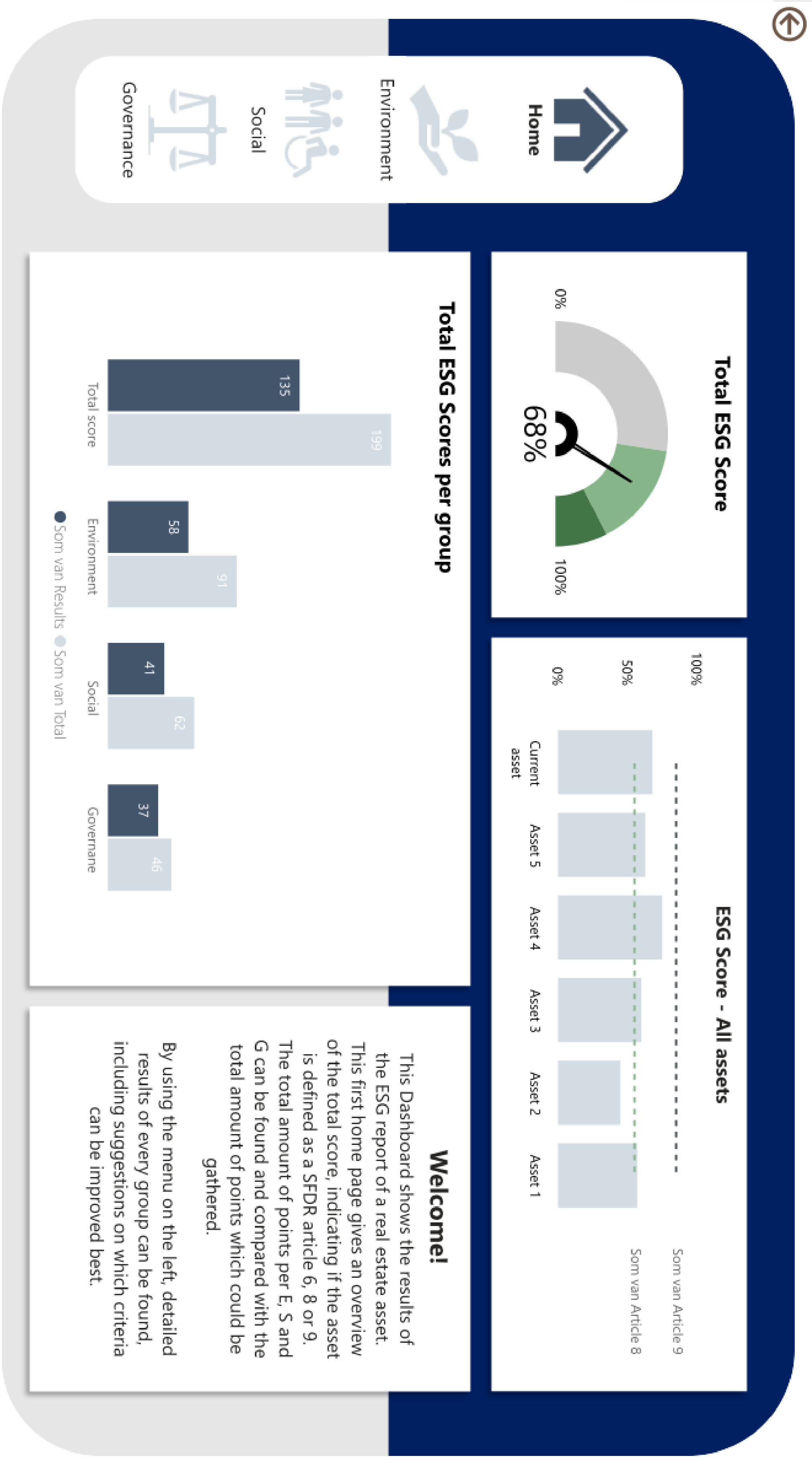
The points given for a certain energy label is set at a minimum of energy label C, as this is the minimum requirement set for office buildings (Informatiepunt Leefomgeving, 2024a). This guideline is taken as a starting point to define the steps, where a higher energy label relates to more points in the assessment instrument. The highest score of 4 points is gathered with an energy label A+ or higher.

