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An Embedded Joint Management Body (JMB) in a Comprehensive Life Cycle Cost Analysis Planning Mode in Sustainable Building Project

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Sustainable building is devised to diminish the environmental impacts of the project life cycle. Sustainability feature selections and waste reductions are essential to the designer during the inception stage. Consequently, the operation cost imposed by the JMB has been raised. This study aims to analyze the cost of involving JMB in the design stage to overcome this design gap. This study analyzes the influence of research and development criteria and their cost association in the initial stage of the project and excludes future costs. The aim of this research is to overcome the issues raised during the operation and maintenance phase of green building, which led to overestimating the operating budget. The implemented methodology in this research comprises secondary and primary data collection. The prime data was collected using a questionnaire survey distributed amongst qualified experts and professionals within green buildings and facility management. The data were analyzed using factor analysis to determine the factor score and weightage factor of the relevant JMB and Life cycle cost analysis. It is found that the highest weightage criteria are innovation, with a total weightage factor of 36.7 %, and criteria engagement of people has 19.2 % as the lowest. The study also explored additional perspectives by verdict association of cost element of JMB involvement and found that management cost is highly associated with research and development criteria with the value of 19 %, followed by development cost with 17.5 %. The outcome of this research will add value to green building development and uplift facility management and sustainable development with a low cost of operation and fees imposed. Furthermore, it paves the way to integrate various criteria of engaging JMB in design and its costs associated with the initial and future phases.

1. Introduction

Green building is the best practice of designing, building, and operating buildings to maximize occupant productivity, use fewer resources, reduce waste and environmental impacts, and decrease life cycle costs (Umar et al., 2020). Sustainable building provides commercial benefits along with environmental benefits. Tenants or households gain cost savings on electricity fees, higher property value, increased occupancy rates, and operating costs. According to the World Green Building Council (2019), LEED certificated building has been observed in the environmental field to consume 11 % less water than non-green buildings and 25 % less energy, a 7 % increase in asset value over traditional buildings. Most sustainable complex buildings were not effectively managed due to incompetent facility managers, especially when facility management was not involved during the preliminary stage of the project. Facilities management becomes an issue after the properties are handed over to the end-users despite being more completed and organized related to the complex low-rise buildings. There are many individual corrective actions from different agencies, authorities, and organizations to overcome that are based on something other than project management and the LCC principle. Service and maintenance costs are too high, which account for 15 % of the investment return in renting the property unit (Medhat Al-Sweifi, 2020). Life Cycle Cost Analysis (LCCA) is an instrument to control the project's construction, operation, and maintenance expenses. It assists in determining cost-effective tools to implement during the design phase for a green building design (Kumari et al., 2022). In 1930, the US Department of Defense introduced LCC in three main approaches; Environmental, Conventional, and Societal, to include maintenance and operating costs

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in public procurement but only consider part of the life cycle and end of life. Environmental LCC intends to sequel the environmental life cycle assessment (LCA). As a result, multiple stakeholders can be involved. According to (Wouterszoon Jansen et al., 2020). Societal LCC further expands the analysis limits by including indirect and direct costs covered by the community. Environmental life cycle costing (ELCC) is a tool that scores five categories of associated costs of a project life cycle cost analysis: capital, maintenance, externalities, operation, and end-of-life (Cook et al., 2022). A body responsible for managing the green building project stages, which involves the representation of the developer, facility manager, tenants, or users of the green building, is called a Joint Management Body (JMB). The Malaysian Strata Management Act defined a Joint Management Body (JMB) or Management Corporation (MC) as a formed committee to manage the complex building and control its maintenance in cross-referral to international efforts. Professionalism is desired to ensure efficient joint project management through the life cycle of the sustainable complex project, from pre-planning to operation and maintenance (Zuo et al., 2017). To ensure proper management of the building's operation activities and maintenance. Through section 17 of the Strata Management Act 2013 law, a body is formed after the project is handed over to the end user (Chan, 2018). A new fundamental should be adopted by implementing facility management as a JMB in the planning phase of the green project. The effect of the transition towards the JMB-LCC cross-referral model will necessitate necessary changes in the design, and introducing a tool with new methods is needed to support this assessment (Khalid et al., 2022).This study employs the Selective Critical Literature Review Analysis (SCLRA) methodology, which utilizes an integrated matrix consisting of 57 critical literature reviews. The analysis using the SCLRA framework identifies multiple dimensions of interpersonal relationships examined in the previous study, for example research and development barriers, sustainable facility management, and the Joint Management Body duties and responsibilities. The SCLRA analysis in Table 1 reveals the importance of developing a novel planning model that effectively integrates the Joint Management Body and Life Cycle Costing (LCC). The analysis found that various studies have identified the challenges of operating and managing the facility in sustainable buildings by the JMB. It has been observed that there is a lack of existing research from a cost-based standpoint regarding the potential consolidation of the Joint Management Body with the LCC. The Joint Management Body-Life Cycle Analysis model examines the financial implications linked to sustainable construction practices and fosters a drive towards adopting research and development initiatives.

