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Mind the Gap: An Evaluation of Indicator Discrepancies between Sustainability Standards and Certifications in the Built Asset Industry

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ABSTRACT:
The built asset industry impacts our global environment significantly, contributing notably to environmental degradation. Various sustainability standards and certifications, such as LEED, DGNB, BREEAM, ISO 14001, and GRI 200 series, have been established to guide the industry toward sustainable practices. Despite their intended purpose, the diversity of these systems has led to a complex and inconsistent landscape. This paper undertakes a review of 25 certifications and 26 standards in the built asset industry, identifying and analyzing gaps and discrepancies in their measuring indicators. Using a rigorous process, we consolidated the diverse measuring indicators from each scheme into a list of 189 specific indicators, for comparative analysis. This analysis revealed notable gaps and inconsistencies within these schemes, illuminating differences in their emphasis and coverage of sustainability indicators. These findings highlight the need for increased standardization and inclusiveness in sustainability assessments within the industry. This study contributes to the discourse on industry standardization, policy decisions, sector transparency, and further research, marking a crucial step towards a more integrated approach to sustainability in the built asset industry.

Keywords: Sustainability, built asset industry, Sustainability standards, Green Building Certification

1. Introduction

The built asset industry, plays a critical role in shaping the world we inhabit. It not only determines the physical characteristics of our built environment but also significantly influences our society's economic, social, and environmental aspects. Despite its importance, this industry is a major contributor to global environmental degradation, responsible for a substantial portion of greenhouse gas emissions, waste production, and resource depletion. Given the urgent need to mitigate these impacts, the sustainability of built assets has become a topic of increasing concern for policymakers, practitioners, and researchers.

In response to this challenge, a wide array of sustainability standards and certifications have emerged worldwide. Examples include the US-based Leadership in Energy and Environmental Design (LEED) to the German Sustainable Building Council's DGNB certification. These initiatives aim to guide the industry towards more sustainable practices. They propose and use a multitude of indicators to measure sustainability performance in areas such as energy use, water conservation, materials sourcing, and indoor environmental quality. However, the diversity and specificity of these standards

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and certifications have resulted in a complex landscape with significant discrepancies in their application, posing challenges for industry professionals and stakeholders. This paper presents the results from a review and comparative analysis of these sustainability standards and certifications within the built asset industry. By examining 25 certifications and 26 standards, we aim to identify and analyse the gaps and inconsistencies in their measuring indicators.

The results of this study can help facilitate industry standardization, inform policy decisions, enhance transparency in the sector, and stimulate further research and innovation. The research also underscores the necessity for a more inclusive and standardized approach to sustainability assessment in the built asset industry. As such, this study contributes to bridging existing gaps and advancing a more holistic approach to sustainability within the built asset industry.

2. Background

2.1 Sustainability in the built asset industry

Sustainability in the built asset industry is an encompassing term, encapsulating environmental, economic, social, and resilience factors. This industry significantly shapes our built environment, contributing meaningfully to reaching global sustainability targets such as the UN's Sustainable Development Goals. Given the industry's substantial environmental impact, it's imperative to infuse sustainability into every stage of the building process. The industry is also expected to foster social value by addressing societal issues and promoting community well-being.

Economic sustainability entails enhancing efficiency and embracing sustainable construction methods, contributing to economic growth. Resilience, particularly considering climate change and economic uncertainties, is equally critical. In essence, the industry's sustainability is a dynamic and evolving concept that requires an integrated approach. Future research should continue to innovate and expand upon the existing knowledge base to foster industry sustainability.

2.2 Sustainability standards and certifications in the built asset industry

Standards and certifications such as ISO 14001 (ISO, 2015), SASB series (SASB, 2018a), GRI series (GRI, 2023), and building-specific initiatives like BREEAM (BRE, 2020), WELL (IWBI, 2016), and LEED (USGBC, 2021) play a crucial role in advancing sustainability within the built environment industry. These frameworks offer organizations ways to effectively manage their environmental impacts and embed sustainability across their operations.

However, the effectiveness of these certifications can vary depending on context-specific factors, including geographical location, local building industry conditions, and existing regulatory frameworks (Giama & Papadopoulos, 2012; Heinrich & Lang, 2019). Despite their differences, all these certifications share a common goal: minimizing environmental impact and promoting sustainable development.

Navigating the complex landscape of these certifications can be daunting, especially when multiple certifications apply to a single project (Sánchez Cordero et al., 2019). Progress is being made, though, with initiatives like the European Union's Level(s) framework (Dodd et al., 2021) that aims to standardize building sustainability certification across EU countries, and Life Cycle Assessment (LCA) methodologies that evaluate the environmental impact of a building throughout its lifecycle (Heinrich & Lang, 2019; Oviir, 2016). The Level(s) framework, represents a pioneering effort to streamline sustainability assessment by focusing on a minimal set of high-impact indicators. This initiative seeks to simplify and clarify the sustainability evaluation process, making it more accessible and impactful for stakeholders across the board (Dodd et al., 2021). These certifications have played a significant role in raising public awareness, inspiring policy development, and driving reductions in energy and CO2 emissions (Giama & Papadopoulos, 2012). They emphasize the importance of integrating sustainability throughout a building's life cycle.

