ANALYZING LEED SCORING SYSTEM BASED ON THE PRIORITIES IN URBAN HOUSING SUSTAINABILITY LITERATURE

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Abstract. There are several tools developed to evaluate the sustainability of buildings, some of which are used internationally. However, their efficiency has been questioned. Several research studies these Sustainability Assessment Tools (SAT) from various perspectives. Nevertheless, only a few have studied the prioritization of SAT indicators based on the recent literature. Paying special attention to urban housing, this research follows the method and data from two previous investigations (parts of the same project) to evaluate the prioritization of credits used in LEED v4 for Homes Design and Construction, one of the most advanced and internationally adopted certificates for urban housing, to see to what extent its scoring system (i.e., the points that are assigned to its credits) is aligned with the priorities existing in the recent literature related to urban housing sustainability. The data from a systematic review of 118 Scopus-indexed papers are used. The results highlight significant differences in the prioritization of factors between the LEED evaluation system and the recent literature. It is suggested to complement this evaluation with the priorities existing in other world-scale urban housing assessment methods (e.g., lifecycle assessments) to have a comprehensive overview of the optimal prioritization of indicators for international SATs.

Keywords: sustainable urban housing, sustainability assessment tools, green building rating system, LEED certificate

1. Introduction

Buildings are often linked with substantial primary investment costs, long-lasting core construction components and integrated construction goods, relatively shorter-lasting technical support installations and systems, and highly complex and interdependent functioning systems (Tomšič and Šijanec Zavrl, 2018). They have diverse local and universal economic and social effects during their entire life cycle. Besides affecting the nearby area, they as well contribute significantly to producing the environmental load and have an impact on end-users wellbeing (De Carvalho *et al.*, 2017; Ding, 2008; Zujo *et al.*, 2017). As an example, in the European Union, the building industry is one of the sectors with the biggest effects on the environment, as it emits 35 percent of greenhouse gases uses 42 percent of the energy and half of the materials that are harvested, consumes about one-third of the water, and produces the same amount of the trash (European Commission, 2014). A significant portion of these effects are specifically attributable to residential buildings, and it is likely that these percentages will rise in the future years (https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20200626-1).

Considering the challenges associated with the built environment, and in order to find some solutions for urban spaces that can boost the social capacity of the community (Sanei *et al.*, 2018), the need to reach sustainable development becomes more and more necessary in cities (Khodadad and Sanei, 2016). Thus, on a global scale, every country strives to guarantee that all sustainability-related objectives are realized as portrayed in the 2030 UN Sustainable Development Goals (SDGs) framework (Owusu-Manu *et al.*, 2021), in which target 11.1 specifically deals with the social, economic, and environmental sustainability goals for the housing sector (Adabre *et al.*, 2022).

To achieve sustainable development in urban housing, as a dynamic procedure (Shen *et al.*, 2011), a holistic approach including all sustainability dimensions (i.e., social, economic, environmental, and institutional) is required (Ogunsanya *et al.*, 2022; Debrah *et al.*, 2020). Numerous factors can influence urban housing sustainability, each of which is imposed by a specific sustainability dimension. A comprehensive list of these factors is established in (Sanei *et al.*, 2022a, 2022b, 2022c). For instance, security and safety (Karji *et al.*, 2019; Woo *et al.*, 2018), the opportunity for social interaction (Gan *et al.*, 2019; Adabre *et al.*, 2020), and aesthetical excellence (Olanrewaju *et al.*, 2018; Nguyen *et al.*, 2019) are some factors related to social (and/or cultural; social and cultural systems are in a tight two-sided connection (Sanei *et al.*, 2017) and sometimes it can be hard to separate them due to having common aspects (Chiu, 2004)) aspects of sustainability. Likewise, the building's lifecycle costs (Soyinka and Siu, 2018; Arkhangelskaya and Arkhangelskaya, 2020), financial or investment measures (e.g., subsidies, financial support options, etc.)' (Saldaña-Márquez *et al.*, 2018; Zasada *et al.*, 2020), and affordable rental or purchase expenses (Ruiz-Pérez *et al.*, 2019; Ignjatovic *et al.*, 2018) are some examples of economic-linked criteria. As instances of environment-conscious principles, which are as well needed to achieve sustainable architecture (Khodadad *et al.*, 2018), natural resource consumption rate or energy efficiency of the building or equipment (Lorek and Spangenberg, 2019; Kaoula and Bouchair, 2020), building envelope (Kapedani *et al.*, 2019; Cheng *et al.*, 2019) and carbon footprint of the building (Asad Poor *et al.*, 2018; Shama and Motlak, 2019) can be named. Finally, the fourth dimension of "institutional sustainability", which encompasses elements like law and regulation, governance, and contracts

