A Concept for Measuring Real Estate Sustainability from the Investors' Perspective

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Abstract: Although there is an increasing demand for sustainable investment products accompanied by increasing regulations regarding sustainability disclosures, people suffer from a lack of information concerning the offered investment products' sustainability. Despite hundreds of ESG indicators for standard investment products available in the literature, there is no holistic approach to assessing real estate sustainability to date. However, as the real estate sector is responsible for 40% of energy consumption and 29% of greenhouse gas emissions in the European Union, it is critical in meeting the Paris Agreement's climate targets. This paper presents our ideas for developing a concept for a real estate sustainability metric and real estate specific sustainability indicators. We aim to develop a metric that offers a transparent sustainability assessment for real estate based on the triple bottom line, thereby enabling (potential) investors to assess the sustainability of offered assets for themselves.

Zusammenfassung: Obwohl die Nachfrage nach nachhaltigen Anlageprodukten steigt und die Regulierung zur Offenlegung von Nachhaltigkeitsaspekten zunimmt, mangelt es auf Seiten der Anleger:innen an Informationen über die Nachhaltigkeit der angebotenen Anlageprodukte. Auch wenn in der Literatur hunderte von ESG-Indikatoren für Standard-Investmentprodukte zur Verfügung stehen, gibt es bisher keinen ganzheitlichen Ansatz zur Bewertung der Nachhaltigkeit von Immobilien. Da der Immobiliensektor jedoch für 40% des Energieverbrauchs und 29% der Treibhausgasemissionen in der Europäischen Union verantwortlich ist, ist er für die Erreichung der Ziele des Pariser Klimaabkommens von entscheidender Bedeutung. In diesem Artikel stellen wir unsere Ideen zur Entwicklung eines Konzepts für eine Nachhaltigkeitsmetrik für Immobilien und immobilienspezifische Nachhaltigkeitsindikatoren vor. Unser Ziel ist es, eine Metrik zu entwickeln, die eine transparente Nachhaltigkeitsbewertung für Immobilien auf der Grundlage des Drei-Säulen-Modells bietet und damit (potenzielle) Investor:innen in die Lage versetzt, die Nachhaltigkeit der angebotenen Assets selbst zu bewerten.

→ JEL classification: G11, Q51, R11
→ Keywords: Real Estate Sustainability, ESG Score, Asset Evaluation

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1 Introduction

Sustainability seems to be on everyone's lips. Individuals are increasingly asking for sustainable products in all sectors (German Federal Environmental Agency "Umweltbundesamt" 2021). In addition, the demand for sustainable investment products has increased rapidly. From 2019 to 2020, investments in sustainable investment products increased by 124.5%, while the overall volume of investment products increased by only 10.7% (BVI 2021, p. 1; FNG 2021, p. 22). This increased demand is also evident in the real estate sector (EY 2021, p. 1). Although more and more people are willing to invest in sustainable products, they suffer from a lack of information regarding the sustainability of the offered investment products (Consumer Advice Centre "Verbraucherzentrale" 2021). In the context of real estate specifically, tools to measure sustainability are missing (Plößl and Just 2020, p. 23; Vieira de Castro et al. 2020, p. 267).

This paper aims to present the development of a concept for a real estate sustainability metric and real estate specific sustainability indicators that enable (potential) investors to assess the sustainability of offered assets for themselves. Several sustainability indicators are aggregated into categories before one final score is determined. The value added of having one total sustainability score is its signaling function. It provides investors with a brief overview of a potential investment's sustainability, while still offering them a more detail-oriented view of each investment through each indicator. In contrast to, e. g., the balanced scorecard or the Common Good Balance Sheet,[1] which are tools for the internal performance measurement of companies, our concept is primarily conceived to enable investors to assess their (potential) investments in real estate. We will only focus on buildings for this article and exclude land. We use the word "metric" for a system of weighted sustainability indicators. "Sustainability indicators" in this article are measures for single aspects of sustainability in the context of real estate, e. g., "women directors". A "category" is defined as a bundle of weighted sustainability indicators, e. g., "diversity".

For our metric, the triple bottom line serves as the basic concept. For the sustainability indicators, we determine relative measures to make our metric applicable to real estate globally, following a multi-step procedure (an algorithm), instead of one formula. These measures are based on scores instead of the binary system, which is the predominant measure for certificates (Rogmans and Ghunaim 2016, p. 607; Vieira de Castro et al. 2020). Scores instead of binary measures are necessary to make the extent and the specific way of sustainability recognizable. Our metric and sustainability indicators aim at providing investors with a transparent sustainability evaluation through a flexible and straightforward analysis. This allows investors to independently check whether the real estate of interest meets their own sustainability preferences. In addition, investors can assess whether their preferences regarding the magic pyramid of sustainable investment (return, risk, liquidity, and sustainability) are considered by investing in real estate. Furthermore, investors can use the metric to assess the current sustainability of their real estate and the potential sustainability risks.

Moreover, applying our metric is simpler than certifications and requires neither expert knowledge nor much time because all sustainability indicators are compiled in one clearly arranged checklist. Therefore, investors no longer need to rely on how private or public organizations assess and probably certify the sustainability of real estate assets. Instead, they can form their own judgment

1 https://www.ecogood.org/apply-ecg/sustainable-development-goals/.

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with the help of our metric. The mechanism will be made publicly available online for free. Our contribution to the literature is developing a concept that provides a transparent and holistic assessment of the sustainability of real estate taking into account its whole lifecycle.

The article is structured as follows: Section 2 explains the peculiarities of the real estate sector and real estate as an asset. Section 3 provides an overview of the existing research and practical approaches. Section 4 details the concept, starting with the system boundaries, before discussing the development of sustainability indicators and their weighting and aggregation to categories. Section 4 concludes by discussing the sustainability score, ensuing ranking of the resulting scores, and the validation of the concept. The article ends with a conclusion in section 5, which summarizes the most important aspects and identifies both limitations of the results and recommendations for further research.