The current landscape of certifications and standards, however, indicates a need for a more streamlined, inclusive, and effective approach to ensure maximum leverage in delivering sustainability. Adopting the principles similar to those of the Level(s) framework across various frameworks could enhance the coherence and impact of sustainability assessments within the built asset industry. This approach would not only address the existing discrepancies among the multitude of standards and certifications but also contribute to a more unified and impactful sustainability strategy in the built asset sector.

3. Methodology

3.1 Explanation of the selection process for the 25 certifications and 26 standards.

To ensure a robust analysis, we selected 25 certifications and 26 standards based on their relevance to sustainability and the built environment for a total of 51 documents. Our selection process initiated with globally recognized frameworks, including BREEAM, LEED, and ISO 14001. We further expanded our pool to involve regional and sector-specific schemes like Klimaaktiv and Green Star, as well as the SASB series. We recognized the importance of human sustainability and occupational health in our selection process, which led us to include certifications like WELL, and Lider A, and standards like ISO 45001. To stay abreast of evolving themes in sustainability, we incorporated emerging certifications and standards such as LEVEL(S), ISO 14090, and the GRI series.

The identification and selection of these specific schemes were not a static process but an evolving one, influenced by continuous engagement with literature related to sustainability certifications and standards within the built asset environment. Each included paper often introduced us to additional schemes. We included these in our list, taking into account our ability to access their updated documents and their relevance to our research scope. This curated and dynamically compiled list, along with a detailed table capturing the geographic scope, domain, and scale for each scheme, provides a structured overview of the sustainability certification and standards landscape.

Table 1: Selected certifications list

Certification Name	Geographic Scope	Domain	Scale
BNB (BNB, 2019)	Germany	Building design, construction, and operation	Asset
BREEAM (BRE, 2020)	UK	Building design, construction, and operation	Asset
DGNB (DGNB, 2020)	Germany	Building design, construction, and operation	Asset
Klimaaktiv (Klimaaktiv, 2019)	Austria	Building design, construction, and operation	Asset
LEED (USGBC, 2021)	USA	Building design, construction, and operation	Asset
CASBEE (IBEC, 2014)	Japan	Building design, construction, and operation	Asset
ENVISION (ENVISION, 2018)	USA	Infrastructure Development	Asset
BCA Green Mark (BCA, 2021)	Singapore	Building design, construction, and operation	Asset
E.E.W.H. (Chuang et al., 2011)	Taiwan	Building design, construction, and operation	Asset
Green Star (GBC, 2020)	Australia & New Zealand	Building design, construction, and operation	Asset
GRIHA (GRIHA, 2021)	India	Building design, construction, and operation	Asset
HK BEAM (BSL, 2021)	Hong Kong	Building design, construction, and operation	Asset
OGNB (OGNB, 2013)	Austria	Building design, construction, and operation	Asset
Green Globes (GBI, 2021)	Canada/ USA	Building design, construction, and operation	Asset
Lider A (Duarte Pinheiro, 2019)	Portugal	Building design, construction, and operation	Asset
WELL (IWBI, 2016)	USA	Health and Wellness in the Built Environment	Asset
LEVEL(S) (Dodd et al., 2021)	EU	Building design, construction, and operation	Asset
NABERS (BRE, 2021)	Australia	Energy Efficiency in Buildings	Asset
MINERGIE (Gugerli et al., 2015)	Swiss	Energy Efficiency in Buildings	Asset
MINERGIE-ECO (Gugerli et al., 2015)	Swiss	Energy Efficiency in Buildings	Asset
GBC HB (GBC Italia, 2016)	Italy	Renovation and use of historic buildings	Asset
Passive House (PHI, 2022)	USA	Energy Efficiency in Buildings	Asset
One Planet (Bioregional, 2020)	Australia	Building design, construction, and operation	Organization
IGBC (IGBC, 2014)	India	Building design, construction, and operation	Asset
ITACA	Italy	Building design, construction, and operation	Asset