Table 1: Integrated matrix of selective critical literature review analysis

No.	Criteria Development Impact	Facility Management	Green Building	LCCA	JMB	Reference
1.	√		√			Zhang et al., 2018
2.	√					Barbosa et al., 2021
3.	√	√	√	√		Dalirazar and Sabzi, 2023

Life Cycle Cost Analysis was not incorporated into a joint management body at the inception phase of a green building project, especially during the planning stage. This creates a gap in traditional management practices where new conditions and terms could arise from implementing a comprehensive management strategy for sustainable building. This restriction revealed a research gap. Therefore, it is urgent, crucial, and necessary to develop, edit, re-establish project management processes, and re-shape Joint Management Body responsibilities. In order to overcome the project management failure that occurred during the operation and maintenance phase, the new planning model will address the LCCA and involve the JMB from the beginning of the green building project. The potential focus of LCCA is to have sustainable buildings with the best cost performance in the future. Keeping in view the life cycle cost, it is necessary to study the impact of research and development criteria in terms of weightage cost, which is embedded as an innovative approach within the JMB and facility management industries. Therefore, the aim of the research is to connect the integrated association of the green building R&D criteria and JMB in the initial stage with life cycle costing (LCC). The outcome will provide ease to stakeholders in sustainable projects and researchers to assess JMB duties and responsibilities ,to find out LCC's association with criteria, sub-criteria, and super-sub-criteria in R&D at the inception stage by providing the cost weightage of R&D criteria to the investors.

2. Methodology

The methodology used to achieve the objective of this study is a quantitative approach through a questionnaire survey among proficient, expert practitioners and Qualified Professionals who are adequate as planners, designers, and green building facilitators. The Likert method was implemented to categorize costing elements

of Research and Development (R&D) criteria, sub-criteria, and super-criteria along with seven life cycle cost elements; construction cost, maintenance cost, risk cost, management cost, replacement cost, operation cost, and development cost. This study evaluated R&D factors and considers that R&D criteria have nine sub-criteria and 36 super sub-criteria in the initial phase (design and construction phases) , as mentioned in Table 2.

Table 2: JMB-LCC initial phase Criteria, sub-criteria, and super sub-criteria

Criteria	Sub-Criteria	ID	Super Sub-Criteria
Research and Development	Innovation (IN)	IN1	Innovation in Design & Environmental Design Initiatives
		IN2	Green Building Index Accredited Facilitator
		IN3	Dedicate additional budget for innovation, creativity and scholarship
	Talent Management (TM)	TM1	The Price of Performance management software per JMB member per month
		TM2	The cost of pre-JMB recruitment (talent acquisition) in facility management and planning field
	Budget (BU)	BU1	The Wages of pre-Joint management body members
		BU2	Capital investments in sustainability features
	Engagement of People (EP)	EP1	The Annual average cost for JMB member Training courses
		EP2	The fees of Engage JMB member in The British Standards Institution training (BSI)

