ICSDI 2022
INTERNATIONAL CONFERENCE ON SUSTAINABILITY: DEVELOPMENTS AND INNOVATIONS
February 19 -22, 2022 – Prince Sultan University
Riyadh, KSA

LEED's Contribution to the United Nations' Sustainable Development Goals

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Abstract. Green and sustainable building standards strongly influence sustainable building activities. Therefore, it is essential to assess how current standards contribute to achieving the United Nations' Sustainable Development Goals (SDGs). A comprehensive catalogue is developed, and the analysis of overlaps between the standard and the SDGs is automated through direct content analysis. LEED V4.1 BD+C for New Construction is selected as the leading green building standard globally. Similar to previous work, LEED generates matches with eight SDGs – SDG3 (health), SDG12 (sustainable consumption and production), SDG 11 (sustainable cities) being the highest-ranked, respectively This content analysis is complemented with a qualitative analysis founded on innovation and risk-management theory, to assess the transformative capacity of the standard. The findings indicate that only about 6% of LEED's score calls for positive value creation and transformative change, with most of its credits directed towards the management and reduction of known building instigated environmental risks. The research concludes that while there are overlaps between the LEED credits and the SDGs' topics, further research is needed to validate its contribution to realizing the 2030 Agenda empirically.

1. Introduction

Globally, buildings are some of the largest consumers of energy, water, raw materials and a major contributor to greenhouse gas emissions, water effluents and landfill waste [1–4]. While buildings' environmental consequences need to be managed and reduced, researchers have also focused on studying the potential contributions of buildings in sustainable development efforts, especially with the expected expansion of construction activities in the coming years [5]. From this lens, sustainable buildings move beyond the reduction of energy use, emissions and resource consumption to create socio-economic, cultural and wellbeing benefits [6–9]. Today, the 17 Sustainable Development Goals (SDGs) [10,11] are seen as a unifying framework for studying sustainable development activities and have been successful in aligning efforts of researchers and practitioners in that regard [12]. Researchers have been proactive in studying the 2030 Agenda's goals and targets, their synergies and trade-offs, as well as the contribution of different sectors, tools, technologies, and policies to achieving the SDGs [13–19]. Green building rating systems have gained prominence in the building sector to improve projects' sustainability potential. Public agencies are increasingly institutionalizing green building rating systems to demonstrate their commitment to sustainable development and integrating them into their policy frameworks [20]. The available rating systems have been studied extensively [21–24]. From the available literature, it can be concluded that the LEED is one of the most widely adopted tools, and it

also offers one of the most comprehensive coverage for green building concerns compared to other international or regional systems [21,23].

The alignment of green rating systems, and in specific LEED, and the SDGs is the topic of recent studies. The issuer of the system also that they significantly contribute to attaining the SDGs beyond SDG11 (sustainable cities and communities) and SDG7 (energy) [25]. Alawneh el al. used regional expert assessment through a Delphi method to determine the alignment and level of contribution of LEED-assessed green buildings to the SDGs in Jordan [26]. In the series of studies they published [26–28], it was concluded that LEED criteria could contribute to up to nine SDGs (namely, 3, 6, 7, 8, 9, 11, 12, 13 and 15). In another study, Wen et al. studied how the criteria of two green building rating tools, LEED and DGNG, contribute to the sustainable development goals and their targets [29]. They used a qualitative method to measure the relation between the tools' indicators and the SDGs, and they found that LEED has a contribution value of more than 10% in SDGs 3 (health), 6 (water), 7 (energy), 11 (sustainable cities), 12 (sustainable consumption and production), with significant contributions in individual targets within these goals.

While these publications offer some insights on the topic, they approach the topic with an *a priori* assumption that connections and overlaps must exist and is therefore concerned with quantifying nominal "contributions". However, the alignment measures they propose between the tools such as LEED and the SDGs remain difficult their dependence of expert elicitation processes, and they consider similarities between topics as potential contributions to the achievement of the 2030 agenda. Most importantly, these studies have not studied green building standards' ability to meet the agenda's call for transformative change [26–28,30]. Thus, two key imperative gaps emerge, namely the need for: 1) a replicable and reliable method for identifying overlaps between green building rating tools and the SDGs, and 2) a procedure for identifying the contribution of green building rating tools to the transformative objective of the 2030 agenda.