2 The Special Need of the Real Estate Sector for Sustainability Measurement

In addition to the increased demand for sustainable investment products, an important driver for needing to establish sustainability indicators is increasing regulation, which is supposed to have a long-term impact on the real estate industry (PwC and the Urban Land Institute 2020, p. 81; Bienert 2016, p. 16). As an example, the Taxonomy Regulation of the European Union imposes additional reporting obligations (European Commission 2019). The German Federal Financial Supervisory Authority "BaFin" published the Guidance Notice on Dealing with Sustainability Risks in January 2020 (German Federal Financial Supervisory Authority "BaFin" 2020). In March 2021, the European Disclosure Regulation came into force, according to which, financial companies must prove how sustainable their offerings are (European Union 2019). Additionally, carbon pricing will result in additional costs for real estate owners and, thus, a loss of return for those owners with less sustainable real estate properties (German Federal Government 2020; Spanner and Wein 2020, p. 289). Regulations regarding money laundering are continuously strengthened as well, such as through the Fifth Money Laundering Directive, which has been transposed into German law through an amendment of the Money Laundering Act in 2020 or the conversion of the Transparency Register in August 2021 to a full register, which, among other things, provides data on beneficial owners of real estate properties (European Union 2018; German Federal Ministry of Finance "Bundesfinanzministerium" 2020, 2021; Bausch and Voller 2020, p. 10 ff.). Finally, in May 2021, the European Union established the European Labour Authority, a permanent platform to tackle undeclared work (European Labour Authority 2021).

For the real estate sector and its related investment products, being part of the change toward more sustainability is of particular importance:

1. From an environmental perspective, the real estate sector has a significant impact, as it is responsible for 40 % of energy consumption and 29 % of greenhouse gas emissions within the European Union (Spanner and Wein 2020, p. 278). Additionally, it is very resource intensive. Due to the real estate's long lifecycle, resources – once consumed – are tied up for the long term.
2. In addition, the real estate sector has a special social role: On the one hand, humans need real estate to satisfy their basic need of housing. On the other hand, the real estate sector is

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particularly susceptible to economic crime, such as illicit work and money laundering (German Federal Criminal Police Office 2012, p. 15).

3. Furthermore, the real estate sector has an exposed economic position because it generates 18.2 % of Germany's gross domestic product; 25.1 % of German companies and 9.5 % of German employees work in this field (German Federal Statistical Office "Destatis" 2021; Just et al. 2017, p. 11).

The peculiarities of the real estate sector and real estate as a product make it impossible to simply adapt the general sustainability indicators developed in the existing literature without specific modifications. First, there are sector-specific stakeholders, e. g., investors, tenants, developers, employees, NGOs, banks, and the general public. As various stakeholders need real estate for different purposes, they each have different understandings of sustainability. Second, in the context of real estate investments, three assessment levels must be distinguished: the single asset, the fund, and the real estate company. At each level, the stakeholders might have divergent interests concerning sustainability (Bienert 2016, p. 32 ff.). In this article, we are focusing on the asset level. The third peculiarity is real estate's unique lifecycle, shown in Figure 1.

Figure 1

Real Estate Lifecycle

Source: Modified from Everling et al. 2009, p. 75.

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On the one hand, the lifecycle is very long compared to other products. On the other hand, the lifecycle has specific stages like conversion followed by a second useful life and the eventual recycling and dismantling phase. Changes made during the renovation phase, which can affect sustainability during the second useful life, make it difficult to assess a real estate asset's sustainability for its entire lifecycle at the outset. Therefore, we suggest at the very least distinguishing between new, old and renovated real estate properties when comparing the real estate sustainability.

Compared to other long-lasting assets, real estate is a relatively expensive, inhomogeneous asset class that is only available to investors as a single property or in small numbers. The individual willingness of potential buyers to pay a price is hardly predictable, because many factors influence the price that go beyond the pure utility value, e. g., the location, the particular building style, the layout or the personal connection (Ghysels et al., p. 571).

3 Existing Research and Practical Approaches

The triple bottom line serves as the basic concept for our metric. This concept stems from socially responsible investing, which began in the 1960 s (Kleine 2009, p. 5). This investment strategy argues that financial success cannot be the only metric to measure success; there are non-financial factors without which companies and their projects cannot survive long term. Both Heins and Elkington claim to have invented the triple bottom line in the 1990 s (Kleine 2009, p. 5; Elkington 1998a, 1998b; Heins 1994). The triple bottom line divides non-financial factors, or rather sustainability, into three dimensions, i. e., pillars: E – environmental, S – social, and G – corporate governance. Nowadays, they are referred to as ESG factors. The development of the triple bottom line has given structure to the complex issue of sustainability (Kopfmüller et al. 2001; Kleine 2009, p. 5 ff.). The practice developed criteria and indicators to measure sustainability, based on the triple bottom line, but mainly focused on capital-oriented companies. With the development of sustainability indicators, the practice subdivides the three pillars into more granular subcategories aimed at assessing with as much detail and objectivity as possible (e. g., Refinitiv 2021, p. 3). This paper uses the term ESG indicators as a synonym for sustainability indicators.

Attempts to adapt these ESG indicators to real estate have various shortcomings (Walker et al. 2019, p. 19 ff.; Kleine 2009, p. 12 f.). Several certification guidelines developed by the practice exist, e. g., LEED (Leadership in Energy & Environmental Design) or DGNB (*Deutsche Gesellschaft für Nachhaltiges Bauen* "German Sustainable Building Council") as well as the organization GRESB (Global Real Estate Sustainability Benchmark) (Vieira de Castro et al. 2020, p. 253 ff.; Bienert 2016, p. 32 ff.). However, most certificates offered are limited to the environmental perspective and do not assess the social and corporate governance dimensions. Furthermore, the use of the certificates is criticized in the literature. They lead to unintended side effects because real estate is only built to meet the required standard but falls short of more extensive possibilities. As a result, sustainability is only superficially achieved. In addition, rating systems are often limited to specific regions, making it difficult to compare a larger number of real estate assets in different regions (Walker et al. 2019, p. 19 ff.; Kleine 2009, p. 12 f.).