(Braulio-Gonzalo *et al.*, 2022) is essential to attaining the three previously mentioned pillars of sustainability (Adabre *et al.*, 2022). In this regard, housing-related policies and decision-making processes (Tupenaite *et al.*, 2017; Suttiwongpan *et al.*, 2019), building codes and standards (Verovsek and Juvancic, 2018; Yuliastuti *et al.*, 2020), and type of tenure (e.g., private or public ownership, etc.) (Wittmann *et al.*, 2019; Mou *et al.*, 2017) are some examples.

All of the aforementioned traits unequivocally lead to the necessity of treating buildings holistically, particularly from the perspective of assessment. In order to do this, many Sustainability Assessment Tools (SAT; also called Green Building Rating Systems (GBRS)) have been developed over the past few decades and have subsequently been examined from various angles (Haapio and Viitaniemi, 2008; Lazar and Chithra, 2021a). The Building Research Establishment Environmental Method (BREEAM) was the initial contribution as a building SAT (Suttie, 2017). Since then, various organizations have developed additional assessment tools. Although some SATs have been tailored to particular areas or nations to fulfill their particular and contextual needs (Lazar and Chithra, 2021a), there are some which are applicable internationally (e.g., LEED (https://www.usgbc.org/leed/), BREEAM (https://www.breeam.com/), DGNB (https://www.dgnb.de/en/council/certification/)).

As a result, a significant number of SATs are now in use worldwide, some of which have even broadened their use to the urban/neighborhood setting. These voluntary tools involve multiple indicators, in different themes such as energy, water, and transport, to assess the associated effects of buildings (e.g., environmental, social, and economic impacts) throughout their lifecycle.

There are numerous reviews done by researchers to study the characteristics of building SATs. Haapio and Viitaniemi (2008) made the first attempt to examine the SATs in greater depth. They categorized the tools according to some general measures in order to analyze the distinctions between them. After their study, more research has been published as new tools have been created. Considering the recent research, Bernardi *et al.* (2017) examined six of the most used SATs to find out their general characteristics and the categories present in each tool. Illankoon *et al.* (2017), in their analysis of the categories used in eight internationally adopted SATs, discovered that energy, water, and the quality of indoor environment were the most prevalent. A study of five tools by Mattoni *et al.* (2018) showed that from the six defined common factors of sustainability, energy was the highest-weighted factor, while water had the lowest weighting. In their study of fifteen SATs, some of which were adopted in Asian regions, Shan and Hwang (2018) categorized the indicators in seven classes and found out that again energy had the highest prioritization, followed by the building's site and indoor environment. From a different point of view, Kylili *et al.* (2016) investigated Key Performance Indicators (KPI) in building renovation projects. Their findings, as well, illustrated that the environmental category is the most popular one, with an emphasis on the energy, climate, and waste management subclasses.

On the other hand, determining how indicators are taking into account the sustainability dimensions is one of the key concerns within the literature. There have been some attempts to revise research based on this concern. Doan *et al.* (2017) studied four SATs to identify the level of prioritization of sustainability aspects (environmental, social, economic, and also institutional) in each tool. Their findings revealed that while the social aspect is prioritized in urban/ neighborhood plans, the environmental aspect is the major emphasis in building schemes. In parallel to the results of an investigation of thirteen SATs by Braulio-Gonzalo *et al.* (2015), both researches came to the conclusion that economic and institutional elements should be supported to increase the capacity of SATs. Lazar and Chithra (2021b), in their study of SATs applied to houses in India, discovered that all three sustainability aspects were evenly weighted, with a tiny higher weighting given to the environmental dimension. According to Awadh's analysis of four SATs and their credit weightings, the environmental concerns are the ones that are most frequently addressed across the tools, followed by the social, procedural, and economic aspects (Awadh, 2017).