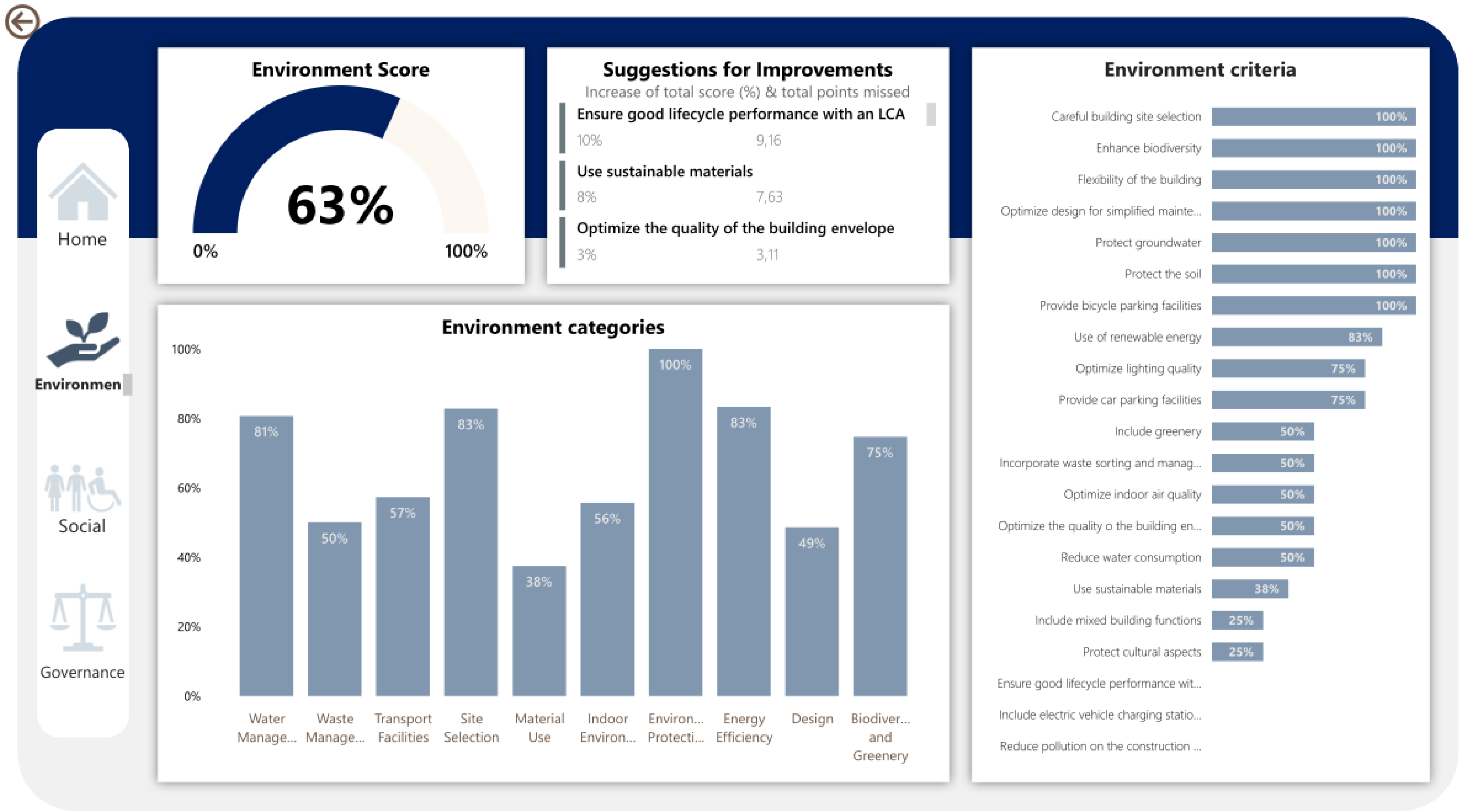
Finally, the cost effectiveness of the project is defined as a percentage showing the difference between the actual costs and the planned costs. As there were no guidelines found on this measurement, an estimation is made where a smaller difference between the costs receives more points compared to a larger difference.