From the addressees' perspective, certifications have two shortcomings. First, some only provide a binary evaluation: either the real estate is sustainable or not. However, the certificate is unlikely to meet the information requirements of all distinct investors or other stakeholders. Investors and

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other stakeholders are supposed to have further information interests. For instance, institutional investors (e.g., banks or insurance companies) require more detailed knowledge about each sustainability dimension's characteristics and target achievement levels, as well as the associated risks due to regulatory requirements (German Federal Financial Supervisory Authority "BaFin" 2020). At the same time, investors have a legitimate interest in knowing what deficiencies an existing, unsustainable real estate asset has. Second, other existing certifications are very detailed, require technical expertise, and are verbalized, making them impossible or time-consuming to comprehend without specialized knowledge. As a result, the assessments are not transparent from the stakeholder's point of view. Stakeholders are not enabled by existing certifications to form their own opinion on the sustainability of a real estate property.

Nevertheless, these certificates are used as indicators for real estate sustainability, too (Eichholtz et al. 2012, p. 1915), which shows that there is no differentiated metric as of yet. Additionally, Plößl and Just claim that data based on sustainability indicators are missing. Instead, they measure sustainability in real estate by using the growth rate of renewable energies to gross final energy consumption (Plößl and Just 2020, p. 23). In their analysis of existing approaches to assessing real estate sustainability Vieira de Castro et al. state that further research needs to be conducted to develop a holistic and detailed metric (Vieira de Castro et al. 2020, p. 267). The existing theoretical approaches often consider only one sustainability dimension like the Carbon Risk Real Estate Monitor (Spanner and Wein 2020) or the German Corporate Governance Code for the real estate sector (Institute for Corporate Governance in the German Real Estate Industry).

To the best of our knowledge, despite the vast amount of existing literature on single aspects of real estate sustainability, there is no holistic approach that applies the concept of the triple bottom line to real estate. Therefore, we aim to help fill this research gap by developing a concept in which the metric is based on sustainability indicators, using scores instead of a binary system that is compatible with standard databases.

4 Concept

4.1 From Sustainability Indicators to one ESG Score

In this section, we begin with describing our metric's system boundaries. We then explain the development of sustainability indicators in three steps. First, a literature review is conducted. Second, the adaptation of these indicators for real estate is examined. Third, real estate specific sustainability indicators from exposés and expert interviews are presented, which can complement the preexisting indicators. Following trends in recent literature, not only do we consider positive disclosed information, but controversies on sustainability issues, too (DasGupta 2021; Dorfleitner et al. 2020; Fiaschi et al. 2020; Nirino et al. 2021).

After developing sustainability indicators, we present our categorization idea and discuss the weighting of both categories and sustainability indicators, as shown in Figure 2.

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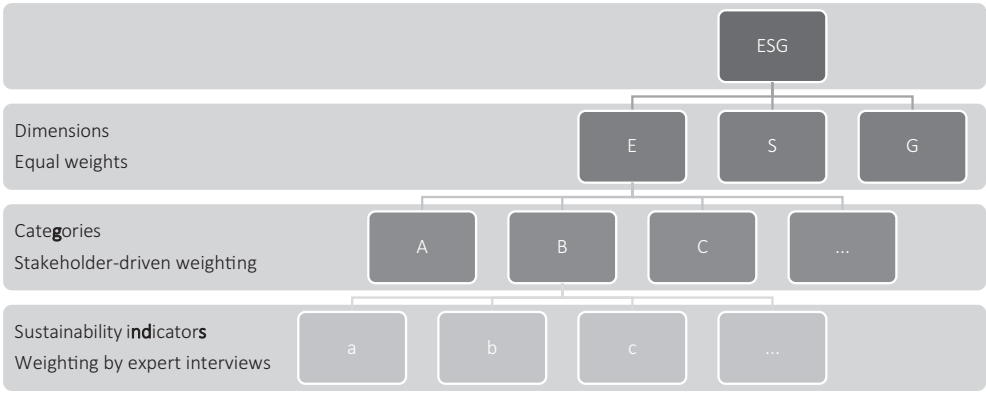
Figure 2

Weighting of Sustainability Indicators and Categories



Source: Own illustration.

The observed sustainability indicators are then compiled in a checklist for investors to use. An example of a potential checklist is shown in Figure 3.

Figure 3

Sample Checklist

Sustainability indicator	Points	Indicator weight	Indicator score	Category	Sum of indicator scores	Category weight	Category score	Dimension	Dimension score	Total ESG score
Waste	1	0.12	0.12							
Water	1	0.14	0.14	Resources	0.26	0.15	0.04			
...	0	0.09	0.00							
Greenhouse gases	1	0.17	0.17							
Noise	0	0.09	0.00	Emissions	0.22	0.29	0.06	Environment	∑	∑
...	1	0.05	0.05							
		...	...							
...	...	...	...	...	∑	...	...			
		...	...							

Figure 3 *(Continued)*

Sustainability indicator	Points	Indicator weight	Indicator score	Category	Sum of indicator scores	Category weight	Category score	Dimension	Dimension score	Total ESG score
Work-life-balance	1	...	...							
On-the-job-safety	0	...	...	Working conditions	∑	...	...			
...	0	...	...							
Donations	0	...	...							
Social housing	1	...	...	Corporate citizenship	∑	...	...	Social	∑	
...	1	...	...							
...	...	...	...							
...	...	...	...	Business ethics	∑	...	...			
...	...	...	...							
Commercial offences	1	...	...							
Tax compliance	0	...	...	Compliance	∑	...	...			
...	1	...	...							
...	...	...	...					Governance	∑	
...	...	...	...	Risk	∑	...	...			
...	...	...	...							
...	...	...	...							
...	...	...	...	...	∑	...	...			
...	...	...	...							