Although some efforts have been made to explore the balance of the sustainability dimensions, and also the scores and prioritization of factors used in building SATs, to our knowledge very few studies have evaluated the prioritization of their evaluation factors/credits based on the recent approaches existing in the literature. In this regard, recently and with a novel approach, Sanei (2022) compared the prioritization of indicators used in the BREEAM international certificate, which is being used in the urban housing sector in various regions of the world, with the priorities that emerged from a comprehensive review of recent literature. The results show a huge difference between the prioritizations used in the BREEAM weighting system and the existing priorities in the recent literature. We use the same approach and method to analyze LEED, another important SAT.

2. Research aim and question

The present paper tries to evaluate the weighting of indicators (credits) used in LEED, as the most applied SAT in the building sector throughout the world, to answer the question of "how is the prioritization of LEED credits compared with the recent trends (prioritization of factors affecting urban housing sustainability) in the literature"?

3. Materials and methods

This paper uses the data from a recent study, which is a systematic review of 118 recent (2015-2020) literature indexed in Scopus (Sanei *et al.*, 2022a, 2022b). The structure of the literature review can be seen in Fig. 1. The results of this literature review define 98 factors (i.e., categories of indicators) that play roles in the sustainability of urban houses (see Table 1). The factors are prioritized based on their Investigation Frequency (IF) which is the number of references mentioning each factor –for example, if 10 papers, out of the total 118, mention a factor in their texts, the IF for that factor is equal to s10. IF is used as a coefficient showing the degree of importance each factor has gotten according to the recent related literature. More detailed information about the methodology of the literature review can be found in (Sanei *et al.*, 2022a, 2022b). To evaluate the prioritization of credits used by LEED v4 for Homes Design and Constructions in its scoring system, we have used the factors and their IFs from the literature review. Likewise, the same methodological approach used by Sanei (2022) is implemented in our evaluation.

Table 1. Prioritized list of factors influencing the sustainability of urban houses based on their investigation frequencies (Sanei *et al.*, 2022a, 2022b)

No.	Factors Influencing the Sustainability of Urban Houses	IF
F1	Natural resource or energy consumption/efficiency of the building/equipment (during the construction, operation, etc.)	87
F2	Materials performance (durability, cost, thermal capacity, permeability, ability to re-use, recycled, eco-friendly materials)	78
F3	Access to public services/infrastructure: availability/quality of services and/or distance/time of travel time to the services (public transport, education/health/shopping/leisure facilities, parks, etc.)	72
F4	Building spatial layout (size and dimensions, building form, internal space distribution, etc.)	72
F5	Location – Site – Development land	67
F6	Healthy conditions (hygiene, clean environment, air/water quality, mental health, etc.)	66
F7	Housing affordable purchase/rental/mortgage costs (market value, relation to household income)	66
F8	Waste management/facilities (waste recycle/reduction, appropriate disposal of waste, etc.)	62
F9	Safety and security	59
F10	Building equipment/technologies (heating/cooling systems, ventilation systems, kitchen appliances, furniture, etc.)	56
F11	Rehabilitation/refurbishment of the building/community (repairing the deteriorations, functional improvements, etc.)	53
F12	Building envelope (thermal performance of the building, insulation, air tightness/exchange, etc.)	52
F13	Indoor environment (air quality, humidity, mold, thermal comfort, air circulation, etc.)	49
F14	Carbon footprint – GHG emissions	48
F15	Water management (consumption rate, irrigation systems, recycling, etc.)	48
F16	Use of renewable/clean resources (solar, wind, geothermal, renewable material, etc.)	47
F17	Opportunity for social cohesion/integrity/interaction/connectivity (common use areas, facility sharing, etc.)	46
F18	Re-use/recycle (materials, water, waste, etc.)	43
F19	Housing-related policies/strategies/guidelines/plans/decision-making procedures	41
F20	Building's basic services (safe drinking water availability, access to electricity, sewer, sanitation, etc.)	40
F21	Noise level – Acoustic design – Aural comfort	40
F22	Building codes/energy standards/technical specifications/regulations	40
F23	Investment/finance measures (subsidies, financial risk/support options, Investment cost, return of investment, payback period, profitability, cost-benefit data, budget adaptability)	39
F24	Pollution (air, water, land)	37
F25	Climatic/microclimatic conditions (air temperature, humidity, wind speed, solar radiation, heat island effect, etc.)	37
F26	Land use (Mixed-use building/community, zoning plans, re-using a developed area instead of new developments, land use change, amount of land supplied, etc.)	36
F27	Natural light – Solar radiation (availability, intensity, etc.)	35
F28	Built-up density	35
F29	Building typology (single-family, attached, apartment, etc.)	35
F30	Flexibility/adaptability (design, construction, function)	35
F31	Neighborhood spatial layout (street layout and network, space between blocks, pedestrian paths, open space layout, human scale features, public furniture, disables accessibility, etc.)	34
F32	Construction method/techniques/technologies (prefabrication, light/heavy structure, energy efficient techniques, traditional method, etc.)	34
F33	Passive/green/low-energy/near-zero-energy/plus energy design/principles	34
F34	Lighting systems (indoor lights, street lights, open space lights, etc.)	33
F35	Housing occupancy rate – Community population	31
F36	Overall/lifecycle costs of the building	31
F37	Operation cost (energy/water/telephone bills, technology investment price, etc.)	31
F38	Aesthetical quality	29