This reliance on green rating systems requires a critical evaluation of their relevance and potential contribution to SDG achievement. This research addresses these gaps by developing a semi-automated direct content-analysis-based methodology for identifying overlaps between green building rating systems and the SDGs and their targets. A framework for assessing the ability of individual criteria and indicators of green rating systems to contribute to sustainable transformations is developed. LEED® V4.1 BD+C for new construction rating system [31] (shortened to LEED) is selected for this study for its wide adoption and international prevalence [23].

2. Methods

In the analysis of LEED, the intent of the prerequisites and credits is extracted from the tool's published guideline [31]. These concise texts present the objectives and rationale of the specific indicator and are the most aligned, semantically, with the goals and targets of the 2030 agenda. From LEED V4.1 BD+C for New Construction published guideline [31], information for 54 attributes distributed across nine categories (604 words) are extracted. Two main methods are used for the analysis.

2.1. Assessing the overlaps between LEED and the SDGs and their targets

A detailed keyword and subject catalogue is developed to map the overlaps between sustainable building standards and the SDGs. This method was recently employed in several studies to map the contribution of research to the SDGs [32,33], and by academic publishers and indexing, providers to assess the contribution of research institutions and researchers to the topics addressed by the 2030 Agenda [34]. The already-published catalogues are merged [32–36], and improvements are made to ensure the comprehensive coverage of all 169 targets; through the systematic examination of the SDG Data Structure Definition [37] and the official agenda's document [10], using direct content analysis tools.

This is to guarantee that target- and goal-specific keywords and subjects are included. The keywords are then revised to ensure non-overlapping terms between goals, targets and distinction between goal- and target-specific keywords. This is achieved by adding specificity to subjects across SDGs. Synonyms for basic words and terms are identified and marked with asterisks (*) to signal variations, such as pluralization, alternate tenses, and differently spelt words with identical meanings. The open-access R-Studio package is deployed to develop a code that uses the catalog to document and tally matches between the catalog and text files to emulate an automated direct content analysis process.

The R-code results are compared to a qualitative assessment conducted on the texts. In this validation, a selection of textual content from five industry-specific sustainability standards beyond LEED V4.1 BD+C for New Construction are analyzed: namely, LEED for Operation and Management, BOMA BEST V3 for the Universal Category [38], GRESB 2020 Real-Estate for Performance and GRESB for Development and STARS [39]. The five standards' intents are coded based on their overlaps with the goals and targets of the 2030 Agenda, independent of the keyword catalog. The catalog is then developed to ensure the consistency between the code output and the qualitative assessment. The final catalog featured 1,503 keywords distributed across the 17 SDGs, with 564 terms including asterisks. As expected, the catalog entries for each SDG are correlated at a significance level of 0.1% with the text length of the goal and its target in the in the original UN document, and with the number of targets in the goal (with an average of 8.57 words per target and a standard deviation of 2.24 words).

2.2. Studying LEED's transformative sustainable development potential

Three major published frameworks are combined: Fletcher & Goggin's [40] three-step structure for eco-design (product, outcome, and need-focused design), Ceschin & Gaziulusoy's [41] four-step evolution of design for sustainability (product, product-service system, spatial-social and socio-technical system innovation levels), and Dyllick et al.'s [42,43] three-level frameworks for business and product sustainability (risk management and harm reduction with selective improvements, integrated and systemic management and design, and holistic improvements focused on overcoming critical challenges and creating value). The design and organizational perspectives is complemented with risk management theory, explicitly suggesting that more nuanced approaches to sustainability move from a preventative to a precautionary approach to risk (as proposed by Harremoës et al. [44], and synthesized by Cucuzzella [45]). A four-level transformative-potential framework presented in Table 1 is suggested and is used to conduct a qualitative assessment of LEED's credits and prerequisites using an expert-elicitation process [46].