Source: Own illustration.

To assess the sustainability of real estate the checklist user must read through the list and decide, whether there is positive, negative or no information about each indicator. If there is no or negative information regarding an indicator, we assign it zero points; we award one point if there is positive information. Each point is then multiplied with its specific indicator weight to calculate the sustainability indicator's score. These indicator scores are added up by category and multiplied with a specific category weight to calculate the overall category score. These category scores are combined to determine each dimension's score. Once dimension scores are added together, the total ESG score for a real estate asset is computed.[2]

4.2 System Boundaries

Before describing specifics on determining sustainability indicators, system boundaries must be defined for our concept.

2 Therefore, the calculation of the dimension scores and the overall ESG score is sectional linear. The sustainability indicators will be calculated in manifold ways.

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As we are describing a concept for asset evaluation instead of performance measurement our spatial system boundary is broad. This means, that we do not only consider the asset but the surrounding area as well (see Figure 1). Here we must think in two directions: from inside the real estate property to the outsight and vice versa. To illustrate this for the environmental dimension, we can examine noise. On the one hand, noise, especially during construction, but also from people using the finished real estate property, affects animals and people in the surrounding area. On the other hand, noise from the outsight, e. g., passing trains, affects the people inside the real estate property. Moreover, considering both directions is socially meaningful. A family-friendly surrounding area that includes schools, playgrounds, and traffic-calmed zones affects real estate users (at least when considering residential buildings). In contrast, the real estate property socially affects the people in its surrounding area, because it shapes the landscape. To specify an explicit limitation of the surrounding area, we define it as a residential, industrial, or comparable area but not an entire city.

In terms of time, we consider the entire lifecycle at the asset level. To illustrate this, we can examine solar panels. Undoubtedly, using solar panels has a positive environmental impact. Nevertheless, disposing of these is problematic due to toxic components (Renner 2010, p. 553). Given this toxicity during the disposal period, we cannot simply focus on the years of use. The environmental impact of the entire lifecycle must be considered.

It is important to note that we do not consider the specific type of real estate tenant. For instance, we would not assess whether the tenant of, e. g., a shop sells tobacco or vegetables since such detail is subject to strong fluctuations and does not permanently change the real estate property itself.

4.3 Sustainability Indicators

The amount of information regarding sustainability disclosed by companies has rapidly increased during the last years (Chen et al. 2021, p. 152). As there is neither an exhaustive list of sustainability indicators nor mandatory sustainability indicators, hundreds of ESG indicators for investment products can be found in the literature and several databases. We conducted a literature review for our concept and compiled the sustainability indicators mentioned into a list (see Appendix). However, this list should only be viewed as a sample since it is not an exhaustive list of all sustainability indicators available in the literature. Most of the indicators have already been assigned to one of the three sustainability dimensions in the literature, since they were developed using the triple bottom line. For our table, we assigned the indicators to one of the three dimensions, if they had not previously been classified in the literature. This list is our starting point for developing sustainability indicators specifically for real estate.

After creating the lists, the sustainability indicators must be screened to select the ones useful in assessing real estate sustainability. The sustainability indicators that measure similar scopes are sorted together, e. g., "recovery/recycling" and "recycling" or "environmental policy" and "environmental policy/management". The next step is to exclude those sustainability indicators that are clearly non-applicable to real estate, e. g., "no revenues in tobacco" or "no revenues in weapons".

The sustainability indicators remaining after this screening are then adapted for real estate; adjustments are necessary due to the peculiarities of real estate. Water as a sustainability indicator perfectly illustrates why adjustments are needed. Looking at this from the perspective of a stock company's sneaker production, water would be an easy indicator to measure. To assess the water

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intensity for one pair of sneakers, it would be enough to determine, how much water is needed in the production plant, e. g., within one year and the number of sneakers produced within the same period. However, in the context of real estate, this is much more complex due to each real estate property's unique lifecycle and different assessment levels. Water is used in every lifecycle stage and by several parties. For instance, the company planning the real estate property and the construction company, e. g., for making the concrete. Once construction is completed, the real estate users' water consumption varies depending on their individual life-styles. Water use continues in the conversion and renovation stage and the second (or more) useful life (or lives), until the real estate property is finally dismantled.

Another aspect highlighting the need to adapt existing sustainability indicators for real estate is that some of the sustainability indicators may belong to multiple dimensions or blur between them, e. g., noise. To illustrate this, we continue with our sneakers example. When assessing the noise emission of sneakers, only the noise generated during production needs to be considered; noise produced during their useful life is irrelevant. Additionally, only noise stemming from sneaker production affects the environment; but obviously there is no effect the other way around. When assessing noise in the context of real estate, however, we have to consider the noise caused during construction that affects the environment, plus the noise generated inside the real estate property by daily use, e. g., a music school will produce a large volume of noise, not to mention further lifecycle stages. Additionally, the noise coming from outside the boundary into the real estate property, e. g., passing trains, must be taken into account – at this point, noise is not only an environmental indicator, but a social one, because people using the real estate are affected by it.

The examples of water consumption and noise show that sustainability indicators are more multifaceted, when adapted for the real estate and therefore need to be examined in a more differentiated manner that considers the whole lifecycle. Consequently, water consumption, noise, and other sustainability indicators must be measured separately for each lifecycle stage, considering different aspects like having state-of-the-art technical systems for water saving or sound protection.