No.	Factors Influencing the Sustainability of Urban Houses	IF
F39	Traffic – Car dependency – Parking area	28
F40	Space functionality	27
F41	Participatory actions (design, management, bottom up governance, educational programs, etc.)	27
F42	Housing/community administration and management (cost/time/risk/maintenance management, etc.), and the types (self-managed, co-managing, etc.)	26
F43	Accessible house (easy physical accessibility for pedestrians/cars/elders/disables/etc.)	26
F44	Structural quality and durability	26
F45	Natural hazards and the related resilience/repair (earthquake, flooding, etc.)	25
F46	Building orientation	25
F47	Natural ventilation	25
F48	Walkability/bikeability (auto-free zones, sidewalks, bike routes, etc.)	24
F49	Access to workplaces (distance/time of travel)	23
F50	Local materials	23
F51	Construction cost (material, transport, labor, equipment and installation, etc.)	22
F52	Household/project team overall satisfaction rate	21
F53	Employment/business activity rate/opportunities in the area	21
F54	Compatibility with household/community cultural values or heritage	20
F55	Shading options – Rain protection	19
F56	Building’s/neighborhood’s identity/reputation/popularity	19
F57	Private/semi-public outdoor space (courtyard, garden, greenhouse, green roof, etc.)	18
F58	Privacy	16
F59	Presence/preservation of cultural heritage/natural resource (ponds, preserved greenery, topographical contours, etc.)	15
F60	Pleasant view/scenery	15
F61	Maintenance cost	14
F62	Renovation/repair/reconstruction cost (material, transportation, etc.)	14
F63	Greening the building (plants, green wall/roof, garden, etc.) and types of greenery (types of plants, etc.)	14
F64	Light pollution/quality – Visual comfort	13
F65	Innovation (design, management, technologies, etc.)	13
F66	Socio-cultural mixing of the community	13
F67	Fire prevention/emergency measures	13
F68	Building age – Year of construction	12
F69	Cost/value of land – Land use rights	12
F70	Household transport costs	11
F71	Type of tenure (private ownership, shared/private rent, etc.)	11
F72	Property value retention – Balanced housing market – Market trends	11
F73	Life expectancy of housing – Long lasting house	10
F74	Biodiversity/wildlife in the area	9
F75	Cater for senior citizens/disables	9
F76	Ease of movement inside the building (elevators, stairs, furniture and decoration placement, etc.)	9
F77	Construction time/speed	9
F78	Smart home/community (smart technologies/equipment: energy management systems, smart communication, intelligent controlling of home performance, smart toilets, etc.)	8
F79	Sense of belonging	8
F80	Odors – Olfactory comfort	7
F81	Access to the city center/urban space (distance/time of travel)	7
F82	Skilled/local labor and/or manager	7
F83	Security of tenure	7
F84	Standards of living	6
F85	Administration/government/management/design cost	6
F86	Ease of maintenance/cleaning (space, equipment)	6
F87	Level of physical deterioration	5