Table 1. Four-Levels sustainable development transformative- capacity framework

	Definition	Approach to sustainability	Approach to risk	Sample signalling keywords
Level 0	"Business as usual"	-	-	-
Level 1	Creating better outcomes through incremental improvements	Harm and negative-impact reduction	Management of a known risk (preventative)	Reduce; manage
Level 2	Creating better outcomes through integrated improvements across the (environmental, social, and economic dimensions	Synergistic triple bottom line management	Integrated approach for managing known risks (preventative)	Promote; conserve
Level 3	Creating 'good' and positive outcomes and public benefits by holistically tackling critical challenges	A holistic and collectivistic approach focused on creating new positive values.	An integrated approach to the identification and management of known risks (preventative) complemented with an exploratory approach based on scenario building (precautionary)	Create; revitalize

* The definition of economy focuses on the provision of economic benefits for a given locality or community

3. Results and discussion

3.1. The overlaps between LEED and the SDGs and their targets

Overall, approximately 21% of the LEED intent texts matched with the catalogue. The text matched with keywords from 8 SDGs and 15 targets. LEED text matches most with keywords from SDG3 (5.46%), followed by SDG12 (4.64%), and SDG11 (3.97%). SDGs 6, 7, 8, 13 and 15 featured matches below 3%. Figure 1 presents these findings. Single LEED credits and prerequisites connected with multiple SDGs, with the 54 intents analyzed creating 66 connections overall: an average of 1.22 SDG-links per credit/prerequisite and a standard deviation of 1.1. The most significant number of connections were also with SDGs 3, 11 and 12. These findings are presented in Table 3, in section 3.2.

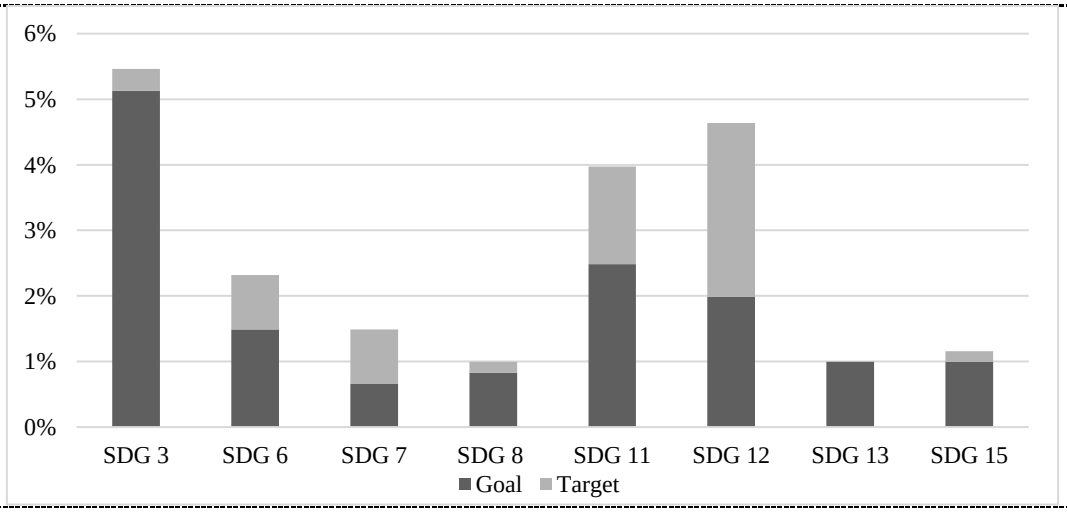

Figure 1. Overlaps between LEED intents and the SDGs and their targets.