So far, we have still only examined existing ESG indicators regularly used for standard investment products. After reviewing and selecting these sustainability indicators and adapting them for real estate on a theoretical basis, we proceed with real estate specific sustainability indicators that complement the existing ones. We begin by analyzing real estate based on exposés, prospectuses, remediation plans, and other informative documents. From such written descriptions, we can extract real estate specific sustainability indicators like family-friendliness, which can be measured by the number of schools or playgrounds in the surrounding area, accessibility through built-in stair lifts, or an eco-friendly infrastructure with public transportation.

Furthermore, we propose conducting expert interviews with architects, craftspeople, and engineers. Through these expert interviews, we anticipate learning about characteristics not expressly described in the analyzed documents, e. g., aspects that are standard from the author's point of view and therefore not mentioned or even negative aspects from an investor's point of view. For instance, if a rental house is to be sold, the exposé will not say that the bathroom is moldy despite this being relevant to a user's health. This is a valuable sustainability indicator in assessing the social dimension of sustainability.

Most sustainability indicators whose expressions can be derived from the analyzed documents, should be assigned to the environmental and social dimensions. This is because usually, only the

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finished asset itself is subject to an exposé, and no corporate governance-related information, e. g., the absence of undeclared work during the construction is disclosed. Therefore, to gather information about real estate specific corporate governance, we start by analyzing real estate companies' sustainability reports, including guidelines for dealing with industry-specific problems such as avoiding undeclared work among subcontractors. We then conduct further expert interviews. Useful experts could be investment company managers, construction company managers and employees, auditors and lawyers specializing in real estate cases, and real estate agents. In the interviews we would ask for internal guidelines, especially, e. g., regarding risk management, compliance, integrity, engagement and sustainability management, and recent court proceedings. Finally, to learn more about real estate specific controversies, public reporting from the last years is analyzed using qualitative content analysis.

The final step of developing sustainability indicators is validating their practicability. This step is needed to examine, which sustainability indicators are measurable and which are not suitable for practical use, e. g., due to a lack of information. This step begins with further analysis of exposés, prospectuses, remediation plans, and other informative documents, that had not been analyzed previously. We also propose conducting additional expert interviews. Moreover, we suggest analyzing publicly offered real estate, such as those presented on real estate portals. After the validation process, the sustainability indicators that are unmeasurable or unsuitable for practical use are excluded. This approach also allows other characteristics that we had not previously considered to be observed. In such cases, we would check whether to add these sustainability indicators and validate them iteratively.

4.4 Aggregation

As discussed in Section 4.3, many sustainability indicators become more complex in the context of real estate. Since absolute measures are impracticable for many sustainability indicators, we develop relative ones (cf. Bogenberger, p. 103 ff.). Using relative measures means that we compare the values of the sustainability indicators of interest for each real estate asset and divide them into five groups ranging from worst to best value.

To illustrate this, let us continue with our sneaker and water consumption example: If we wanted to assess the water intensity of a pair of sneakers, we could undoubtedly measure it in liters. Conversely, measuring a real estate property's water consumption for its entire lifecycle in absolute numbers is impossible at the outset. After all, there are too many unknowns in the future: we do not know how long the real estate property will be used and whether there will be periods of vacancy. Furthermore, we do not know, whether the real estate users will even try to conserve water. There are also significant regional differences in water use, as demonstrated in Figure 4. The variations in water consumption are not solely due to differences in technical standards; factors such as climate and cultural differences also play a role. Using such relative measures allows us to compare real estate sustainability despite regional differences. We rely on data from sources like public water and energy suppliers to develop these relative measures.

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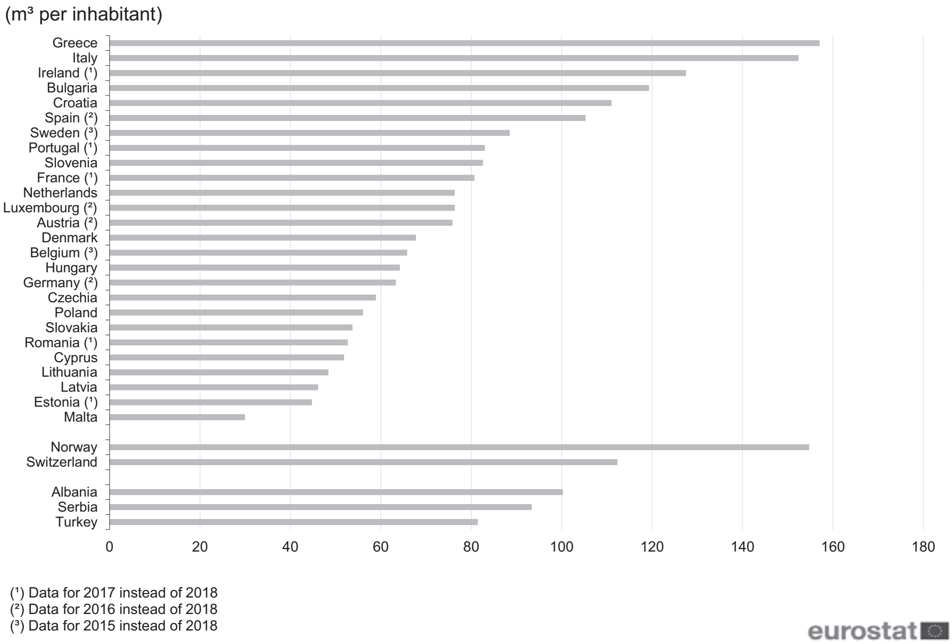
Figure 4

Total Freshwater Abstraction for Public Water Supply



Source: Eurostat 2018.

The next aggregation step is to categorize the sustainability indicators. Since we already assigned each indicator to one of the sustainability dimensions during the literature review, we assign each sustainability indicator to a category. For instance, all diversity-related sustainability indicators could be grouped into one category, e.g., "nationalities on board", "women directors", and "board structure". A category named "pollutant emissions" could be created for sustainability indicators like "greenhouse gas emissions, scope 1", "greenhouse gas emissions, scope 2", "greenhouse gas emissions, scope 3", "NO_2 and SO_2 emissions", and "pollution control". The categorization results in a tree structure that begins with the sustainability indicators, e.g., "women directors", which interwine into categories, e.g., "diversity", before combining into dimensions and ending with the overall ESG score. The tree structure is illustrated in Figure 5. The tree structure will provide the users of our metric with a better overview of the sustainability indicators and allows the user of the metric to decide how many details they want to know.