Table 58: Overview of points per criterion - Governance

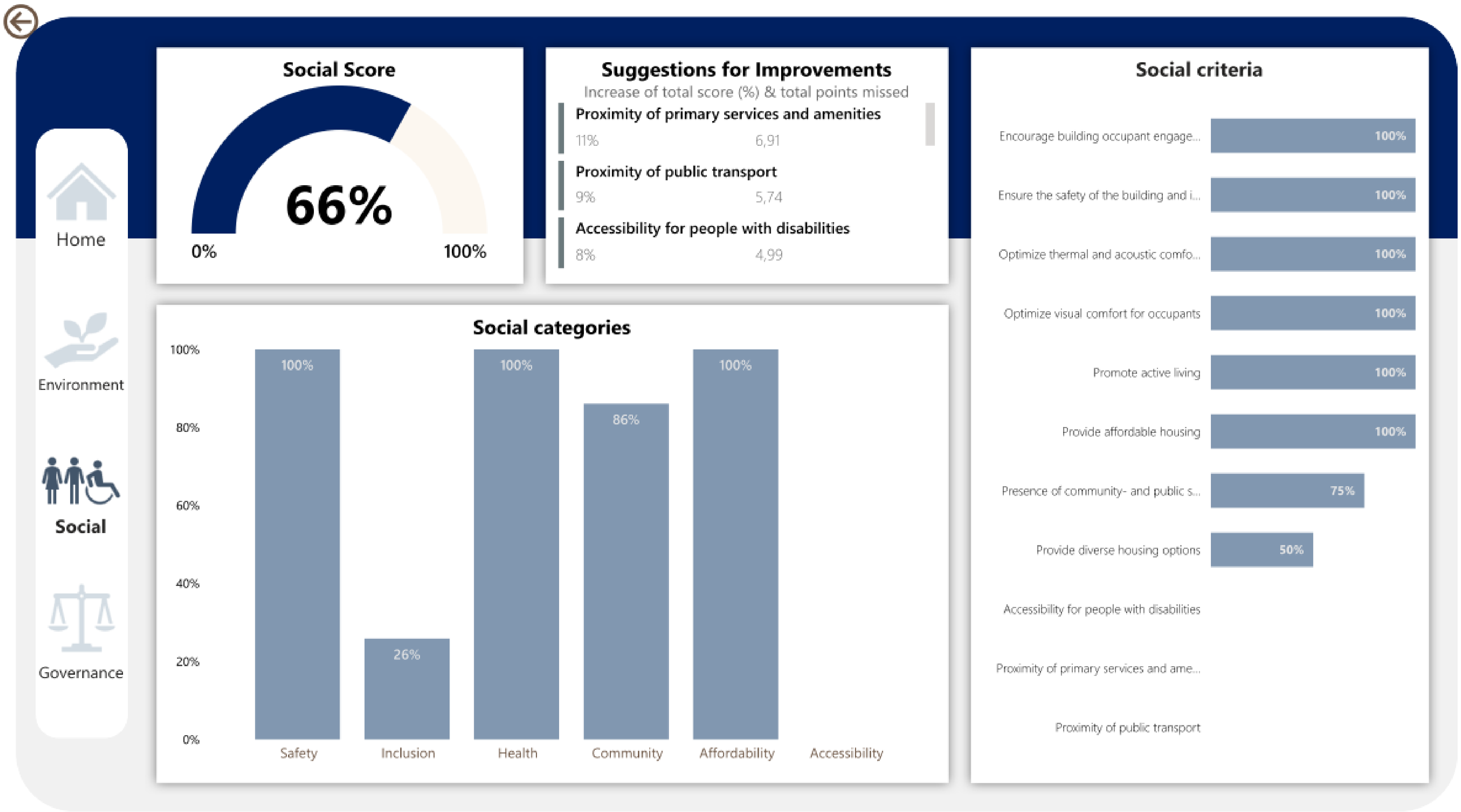
Category	Criteria	Definition	Input	Points 0	1	2	3	4
Innovation	Use of technology systems	Amount of technology systems used in the project	#	0	1	2	3	≥ 4
Management	Avoidance of Forced or Compulsory Labor	Score code of conduct	#	< 6	6	7	8	≥ 9
	Facilitate stakeholder engagement	Amount of measures present to facilitate stakeholder engagement	No/Yes/ Multiple	No	-	Yes	-	Multiple
Documentation	Ensure commissioning and handover procedures	Presence of handover documents	No/Yes	No	-	-	-	Yes
	Presence of technical documentation	Presence of technical documentation	No/Yes	No	-	-	-	Yes
Certification	Compliance with regulations and policies	Compliance with regulations and policies	No/Yes	No	-	-	-	Yes
	Presence of certifications of technological systems	Energy labels of technological systems	label	≤ D	C	B	A	≥ A+
	Compliance with sustainability certifications	Amount of sustainability certifications	#	0	1	2	3	≥ 4
Finance	Cost effectiveness of the project	Actual vs planned costs of the project	%	> 30%	30%-25%	24%-20%	19%-10%	< 10%
Economic	Creating direct and indirect jobs	Amount of vacancies in the area	No/Yes	No	-	-	-	Yes
	Support local economy	Amount of local goods, services, or employment used in the project	No/Yes	No	-	-	-	Yes