From the total, 14.6% of the matches were with goal level keywords (i.e. generic keywords that link to the topic of the SDG but not specific to any of the SDG's targets), and 6.4% matches were with target-level keywords (i.e. keywords that link to the specific topics of the agenda's targets). For example, LEED presents many requirements related to health and wellbeing (both physical and mental), which match with the general topic of SDG 3. However, only a very small number of credits and prerequisites in LEED are linked to SDG 3's targets. In fact, the LEED standard mainly, and rightfully, matched only matched with targets that focus on chemical exposure, as it relates to VOCs in buildings) and tobacco control. Similarly, in SDG 15 and 8, LEED matches with the general topic of the goals but does not address the specific subjects of their targets. Adversely, LEED matches significantly with the targets of SDGs 12, 11 and 7 (by decreasing order, as seen in Figure 1), indicating a more substantial overlap between the concerns of the agenda and potential concrete contributions in the areas of sustainable consumption and production, sustainable cities and energy. Table 2 presents the full matching results between LEED intent texts' and the 2030 agenda's goals and targets.

When comparing the matching or alignment results obtained with that of this Alawneh el al. [26–28] and Wen et al. [29], we find them consistent on the goal level, except SDG 9 (Industrial innovation and infrastructure). Overall, our findings are consistent with previously published work, showcasing close to 90% match on the goal level. This suggests that our computerized content analysis, which is faster and less demanding of human input, effectively replaces quantitative and laborious qualitative methods such as Delphi.

Previous publications have matched transit issues (access and alternative means of transport) and energy to the infrastructure and innovation. Alawneh el al. [26–28] and Wen et al. [29] both matched renewable energy and building-level innovations with the goal, with Wen et al. [29] aligning it to target 9.4. However, target 9.4 is focused on industries and industrial processes, which is beyond the scope of LEED's new construction guidelines. Also, Wen et al. [29] matched transit issues with target 9.1, yet the target's focus is on rural access and transit mode diversification, which are issues that are arguably beyond the scope of building projects assessed by LEED new construction scheme. While issues of transit access are considered in LEED, they arguably align more significantly with SDG 11 and its targets (e.g. target 11.2 that focuses on access to transit). Some of the targets Wen et al. [29] reported as aligned with LEED arguably fall beyond the scope of buildings and construction, such as target 3.4, which aims to reduce premature mortality from non-communicable and chronic illnesses. Additionally, for SDG 15, Wen et al. [29] matched LEED site selection criteria with a multitude of targets. However, the LEED's guidelines only remotely link to the suggested targets, which are more policy and legislation focused on national-level action. Table 2 presents the complete comparison between the results of the R-code content analysis and the findings of Alawneh el al. [26–28] and Wen et al. [29].

Table 2. Overlaps between LEED and SDGs and targets – in this study and published works [26–29]

	Alawneh el al. [26–28]	Wen et al. [29]	This study
SDG 3	✓	✓	✓
3.04		✓	
3.09	**NA**	✓	✓
3.a			✓
SDG 6	✓	✓	✓
6.03		✓	✓
6.04	**NA**	✓	

	Alawneh el al. [26–28]	Wen et al. [29]	This study
SDG 12	✓	✓	✓
12.02		✓	✓
12.04		✓	✓
12.05		✓	✓
12.6		✓	
11.b		✓	
SDG 13	✓	✓	✓

6.05		✓	✓
SDG 7	✓	✓	✓
7.01		✓	
7.02	**NA**	✓	✓
7.03		✓	✓
7.b			✓
SDG 8	✓	✓	✓
8.04		✓	
8.07	**NA**	✓	
8.08			✓
SDG 9	✓	✓	
9.01	**NA**	✓	
9.04		✓	
SDG 11	✓	✓	✓
11.02		✓	✓
11.03		✓	
11.05	NA	✓	
11.06		✓	✓
11.07		✓	✓
11.b		✓	
13.01		✓	
13.02		✓	
SDG 15	✓	✓	✓
15.01		✓	
15.02		✓	
15.03	NA	✓	✓
15.05		✓	
15.08		✓	
15.09		✓	