No.	Factors Influencing the Sustainability of Urban Houses	IF
F88	Green/electric car usage – Carpooling	4
F89	Community acceptance/opposition with the project	4
F90	Economic mixing of the community	4
F91	Demographic/ethnic mixing of the community	4
F92	Diversity of building typology and/or spatial/aesthetic forms in the area	3
F93	Openness/closeness of the community (open/semi-open/gated neighborhoods)	3
F94	Community agriculture/gardening	3
F95	Mixed tenure community	3
F96	Access to internet (speed, capacity)	3
F97	Access to telecommunication service	3
F98	Access to television/cable system	3

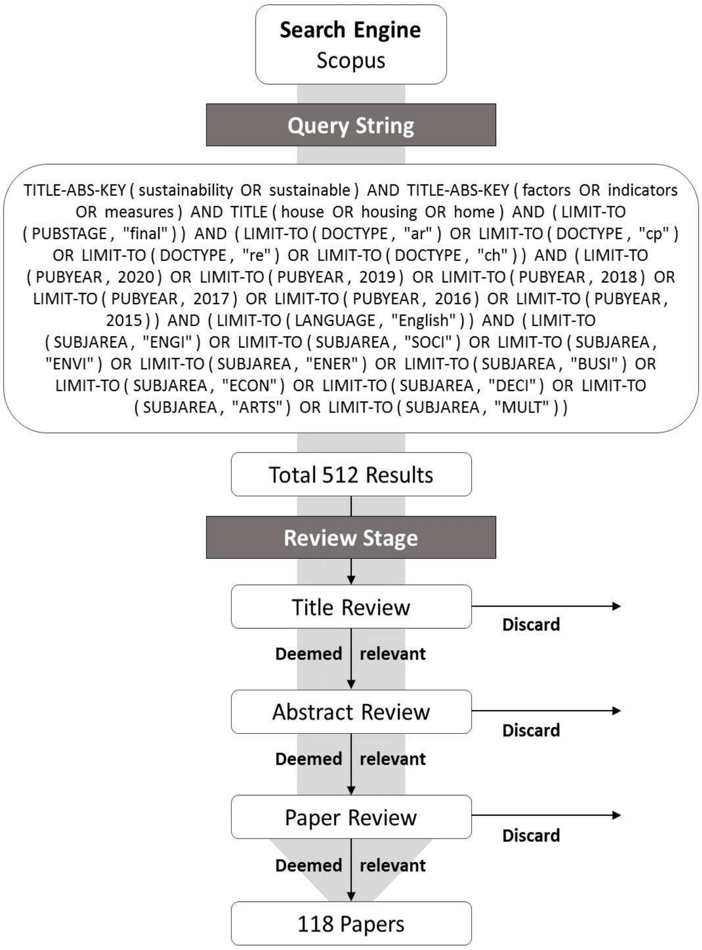

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Fig. 1. The structure of the literature review for extracting urban housing sustainability factors (Sanei *et al.*, 2022a, 2022b)

The credit explanations in the official report of LEED v4 for Homes Design and Constructions are fully read and based on them, for each LEED credit, all directly related factors from the literature review results are selected. Then the point (score) for each LEED credit is compared to the average of IFs (AIF) for the related factors extracted from the literature review. It is noticeable that there may be some other factors from the literature review results that seem to be related to each LEED credit but as this relationship is not mentioned directly in the description of the credits, these factors are not included in the analysis of credits, because they do not have roles in the scoring procedure of the LEED certificate.