Table 2: Selected Standards list

Standards Name	Geo Scope	Domain	Scale
GRI 200 Series (GRI, 2018a)	Global	Economic performance Reporting	Organization
GRI 300 Series (GRI, 2018b)	Global	Environmental impact Reporting	Organization
GRI 400 Series (GRI, 2018c)	Global	Social impact Reporting	Organization
GRI Sector Series (GRI, 2023)	Global	Sector-Specific Sustainability Reporting	Organization
SASB (Construction Materials) (SASB, 2018b)	Global	Sustainability reporting in construction materials industry	Organization
SASB (Products and Furnishings) (SASB, 2018a)	Global	Sustainability reporting in products and furnishings industry	Organization
SASB (Engineering Services) (SASB, 2018c)	Global	Sustainability reporting in engineering services industry	Organization
SASB (Real Estate) (SASB, 2018d)	Global	Sustainability reporting in real estate industry	Organization
SASB (Waste Management) (SASB, 2018e)	Global	Sustainability reporting in waste management industry	Organization
PIEVC (Nodelman et al., 2021)	Canada	Climate Change in Public Infrastructure	Asset
LBC 4.0 (LBC, 2019)	USA	Building design, construction, and operation	Asset
CEN - EN 15978 (CEN, 2018)	Europe	Built Environment Sustainability	Asset
CEN - EN 15804 (CEN, 2020)	Europe	Environmental Assessment of Construction Products	Asset
ASHRAE 189.1 (ASHRAE & USGBC, 2014)	USA	Building design, construction, and operation	Asset

ISO 14001 (ISO, 2015)	Global	Environmental Management	Organization
ISO 14040 (ISO, 2006a)	Global	Life Cycle Assessment (LCA)	Asset
ISO 14044 (ISO, 2006b)	Global	Life Cycle Assessment (LCA)	Asset
ISO 14090/14091 (ISO, 2019a)	Global	Climate change adaptation in an organization	Organization
ISO 26000 (ISO, 2010)	Global	Social Responsibility in Organizations	Organization
ISO 45001 (ISO, 2018b)	Global	Occupational Health and Safety	Organization
ISO 37101/37104 (ISO, 2016)	Global	Sustainable Development in Communities	Organization
ISO 20887 (ISO, 2020)	Global	Buildings and civil engineering works	Asset
ISO 15392 (ISO, 2019b)	Global	Building construction	Asset
ISO 37120 (ISO, 2018a)	Global	Sustainable Development in Communities	Organization
ISO 21930 (ISO, 2007)	Global	Environmental Assessment of Construction Products	Asset
ISO 21929 (ISO, 2011)	Global	Building construction	Asset

The word clouds, presented below for both certifications and standards, provide a visual representation of the primary focus areas in each category. In certifications, the most recurrent term is "building," signifying the emphasis on built environmental sustainability. In standards, the term "organization" surfaces most frequently, denoting an overarching organizational perspective towards sustainability. The term "building" also manifests notably in the standards, ranking as the eighth most common term, further emphasizing the inherent connection between these selections and the built environment.

Figure 1: Word cloud for each classification document: Left: Certifications, right: Standards

3.2 Extracting data from each scheme

Data extraction from the selected certification and standard schemes involved detailed analysis of all associated official sources and documents. For certifications, data included the official name, country of origin, scope, scale, publication year and updates, ranking method, and measuring categories and indicators. For standard schemes, data encompassed the official name, region, title, scale, scope, years of publication and updates, and categories and indicators. This process provided a solid basis for an informed analysis of sustainability certifications and standards in the built asset industry. The subsequent sections offer deeper comparisons and analyses based on this data.

	Name	Cert M...	Stand for	Count...	Scope	Scale	Y..	Y...	Ranking Method	Website
1	BNB		Bewertungssystem Nachhalti...	Germany	New Bldg Re	Large Scal...	2009	2017	1. Gold 2. Silver 3. Bronze	https://www.bnb-nachha...
2	BREEAM		Building Research Establishm...	UK	New Bldg Re	Large Scal...	1990	2021	OUTSTANDING ≥ 85 EX...	https://bregroup.com/pr...
3	DGNB	DGNB	Deutsche Gesellschaft für Nac...	Germany	New Bldg In	Large Scal...	2007	2020	Bronze: > 50% Silver: > ...	https://www.dgnb.de/en/
4	Klimaaktiv	klimaaktiv		Austria	New Bldg In	Large Scal...	2016	2019	Bronze: >35% Silver: >5...	
5	LEED (USGBC)		Leadership in Energy and Env...	USA	New Bldg In	Small Scal...	1998	2021	Certified (40-49 credits) ...	https://www.usgbc.org/l...
6	CASBEE		Comprehensive Assessment S...	Japan	New Bldg In	Large Scal...	2001	2014	BEE≥3 Excellent (5 Stars...	https://www.ibec.or.jp/C...
7	ENVISION			USA	Infrastructu...	Large Scal...	2012	2018	Verified: 20% Silver: 30...	https://sustainableinfrast...
8	BCA Green Mark		Building and Construction Au...	Singapore	New Bldg In	Small Scal...	2005	2021	Green Mark Platinum: 9...	https://www1.bca.gov.sg...
9	E.E.W.H.		Ecology, Energy Saving, Wast...	Taiwan	New Bldg Cc	Small Scal...	1999	2011	(i) Qualified (30% of the...	
10	Green Star	greenstar		Australia New	New Bldg In	Large Scal...	2003	2022	1 to 6 stars	
11	GRIHA		Green Rating for Integrated ...	India	New Bldg In	Large Scal...	2007	2019	25-40 points - 1 star 41...	https://www.grihaindia.o...
12	HK BEAM		Hong Kong Building Environ...	Hong Kong	New Bldg		2010	2021	Bronze: at 40% of the cr...	https://www.beamsociet...

