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Research article

Impact of the bonus approach on recertification strategies for LEED-EB v3 office projects in major US metropolitan areas: A case study

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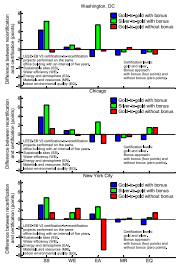
HIGHLIGHTS

- We examined the impact of four bonus points on LEED-EB v3 recertification.
- 112 LEED-EB v3 offices in Washington, DC; Chicago; and New York City were analyzed.
- Gold certification-to-recertification led to decreased MR and EQ credits.
- We offer a moderate penalty as a form of control over the re-certified categories.

GRAPHICAL ABSTRACT



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ABSTRACT

Leadership in Energy and Environmental Design for Existing Buildings (LEED-EB) version 3 (v3) encourages the recertification of existing buildings by offering them four bonus points ("bonus approach"). This study investigates the influence of a bonus approach on recertification strategies. We analyzed 112 LEED-EB v3 certification-to-recertification office space projects in Washington, DC; Chicago; and New York City. The percentage of average score (PAS) was used to evaluate the difference in certification strategies between (1) gold certification and recertification (with bonus); (2) silver certification and gold recertification (with bonus); (3) gold certification and recertification (without bonus); and (4) silver and gold certification, and gold recertification (combined data from Cases 1–3). In Case 1, recertification showed worse results in the materials and resources (MR), and indoor environmental quality (EQ) categories. In Case 2, recertification showed better results in the water efficiency, and energy and atmosphere categories. In Case 3, certification and recertification showed the same results. We found that recertification of LEED-EB v3 projects with a four-point bonus system resulted in lower results in the MR and EQ categories. This highlights the need to include additional controls in the LEED-EB v3 and v4.1 bonus systems, possibly including a moderate penalty for diminishing achievements in certain categories.

1. Introduction

Sustainability is currently a mainstream movement due to the escalation of natural-resource depletion and global climate change. The construction sector plays a significant role in the attempt to move towards a more sustainable society, as construction activity consumes large amounts of natural resources, such as limestone, gravel, sand, wood, water and fossil-energy sources (coal, oil and natural gas), and produces huge amounts of emissions, such as the global-warming gases CO_2, N_2O and CH_4, and construction waste (Bao et al., 2020). According

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to Meyer (2009), 10 billion tons of concrete are globally produced per year. In this respect, two main concrete materials, cement and steel, are huge CO_2 polluters, with 0.833 and 3.44 kg CO_2-equivalent emissions per 1 kg of cement and 1 kg of steel production, respectively (Stengel and Schiessl, 2014). In addition, the construction sector is responsible for 30%–40% of global energy consumption (Dhuoki and Çağnan, 2021). To mitigate this environmental impact of the construction sector, relevant global measures have been taken, such as green building standards and regulations, including voluntary green-rating systems.

Green-rating systems are specific measures that allow for each building to be assessed according to its environmental impact. The Building Research Establishment's Environmental Assessment Method (BREEAM) was the first green-rating system issued in 1990 in the United Kingdom (Cohen et al., 1998). Since then, green-rating systems have been issued by many other countries focusing on country-specific environmental problems. More than 600 green-rating systems have been globally designed (Vierra, 2014). In this respect, Leadership in Energy and Environmental Design (LEED) is one of the most popular global rating systems (Gluszak et al., 2021).

LEED was launched in 1998 in the United States by the US Green Building Council (USGBC) (USGBC n.d.). At that time, the first version of LEED (LEED v1) was only intended for new buildings and included a very limited credit list. This credit list included requirements for air filtration, energy conservation, waste disposal and banning smoking (Ade and Rehm, 2020). Since then, however, LEED has undergone great changes in expanding its rating system from newly constructed buildings (LEED-NC) to core and shell buildings (LEED-C&S), existing buildings (LEED-EB), commercial interiors (LEED-CI) and homes, and has increased the number of categories and credits from version to version: LEED v2 in 2000, LEED v2.2 in 2004 and 2005, LEED v3 in 2008 and 2009 and LEED v4 in 2013.

Different green building rating systems have similar categories and credits. However, the weighting of their categories and credits differ from system to system (Lee, 2013). Usually, a stakeholder group of specialists in environmental issues and building design practices decides on the weighting of the categories and credits of these so called "score--based" rating systems (Lu and Realff, 2012).

LEED also used this "score-based" approach to weigh credits in all of its early versions prior to LEED v3 (Ade and Rehm, 2020). However, such approach has received a large amount of criticism for decades as it is highly subjective and difficult to apply in practice (Suzer, 2015). Thus, since 2006, the USGBC started thinking about life cycle assessment (LCA) integration in LEED (Trusty, 2006). LCA is a total "cradle to grave" method, in which the whole life cycle of products as well as services from raw material acquisition to final disposal is taken into account to evaluate all (theoretically) environmental impacts (ISO 14040, 2006).

As a result, in 2009, LEED v3 became the first version that weighed credit scores against the LCA. This weighting procedure uses 13 environmental impacts embedded in the Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) life cycle impact assessment tool and then weighs these impacts against each other using the Building for Environmental and Economic Sustainability (BEES) tool. After that, the TRACI impacts with evaluated BEES weightings accustomed to LEED credits, producing different awarded points for credits (USGBC 2008). The current LEED v4 continues to weight credit scores against the LCA (Owens at al., n.d.).

However, the LEED system does not contain psychometric data such as the level of validation and reliability. According to Elf et al. (2017), LEED is based on a mission of advocacy rather than empirical, theoretical and psychometric basis, and therefore its reliability and validity should be treated with caution.

The latest two versions, LEED-EB v3 and v4, include the following categories: location and transportation (LT), sustainable sites (SS), water efficiency (WE), energy and atmosphere (EA), materials and resources (MR), indoor environmental quality (EQ), innovation and design (ID) and regional priority (RP). In total, LEED v3 and v4 contain 110 points and certify buildings as certified (40–49 points), silver (50–59 points), gold (60–79 points), or platinum (80 points and above) (LEED-EB v3, 2009; LEED-EB v4, 2018). All of these LEED versions mostly measure the static status of green buildings during their design and construction. In this way, ongoing green building performance is ignored (LEED-EB v4.1, 2018).