Table 2. The LEED Credits and Their Related Factors

LEED Credits	**Points for Homes**	**Points for Midrise**	**AP**	**Related Factors from Literature**	**AIF**	**CIF**
Annual Energy Use	29	30	29.5	F1, F2, F4, F10, F12, F14, F22, F29, F32, F33	53.6	25.84
LEED for Neighborhood Development	15	15	15	F5, F22	53.5	25.77
Total Water Use	12	12	12	F1, F10, F15, F18, F22, F41, F78	51.5	24.41
Site Selection	8	8	8	F3, F5, F9, F22, F26, F28, F31, F45, F48	43.55	19.02
Indoor Water Use	6	6	6	F1, F10, F15, F22, F29	53.2	25.56
Efficient Hot Water Distribution System	5	5	5	F1, F8, F10, F12, F15, F22, F32, F33	51.62	24.49
Innovation	5	5	5	F19, F22, F32, F33, F52, F65	30.5	10.16
Environmentally Preferable Products	4	5	4.5	F2, F16, F18, F22, F29, F32, F33, F50	41.75	17.79
Outdoor Water Use	4	4	4	F1, F10, F15, F22, F63	49	22.71
Regional Priority	4	4	4	F5, F19, F22	49.33	22.94
Compact Development	3	3	3	F5, F26, F28	46	20.68
Rainwater Management	3	3	3	F2, F4, F9, F15, F22, F24, F32, F33, F45, F63	44.1	19.39
Construction Waste Management	3	3	3	F4, F8, F18	59	29.50
Enhanced Ventilation	3	3	3	F6, F9, F10, F13, F22, F24, F29, F32, F33	45.55	20.37
Balancing of Heating and Cooling Distribution Systems	3	3	3	F1, F4, F10, F12, F13, F22, F29, F32, F33, 82	45.55	20.37
Low-Emitting Products	3	3	3	F2, F6, F9, F13, F22, F24, F32, F33	49.62	23.14
Integrative Process	2	2	2	F23, F32, F33, F36, F37, F41, F51, F82, F85	25.67	6.88
Community Resources	2	2	2	F3, F26	54	26.11
Access to Transit	2	2	2	F3, F6, F9, F24	58.5	29.16
Heat Island Reduction	2	2	2	F2, F22, F25, F55, F63	37.6	14.98
Nontoxic Pest Control	2	2	2	F6, F9, F19, F24, F32, F41, F42, F63, F74	34.78	13.07
Advanced Utility Tracking	2	2	2	F1, F10, F15, F22, F29, F32, F33	47.71	21.84
Contaminant Control	2	2	2	F6, F9, F10, F12, F13, F22, F24, F29, F32, F33, F86	42.54	18.33
Enhanced Compartmentalization	1	3	2	F6, F9, F10, F12, F13, F22, F24, F29, F32, F33,	46.2	20.81
Combustion Venting	2	2	2	F6, F9, F10, F12, F13, F22, F32, F33, F67	44.78	19.85
Enhanced Garage Pollutant Protection	2	1	1.5	F6, F9, F10, F12, F13, F22, F24, F29, F32, F33	46.2	20.81
Durability Management Verification	1	1	1	F2, F15, F22, F32, F44, F82	38.83	15.81
LEED Accredited Professional	1	1	1	F41, F82	17	1.00

Similarly, the prerequisites of the LEED certificate are not included in this evaluation, as although meeting these prerequisites is mandatory for buildings in order to be involved in the certificate evaluation procedure, there is no score (point) assigned to these criteria in the LEED assessment.

There are two categories of residential buildings in the LEED evaluation system: 'homes' and 'midrise'. Accordingly, each credit can have two points; one is assigned to 'homes' and one to 'midrise' categories. It is important to note that for this study, only the credits that have influence on both 'homes' and 'midrise' categorization are included in the analysis. This is due to the fact that the results of the literature review are not classified based on this typology of the buildings and all typologies of urban houses are considered in the analysis of factors gathered from the literature; therefore, the credits that have impacts only on one of 'homes' or 'midrise' sections are not involved in the analysis of this study. For the credits influencing both 'homes' and 'midrise' buildings, the average value of the points assigned to each category (AP) is calculated for comparison with AIFs. For example, the highest point which is allocated to a credit in the LEED evaluation procedure is 30 which is assigned to 'Annual Energy Use' credit for 'midrise' classification. However, the point for this credit for 'homes' classification is 29. Therefore, the AP value for this credit in this analysis is considered as 29.5, as the average of the two assigned points for the two classifications and as the value for AP_{max}.