Figure 2: A part of extracted data for certification schemes

3.3 Description of the process for consolidating the measuring indicators into a list of 189 specific indicators.

The process of consolidating the measuring indicators into a list of 189 specific indicators required a meticulous approach, underpinned by rigorous data collection, analysis, and validation. The following elucidates this process over 6 sequential steps:

Table 3: Process of consolidating the measuring indicators

Steps	Title	Description
Step 1	Data Extraction & Understanding	Extract the major categories and indicators for each scheme and delve deep into each scheme's documentation to fully understand their unique methodologies.
Step 2	Comparison & Alignment	Identify overlaps, similarities, and potential areas of alignment between the schemes' categories and indicators.
Step 3	Framework Development	Develop separate unified frameworks for certifications and standards based on the identified common indicators.
Step 4	Framework Consolidation & Validation	Integrate the two separate frameworks into a single comprehensive one and validate this unified framework through expert scrutiny and feedback.
Step 5	Refinement & Inclusiveness Testing	Refine the framework iteratively based on feedback, assign specific descriptions to each indicator, and validate the inclusiveness of the merged indicators through a systematic search in all original documents.
Step 6	Documentation	Clearly document the unified framework, the process, and the methodology used, facilitating transparency, reproducibility, and understanding for future users and researchers.

						Date		Comparable criteria (Building Certifications and Standar																
								Energy																
						Year of Publication	Year of last Update/ Revision	Primary energy demand	Flexible demand side response	Energy efficiency/performance	Energy monitoring	Energy metering	Heat requirement/Insulation	Consumption forecast	Building shell airtight / Thermal bridge	Renewable energy	Enhanced Commissioning	Grid harmonization	Energy conservation/ Reduction	Tenancy sub-metering	Power density / Energy intensity	Decentralised energy consumption	Non-renewable alternative Sources	Fleet fuel management
No.	Classification	Scheme Name	Geographic Scope	Domain	Scale			EN 01	EN 02	EN 03	EN 04	EN 05	EN 06	EN 07	EN 08	EN 09	EN 10	EN 11	EN 12	EN 13	EN 14	EN 15	EN 16	EN 17
1		**BNB**	Germany	Built Environment Sustainability	Asset	2009	2017	1		1	1	1	1	1	1	1			1			1		
2		**BREEAM**	UK	Built Environment Sustainability	Asset	1990	2021	1	1	1	1	1	1		1	1		1	1					
3		**DGNB**	Germany	Built Environment Sustainability	Asset	2007	2020	1		1						1	1		1					
4		**Klimaaktiv**	Austria	Built Environment Sustainability	Asset	2016	2019	1		1	1	1	1	1	1	1								
5		**LEED (USGBC)**	USA	Built Environment Sustainability	Asset	1998	2021		1	1	1	1	1	1		1	1	1				1		
6		**CASBEE**	Japan	Built Environment Sustainability	Asset	2001	2014	1		1	1		1			1			1		1	1		
7		**ENVISION**	USA	Infrastructure Sustainability	Asset	2012	2018			1	1					1	1		1				1	1
8		**BCA Green Mark**	Singapore	Built Environment Sustainability	Asset	2005	2021			1			1	1	1	1			1					
9		**E.E.W.H.**	Taiwan	Built Environment Sustainability	Asset	1999	2011									1			1					
10		**Green Star**	ustralia & New Zealan	Built Environment Sustainability	Asset	2003	2022			1		1							1	1	1		1	
11	ons	**GRIHA**	India	Built Environment Sustainability	Asset	2007	2019			1	1	1	1			1			1					

Figure 3: A part of the unified framework including all certifications and standards

The process of consolidating indicators from diverse schemes was iterative, resulting in an inclusive framework. It required deep understanding and interpretation, as well as handling unique challenges like varying descriptions and metrics, or unique indicators. The framework was refined iteratively, using expert feedback to adjust categories. A 'reverse check' ensured all important aspects were included while documenting and communicating the methodology aided transparency.

The resulting unified framework consists of 15 categories and 189 specific indicators, capturing the breadth of sustainability measurement. This flexible and adaptable tool is designed to accommodate changes in the sustainability landscape. New schemes can be incorporated as they emerge, keeping the framework relevant and effective in measuring sustainability in the built asset industry. This implies the need for periodic reassessments and updates, reflecting the dynamic nature of sustainability.

4. Outline of the comparative analysis method used to discern gaps and inconsistencies.

To evaluate sustainability indicators across Green Building Certification Schemes (GBCSs) and standards, we utilized Power BI. Two Excel tables were prepared: "Analytical table 1" recorded the presence (1) or absence (0) of each of the 189 indicators within each scheme, and "Analytical table 2" classified each indicator into one of 15 categories.