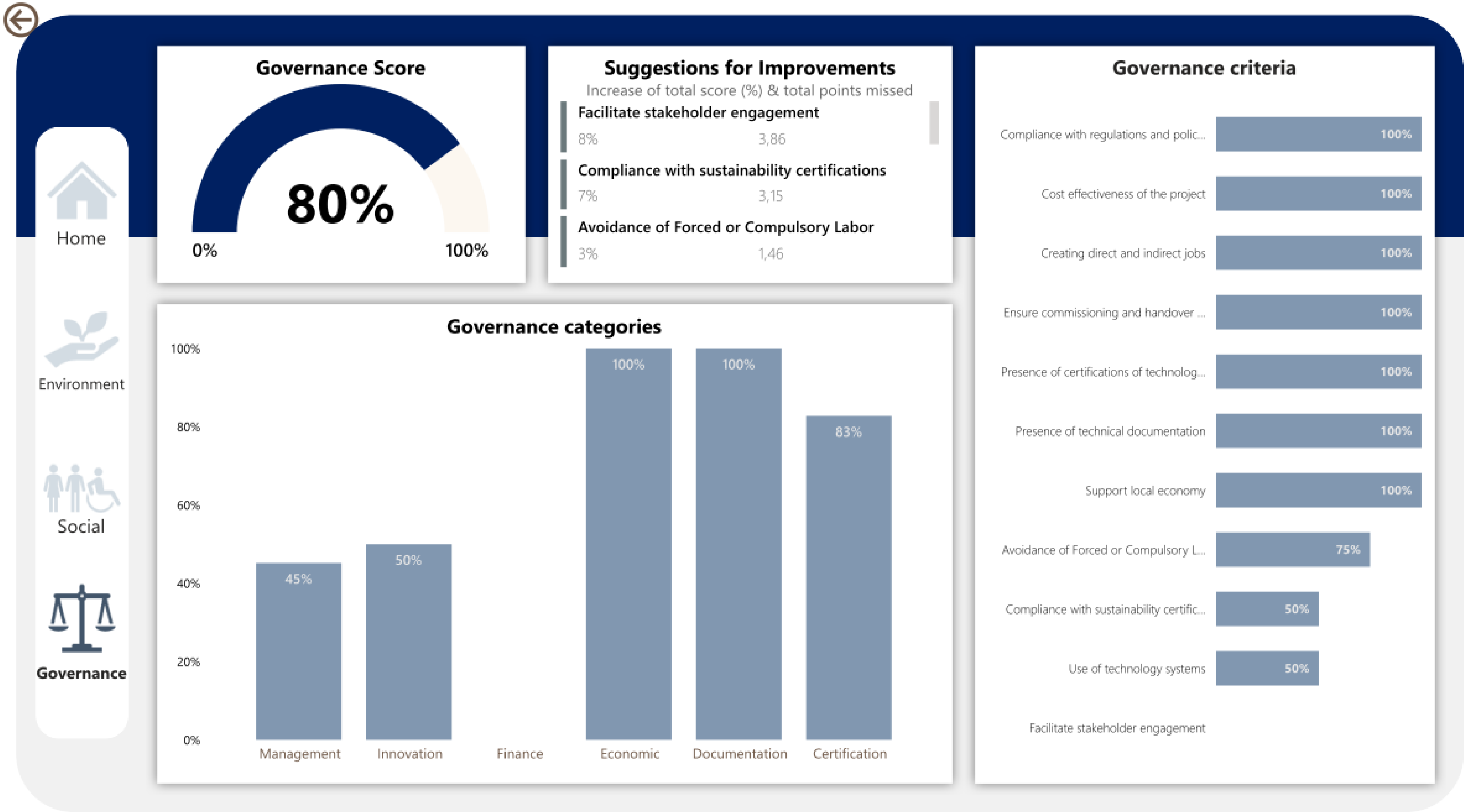
Appendix I


Home
Environment
Social
Governance
Total ESG Score
0%
68%
100%
ESG Score - All assets
100%
50%
0%
Current asset
Asset 5
Asset 4
Asset 3
Asset 2
Asset 1
Som van Article 9
Som van Article 8
Total ESG Scores per group
135
199
Total score
58
91
Environment
41
62
Social
37
46
Governane
Som van Results
Som van Total
Welcome!
This Dashboard shows the results of the ESG report of a real estate asset.
This first home page gives an overview of the total score, indicating if the asset is defined as a SFDR article 6, 8 or 9.
The total amount of points per E, S and G can be found and compared with the total amount of points which could be gathered.
By using the menu on the left, detailed results of every group can be found, including suggestions on which criteria can be improved best.



Home
Environmen
Social
Governance
Environment Score
63%
0%
100%
Suggestions for Improvements
Increase of total score (%) & total points missed
Ensure good lifecycle performance with an LCA
10%
9,16
Use sustainable materials
8%
7,63
Optimize the quality of the building envelope
3%
3,11
Environment criteria
Careful building site selection 100%
Enhance biodiversity 100%
Flexibility of the building 100%
Optimize design for simplified mainte... 100%
Protect groundwater 100%
Protect the soil 100%
Provide bicycle parking facilities 100%
Use of renewable energy 83%
Optimize lighting quality 75%
Provide car parking facilities 75%
Include greenery 50%
Incorporate waste sorting and manag... 50%
Optimize indoor air quality 50%
Optimize the quality o the building en... 50%
Reduce water consumption 50%
Use sustainable materials 38%
Include mixed building functions 25%
Protect cultural aspects 25%
Ensure good lifecycle performance wit...
Include electric vehicle charging statio...
Reduce pollution on the construction ...
Environment categories
100%
80%
60%
40%
20%
0%
Water Manage... 81%
Waste Manage... 50%
Transport Facilities 57%
Site Selection 83%
Material Use 38%
Indoor Environ... 56%
Environ... Protecti... 100%
Energy Efficiency 83%
Design 49%
Biodiver... and Greenery 75%


Home
Environment
Social
Governance
Social Score
66%
0%
100%
Suggestions for Improvements
Increase of total score (%) & total points missed
Proximity of primary services and amenities
11% 6,91
Proximity of public transport
9% 5,74