Sustainable building performance means monitoring the performance data of LEED-certified buildings in the LT, WE, EA, MR and EQ categories over their occupation period (LEED-EB v3, 2009). In this respect, LEED-EB v3 was the first system to support ongoing green building performance by using a recertification approach with a 5-year interval for existing buildings (LEED-EB v3, 2009). This means that recertification can be performed as regularly as each year, but must be performed at least once every 5 years to maintain LEED-EB v3-certified status (LEED-EB v3, 2009).

To encourage the recertification of buildings, LEED-EB v3 offers a bonus, namely, the LEED Certified Design and Construction (SSc1) credit of four points for the building having been previously certified under LEED-NC, LEED-C&S, LEED-CI or LEED for Schools (LEED-EB v3, 2009). The purpose of this bonus credit is to "reward environmentally sensitive building design and construction, thereby enabling high-performance building operations to be achieved more easily" (LEED-EB v3, 2009).

In addition, in 2018, the USGBC released an improved version of LEED-EB, v4.1, to track the ongoing recertification of LEED projects that had originally been certified under any LEED system (LEED-EB v4.1, 2018). As the main part of this recertification, LEED-EB v4.1 introduced five performance-based credits: transportation performance (14 points), water performance (15 points), energy performance (33 points), waste performance (8 points) and indoor environmental quality performance (20 points). Thus, a total of 90 points could be achieved through providing 12 months of data on these performance categories, and this recertification is valid for 3 years. The next 10 points can be achieved by applying additional credits, such as rainwater management (SS category), enhanced refrigerant management (EA category) and integrated pest management (EQ category). Eventually, similar to LEED-EB v3, LEED-EB v4.1 automatically assigns 10 bonus points to each recertified building (LEED-EB v4.1, 2018).

In theory, these bonus points (four points in LEED-EB, 2009 and 10 points in LEED-EB v4.1) should positively influence the willingness of LEED shareholders to re-certify the office building. This is the so-called contingency management (CM) approach or "motivational incentives" approach that uses rewards/punishments to increase the level of target behavior (s) (Petry et al., 1998). The effectiveness of CM in reducing the use of alcohol, tobacco and other drugs has been demonstrated in research literature for many decades (Oluwoye et al., 2019).

Green building-related CM, such as municipal and federal green building mandatory policies and incentive-based policies, are also well-known practices. The commonly used incentive-based policies have structural (review/permitting and density/height bonuses) and financial (tax credits/abatements and awards) formats (Gündes and Yildirim, 2015). Simcoe and Toffel (2014) studied the influence of California-related green building policies on the adoption of the LEED certification by local practitioners and concluded that these policies had a positive effect. Song et al. (2021) studied the influence of mandatory policies and incentive-based policies on the development of the local Chinese green building market and noticed that both these encouragements had a positive effect.

However, green rating-related CM, the stimulating effect of bonus points on LEED recertification can be viewed as doubtful. This is due to the "principle of least effort", which first was revealed by Fuerst in 2009 (Fuerst, 2009). The author analyzed 2000 LEED-NC-, LEED-CI-, LEED-CS and LEED-EB-certified projects in the United States, and revealed the clustering of awarded scores near the lower bounds of certified, silver, gold and platinum certification levels. Fuerst (2009) called this phenomenon the "principle of least effort"; that is, the idea of improving the

environmental effectiveness of LEED projects within a given certification level had a lower priority than achieving the LEED certification level.

Later, this was confirmed by other researchers. For example, Wu et al. (2017) analyzed 3416 LEED-NC v3 globally certified projects, and noted that projects generally only received certification scores near the lower bound of certified, silver, gold and platinum certification levels. Pushkar and Verbitsky (2018) evaluated 920 silver and gold LEED-NC v3 in the United States, and reported similarly low certification levels for both silver (50–53 points) and gold (60–64) projects.

The above results contradict the results published by Flowers et al. (2020). The authors analyzed 4486 LEED-NC v2.0–2.2 projects certified in the United States from 2000 to 2016 and concluded that the trend to be certified close to the lower bounds of LEED certification was changed over time. In particular, Flowers et al. (2020) showed the smoothed distribution of LEED certification scores around the threshold scores of four certification levels through later years.

Thus, our attention was attracted by studies on the successful application of the CM approach or "motivational incentives" in the field of behavioral psychology (Petry et al., 1998; Oluwoye et al., 2019) and the principle of "least effort" (Fuerst, 2009; Wu et al., 2017; Pushkar, Verbitsky, 2018).

We hypothesized that the use of the bonus system for LEED-EB v3 and v4.1 projects will not necessarily lead to higher levels of certification. In addition, we hypothesized that performance in the MR and EQ categories might decrease when earning bonus points. This is due to the fact that in the LEED projects, the MR and EQ categories had low achievements, while the WE and EA categories had high achievements (Wu et al., 2017; Pushkar and Verbitsky, 2018).

On the basis of a critical literature review, the influence of the bonus approach on the recertification strategy of LEED-EB v3 and v4.1 projects has not yet been studied. It is not clear which strategy using the “bonus approach” would be preferable for designers to “keep buildings at the same level of LEED certification as a satisfactory solution” or “increase the level of certification in LEED projects as a better environmental solution”. However, the LEED-EB v4.1 system has not yet accumulated the required number of projects for statistical analysis. Therefore, the goal of the present study was to assess the impact of the bonus approach on the recertification strategy of LEED-EB v3 office space projects.

2. Methods

2.1. Study design

2.1.1. Statistical terminology

In the present study, several statistical terms (e.g., “sampling frame” and “primary sampling unit”, presented by Picquelle and Mier (2011) (p. 2), and “evaluation units“, presented by Hurlbert and White (1993)) are used. The sampling frame is defined as a “collection of all elements (primary sampling units) accessible for sampling in the population of interest”. The primary sampling unit is defined as an “element within the sampling frame that is sampled and is statistically independent of other sampling units within frame”. If the primary sampling unit contains two or more “evaluation units”, then the ‘‘evaluation units’’ are statistically dependent units. Measurements were performed on the evaluation units (Hurlbert, 2013).