These tables were imported into Power BI, where the "unpivot" function transformed the wide format of Table 1 into a more analysable long format. The tables were linked using the "Indicator Code" field, facilitating inter-table analysis. Using Power BI's robust capabilities, we conducted an in-depth analysis, identifying gaps and inconsistencies in the sustainability indicators across the studied schemes.

5. Findings

The comparative analysis of the sustainability standards and certifications yielded intriguing results, revealing important insights about their scopes, areas of emphasis, and the extent to which they cover the sustainability indicators. The findings presented here are structured according to the specific areas of comparative analysis previously outlined.

5.1 Distribution of Indicators across Certification and Standard Schemes

In our data analysis, we evaluated the overall presence and distribution of indicators across the primary groups: Certifications and Standards. Through an exhaustive count of instances where indicators were present, we quantified a total of 2,056 instances distributed across the 51 documents. The breakdown of these instances revealed that 699 (~34%) were associated with Standard schemes and 1,357 (~66%) were linked to Certification schemes. The distribution of instances suggests that Certifications generally incorporate more indicators compared to Standards. However, it's crucial to interpret these figures with an understanding that they represent the quantity of indicators, not necessarily the coverage or comprehensiveness of each scheme. This understanding is fundamental to our study, as it offers an empirical basis for the subsequent comparative analysis and can aid in discerning potential gaps or over-representations in indicator coverage between Certifications and Standards.

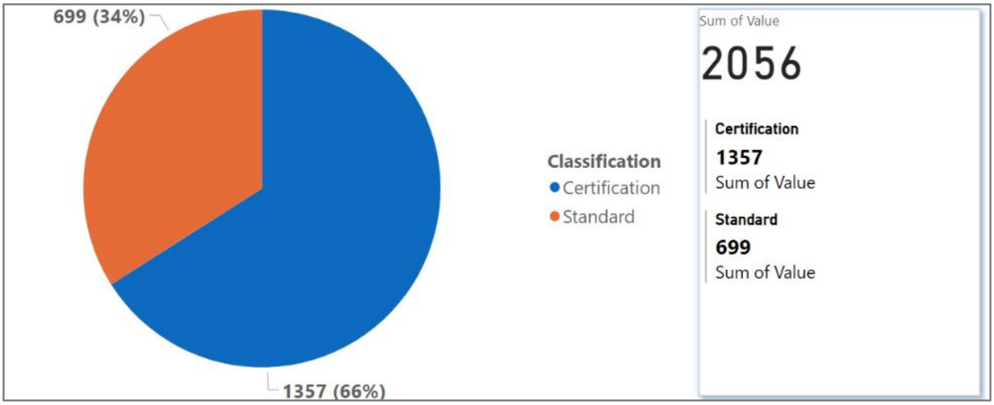

Figure 4: Distribution of indicator instances across certifications and Standards

The figure below presents an overview of indicator instances, broken down by individual scheme names and their respective classifications. This representation aids in understanding the distribution of indicators across different schemes, revealing variances in indicator coverage within and between the Certifications and Standards classifications.

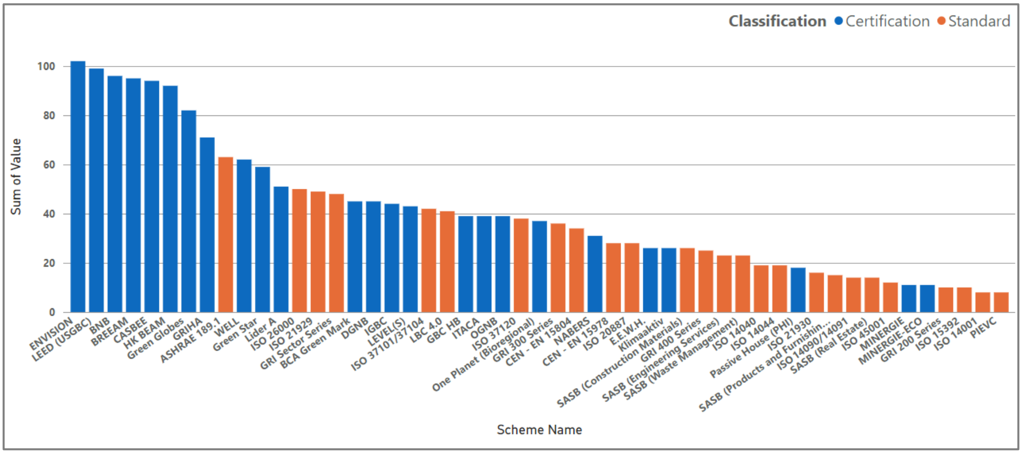

Figure 5: Sum of indicator instances for each certification and standard scheme

5.2 Indicator Distribution Analysis Across Categories and Classifications

In this phase, we delved into the categorization of indicators across the two classifications. This allowed us to observe the distribution of indicators amongst the 15 different categories. This distribution gives us insights into the focus areas of the various schemes and highlights potential areas of expansion or consolidation.