Accessibility for people with disabilities
8% 4,99
Social criteria
Encourage building occupant engage... 100%
Ensure the safety of the building and i... 100%
Optimize thermal and acoustic comfo... 100%
Optimize visual comfort for occupants 100%
Promote active living 100%
Provide affordable housing 100%
Presence of community- and public s... 75%
Provide diverse housing options 50%
Accessibility for people with disabilities
Proximity of primary services and ame...
Proximity of public transport
Social categories
100%
80%
60%
40%
20%
0%
Safety 100%
Inclusion 26%
Health 100%
Community 86%
Affordability 100%
Accessibility


Home
Environment
Social
Governance
Governance Score
80%
0%
100%
Suggestions for Improvements
Increase of total score (%) & total points missed
Facilitate stakeholder engagement
8% 3,86
Compliance with sustainability certifications
7% 3,15
Avoidance of Forced or Compulsory Labor
3% 1,46
Governance categories
100%
80%
60%
40%
20%
0%
45%
50%
100%
100%
83%
Management
Innovation
Finance
Economic
Documentation
Certification
Governance criteria
Compliance with regulations and polic... 100%
Cost effectiveness of the project 100%
Creating direct and indirect jobs 100%
Ensure commissioning and handover ... 100%
Presence of certifications of technolog... 100%
Presence of technical documentation 100%
Support local economy 100%
Avoidance of Forced or Compulsory L... 75%
Compliance with sustainability certific... 50%
Use of technology systems 50%
Facilitate stakeholder engagement

Appendix J

Within this appendix, the results of the case studies performed by the five participants can be found as well as the two additional cases performed by the researcher. Table 59 includes the results from the first case performed by the participants and focuses on the logistics building. The five columns indicate the outcomes of the assessment made by every participant. Table 60 includes the results from the second case study performed by the participant on the residential project, showing the results from each participant in an individual column. Finally, the additional cases which were performed by the researcher are added as well in Table 61. Here, each row indicates a project. Note that for the additional case studies, the criteria within the category affordability and finance are empty as no information was available on these topics.