In this context, Washington, DC; Chicago; and New York City are three sampling frames. For each city (sampling frame), the primary sampling unit is LEED-EB v3 building, i.e., LEED-EB certification project and LEED-EB recertification project performed on the same office building with an interval of five years. The LEED-EB v3 building contains two evaluation units, namely, LEED-EB certification and recertification projects. Measurements were performed on each LEED-EB v3 project.

2.1.2. Methodology flowchart

Figure 1 shows the methodology flowchart of the present study.

2.2. Data collection

The USGBC database was used to collect the credit achievement of LEED-EB v3 projects (USGBC n.d.). The Green Building Information Gateway (GBIG) database was used to collect the space–type and urban–rural classification of the LEED-EB v3 projects (GBIG, n.d.).

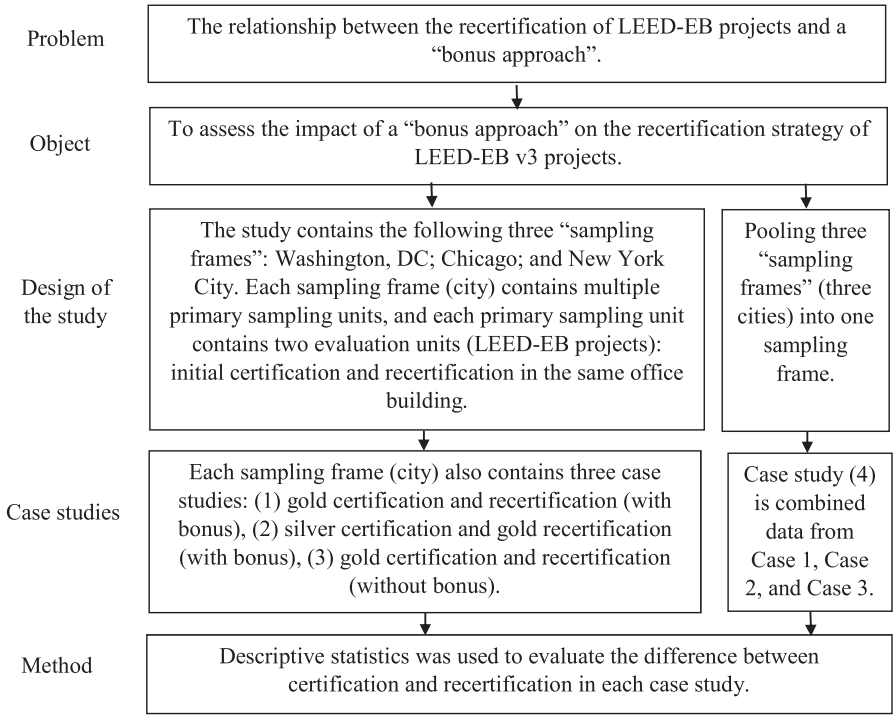

Figure 1. Methodology flowchart of the present study.

To minimize the influence of uncontrolled factors, we selected LEED-EB v3 projects according to the following properties: LEED-EB v3 projects should belong to big cities in one country where each city should be separately analyzed, space type (office space), urban–rural classification (large central metro), and the existing building must undergo LEED-EB v3 certification–recertification at intervals of 5 years.

According to the national center for Health Statistics' Urban–Rural Classification Scheme for Counties[1], "Large central metros—counties in metropolitan statistical areas (MSAs) of 1 million or more population that: (1) contain the entire population of the largest principal city of the MSA, or (2) have their entire population contained in the largest principal city of the MSA, or (3) Contain at least 250,000 inhabitants of any principal city of the MSA." The current metro area populations of Washington, DC; Chicago; and New York City are 5,378,000[2], 8,877,000[3] and 18,823,000[4], respectively. Therefore, all LEED-EB v3 certification-to-recertification projects belong to large central metros.

The analyzed LEED-EB v3 projects included the following cases: Case 1: gold certification and recertification (with bonus); Case 2: silver certification and gold recertification (with bonus); Case 3: gold certification and recertification (without bonus); and Case 4: silver and gold certification, and gold recertification (combined data from Cases 1–3). "Recertification (with bonus)" means that these projects received four bonus points of SSc1, whereas "recertification (without bonus)" means that these projects did not receive four bonus points of SSc1.

Table 1 shows that, as of 29 April 2021 (USGBC n.d.; GBIG n.d.), there were three cases of certification–recertifications in three US cities, where the minimal sample size of the primary sample units was 3 for Case 2 in Washington, DC, and Case 3 in Chicago. The maximal sample size of primary sample units was 13 for Case 1 in Washington, DC.

Case 4 contains the sum of Cases 1–3. For Washington, DC, and Chicago, the equivalent value for Cases 1–3 was 3; hence, Case 4 contains 9 primary sampling units, while for New York City, the equivalent value for Cases 1–3 was 5; therefore, Case 4 contains 15 primary sampling units (Table 1). If the primary sampling units were larger than the equivalent value, then the primary sampling units for summation for Case 4 were chosen at random.

2.3. Data analysis

We separately analyzed each of the three cities as the green building policy is based on local codes (Greer et al., 2019). Thus, pooling Washington, DC; Chicago; and New York City LEED certification and recertification projects into one group could result in the loss of important information (Pushkar, 2018).

Table 1. Number of primary sampling units of LEED-EB 2009 v3 silver/gold projects for three cites (accessed on 29 April 2021) (USGBC n.d.; GBIG n.d.).

Case	Primary sampling units		
	Washington, DC	Chicago	New York City
Case 1: gold certification and recertification (with bonus)	13	6	8
Case 2: silver certification and gold recertification (with bonus)	3	4	5
Case 3: gold certification and recertification (without bonus)	9	3	5
Case 4: silver and gold certification, and gold recertification (combined equal number of primary sampling units from Cases 1–3)	9	9	15

[1] 2013 NCHS Urban–Rural Classification Scheme for Counties, US department of health and human services.

[2] https://www.macrotrends.net/cities/23174/washington-dc/population.

[3] https://www.macrotrends.net/cities/22956/chicago/population.

[4] https://www.macrotrends.net/cities/23083/new-york-city/population.