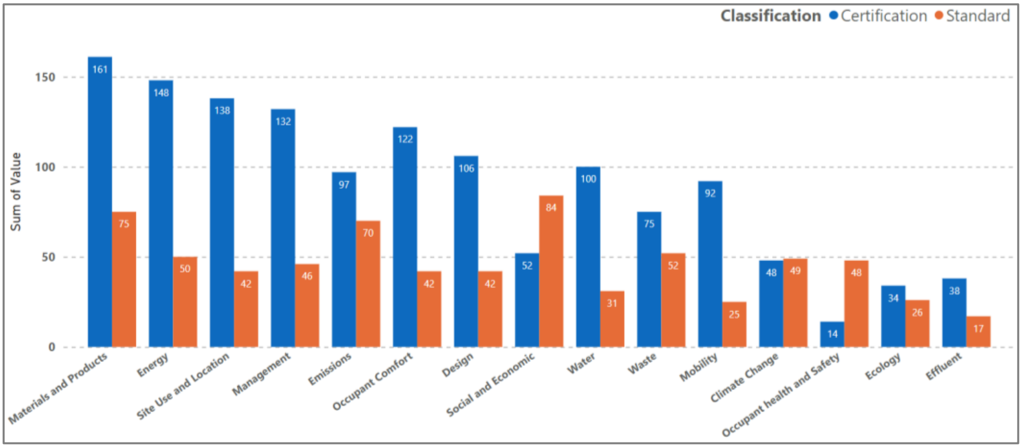

Figure 6: Sum of indicator instances in each category

In the Certifications classification, the category "Materials and Products" emerged with the most indicators, denoting its significant emphasis within Certification schemes. On the other hand, the "Occupant Health and Comfort" category featured the least within this classification, signalling a possible area of lesser focus in Certifications. For the Standards classification, the "Social and Economic" category held the most indicators, underscoring its critical importance within Standard schemes. Conversely, the "Effluent" category demonstrated the least presence, marking a potential area of reduced focus within the Standards.

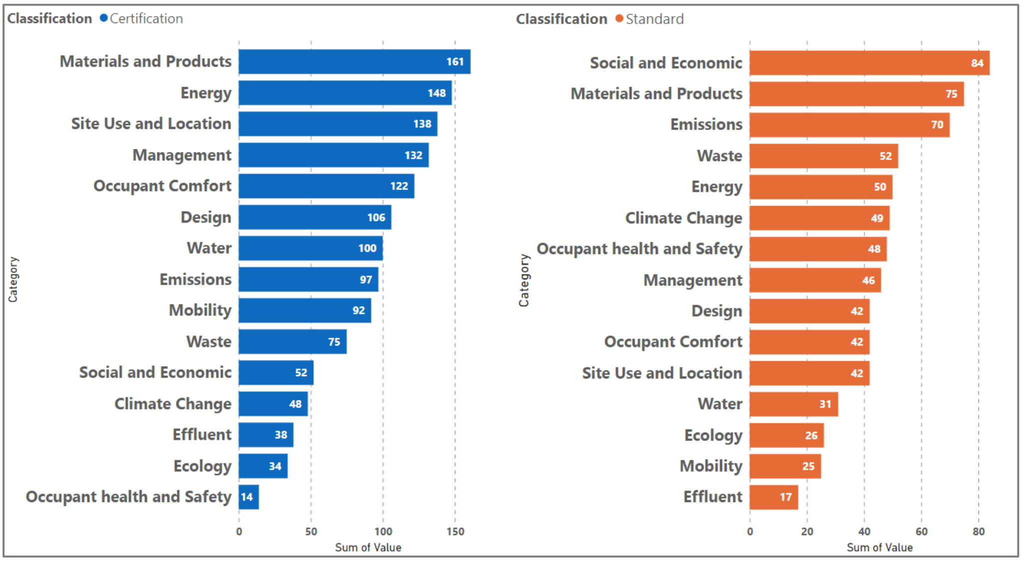

Figure 7: Sum of indicator instances separated by classification (Certifications and Standards)

Interestingly, when observing the sum of indicators across all categories, Certifications generally showcased higher values, except for three notable categories: "Social and Economic," "Climate Change," and "Occupant Health and Safety." In these specific categories, Standards held a more substantial number of indicators, highlighting their relative emphasis on these areas compared to the Certifications. This divergence marks areas of distinct focus for Certifications and Standards, illustrating the unique lenses through which they approach sustainability.

5.3 Analysis of Dominant Indicators

Our analysis reveals intriguing patterns in the coverage of specific indicators across both Certifications and Standards. It was found that the "Reduction of Greenhouse Gas Emission" indicator was the most prevalent across both classifications, boasting a total value of 37. This prominence underscores the widespread recognition and prioritization of reducing greenhouse gas emissions in both Certifications and Standards schemes, likely reflective of the universal environmental concern over climate change.