For the intent of data collection, the online survey method was used as it is the best approach to target as many respondents as possible in several domains; survey questionnaires are used to erect generalizable and quantitative on attitudes, cognition, and human behavior (Tacchini et., 2022). The primary respondents in the survey are members or required contractors, consultants, facilities management, and green building consultants of the Economic Department and the Dubai Land Department - Real Estate Regulatory Agency (RERA) in Dubai. Face-to-face interviews were conducted with residents of Dubai Sustainable City. The elite group interviewed the pioneers and experts in the complex sustainable market, such as EMAR, Nakeel, and Shams Developers. Data collection through a combination of face-to-face interviews and questionnaires using a semi-structured interview method is the best tool for the objective of this study. A total of 105 questionnaires were distributed, and 56 Questionnaires were returned. The data obtained were interpreted using Statistical Package for the Social Sciences (SPSS) software and Microsoft Excel in conducting factor and weightage analysis. The reliability test through The Kaiser–Meyer–Olkin (KMO) test was performed to measure if the data is suitable for factor analysis. Then, the factor score and mean index were calculated to figure out the factor loading, followed by the weightage factor (WF). Finally, the result of weightage was prioritized and ranked base on influence with sustainable building and motivation to promote the interest of various stakeholders in green building.

3. Result and Discussion

3.1 Respondents' personal details

According to the result collected from the questionnaire survey, the highest percentage of respondents was aware of Life cycle cost Analysis (LCC). Figure 1 shows the respondent's level of LCC awareness. 67 % of the respondents were aware of LCC (Aware 36.7 % and extremely aware 31 %). The lowest range of 13.3 % is slightly aware of LCC. From the result, we can indicate that most respondents are aware of life cycle cost analysis. As a result, the data collected is characterized by precision, accuracy, and credibility.

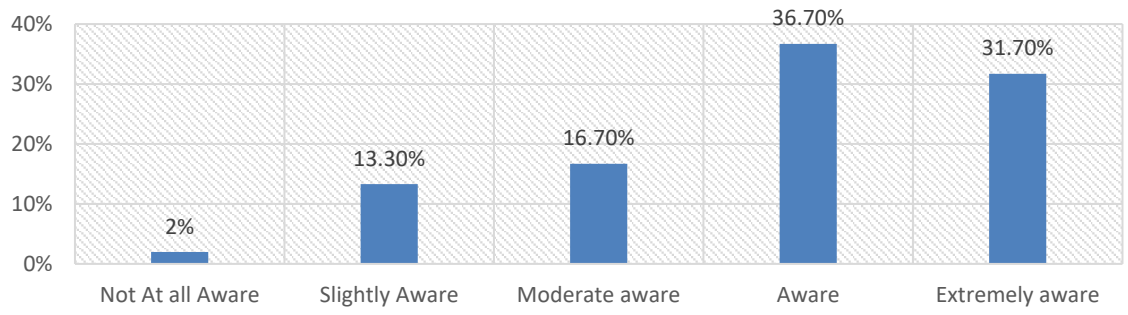

Figure 1: Level of awareness on Life cycle cost Analysis (LCC)

3.2 Reliability Test

Reliability tests were performed on the collected data to test the consistency before proceeding to the validity of a test. Cronbach's alpha was measured to check the reliability. Cronbach's alpha coefficients, ranging from 0.60 to 0.70, indicate a satisfactory reliability level (Jian et al., 2022). The Statistical Package for Social Science (SPSS) software version 2016 was used to compute all data analyses. The Cronbach's Alpha result value indicates that the survey data set has high internal consistency because the Alpha value obtained is 0.63. The outcomes are within the limit of 0.6 – 0.7, which is considered an acceptable level of reliability. The findings also indicated that the instrument demonstrates a positive correlation with the respondents' comprehension of the research, exhibiting high internal consistency for the collected data.