2.4. Statistical analysis

Since LEED data are associated with an ordinal scale, the assumption of normality was not met (Chi et al., 2020). In this context, an appropriate significance test is the exact Wilcoxon's signed rank nonparametric procedure. However, the Wilcoxon's signed rank test could be used if the number of primary sample units was greater than or equal to 8 (Mundry and Fischer, 1998). Table 1 illustrates that 6 of 12 groups contain less than 8 primary sampling units. Therefore, we only used descriptive statistics, namely, the percentage of average score (PAS)—the ratio of achieved points to maximal points (expressed as a percentage), to assess the performance of LEED data (Pham et al., 2020).

3. Results

3.1. Case 1: gold certification and recertification (with bonus)

Tables 2, 3, 4, and 5 show the results of the PASs of Case 1 of the projects, which initially received LEED-EBv3 gold certification, and these projects were then recertified within gold (with four bonus points). Regarding the projects' transition from gold certification to gold recertification (with bonus), the PAS of the SS category increased, whereas the PASs of the MR and EQ categories decreased in all three cites (Table 2).

Table A1 (Appendix A) presents full titles of SS, WE, EA, MR and EQ credits. Table A2 (Appendix A) shows the PASs of all SS, WE, EA, MR and EQ credits of Case 1, whereas Tables 2, 3, 4, and 5 present only the PASs of SSc1 and decreased during the recertification SS, MR and EQ credits. Table 3 shows that, in the SS category, the increase in PASs from gold certification to gold recertification (with bonus) was due to SSc1 LEED Certified Design and Construction. Thus, in the case of SSc1, projects with gold certification had PAS = 0, and gold-recertified (with bonus) projects had PAS = 100. Table 3 also demonstrates three credits: SSc2 Building Exterior and Hardscape Management Plan; SSc3 Integrated Pest Management, Erosion Control, and Landscape Management Plan; and SSc5 Site Development—Protect or Restore Open Habitat, in which gold-recertified (with bonus) projects received lower PASs compared to the PASs of projects with gold certification. This tendency was held at all three sites. All three credits are equally weighted with 1 point.

Table 4 shows that, in the MR category, the decrease in PASs from gold certification to gold recertification (with bonus) was due to two sustainable purchasing credits, namely, MRc2.2 Sustainable Purchasing—Furniture and MRc3 Sustainable Purchasing—Facility Alterations and Additions, and three waste-management credits, namely, MRc6 Solid Waste Management—Waste Stream Audit, MRc7 Solid Waste Management—Ongoing Consumables and MRc9 Solid Waste Management—Facility Alterations and Additions. This tendency was relevant for all three sites. Each of the five credits was 1 awarded point.

Table 5 shows that, in the EQ category, the decrease in PASs from gold certification to gold recertification (with bonus) was due to two indoor air quality credits, namely, EQc1.3 Indoor Air Quality Best Management

Table 2. Case 1: gold certification and recertification (with bonus) in categories of LEED-EB v3 projects.

City (primary sampling units)	Variables	Categories				
		SS	WE	EA	MR	EQ
Washington, DC (n = 13)	Certification (PAS)	62	45	56	43	63
	Recertification (PAS)	78	48	52	31	57
Chicago (n = 6)	Certification (PAS)	63	35	55	42	63
	Recertification (PAS)	78	40	50	27	56
New York City (n = 8)	Certification (PAS)	71	54	48	41	59
	Recertification (PAS)	83	54	51	35	51

Table 3. Case 1: gold certification and recertification (with bonus) in sustainable sites (SS) credits of LEED-EB v3 projects.

City (primary sampling units)	Variables	Bonus credit	Decreased credits		
		SSc1	SSc2	SSc3	SSc5
Washington, DC (n = 13)	Certification (PAS)	0	100	100	23
	Recertification (PAS)	100	54	77	8
Chicago (n = 6)	Certification (PAS)	0	83	83	33
	Recertification (PAS)	100	67	67	17
New York City (n = 8)	Certification (PAS)	0	100	100	38
	Recertification (PAS)	100	38	88	25

SSc1 LEED Certified Design and Construction (4 points); SSc2 Building Exterior and Hardscape Management Plan (1 point); SSc3 Integrated Pest Management, Erosion Control, and Landscape Management Plan (1 point); SSc5 Site Development—Protect or Restore Open Habitat (1 point).

Table 4. Case 1: gold certification and recertification (with bonus) in materials and resources (MR) credits of LEED-EB v3 projects.

City (primary sampling units)	Variables	Decreased credits				
		MRc2.2	MRc3	MRc6	MRc7	MRc9
Washington, DC (n = 13)	Certification (PAS)	15	31	92	46	46
	Recertification (PAS)	0	0	77	23	15
Chicago (n = 6)	Certification (PAS)	17	33	67	67	50
	Recertification (PAS)	0	0	50	15	17
New York City (n = 8)	Certification (PAS)	13	13	88	88	88
	Recertification (PAS)	0	3	75	68	25

MRc2.2 Sustainable Purchasing—Furniture; MRc3 Sustainable Purchasing—Facility Alterations and Additions (1 point); MRc6 Solid Waste Management—Waste Stream Audit (1 point); MRc7 Solid Waste Management—Ongoing Consumables (1 point); MRc9 Solid Waste Management—Facility Alterations and Additions (1 point).

Practices—Increased Ventilation and EQc1.5 Indoor Air Quality Best Management Practices—Indoor Air Quality Management for Facility Alterations and Additions, and three additional credits, namely, EQc2.1 Occupant Comfort—Occupant Survey, EQc2.2 Controllability of Systems—Lighting and EQc3.6 Green Cleaning—Indoor Chemical and Pollutant Source Control. This tendency was more prominent for Washington, DC, and New York City than that for Chicago. All these credits were awarded with 1 point.

3.2. Case 2: silver certification and gold recertification (with bonus)

Tables 6 and 7 show the results of the PASs of Case 2 of the projects, which initially received LEED-EBv3 silver certification and were then recertified at the gold level (with bonus). Table 6 demonstrates PASs at a category evaluation level. According to the results, the PAS of the SS category increased from silver certification to gold recertification (with bonus). These results were identical to those of the SS category for Case 1, which was considered above. However, in Case 2, during gold recertification (with bonus), a change from silver to gold was achieved by increasing the additional PASs of the WE and EA categories. This tendency was revealed in all three cities.