Shading indicates overlaps in findings

3.2. LEED's transformative sustainable development capacity

Analyzing the LEED's credit and prerequisites intents based on the 4-level framework presented in Table 1, it is found that 38 of the 54 intents are considered level 1, which is only focused on harm reduction and limiting or managing negative impacts mainly in the environmental dimension. About 20% of the connections. Only six intents were found to be advocating for a business as usual (level-0), 7 for triple bottom line management (level-2), and only 3 that are focused on creating new-positive value (level-3). However, when the connections these intents make with the 2030 Agenda is analyzed, it is clear that the six intents assessed at level 0 make the least connections with the SDGs (4.6% of the 66 connections), followed by level-3 intents (7.6%), then level-2 intents (19.7%), and level 1 intents with the highest number of connection (68.1%). Level 2 and 3 intents, which represent an approach to sustainability that moves beyond harm reduction, connect with SDG 3, 11, 13 and 15, with Level 3 intents (creating positive value and highest potential for transformative development) connecting to SDG 3 and 11. These findings are well aligned with the intent of the LEED system as per its issuer [25]. These findings are clear in Table 3.

Table 3. Connections between LEED credits and prerequisites and the SDGs, and their respective sustainable development transformative capacity

	Total	**Level 0**	**Level 1**	**Level 2**	**Level 3**
SGD 3	17		9	5	3
SGD 6	5	1	4		
SGD 7	3	1	2		
SGD 8	6		6		
SGD 11	14		7	5	2
SGD 12	10	1	9		
SGD 13	5		4	1	
SGD 15	6		4	2	
Total	66	3	45	13	5

When looking at the relative score allocated to each of these levels, close to 66% of the available LEED credits are allocated to Level-1 intents, highlighting the standard's focus on reducing negative environmental impact and managing known building-induced risks. Only about 6% of the credits are allocated to potentially transformative intents, and about 25% to triple-bottom-line management intents, which balance between the environmental, social and economic dimensions. This is clear in Figure 2. Appendix A presents the details of the LEED credits and prerequisites that were assessed above level 1.

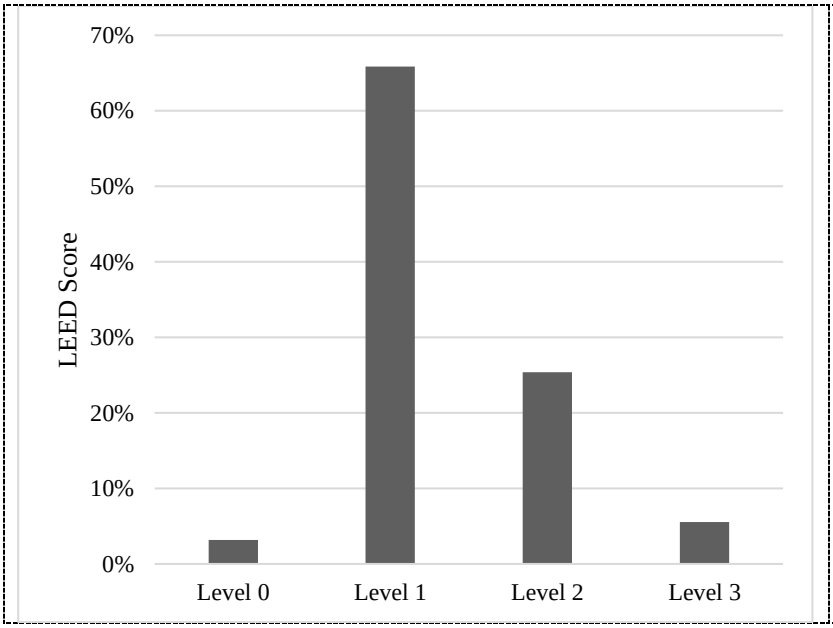

Figure 2. Score allocated in LEED to each of the four levels of sustainable development transformative capacity

The direct content analysis presented confirms the overlaps between LEED and the SDGs and their targets, which were previously reported. However, we arrive at these comparable conclusions using a less laborious semi-automated process. However, the qualitative assessment of LEED's sustainable development transformative capacity highlights a misalignment of the value-driven approaches required to realize the broader transformative vision of the 2030 Agenda. An analysis of possible *relationships* – such as synergies and trade-offs [13,15] or direct or indirect relationships [47] – between different sectors, standards and the 2030 Agenda is needed to provide more clarity and better transparency on their contribution.