3.3 Kaiser-Meyer Olkin & Bartlett's Test

The Kaiser-Meyer Olkin (KMO) and Bartlett Test is a crucial procedure utilized in data analysis to assess the appropriateness of the data for subsequent analyses. This test serves the purpose of determining whether the data is suitable for further analysis. The Kaiser-Meyer Olkin (KMO) and Barlett's Test of Sphericity were conducted to assess the adequacy of the sample. The KMO value is a measurement unit that falls from 0 to 1. A minimum KMO value of 0.50 is required. The values of the KMO and Bartlett tests were categorized as unacceptable if they fell within the range of 0.00 to 0.49 (Nguyen et al., 2022).
The Bartlett test of sphericity is a statistical procedure used to assess the overall significance of the correlations present in a correlation matrix. Bartlett's test of sphericity, with a significance level (sig.) of less than 0.05, indicates significant correlations among the variables to conduct factor analysis.
The KMO and Bartlett tests determine whether the data is suitable for factor analysis. Resulted in a value greater than 0.5. According to Table 2, KMO has a value of 0.59. This is one of the indicators indicating that the raw data are suitable for factor analysis. Whereas Sig+.000 indicates that these data have sufficient correlations between variables to proceed with factor score and weighted factor analysis in this study. The data analysis shows that the data is suitable for factor score and weightage factor analysis based on the KMO and Bartlett test outcomes presented in Table 3.

Table 3: Result of KMO & Bartlett's Test

	Type of Test		Result
1	Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.59
2	Bartlett's Test of Sphericity	Approx. Chi-Square	1028.490
		df	496
		Sig.	0.000

3.4 Factor Analysis

The main aim of this research is to figure out the weightage factor for JMB_LCC criteria. This was achieved by obtaining factor score analysis (FS) for super sub-criteria, as illustrated in Table 2. The study analyzed the data on the weightage factor of the cost-associated elements, followed by finding the total weightage. Table 4 shows Research and development super sub-criteria, sub-criteria, and finally, criteria. In the sub-criteria, Innovation achieved 36.7 % as the highest weightage concerning cost. According to Ebolor et al. (2022), this result confirmed by Innovation applies novel deviations that produce significant cost advantages and functional. The commercial advantage of adopting Innovation is that better services are provided at a low cost of operation and production. The absence of Innovation scuttles financial and commercial growth. Innovation flexibility behavior positively affects the project outcome and success (Fey and Kock, 2022). Talent Management has the most significant influence on cost after Innovation, with a weightage of 23 %, followed by Budget at 20.8. The lowest cost associated with sub-criteria is Engagement of people with 19.2 %
The cost elements considered with research and development criteria for this research elucidate the association cost of seven elements in LCC. The results outlined that the management cost is found to be 19 % as the highest, the development cost at 17 %, operation cost at 15 %, both contingencies and construction cost and replacement cost are found at 13 %, followed by maintenance cost at 12 % and last one risk cost found as 11 %. This result indicates that the management cost is highly associated with JMB involvement at the design stage of JMB-LCC because the management cost is one of the critical cost elements in green building projects (Ebolor et al., 2022). Figure 2 illustrates the ranking cost weightage distribution for all seven life cycle cost elements in research and development criteria.

Table 4: JMB-LCC Criteria and sub-criteria weightage cost factor

Sub-Criteria	ID	∑FS of Sub-Criteria	∑FS of sub-criteria	∑ FSsc	WFsc	%	WFc (%)
Innovation (IN)	IN1	10.98	32.77	89.02	0.335	33.52	0.367
	IN2	11.04			0.337	33.70	
	IN3	10.73			0.327	32.76	
Talent Management (TM)	TM1	12.29	20.55		0.598	59.83	0.230
	TM2	8.25			0.401	40.16	
Budget (BU)	BU1	7.96	18.61		0.427	42.79	0.208
	BU2	10.64			0.572	57.20	
Engagement of People (EP)	EP1	8.34	17.14		0.486	48.68	0.192
	EP2	8.79			0.513	51.31	