Table A3 (Appendix A) presents PASs of all SS, WE, EA, MR and EQ credits of Case 2, whereas Table 7 presents only the PASs of SSc1, WE, and EA credits. According to PAS = 0 and PAS = 100 in silver-certified and gold-recertified (with bonus) projects, Case 2 belongs to "recertification (with bonus)", as does Case 1 (considered earlier) (Table 7). The credits that were increased during gold recertification (with bonus) were one water-saving credit, WEc2 Additional Indoor Plumbing Fixture and Fitting Efficiency (1-5points), and two energy-saving credits, EAc1 Optimize Energy Efficiency Performance (1–18 points) and EAc4 On- and Off-Site Renewable Energy (1–6 points), and EAc5 Enhanced Refrigerant Management (1 point).

3.3. Case 3: gold certification and recertification (without bonus)

Table 8 demonstrates the results of Case 3, in which projects were recertified without bonus. The first certification was at the gold level; after that, these projects were recertified at the gold level (without bonus). This was evident from PAS = 0 in SSc1 LEED Certified Design and Construction in gold certification and recertification (without bonus). The absence of this bonus credit during gold recertification (without

Table 6. Case 2: silver certification and gold recertification (with bonus) in categories of LEED-EB projects.

City (primary sampling units)	Variables	Categories				
		SS	WE	EA	MR	EQ
Washington, DC (n = 3)	Certification (PAS)	58	55	32	30	56
	Recertification (PAS)	79	62	46	30	49
Chicago (n = 4)	Certification (PAS)	62	27	39	38	47
	Recertification (PAS)	87	34	46	30	50
New York City (n = 5)	Certification (PAS)	62	47	37	32	44
	Recertification (PAS)	83	54	45	36	47

Table 5. Case 1: gold certification and recertification (with bonus) in indoor environmental quality (EQ) credits of LEED-EB v3 projects.

City (primary sampling units)	Variables	Decreased credits				
		EQc1.3	EQc1.5	EQc2.1	EQc2.2	EQc3.6
Washington, DC (n = 13)	Certification (PAS)	8	54	62	92	85
	Recertification (PAS)	0	38	54	82	54
Chicago (n = 6)	Certification (PAS)	0	17	100	83	67
	Recertification (PAS)	0	17	33	67	83
New York City (n = 8)	Certification (PAS)	38	25	25	63	75
	Recertification (PAS)	0	0	15	38	50

EQc1.3 Indoor Air Quality Best Management Practices—Increased Ventilation (1 point); EQc1.5 Indoor Air Quality Best Management Practices—Indoor Air Quality Management for Facility Alterations and Additions (1 point); EQc2.1 Occupant Comfort—Occupant Survey (1 point); EQc2.2 Controllability of Systems—Lighting (1 point); EQc3.6 Green Cleaning—Indoor Chemical and Pollutant Source Control (1 point).

Table 7. Case 2: silver certification and gold recertification (with bonus) in water efficiency (WE) and the energy and atmosphere (EA) credits of LEED-EB v3 projects.

City (primary sampling units)	Variables	Bonus credit	Increased credits			
		SSc1	WEc2	EAc1	EAc4	EAc5
Washington, DC (n = 3)	Certification (PAS)	0	73	50	22	0
	Recertification (PAS)	100	100	63	56	33
Chicago (n = 4)	Certification (PAS)	0	20	50	0	25
	Recertification (PAS)	100	60	58	8	50
New York City (n = 8)	Certification (PAS)	0	64	23	20	0
	Recertification (PAS)	100	80	46	43	20

SSc1 LEED Certified Design and Construction (4 points); WEc2 Additional Indoor Plumbing Fixture and Fitting Efficiency (1-5points); EAc1 Optimize Energy Efficiency Performance (1–18 points); EAc4 On- and Off-Site Renewable Energy (1–6 points); EAc5 Enhanced Refrigerant Management (1 point).

bonus) led to almost the same PASs of gold certification and recertification in all the five main categories. The only exception was New York City in the WE and EA categories, with an obviously increased PAS in WE and decreased PAS in EA during gold recertification (without bonus). Table A4 (Appendix A) presents the PASs of all the SS, WE, EA, MR and EQ credits of Case 3.

3.4. Case 4: silver and gold certification, and gold recertification (combined data from cases 1–3)

Table 9 shows Case 4, in which an equal number of primary sampling units from three cases (Cases 1–3) was combined into certification and recertification variables. As a result of the presence of the recertified projects from Cases 1 and 2, during recertification, the PASs of the SS category in this single evaluation set were increased. This tendency was revealed in all three cities.

However, no large decrease in the PASs of the recertified projects compared to their previous certification was seen in the MR and EQ categories (as shown in Case 1). In addition, no large increase in the PASs of recertified projects compared to their previous certification was seen in the WE and EA categories (as was revealed in Case 2). The only exception was New York City, which showed increased PAS in the recertified projects compared to the previous certification in the WE category.

4. Discussion

4.1. Recertification (with bonus)

In cases of gold certification and recertification and silver certification and gold recertification with the bonus credit, SSc1 LEED Certified Design and Construction, the opposite results were revealed. In the analysis of Case 1: gold certification and recertification (with bonus), during the recertification, MR/EQ points decreased compared to those received during the previous certification of these projects.

The MR and EQ credits were equally weighted, and each of them was awarded 1 point. It could be supposed that these low-valued credits can be considered as the first candidates for omission during recertification when a four-point bonus is available. The EQ and especially MR-related credits also showed low performance in the certified projects that were explored by other researchers. Examples of low MR performance were found by Wu et al. (2017), who analyzed the LEED-NC 2009 certified projects in the US and globally, and Pushkar and Verbitsky (2018), who studied the LEED-NC 2009 certified projects in 10 US states.

Table 8. Case 3: gold certification and recertification (without bonus) in categories of LEED-EB v3 projects.