4. Conclusion and Recommendations

This study sought to analyze the contribution of LEED V4.1 BD+C for New Construction to achieving the 2030 Agenda, its SDGs and their targets. Two key gaps were identified in the current knowledge on the topic: 1) a replicable and reliable method for identifying overlaps between green building rating tools and the SDGs, and 2) a procedure for identifying the contribution of green building rating tools to the transformative objective of the 2030 agenda.

This research answers the first gap by designing, developing, and validating a clear and replicable methodology for analyzing overlaps between sustainable building standards and the SDGs, using a direct content analysis approach used by researchers [32,33] and publishers [34] for this purpose. The research uses the target-level catalog developed to study intents of LEED credits and prerequisites. It arrives at findings in line with the published work by Alawneh el al. [26–28] and Wen et al. [29]. The main findings are:

- 14.6% of the matches were with goal level keywords (i.e. generic keywords that link to the topic of the SDG but not specific to any of the SDG's targets), and 6.4% matches were with target-level keywords (i.e. keywords that link to the specific topics of the agenda's targets).
- Highest matches are for SDG3 (5.46%), followed by SDG12 (4.64%), and SDG11 (3.97%). SDGs 6, 7, 8, 13 and 15 featured matches below 3%.

The research addressed the second gap by proposing a 4-levels framework for assessing building standards' sustainable development transformative capacity. It was found that

- more than 50% of LEED's credits and attributes are focused on harm reduction and management of environmental risks posed by buildings.
- Only six intents were found to be advocating for a business as usual (level-0), 7 for triple bottom line management (level-2), and only 3 that are focused on creating new-positive value (level-3).
- The score distribution of the standard follows the same trend.

The research findings complement the available work on the topic: highlighting that overlaps in topics between LEED and the SDGs do not automatically translate to contribution to the 2030 Agenda – when there are disparities in the approach to sustainability and risk management.

We recommend that building and real estate researchers use evidence-based approaches, case studies, and control trials to validate theoretical contributions (i.e. those that fall beyond direct topic/subject matches) to serve policymakers and practitioners better. Ultimately, we propose that more transformational, contextual, and comprehensive standards [48] that are fundamentally designed around the SDGs are needed for the industry to contribute to the 2030 Agenda meaningfully.

5. Appendix A: Credits and prerequisites moving beyond harm reduction and their analysis

Category	Name	Score	Transformative potential	SGD 3	11	13	15	3.09	11.02	11.07
Location and Transportation	LEED for Neighborhood Development Location	16	2	X	X					
Location and Transportation	High Priority Site	2	3	X	X					
Location and Transportation	Surrounding Density and Diverse Uses	5	2	X	X		X		X	
Location and Transportation	Access to Quality Transit	5	2	X	X	X		X	X	
Location and Transportation	Bicycle Facilities	1	2	X	X				X	
Sustainable Sites	Open Space	1	3	X	X					X
Sustainable Sites	Light Pollution Reduction	1	2				X			
Indoor Environmental Quality	Daylight	3	2	X						
Indoor Environmental Quality	Quality Views	1	2		X					
Regional Priority	Regional Priority: Specific Credit	4	3	X						