Table 59: Results case study - logistic project

Case 1 (Logistics building)	1	2	3	4	5
ESG score	**61%**	**62%**	**60%**	**58%**	**64%**
Environment	65%	62%	59%	56%	65%
Waste Management	50%	50%	50%	50%	50%
Water Management	81%	81%	81%	74%	81%
Energy Efficiency	83%	83%	83%	83%	83%
Environmental Protection	100%	100%	100%	100%	100%
Site Selection	83%	83%	83%	83%	83%
Biodiversity and Greenery	62%	62%	62%	62%	62%
Indoor Environment	94%	56%	100%	56%	100%
Material Use	38%	38%	38%	38%	38%
Design	50%	49%	29%	29%	49%
Transport Facilities	63%	63%	63%	63%	63%
Social	54%	56%	50%	49%	53%
Health	90%	90%	79%	73%	100%
Community	64%	86%	58%	64%	36%
Inclusion	0%	0%	0%	0%	0%
Safety	100%	100%	100%	100%	100%
Affordability	-	-	-	-	-
Accessibility	0%	0%	0%	0%	0%
Governance	61%	69%	73%	69%	73%
Innovation	50%	50%	50%	50%	50%
Management	45%	45%	65%	45%	65%
Documentation	100%	100%	100%	100%	100%
Certification	83%	83%	83%	83%	83%
Finance	-	-	-	-	-
Economic	35%	100%	100%	100%	100%

Table 60: Results case study - Residential project

Case 2 (Residential building)	1	2	3	4	5
ESG score	**62%**	**60%**	**62%**	**62%**	**61%**
Environment	52%	50%	57%	55%	52%
Waste Management	50%	50%	50%	50%	50%
Water Management	87%	81%	81%	81%	87%
Energy Efficiency	33%	33%	33%	33%	33%
Environmental Protection	100%	100%	100%	100%	100%
Site Selection	83%	83%	83%	83%	83%
Biodiversity and Greenery	75%	75%	75%	75%	75%
Indoor Environment	50%	50%	50%	50%	50%
Material Use	31%	31%	31%	31%	31%
Design	35%	31%	54%	49%	35%
Transport Facilities	43%	43%	43%	43%	43%
Social	71%	71%	69%	70%	70%
Health	85%	75%	69%	69%	69%
Community	78%	100%	86%	100%	100%
Inclusion	87%	87%	87%	87%	87%
Safety	50%	50%	50%	50%	50%
Affordability	25%	25%	25%	25%	25%
Accessibility	100%	100%	100%	100%	100%
Governance	69%	64%	64%	64%	69%
Innovation	25%	25%	25%	25%	25%
Management	70%	50%	50%	50%	70%
Documentation	100%	100%	100%	100%	100%
Certification	74%	74%	74%	74%	74%
Finance	-	-	-	-	-
Economic	35%	35%	35%	35%	35%

Table 61: Results additional cases

Additional cases	Office building (Arnhem)	Office building (Rotterdam)
ESG score	31%	77%
Environment	14%	82%
Waste Management	0%	100%
Water Management	0%	100%
Energy Efficiency	17%	100%
Environmental Protection	0%	100%
Site Selection	0%	83%
Biodiversity and Greenery	0%	87%
Indoor Environment	50%	61%
Material Use	0%	56%
Design	29%	85%
Transport Facilities	23%	46%
Social	43%	74%
Health	48%	66%
Community	50%	78%
Inclusion	0%	100%
Safety	50%	50%
Affordability	-	-
Accessibility	48%	86%
Governance	53%	70%
Innovation	25%	75%
Management	30%	65%
Documentation	100%	100%
Certification	74%	91%
Finance	-	-
Economic	35%	35%