City (primary sampling units)	Variables	Categories				
		SS	WE	EA	MR	EQ
Washington, DC (n = 9)	Certification (PAS)	66	61	52	33	60
	Recertification (PAS)	64	63	51	36	54
Chicago (n = 3)	Certification (PAS)	65	52	58	47	44
	Recertification (PAS)	69	55	50	40	56
New York City (n = 5)	Certification (PAS)	67	44	63	34	53
	Recertification (PAS)	72	63	43	36	63

Denzer and Hedges (2011) pointed out that the problem lies in the positive scoring system, ignoring the negative assessment of non-compliance with green design. Thus, a building can be LEED certified even without using recycled materials and installing non-chlorofluorocarbon-based refrigerants if some of the other categories have high scores.

This study revealed a similar problem. In case 1, the recertification of LEED-EB v3 projects at the gold to gold certification level resulted in lower MR and EQ scores. In this case, a moderate penalty may be required due to lower scores in the MR and EQ categories. This idea is not new, and the system of negative weights is already included in other green systems such as the Japan System (CASBEE) (Denzer and Hedges, 2011).

In the analysis of Case 2—silver certification and gold recertification (with bonus)—an incremental increase in the awarded points of WE and EA categories was observed. Most of the WE (three of five) and EA (six of nine) credits were awarded with more than 1 point. The maximum possible points in the two WE credits (WEc2 Additional Indoor Plumbing Fixture and Fitting Efficiency and WEc3 Water Efficient Landscaping) was up to 5 points, and in one EA credit (Optimize Energy Efficiency Performance), it was up to 18 points. Thus, it is quite clear that these heavily valued credits may be considered as the first candidates for investing additional time, effort and money to reach the next highest certification level (gold in this case) during recertification.

Similar results also confirmed in the previous certification-related results revealed by other studies, which reported that WE and EA are well-known driving categories in moving projects from level to level. This is evidenced from the cross-certification analysis of Wu et al. (2016), who analyzed LEED-NC v2.2 projects all over the world and reported that the EA category was a main driving force, pushing projects from certified to silver, silver to gold and gold to platinum. An additional example is the study of Pushkar and Verbitsky (2019), who studied silver to gold cross-certification under LEED-CI-2009 in 14 US states, and noted the same EA and WE categories as driving forces moving projects from silver to gold.

4.2. Recertification (without bonus)

As followed from the analysis of Case 3: gold certification and recertification (without bonus), the same certification strategies were

Table 9. Case 4: silver and gold certification, and gold recertification (combined data from Cases 1–3) in categories of LEED-EB v3 projects.

City (primary sampling units)	Variables	Categories				
		SS	WE	EA	MR	EQ
Washington, DC (n = 9)	Certification (PAS)	64	53	44	36	60
	Recertification (PAS)	75	63	50	29	53
Chicago (n = 9)	Certification (PAS)	64	33	50	43	53
	Recertification (PAS)	80	40	47	33	57
New York City (n = 15)	Certification (PAS)	66	49	50	37	52
	Recertification (PAS)	79	58	46	35	53

applied in both gold certification and recertification. As a result, the absence of the bonus credit resulted in maintaining the categories and performances in both gold certification and recertification (without bonus) at the same level.

4.3. Combining data of cases 1–3

Pooling together these three data groups led to averaged strategies in the recertification of LEED-EB v3 projects. In particular, due to the four bonus points as part of the analyzed projects, compared to the certificated projects, there was an increase in the SS category of the recertified projects in Washington, DC; Chicago; and New York City. A similar increase was noted for the WE category in New York City (as prominently revealed in Case 2). However, no significant decrease in the PAS of recertified projects compared to their first certification was observed for the MR and EQ categories (as revealed in Case 1). Therefore, such averaged strategies should be treated with caution.

Recently, Scofield et al. (2021) used similar city-by-city analysis of energy saving achieved by LEED-certified buildings compared to non-LEED buildings in 10 major US cities. In this context, each city was separately analyzed as a sampling frame. Buildings from one city with and without LEED certification were identified as primary sampling units. Only an office building was selected, and analysis was performed in a single time interval for all buildings. All of these constraints were met to reduce data selection bias.

5. Conclusions

This paper analyzed the recertification strategies of the LEED-EB v3 projects, considering four different cases of recertification: Case 1: gold certification and recertification (with bonus); Case 2: silver certification and gold recertification (with bonus); Case 3: gold certification and recertification (without bonus); and Case 4: silver and gold certification, and gold recertification (combined data from Cases 1–3).

The results of this study shed light on the recertification results that impact the sustainable management of the building lifecycle. The projects with bonus points showed different results. Using a certification-to-recertification strategy to maintain LEED-EB v3 gold certification led to a decrease in the MR and EQ categories by an average of 11% and 7%, respectively. Using a certification-to-recertification strategy to increase the certification level from silver to gold in LEED-EB v3 projects led to an increase in the WE and EA categories by an average of 7% and 10%, respectively.

It may be difficult to project the recertification results motivated by the four-point bonus of LEED-EB v3 to the future recertification results motivated by the 10-point bonus of LEED-EB v4.1. This is due to the fact that a bonus of four points is not enough to move a project to the next highest certification level, and additional time, effort and money are required to apply for additional credits, whereas a bonus of 10 points is sufficient for such a transition. However, the revealed impact of the four-point bonus offered by LEED-EB v3 may be helpful for building practitioners to understand that, when a recertification (with bonus) is used, it is important to preserve all LEED-EB categories at the same level of performance as they were awarded in the previous certification. As a result, bonus points should be considered as a starting point for increasing the LEED-EB certification level.

An additional conclusion that may be drawn from Case 4 is that combining LEED data from different cities may lead to misleading conclusions regarding the recertification results of existing buildings. These results can help LEED researchers to more accurately select an appropriate sampling frame to better assess LEED-EB recertification strategies.

We came to the conclusion that the system of bonuses for LEED-EB v3 recertification projects should be adjusted. A moderate penalty can be used to avoid a decline in previously certified achievement in any LEED-EB category.

6. Limitations

The main limitation of this study is that only LEED-EB v3 certification-to-recertification data are presented. This is due to the lack of data on LEED-EB v4.1 certification-to-recertification. The results of LEED-EB v3 certification-to-recertification projects with a bonus of four points cannot be projected to predict the results of LEED-EB v4.1 certification-to-recertification projects with a bonus of 10 points. Therefore, we decided to present only LEED-EB v3 data as a first step towards opening up a new research base for the certification–recertification strategy, while interviews with members of the relevant project teams were postponed until the LEED-EB v4.1 certification-to-recertification projects are available.