6. References

1. World Economic Forum. Environmental Sustainability Principles for the Real Estate Industry. Cologny: World Economic Forum; 2016.
2. Rashid AFA, Yusoff S. A review of life cycle assessment method for building industry. Renew Sustain Energy Rev. 45:244–8.
3. Willmott Dixon. Briefing Note 33: The Impacts of Construction and the Built Environment. 2010.
4. Laboratory LLN. Energy Flow Charts [Internet]. LLNL; 2014 [cited 2015 Dec 11]. Available from: https://flowcharts.llnl.gov/
5. United Nations - Department of Economic and Social Affairs Population Division. World Urbanization Prospects: The 2018 Revision (ST/ESA/SER.A/420). New York: United Nations; 2018.
6. Goubran S, Masson T, Caycedo M. Evolutions in Sustainability and Sustainable Real Estate. In: Walker T, Krosinsky C, Hasan LN, Kibsey SD, editors. Sustainable Real Estate. Cham, Switzerland: Palgrave Macmillan; 2019. p. 11–31. (Palgrave studies in sustainable business in association with Future Earth).
7. Sustainable Development Solutions Network Thematic Group on Sustainable Cities. The Urban Opportunity: Enabling Transformative and Sustainable Development. New York, NY: Sustainable Development Solutions Network; 2015.
8. Intergovernmental Panel on Climate Change. Climate Change 2014 Mitigation of Climate Change: Summary for Policymakers and Technical Summary. Edenhofer O, Pichs-Madruga R, Sokona Y, Minx JC, Head EF, Kadner S, et al., editors. Climate Change 2014 Mitigation of Climate Change. Part of the Working Group III Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press; 2014.
9. Bulkeley H. Cities and Climate Change. Abingdon, UK: Routledge; 2013.
10. United Nations. Transforming our world: The 2030 agenda for sustainable development. New

York, NY: United Nations; 2015.
11. The World Business Council for Sustainable Development. SDG Sector Roadmaps. Geneva, Switzerland: WBCSD; 2018.
12. Pedersen CS. The UN Sustainable Development Goals (SDGs) are a Great Gift to Business! In: Procedia CIRP. Copenhagen, Denmark; 2018. p. 21–4.
13. Fuso Nerini F, Tomei J, To LS, Bisaga I, Parikh P, Black M, et al. Mapping synergies and trade-offs between energy and the Sustainable Development Goals. Nat Energy. 3(1):10–5.
14. Salvia AL, Leal Filho W, Brandli LL, Griebeler JS. Assessing research trends related to Sustainable Development Goals: Local and global issues. J Clean Prod. 208:841–9.
15. Kroll C, Warchold A, Pradhan P. Sustainable Development Goals (SDGs): Are we successful in turning trade-offs into synergies? Palgrave Commun. 5(1):1–11.
16. Nilsson M, Griggs D, Visbeck M. Policy: Map the interactions between Sustainable Development Goals. Nature. 534(7607):320–2.
17. Yeeles A. Sustainable development and climate goals. Nat Clim Chang. 9(7):497–8.
18. Maes MJA, Jones KE, Toledano MB, Milligan B. Mapping synergies and trade-offs between urban ecosystems and the sustainable development goals. Environ Sci Policy. 93:181–8.
19. Tjoa AM, Tjoa S. The Role of ICT to Achieve the UN Sustainable Development Goals (SDG). In: Mata FJ, Pont A, editors. ICT for Promoting Human Development and Protecting the Environment. Cham: Springer International Publishing; 2016. p. 3–13. (6th IFIP World Information Technology Forum, WITFOR 2016).
20. Cole RJ. Building environmental assessment methods: redefining intentions and roles. Build Res Inf. 33(5):455–67.
21. Doan DT, Ghaffarianhoseini AA, Naismith N, Zhang T, Ghaffarianhoseini AA, Tookey J. A critical comparison of green building rating systems. Build Environ. 123:243–60.
22. Díaz-López C, Carpio M, Martín-Morales M, Zamorano M. A comparative analysis of sustainable building assessment methods. Sustain Cities Soc. 49(February):101611.
23. Bernardi E, Carlucci S, Cornaro C, Bohne RA. An Analysis of the Most Adopted Rating Systems for Assessing the Environmental Impact of Buildings. Sustainability. 9(7):1226.
24. Liu, Chen, Chou. Comparison of Assessment Systems for Green Building and Green Civil Infrastructure. Sustainability. 11(7):2117.
25. Czerwinska D. Green building: Improving the lives of billions by helping to achieve the UN Sustainable Development Goals [Internet]. Green building & the Sustainable Development Goals. 2017 [cited 2019 Jun 3]. Available from: https://www.worldgbc.org/green-building-sustainable-development-goals
26. Alawneh R, Ghazali F, Ali H, Asif M. A new index for assessing the contribution of energy efficiency in LEED 2009 certified green buildings to achieving UN sustainable development goals in Jordan. Int J Green Energy. 16(6):490–9.
27. Alawneh R, Ghazali F, Ali H, Sadullah AF. A novel framework for integrating United Nations Sustainable Development Goals into sustainable non-residential building assessment and management in Jordan. Sustain Cities Soc. 49(May):101612.
28. Alawneh R, Mohamed Ghazali FE, Ali H, Asif M. Assessing the contribution of water and energy efficiency in green buildings to achieve United Nations Sustainable Development Goals in Jordan. Build Environ. 146(September):119–32.
29. Wen B, Musa SN, Onn CC, Ramesh S, Liang L, Wang W, et al. The role and contribution of green buildings on sustainable development goals. Build Environ. 185(Iii):107091.
30. Roostaie S, Nawari N, Kibert CJ. Sustainability and resilience: A review of definitions, relationships, and their integration into a combined building assessment framework. Build Environ. 154(February):132–44.
31. The U.S. Green Building Council. LEED v4.1 Building Design and Construction. Washington, D.C.: USGBC; 2020.