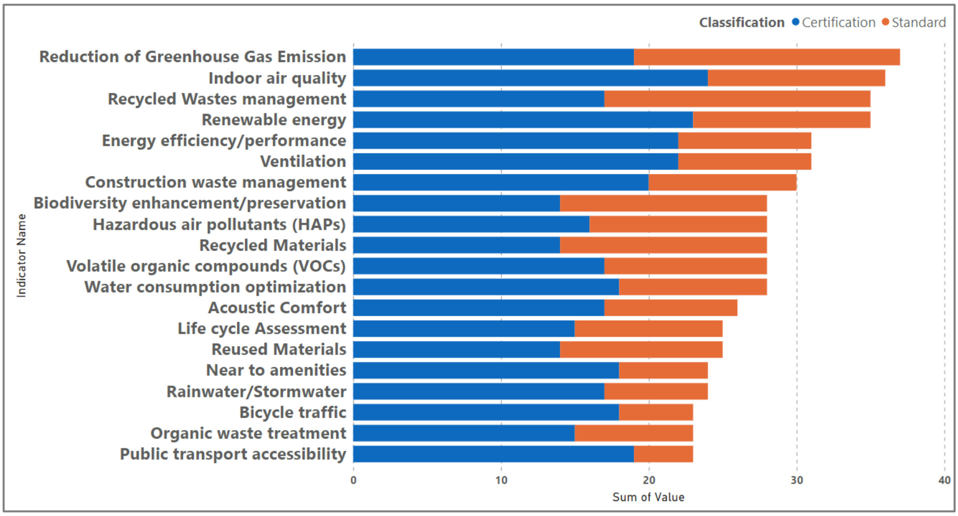

Figure 8: Dominant indicators across both certifications and standards

However, when dissecting the data further into the two distinct classifications, we observed some variations. The Certifications classification was most heavily skewed towards the "Indoor Air Quality" indicator, demonstrating a significant emphasis on internal environmental factors within certification schemes.

Conversely, within the Standards classification, the most common indicator was "Recycled Wastes Management". This prevalence points towards a strong focus on waste management and the circular economy in standard schemes. The different foci highlight the unique characteristics and priorities inherent in each of the Certifications and Standards schemes, all converging towards comprehensive sustainability.

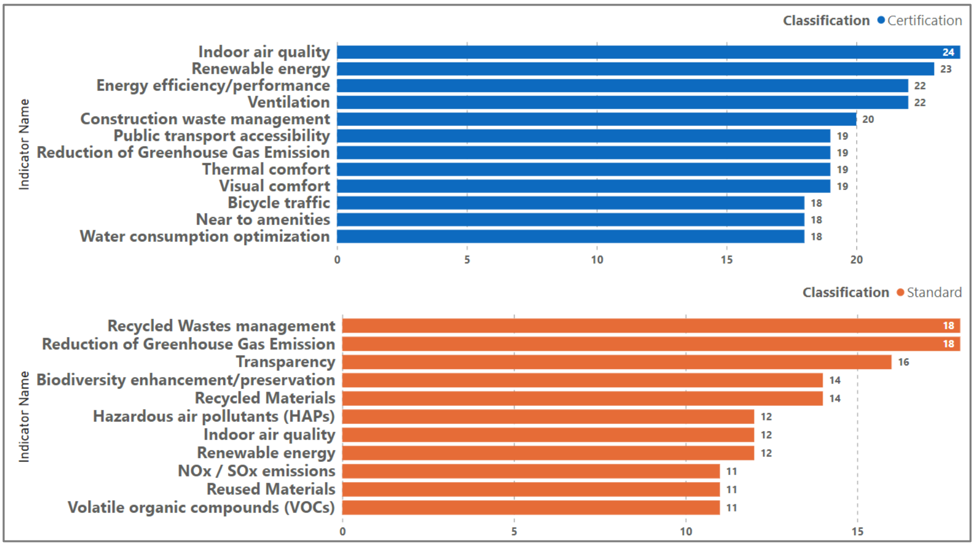

Figure 9: Dominant indicators in each classification

5.4 Analysis of lacking Indicators within Certifications and Standards

Our analysis further extended to identifying those indicators that were unrepresented in each classification - Certifications and Standards - despite being present in the other. This examination produced a set of indicators for each classification that are currently not being addressed within their respective schemes, as illustrated in the ensuing tables. This discrepancy underscores potential areas of improvement and scope for inclusion in order to enhance the comprehensiveness of both Certifications and Standards. Recognizing these unique absences provides an opportunity for the respective schemes to broaden their coverage and further align with the diverse facets of sustainability.