The next limitation is that we only investigated the impact of the bonus approach on the recertification strategy for LEED-EB v3 projects. Further research is needed on recertification strategies to compare weighted (EA and WE) and unweighted (MR and EQ) scores/credit scores using a new appropriate study design.

Declarations

Author contribution statement

Svetlana Pushkar: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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Appendix A

Table A1. Full credit titles of sustainable sites (SS), water efficiency (WE), energy and atmosphere (EA), materials and resources (MR) and indoor environmental quality (EQ) credits of LEED-EB v3 projects.

Credit	Credit name	Points
SSc1	LEED Certified Design and Construction	4
SSc2	Building Exterior and Hardscape Management Plan	1
SSc3	Integrated Pest Management, Erosion Control, and Landscape Management Plan	1
SSc4	Alternative Commuting Transportation	3–15
SSc5	Site Development—Protect or Restore Open Habitat	1
SSc6	Stormwater Quantity Control	1
SSc7.1	Heat Island Reduction—Nonroof	1
SSc7.2	Heat Island Reduction—Roof	1
SSc8	Light Pollution Reduction	1
WEc1	Water Performance Measurement	1–2
WEc2	Additional Indoor Plumbing Fixture and Fitting Efficiency	1–5
WEc3	Water Efficient Landscaping	1–5
WEc4	Cooling Tower Water Management	2
EAc1	Optimize Energy Efficiency Performance	1–18
EAc2.1	Existing Building Commissioning—Investigation and Analysis	2
EAc2.2	Existing Building Commissioning—Implementation	2
EAc2.3	Existing Building Commissioning—Ongoing Commissioning	2
EAc3.1	Performance Measurement—Building Automation System	1
EAc3.2	Performance Measurement—System Level Metering	1–2
EAc4	On-site and Off-site Renewable Energy	1–6
EAc5	Enhanced Refrigerant Management	1
EAc6	Emissions Reduction Reporting	1
MRc1	Sustainable Purchasing—Ongoing Consumables	1
MRc2.1	Sustainable Purchasing—Electric-Powered Equipment	1
MRc2.2	Sustainable Purchasing—Furniture	1
MRc3	Sustainable Purchasing—Facility Alterations and Additions	1
MRc4	Sustainable Purchasing—Reduced Mercury in Lamps	1
MRc5	Sustainable Purchasing—Food	1
MRc6	Solid Waste Management—Waste Stream Audit	1
MRc7	Solid Waste Management—Ongoing Consumables	1
MRc8	Solid Waste Management—Durable Goods	1
MRc9	Solid Waste Management—Facility Alterations and Additions	1
EQc1.1	Indoor Air Quality Best Management Practices—Indoor Air Quality Management Program	1
EQc1.2	Indoor Air Quality Best Management Practices—Outdoor Air Delivery Monitoring	1
EQc1.3	Indoor Air Quality Best Management Practices—Increased Ventilation	1
EQc1.4	Indoor Air Quality Best Management Practices—Reduce Particulates in Air Distribution	1
EQc1.5	Indoor Air Quality Best Management Practices—Indoor Air Quality Management for Facility Alterations and Additions	1
EQc2.1	Occupant Comfort—Occupant Survey	1
EQc2.2	Controllability of Systems—Lighting	1
EQc2.3	Occupant Comfort—Thermal Comfort Monitoring	1
EQc2.4	Daylight and Views	1
EQc3.1	Green Cleaning—High Performance Cleaning Program	1
EQc3.2	Green Cleaning—Custodial Effectiveness Assessment	1
EQc3.3	Green Cleaning—Purchase of Sustainable Cleaning Products and Materials	1
EQc3.4	Green Cleaning—Sustainable Cleaning Equipment	1
EQc3.5	Green Cleaning—Indoor Chemical and Pollutant Source Control	1
EQc3.6	Green Cleaning—Indoor Integrated Pest Management	1

Table A2. Case 1: gold certification and recertification (with bonus) in sustainable sites (SS), water efficiency (WE), energy and atmosphere (EA), materials and resources (MR) and indoor environmental quality (EQ) credits of LEED-EB v3 projects.

Credit	Credit points	Washington, DC		Chicago		New York City	
		Certificat.	Recertificat.	Certificat.	Recertificat.	Certificat.	Recertificat.
SSc1	4	0	100	0	100	0	100
SSc2	1	100	54	83	67	100	38
SSc3	1	100	77	83	67	1.00	0.88
SSc4	15	85	92			100	100
SSc5	1	23	8	33	17	38	25
SSc6	1	0	0	0	0		
SSc7.1	1	100	100	83	83	88	88
SSc7.2	1	0	0	0	0	0	0
SSc8	1	8	15	17	17	25	25
WEc1	2	96	50	50	50	100	88
WEc2	5	68	74	47	70	90	95
WEc3	5	0	23	0	0	0	0
WEc4	2	46	46	42	42	50	50
EAc1	18	71	67	63	73	49	60
EAc2.1	2	77	77	100	50	88	100
EAc2.2	2	77	77	100	84	75	88
EAc2.3	2	17	8	67	34	38	63
EAc3.1	1	15	8	17	0	26	13
EAc3.2	2	0	0	25	0	0	7
EAc4	6	50	26	17	0	42	13
EAc5	1	8	23	0	17	26	13
EAc6	1	100	100	100	100	100	100
MRc1	1	8	0	0	0	0	0
MRc2.1	1	31	15	0	17	13	0
MRc2.2	1	15	0	17	0	13	0
MRc3	1	31	0	33	0	13	3
MRc4	1	77	92	83	67	88	63
MRc5	1	0	0	0	0	0	0
MRc6	1	92	77	67	50	88	75
MRc7	1	46	23	67	15	88	68
MRc8	1	85	85	100	100	88	88
MRc9	1	46	15	50	17	88	25
EQc1.1	1	92	77	100	83	100	100
EQc1.2	1	0	0	0	0	0	0
EQc1.3	1	8	0	0	0	38	0
EQc1.4	1	92	92	83	83	88	88
EQc1.5	1	54	38	17	17	25	0
EQc2.1	1	62	54	100	33	25	15
EQc2.2	1	92	82	83	67	63	38
EQc2.3	1	0	0	0	0	0	0
EQc2.4	1	8	0	50	33	13	13
EQc3.1	1	100	100	100	100	100	100
EQc3.2	1	100	92	100	100	88	75
EQc3.3	1	100	92	100	100	100	100
EQc3.4	1	100	92	100	67	88	88
EQc3.5	1	62	69	50	67	88	88
EQc3.6	1	85	54	67	83	75	50

Table A3. Case 2: silver certification and gold recertification (with bonus) in sustainable sites (SS), water efficiency (WE), energy and atmosphere (EA), materials and resources (MR) and indoor environmental quality (EQ) credits of LEED-EB v3 projects.