32. Körfgen A, Förster K, Glatz I, Maier S, Becsi B, Meyer A, et al. It's a Hit! Mapping Austrian Research Contributions to the Sustainable Development Goals. Sustainability. 10(9):3295.
33. Mori Junior R, Fien J, Horne R. Implementing the UN SDGs in Universities: Challenges, Opportunities, and Lessons Learned. Sustain J Rec. 12(2):129–33.
34. Elsevier, SciDev.Net. Sustainability Science in a Global Landscape. 2015.
35. The UN Sustainable Development Solutions Network. Compiled Keywords for SDG Mapping. SDSN; 2017.
36. The UN Sustainable Development Solutions Network. Universities and the SDGs [Internet]. SDSN; 2017 [cited 2020 May 15]. Available from: http://ap-unsdsn.org/regional-initiatives/universities-sdgs/
37. United Nations. Guidelines for the Global Data Structure Definition for Sustainable Development Goals Indicators. United Nations; 2019.
38. The Building Owners and Managers Association. Application Guide: BOMA BEST Sustainable Buildings 3.0. Ottawa, ON: BOMA Canada; 2018.
39. The Association for the Advancement of Sustainability in Higher Education. STARS Technical Manual. V2.2. AASHE, editor. Philadelphia, PA: AASHE; 2019.
40. Fletcher KT, Goggin PA. The Dominant Stances on Ecodesign: A Critique. Des Issues. 17(3):15–25.
41. Ceschin F, Gaziulusoy I. Evolution of design for sustainability: From product design to design for system innovations and transitions. Des Stud. 47:118–63.
42. Dyllick T, Muff K. Clarifying the Meaning of Sustainable Business: Introducing a Typology From Business-as-Usual to True Business Sustainability. Organ Environ. 29(2):156–74.
43. Dyllick T, Rost Z. Towards true product sustainability. J Clean Prod. 162:346–60.
44. Harremoës P, Gee D, MacGarvin M, Stirling A, Keys J, Wynne B, et al., editors. Late lessons from early warnings: the precautionary principle 1896–2000. Luxembourg: European Environment Agency; 2001. (Environmental issue report).
45. Cucuzzella C. Creativity, sustainable design and risk management. J Clean Prod. 135:1548–58.
46. Morgan MG. Use (and abuse) of expert elicitation in support of decision making for public policy. Proc Natl Acad Sci. 111(20):7176–84.
47. Goubran S. On the Role of Construction in Achieving the SDGs. J Sustain Res. 1(2).
48. Brandon PS, Lombardi PL, Shen G. Future challenges in evaluating and managing sustainable development in the built environment. Chichester, West Sussex: Wiley-Blackwell; 2017.