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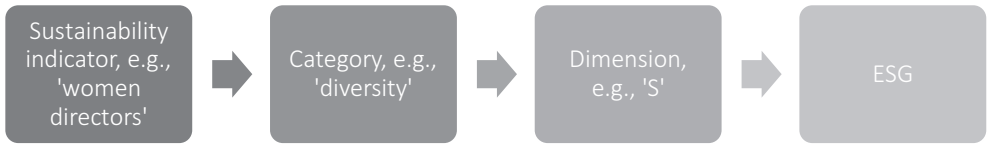
Figure 5

Tree Structure of Sustainability Indicators, Categories, and Dimensions



Source: Own illustration.

After the sustainability indicators and categories are defined, we gather them into a checklist. This checklist is only applicable at the asset level. Those who analyze a real estate asset can use the checklist to evaluate every sustainability indicator in a binary way, resulting in Boolean data. In other words, the answers are transferred into a system of zeros and ones. If a sustainability indicator applies, the value is one. If it does not apply or the information in question is unavailable, the value is zero. Since there are not only positive but also negative indicators, we define a polarity for each one. Therefore, the value determination is reversed for negative indicators, e. g., controversies on employee rights. If the user ticks yes, i. e., there have been recent controversies related to employee rights, the value is zero. If there are none, the value is one.

The categories are weighted differently. This is necessary for two reasons: First, if every reported detail is rewarded with one point the real estate asset that provides most information would automatically be classified as the most sustainable one. To prevent this, we propose to weight the categories depending on their materiality to assess real estate sustainability and the significance of their contribution toward reaching specific sustainability goals. Second, the weight scheme might stimulate transparency. Not providing highly material information leads to a worse result and cannot easily be compensated for with other, less material information (Refinitiv 2021, p. 3).

The regulations regarding sustainability disclosures do not explicitly influence how sustainability indicators are weighted for our metric. In contrast, our aim is to develop a metric that considers investors' understanding of sustainability, which can be congruent with current regulations or influenced by them, but not necessarily. From our point of view, there are two alternatives for weighting the categories: data-driven or stakeholder-driven. Databases commonly use data-driven weighting; for Boolean data, this is the transparency weights. When using this data-driven weighting, the level of disclosure is decisive for a category's weight. In other words, the categories most reported by companies are weighted as highly material and vice versa. A category's disclosure percentage is calculated to decide its weight. This percentage is determined by dividing the number of provided values for a category by the number of relevant reporting companies. These disclosure percentages are then converted into decile ranks, i. e., from 1 to 10 (Refinitiv 2021, 10 ff.).

An alternative to the data-driven approach is weighting by stakeholder surveys. We assume that stakeholder groups, such as users, investors, architects and financiers, have different understandings of sustainability. To find out what sustainability means from the investors' perspectives, we propose conducting a survey among them. From this survey, we can derive one uppermost goal for each dimension, e. g., climate protection for the environmental dimension, health for the social dimension, or going concern for corporate governance. Depending on their contribution to the

uppermost goal, we would assign a weight between 1 and 10 to determine each category's score. If a category is important for attaining a dimension's uppermost goal, it is given a weight of 10. If it is less important, the weight is progressively reduced by 1. For instance, if we find out that the existence of a combined heat and power plant is significant in reaching the uppermost environmental goal of reducing carbon emissions, we would assign 1 point if such an installation exists and multiply it by the weight of 10. The default weight is 5.

An advantage of data-driven weighting is that it is objective and impartial; it only depends on the information provided. Additionally, it is flexible and continually adjusts itself to the current reporting practice. In comparison, stakeholder-driven weighting is fixed: investor surveys must be conducted repeatedly to adjust the weightings. Thus, the stakeholder-driven weighting is inflexible and time intensive, while the data-driven one works automatically. Although it is time intensive, a great advantage of the stakeholder-driven weighting is that the investors' understanding of sustainability is reflected. Data-driven weighting does not allow for different weightings and therefore, different understandings of sustainability between stakeholder groups. Since it depends on the data provided by companies, or rather real estate owners, the data-driven weighting only considers a single stakeholder's understanding of sustainability, i. e. the understanding of reporting companies. It is also possible that in data-driven weighting, easy-to-generate data are disclosed instead of the data actually material to reaching sustainability goals. A disadvantage of the stakeholder-driven weighting is that it could lead to results without extremes. If one investor classifies a sustainability indicator as rather immaterial another as highly material, the result is that it is moderately material. The results from data-driven weighting are clearer since they show the extremes.

In conclusion, both approaches to weighting the categories have their merits. From our perspective, stakeholder-driven weighting is preferable because it considers the needs and attitudes of each stakeholder group as summarized in Figure 2. However, since the data-driven weighting is not as time intensive, we suggest to use this approach additionally and compare the results afterward. In both cases, the weights are normalized into percentages.

The sustainability indicators have to be weighted within the categories, too, before ultimately being normalized into percentages. The sustainability indicators' weights depend on their contribution to a category's specific assigned goal. For some sustainability indicators, evaluating their contribution to the category goal might be straightforward, e. g., carbon emissions can be quantified. Expert interviews with engineers should be conducted for sustainability indicators within the environmental dimension. Estimating the importance of sustainability indicators within social and corporate governance dimensions might prove more difficult. For some social indicators, expert interviews with doctors, psychologists, and city planners could be helpful. Additionally, we propose conducting a survey among real estate users on what makes them feel comfortable in a real estate property. Interviews should be done with auditors, consultants, lawyers and managers to discover what is most important in the corporate governance dimension.