Table 4: Lacking indicators within each classification

Classification	Certification	
Indicator Name	Code	Sum of Value
Anti corruption activities	SE 17	0
Child Labor	SE 11	0
Consumer data protection and privacy	SE 09	0
Exported Energy	EN 20	0
Fatality rate	HS 02	0
Indirect economic impacts	SE 14	0
Ionizing radiation	HS 09	0
landfill releases corrective actions	EF 05	0
Materials for Energy recovery	EN 19	0
Near miss frequency rate	HS 03	0
Operational sites in or near protected area	EC 04	0
Reported cases of Silicosis	HS 04	0
Safety Measurement System for driving	HS 07	0
Significant spills	EF 06	0
Terrestrial acreage disturbed	EC 03	0
Transport of hazardous waste	WS 07	0
Waste facilities near dense population area	EM 08	0
Water bodies affected by water discharges	EF 07	0
Water discharge	EF 01	0
Water withdrawal	WT 02	0
Worker participation on occupational health and safety	HS 10	0
Worker training on occupational health and safety	HS 11	0

Classification	Standard	
Indicator Name	Code	Sum of Value
Decentralised energy consumption	EN 15	0
Development with Transportation Access	MB 09	0
Easy cleaning	MT 08	0
Enhanced Commissioning	EN 10	0
Flexible demand side response	EN 02	0
Grid harmonization	EN 11	0
Home office	DS 11	0
Influence of the user / Interface Technologies	OC 08	0
Joint use of facilities	DS 08	0
Material resiliency	MT 06	0
metering and monitoring/ Digital facility management	MG 15	0
Private space	OC 05	0
Responsible construction practice	MG 04	0
Safe containment in laboratories	HS 05	0
Site assessment	LU 03	0
Site plan	LU 04	0
Small car space	MB 04	0
Space efficiency	DS 01	0
Tenancy sub-metering	EN 13	0
Twin tank system	WT 11	0
Water demand	WT 05	0
Water intensive application	WT 12	0
Water self-sufficiency	WT 10	0
Wildland-urban interface design	DS 12	0

6. Discussion and Conclusion

Our study conducted a thorough analysis of 25 sustainability certifications and 26 sustainability standards within the built asset industry, identifying a list of 189 specific indicators that span a wide range of sustainability dimensions. These dimensions encompass environmental concerns, such as energy efficiency and resource conservation, and extend to social factors, including occupant health, well-being, and broader socio-economic impacts.

Reflecting on the findings in light of the literature review, it is clear that our analysis corroborates existing studies' observations of the diverse and often fragmented landscape of sustainability assessments in the built asset industry. This diversity, as documented in our review, poses challenges to achieving a cohesive and universally accepted approach to sustainability. The literature underscores the necessity for more integrated and comprehensive frameworks, a need that our findings further highlight through the identification of distinct focus areas within certifications and standards.

The comparative analysis between certifications and standards revealed that certifications tend to incorporate a larger number of indicators than standards, with distinct emphases observed in each. Certifications prioritized "Materials and Products," highlighting a focus on responsible sourcing and lifecycle impacts. Conversely, standards more frequently addressed "Social and Economic" aspects, emphasizing the social dimensions of sustainability. These divergences not only align with discussions in the literature regarding the scope and focus of different sustainability frameworks but also underscore the implications of such differences for the industry.

6.1 Implications for the Industry

The prevalence of certain indicators in certifications versus standards has diverse implications for the built asset industry. It indicates a potential fragmentation in how sustainability is approached, with certifications focusing on immediate, project-level impacts and standards addressing broader, systemic changes. This divergence underscores the need for a more integrated approach to sustainability that bridges the gap between specific project outcomes and overall industry progress.

To address these differences, policymakers and industry professionals are encouraged to:

- Foster dialogue and collaboration between the bodies governing certifications and standards to explore opportunities for alignment and mutual reinforcement.
- Advocate for the development of comprehensive sustainability strategies that encompass both the detailed focus of certifications and the broad, systemic perspective of standards.
- Utilize the insights from similar studies to guide the evolution of sustainability assessments, ensuring they remain responsive to the industry's changing needs and contribute effectively to global sustainability goals.

6.2 Limitations of the study

This research navigates the complexities of sustainability in the built asset industry with the acknowledgment of certain limitations. The dynamic nature of sustainability concepts and the evolving landscape of certifications and standards mean that our findings represent a snapshot in time. Moreover, the selection of indicators, may not capture the full spectrum of sustainability concerns relevant to all stakeholders. Future research should continue to explore these areas, aiming to uncover the reasons behind the prevalence of certain indicators and their impact on sustainability outcomes.

In summary, this study offers valuable insights into the complex landscape of sustainability standards and certifications within the built asset industry, highlighting the distinct priorities and focus areas of different schemes. By identifying gaps and inconsistencies, our findings provide a foundation for enhancing transparency, streamlining assessment processes, and fostering a more unified approach to sustainability. This research underscores the importance of continuous dialogue, collaboration, and innovation in refining and harmonizing sustainability certifications and standards.

Ultimately, it contributes to the ongoing effort to promote more sustainable practices and achieve a more sustainable future for the built asset industry.

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