To have both AIFs and APs on the same scale for a clearer comparison, a linear conversion is used to convert the AIF range ($AIF_{min}=17$, $AIF_{max}=59$) to the range of APs ($AP_{min}=1$, $AP_{max}=29.5$). The following equation is used for this conversion to maintain the ratio, which results in Converted IFs (CIF; see Table 2):

$$CIF = ((\text{LEED credit's } AIF - AIF_{min}) / (AIF_{max} - AIF_{min})) \times (AP_{max} - AP_{min}) + AP_{min}$$

4. Results and discussion

The outcomes of the literature review done by Sanei *et al.* (2022a, 2022b) are shown in Table 1. A total of 98 factors (categories of sustainability indicators) are prioritized based on the number of references mentioning each of them (IF). This comprehensive list of factors and IFs is used to analyze the LEED certificate credits and the points that are assigned to each of them in the LEED scoring system.

The LEED credits are included in the next table (Table 2), together with the points assigned to them in 'homes' or 'midrise' classifications of buildings and the AP values. The factors that are related to each credit, and the average IF and CIF for them are as well included in this table. The organization of credits is based on their APs (high to low).

Fig. 2 shows the comparison of AP values and CIFs for the credits. The range for both APs and CIFs is 1 to 29.5, so they can be compared easier. As can be seen, there is a huge difference between APs and CIFs. There are fewer differences in some points of the graph, for example for 'site selection' (AP=8, CIF=19.02), 'innovation' (AP=5, CIF=10.16), 'integrative process' (AP=2, CIF=6.88) credits, but the general trend of the graph illustrates the great gap between APs and CIFs. Based on this data, the biggest difference in scoring the credits (in LEED and based on literature) happens in 'access to transit' credit, where according to the literature it is a very important factor to notice in the sustainability of houses (it has a lot of repetitions in the literature, CIF=29.16) but according to LEED certification, it only has 2 points in the general evaluation of houses. Also, in the points that the two trends in the graph come closer to each other or intersect, there are credits that are more or less equally prioritized by the LEED and literature, namely 'annual energy use' (AP=29.5, CIF=25.84), 'integrative process' (AP, CIF=6.88), and 'LEED accredited professional' in which the lines intersect in the value of 1.