4.5 Ranking

Before the sustainability of real estate assets can be compared, the assets need to be clustered, because some sustainability indicators and weights vary depending on the real estate use type. For instance, in the COVID-19 crisis, air filtration might be more important in public real estate, e. g., schools, than in private houses. Furthermore, following the literature, we must distinguish real estate assets by their current lifecycle stage (Buyle et al. 2013; Vladimirova et al. 2018; Sharma et al.

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2011; Ristimäki et al. 2013; König and Cristofaro 2012). After all, nearly every new real estate project will appear sustainable compared to an old one, regardless of whether it is truly that sustainable, i. e., when compared to other projects in the same lifecycle stage. Therefore, to ensure that only similar real estate assets are compared, they must be clustered into a grid that differentiates by use type and lifecycle stage. At a minimum, the use types should be separated into private, commercial and public. The lifecycle stage should be differentiated as new, renovated, or old at the very least. Figure 6 displays the planned real estate clustering.

Figure 6

Cluster Grid for Real Estate Properties

Use type	Lifecycle stage			
		New	Renovated	Old
	Private			
	Commercial			
	Public			

Source: Own illustration.

In addition to the distinctions shown in Figure 6, the practice could add further distinctions, e. g., the reason for the assessment. We assume that an assessment's purpose affects its result. For instance, if a bank plans to build new apartment buildings and attempts to acquire investors, the sustainability of the real estate assets is mainly assessed based on exposés. Both circumstances contribute to a relatively high sustainability score because the real estate project is presented in the best light when trying to acquire investors and more generally, when discussed in exposés. In contrast, if the agency responsible for a public real estate property applies for money to remediate its real estate property, the agency would emphasize the property's weaknesses.

After the clusters are determined, real estate within the same cluster can be compared using their ESG score. This comparison could be made by either absolute or relative thresholds. Although relative thresholds suffer from the disadvantage that the best are not necessarily good, this approach has several advantages. First, the evaluation changes over time automatically. When the sustainability of one real estate asset is strengthened, it improves or rather becomes more sustainable relative to other properties. Second, there may be sustainability indicators where data are completely unavailable. In such cases it should not negatively impact on the ESG score. Relative thresholds, are flexible and avoid unattainable goals. Third, when using relative thresholds, we do not have to decide which score is enough to be sustainable. This is precisely the issue with certificates, where simply exceeding a threshold makes real estate sustainable, and details are no longer important. Due to these advantages, we have decided in favor of relative thresholds, i. e., percentiles. Following established databases, we calculate the percentile rank score as follows (Dorfleitner et al. 2020, p. 397; Ronald Rousseau 2012, p. 417):

$$\text{percentile rank score} = \frac{\text{no. of companies with a worse value} + \frac{\text{no. of companies with the same value including the current one}}{2}}{\text{no. of companies with a value}}$$

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The resulting percentile rank scores could be classified, e. g., from A ... to D ..., where A ... represents the best ESG performance and the highest level of transparency and D ... the worst. The exact classification and thresholds depend on subsequent validation.

4.6 Validation of the Metric

At this point, the sustainability indicators have been validated, but their aggregation, weighting, and the ranking have not. The empirical validation of the aggregation, weighting, and ranking is essential to ensure that

1. assessing the sustainability of two or more real estate assets with the same sustainability characteristics leads to identical ESG scores when using our metric;
2. assessing real estate assets with our metric leads to a coherent overall evaluation;
3. ranking real estate assets based on our metric's assessment is comprehensible and corresponds to human perception;
4. valuating also works out-of-sample, i. e., when applied to real estate assets not part of the previous analyses conducted during the metric's development.

For these purposes, additional material on real estate must be collected and analyzed on a larger scale.

5 Conclusion

This paper aimed to present our idea of a concept for a real estate sustainability metric and real estate specific indicators at the asset level. Although there is an increasing demand for sustainable investment products, including real estate, investors suffer from a lack of information regarding the offered products. Moreover, increasing regulations are a driving factor in the need for sustainability indicators.

Although several ESG indicators are found in the literature and various databases, they cannot be used without adjustments due to the peculiarities of real estate, i. e., sector-specific stakeholders, the three assessment levels and the unique lifecycle of real estate properties. Due to these peculiarities, a real estate specific metric for sustainability and sustainability indicators are necessary. Different theoretical and practical approaches to assessing real estate sustainability exist, but these either focused on only one of the three sustainability dimensions or offered a binary evaluation, i. e., "sustainable" or "not sustainable".

For our metric, the triple bottom line served as the basic concept. Developing real estate specific sustainability indicators begins with a literature review to extract the relevant sustainability indicators. These relevant indicators are adapted for real estate and then complemented by real estate specific sustainability indicators. The developed sustainability indicators then have to be weighted based on expert interviews and assigned to categories. As discussed in Section 4.4, the categories could be weighted with either a data-driven or stakeholder-driven approach. We decided on the latter.

These categories, consisting of several sustainability indicators, are assigned to the ESG dimensions. All three levels of our metric are summarized in a checklist. To assess real estate

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sustainability, the checklist users must work through the list and decide, whether there is positive, negative, or no information for each sustainability indicator. Based on the weighted results for each sustainability indicator, the category scores are calculated and combined to determine a dimension score and, ultimately, an ESG score. The ESG scores are then compared based on the percentile rank score.

Our contribution to the literature is the idea of how to develop a concept that provides a transparent and holistic assessment of real estate sustainability. Moreover, our checklist is less complicated than certifications and requires neither expert knowledge nor much time.

The concept of the metric as presented in this paper is limited to the investors' perspective. Further research should be conducted to extend the metric to help even more stakeholder groups, e. g., users. Additionally, the metric is limited to sustainability assessment of assets. Further research must be conducted on aggregating the ESG scores at the asset level to determine an ESG score at the fund or company level. Based on our metric, gap analyses could be conducted with minor modifications, too. Furthermore, our metric could be extended to a concept for real estate sustainability risk assessments that banks and fund managers need.