Credit	Credit points	Washington, DC		Chicago		New York City	
		Certificat.	Recertificat.	Certificat.	Recertificat.	Certificat.	Recertificat.
SSc1	4	0	100	0	100	0	100
SSc2	1	75	100	50	75	86	43
SSc3	1	50	100	75	100	86	86
SSc4	15	82	92	85	92	90	100
SSc5	1	0	0	0	25	71	43
SSc6	1	0	0	50	75	0	0
SSc7.1	1	100	100	100	100	71	71
SSc7.2	1	0	0	25	75	14	14
SSc8	1	0	0	25	25	14	14
WEc1	2	100	50	100	50	100	100
WEc2	5	73	100	20	60	64	80
WEc3	5	0	0	0	0	6	9
WEc4	2	1.00	1.00	0.75	0.75	1.00	1.00
EAc1	18	50	63	50	58	23	46
EAc2.1	2	0	50	75	75	100	100
EAc2.2	2	0	50	50	100	100	100
EAc2.3	2	0	0	0	0	72	57
EAc3.1	1	50	0	25	25	14	0
EAc3.2	2	0	0	25	0	0	0
EAc4	6	22	56	0	8	20	43
EAc5	1	0	33	25	50	0	20
EAc6	1	100	100	100	100	100	100
MRc1	1	0	0	0	0	0	0
MRc2.1	1	0	0	25	0	14	14
MRc2.2	1	0	0	25	25	0	14
MRc3	1	0	0	25	0	29	0
MRc4	1	100	100	50	75	71	57
MRc5	1	0	0	0	0	0	0
MRc6	1	100	75	50	25	100	100
MRc7	1	75	25	50	25	100	100
MRc8	1	75	100	75	100	71	86
MRc9	1	0	0	75	50	14	14
EQc1.1	1	100	75	100	100	100	71
EQc1.2	1	0	0	0	0	0	0
EQc1.3	1	0	0	0	0	0	0
EQc1.4	1	100	100	100	100	57	57
EQc1.5	1	25	0	0	0	14	43
EQc2.1	1	25	0	25	75	29	14
EQc2.2	1	75	75	25	50	14	14
EQc2.3	1	0	0	0	0	0	0
EQc2.4	1	0	0	0	0	0	0
EQc3.1	1	100	100	100	100	86	.00
EQc3.2	1	100	100	75	100	86	86
EQc3.3	1	100	100	100	100	100	100
EQc3.4	1	100	100	100	50	86	86
EQc3.5	1	25	50	50	100	57	57
EQc3.6	1	100	100	25	75	57	86

Table A4. Case 3: gold certification and recertification (without bonus) in sustainable sites (SS), water efficiency (WE), energy and atmosphere (EA), materials and resources (MR) and indoor environmental quality (EQ) credits of LEED-EB v3 projects.

Credit	Credit points	Washington, DC		Chicago		New York City	
		Certificat.	Recertificat.	Certificat.	Recertificat.	Certificat.	Recertificat.
SSc1	4	0	0	0	0	0	0
SSc2	1	100	67	75	100	100	100
SSc3	1	100	78	50	100	80	100
SSc4	15	93	93	95	100	93	100
SSc5	1	22	0	0	0	40	80
SSc6	1	0	11	0	0	0	0
SSc7.1	1	100	100	100	100	100	80
SSc7.2	1	11	22	0	0	0	0
SSc8	1	0	0	25	0	20	20
WEc1	2	95	89	100	100	100	100
WEc2	5	89	98	65	85	68	96
WEc3	5	22	22	25	0	0	20
WEc4	2	50	50	50	50	50	50
EAc1	18	64	75	74	71	73	57
EAc2.1	2	78	67	50	75	100	80
EAc2.2	2	67	67	100	100	100	60
EAc2.3	2	11	22	25	0	60	40
EAc3.1	1	0	0	25	25	40	0
EAc3.2	2	0	0	0	0	20	0
EAc4	6	43	6	25	0	33	0
EAc5	1	11	0	0	0	0	40
EAc6	1	89	89	100	100	100	100
MRc1	1	0	0	0	25	0	0
MRc2.1	1	0	22	25	25	0	20
MRc2.2	1	0	22	25	0	0	0
MRc3	1	11	11	25	25	20	0
MRc4	1	78	89	100	75	0	60
MRc5	1	0	0	0	0	0	0
MRc6	1	100	56	100	100	100	40
MRc7	1	11	44	50	0	100	100
MRc8	1	89	100	100	100	80	100
MRc9	1	44	33	50	75	40	40
EQc1.1	1	89	100	75	100	100	100
EQc1.2	1	0	0	0	0	0	0
EQc1.3	1	22	0	0	0	0	0
EQc1.4	1	89	89	75	100	60	80
EQc1.5	1	11	22	0	0	20	40
EQc2.1	1	67	56	75	50	60	80
EQc2.2	1	67	44	50	75	20	40
EQc2.3	1	0	0	0	0	0	0
EQc2.4	1	11	11	0	25	40	60
EQc3.1	1	100	100	100	100	80	100
EQc3.2	1	89	89	50	100	100	100
EQc3.3	1	100	100	100	75	80	100
EQc3.4	1	100	100	100	75	60	80
EQc3.5	1	67	22	0	50	80	80
EQc3.6	1	89	67	75	100	100	80

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