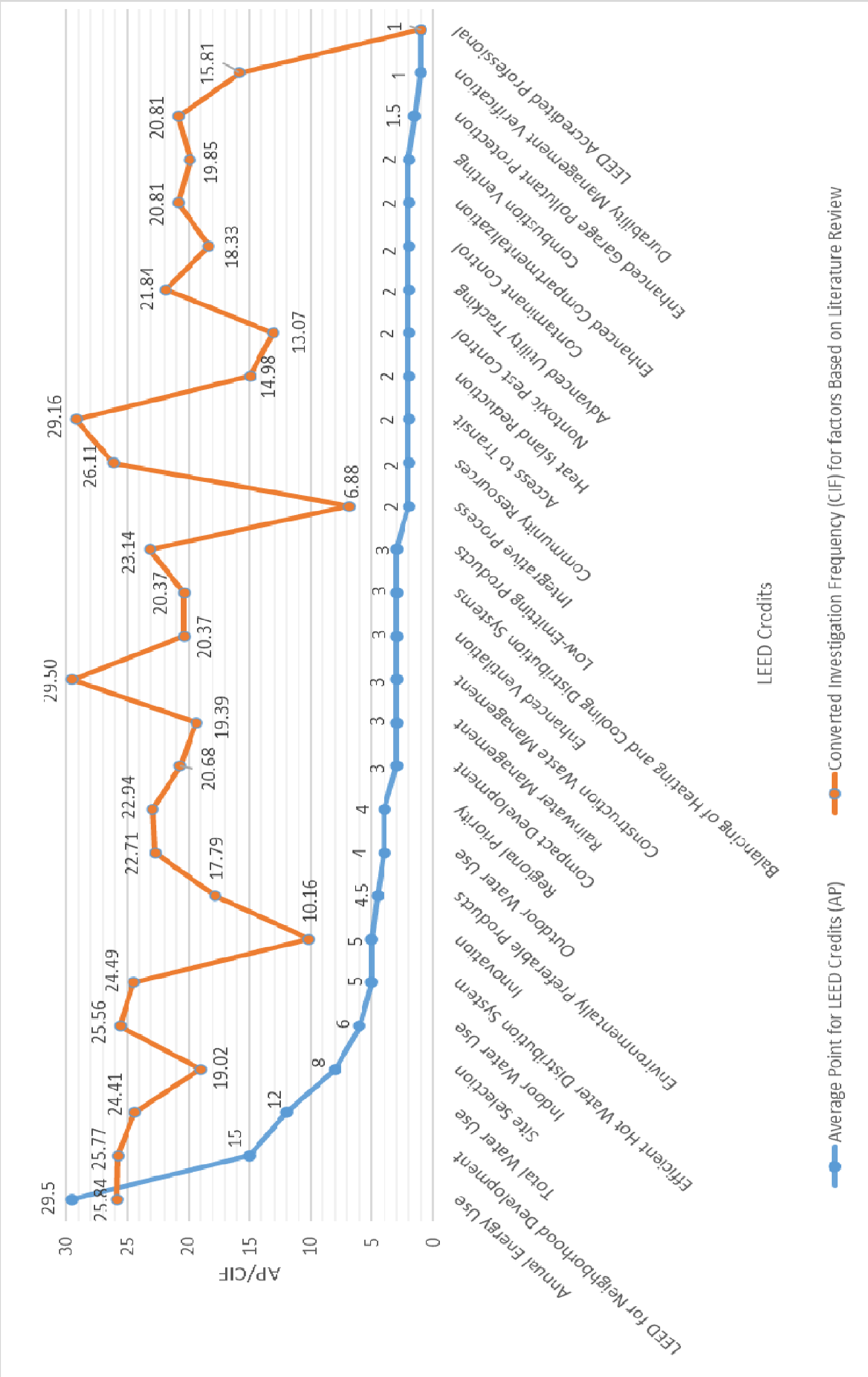

Fig. 2. The comparison of APs and CIFs for the LEED credits.

According to Fig. 2, and looking at the points and values that are used in the LEED certificate and the recent housing sustainability-related literature, it can be said that the points that are used in the LEED certificate are not well aligned with the trend which is used in recent literature about the sustainability of urban houses and there is a huge gap and inconsistency in the ways that these two sources evaluate the housing sustainability-related factors. This result is in line with the previous evaluation of the weightings of indicators in the BREEAM international certificate used for urban housing (Sanei, 2022). It is suggested to complement these results with other resources used to assess urban housing sustainability (e.g., lifecycle assessments). The results provide insights for authorities to improve the efficiency of international SATs used in the urban housing sector.

5. Conclusions

Housing sustainability is proven to be a crucial matter in urban societies. This is due to the vital impact of housing on every aspect of citizens' well-being and also their surroundings. As a result, the need for evaluating the sustainability of urban housing becomes valid and consequently, multiple tools are developed to do so, some of which are applied internationally. However, the efficiency of these tools, especially the internationally-adopted ones such as LEED and BREEAM, has been questioned by academics.

From a different perspective and in line with the approach used in (Sanei, 2022), and by using the data from a recent review of 118 literature related to urban housing sustainability (Sanei *et al.*, 2022a, 2022b), this study provided an evaluation of the prioritization of credits in the scoring system used in LEED v4 for Homes Design and Constructions certificate with comparison to the factors extracted from the literature review.

The results show huge gaps between the values that credits have in these two evaluation sources (LEED and the recent literature). Although for some credits the values are closer to each other, the general trend shows a significant difference in the way these methods prioritize and give importance to the studied credits. There are limitations to this study, from which the limitation of writing space in articles can be named. This might affect the number of factors that authors have mentioned in their manuscripts and therefore might affect the IFs, which are used for our analysis. Also, the literature review consists the recent (2015-2020) English literature. Although our aim was to distinguish the recent trends existing in the literature, including older studies published in other languages might influence the results.

6. Recommendations

We suggest complementing our findings by including other literature (e.g., published before 2015 or in languages other than English) and also important secondary resources, such as international standards and strategies in this field or research. Also, analyzing the priorities used in other sustainability assessment methods of urban housing (e.g., lifecycle assessments) is recommended to accompany our results and to have a more comprehensive overview of the priorities for urban housing sustainability on an international scale. The utmost impact of our analysis is in this direction which can enhance the efficiency of internationally-used SATs in urban housing.

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