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Appendix

Table 1

Environmental	Social	Corporate Governance
Access to land	Absenteeism	Anti-competitive behavior, monopoly
Agricultural chemicals	Access to basic services	Anti-competitive practices
Alternative fuels	Access to healthcare	Audit
Animal Welfare	Access to medicine	Audit and control
Announcement of environmental awards	Charity	Board
Beneficial products and services	Child labor	Board diversity
Biodiversity	Clinical trials	Board structure

Table 1 *(Continued)*

Environmental	Social	Corporate Governance
Biodiversity management	Collective bargaining	Bribery and corruption
Biofuels	Community relations	Business ethics
Certification status	Community and society	
Chemical controls	Corporate citizenship/philanthropy	CEO reputation
Chemical or oil spills	Customer relationship	Chair/CEO role
Climate change	Customer satisfaction	Chairperson-CEO separation
Climate change strategy	Diversity	Climate risk management
CO_2 emissions	Education	Codes of conduct
Competence and commitment and policy and goals	Employee development	Committees
Deployment of renewable energy sources	Employee turnover	Compensation of directors[3]
Eco-product/process strategy	Employment	Compliance
Ecosystem service	External social policy	Contributions to political parties
Electromagnetic fields	Health and safety	Corporate governance
Emissions	Health and safety of products	Corruption
Emissions management and reporting	HIV and AIDS	Customer relationship management
End-of-lifecycle impact	HIV programs	Dimension of pending legal proceedings
Energy	Human capital development	Disclosure and reporting
Energy efficiency	Human resources management	Employee representatives
Environmental brochures	Human rights	ESG incentives
Environmental compatibility	ILO core conventions	Ethical behavior
Environmental compatibility of products	Indigenous rights	Ethical economic policy
Environmental evaluation or conditions placed on suppliers	Internal social policy	Extent of stakeholder dialogue
Environmental fines	Knowledge management	Financial inclusion
Environmental impact of the product(s)	Labor practice indicators	Financial robustness
Environmental index based on SO_2, NO_x and COD emissions per production unit	Labor practices	Formal governance policy
Environmental liabilities	Labor standards	Global compact membership
Environmental management	Maturity of workforce	Governance of sustainability issues
Environmental management system	No revenues in alcohol	Independent directors
Environmental performance	No revenues in gambling	Investor relations
Environmental policy	No revenues in gaming	Law suits, fines and penalties
Environmental policy/management	No revenues in nuclear power	Litigation payments
Environmental reporting	No revenues in tobacco	Lobbying
Environmental standards	No revenues in uranium	Management
Environmentally-driven commercial development	No revenues in weapons	Management consulting/auditors
Forests	Nutrition	Nationalities on board

3 There are several indicators that blur between the dimensions. E.g., "remuneration" and "compensation of directors" could be classified as social or corporate governance-related indicator. In this table, we decided to follow the literature and classified "remuneration" as social and "compensation of directors" as corporate governance-related indicator. This classification seems reasonable, because "remuneration" is rather the salary of the employees and influences their wealth, while "compensation of directors" touches the management structure, e.g., by incentives.

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Table 1 *(Continued)*

Environmental	Social	Corporate Governance
GHG emissions	Partnership with subcontractor	Number of board members
GHG policies	Privacy and free expression	Political influence
GMOs	Product safety	Privacy and IT
Green buildings	Public health	Regulatory problems
Green products	Remuneration	Renumeration
Greenhouse gas emissions, scope 1	Restructuring-related relocation of jobs	Reporting quality
Greenhouse gas emissions, scope 2	Security	Responsible marketing
Greenhouse gas emissions, scope 3	Site closure	Risk & crisis management
Hazardous waste	Social and political contribution	Risk & opportunities management
Innovation	Social reporting	Scorecards/measurement systems
Low Carbon	Society	Shareholders
Material and energy consumption	Staff turnover	Shareholder rights
Nature loss	Stakeholder Engagement	Stakeholder engagement
News on environmental investments	Standards for suppliers	Strategic planning
Non-GHG air emissions	Supply chain	Sustainability management and reporting
NO_2 and SO_2 emissions	Supply chain labor standards	Sustainability relations with stakeholders
Organization of the environmental program	Talent attraction & retention	Sustainable finance
Ozone-depleting chemicals	Training & qualification	Systemic risk
Ozone-depleting gases	Unions	Taxes
Packages	Weak governance zones	Transparency
Permit denials or shut-ins	Workforce	UNGC compliance
Pollution control		Whistle-blowing system
Pollution prevention		Women directors
Pounds of toxic chemical emissions		
Product development		
Product opportunities		
Quality of environmental and annual report		
Ratio of toxic waste recycled to total toxic waste generated		
Recovery/recycling		
Recycling		
Regulatory penalty value		
Renewable energy sources		
Resource depletion		
Resource efficiency		
Resource use		
Role of the executive in environmental work		
Substantial emissions		
Supply chain environmental standards		
Toxic spills		
Transportation		
Types of raw materials used		

Table 1 *(Continued)*

Environmental	Social	Corporate Governance
Use of audits		
use of eco-labels		
Waste		
Waste and recycling		
Water		

Compilation of ESG Indicators from the Literature (Alda 2021; Baier et al. 2020; Bassen and Kovács 2020; Beschorner et al. 2020; Chatterji, Aaron K., Levine, David I. and Toffel 2009; Daugaard 2020; Drempetic et al. 2020; DVFA 2008; Fowler and Hope 2007; Hahn and Kühnen 2013; O'Rourke 2003; Park and Jang 2021; Schultze and Trommer 2012; Dorfleitner et al. 2020; Berg et al. 2019).

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