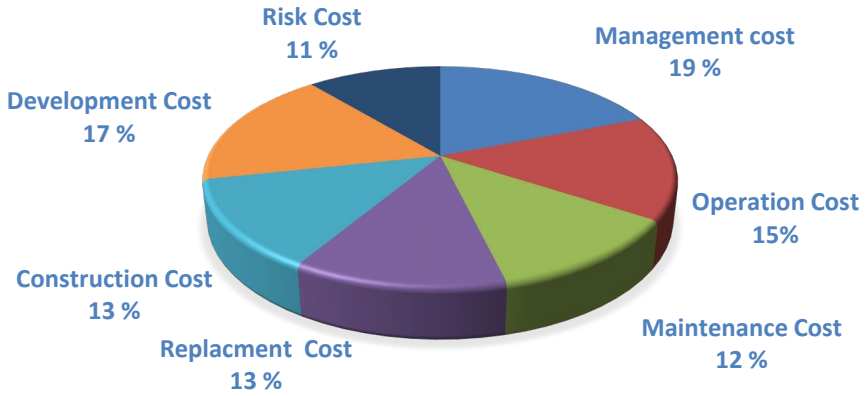

Figure 2: LCC Elements Ranking

3.5 Criteria Mathematical Model Equation Cost Weightage Factor Distribution

A mathematical model as shown by Eq(1) was developed from the following weightage factor equation to calculate the cost weightage distribution. This study was culpably involved in analyzing joint management body criteria along with their cost association to the life cycle costing elements to provide ample solicitude for sustainable building planning. This equation helps stakeholders identify cost associations with respect to each criteria and sub-criteria and super sub-criteria to better understand their worth of investment.

$$\pi \text{ (Criteria)} = \frac{\%\text{ of Stratum Crietria } (\Sigma FS\ (C))}{\%\text{ of Stratum in Core}-\text{Criteria } (\Sigma FS\ (CC))} = \frac{\sum \text{FS SC}}{y} \quad (1)$$

4. Conclusion

This research determined the cost associated with research and development criteria, sub-criteria, and super-sub-criteria of joint management body involvement in green buildings and its effect on the life cycle analysis through implementing factor loading and weightage factor analysis. The research methodology outlined the potential for life cycle cost integration with JMB involvement. The data has high internal consistency with the obtained Cronbach's Alpha value of 0.63, which indicates a positive correlation within the data and is considered within the acceptance level of reliability. KMO has a value of 0.59, whereas Sig+.000 specifies that the raw data are suitable for factor analysis. The aim of this study is to determine the cost association for R&D criteria. Factor analysis found that Innovation achieved 36.7% as the highest weightage concerning cost in the sub-criteria, and the lowest cost associated with the sub-criteria was Engagement of people with 19.2%. This demonstrates that smart building design and budgeting should be evaluated and considered by pre-JMB in the planning stage to overcome the operation and maintenance fees. As a result, management cost is highly associated with the cost element at 19%, followed by development cost at 17%. The lowest cost association is risk cost. The difference among management costs demonstrates that management costs are one of the most significant initial-phase cost elements. Since the design and construction phases are crucial to the successful completion of a project and all management factors are firmly integrated at this stage, the design phase must be carefully planned and evaluated. The research developed a baseline as a prototype by analyzing R&D criteria emergence to life cycle

costing and figuring out the influence of initial cost (design and construction phases); this study is limited to research and development criteria and the initial stage of green building and does not consider future phases of the project (operation and maintenance phases). This research can be extended by considering other challenges and criteria for involving JMB in the planning stage and figuring out the correlation with life cycle costing element cost and factor weightage to establish a new assessment model for better decision-making. Significant criteria such as engineering, law, risk management, and green building need to be investigated and studied for their impact on life cycle analysis and the initial and future costs.

Nomenclature

FS – Factor score in the variables for each item
SC – Factor score in the Sub-Criteria for each item
C – Factor score in the Criteria for each item
CC – Cumulative of factor score in the Core-Criteria
∑ FSsc – sum of Sub-Criteria weightage
y – Total number of sub-criteria

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