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AL-ACHIEVING SUSTAINABLE WASTE MANAGEMENT AT CONSTRUCTION SITES VIA LIFE-CYCLE OF ENVIRONMENTAL IMPACT ASSESSMENT

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Abstract

Construction waste management by performing environmental impact assessment (EIA) is a useful technique for achieving sustainability objectives. A framework for conducting EIA usually outlines functional strategies, challenges, and obstacles for setting any project's sustainability goals. This paper discussed an approach for sustainable waste management at construction sites in Malaysia. The environmental impacts on the construction waste generation were assessed by explicit incorporation into the EIA. A survey technique using questionnaires was used for data collection. Data analysis was performed through relative important index RII, frequency statistics, and exploratory factor analysis to obtain this study's results with the confirmation of construct validity and scale reliability. The result indicates three high key factors for attaining sustainable development practices, reducing the energy required to transform goods and service provision with 0.842, reviewing (EIA) has 0.835, Stakeholder's development with RII of 0.790, and assessing the overall variance in health and quality of life with 0.756. The research outcome would be helpful for stakeholders in the Malaysian construction industry. Other factors, like public participation and site operator's observations, were also considered. Finally, The EIA scheduling process recognized the methods for integrating sustainability into every construction activity

Keywords: Construction waste, Environmental impact assessment (EIA), Life-cycle, sustainability, Statistical analysis.

1. Introduction

At present, the global construction industry processes and methods are substantially contributing to the environmental cost. Modern cities are facing severe environmental issues, primarily exacerbated by several contaminating productions. The construction industry is considered one of the significant environmental pollution sources in every country. The global construction industry is consuming a massive number of natural resources requiring multiple energy sources for processing raw materials. Construction and demolition (C&D) waste is a common term that refers to all sorts of waste materials derived by different construction activities [1]. It is noted that the most frequently produced C&D waste is among inert materials, which may not face a significant challenge to municipal and solid hazardous waste [2].

Nevertheless, construction demolition waste C&DW might have a significant impact on the environment, including increased carbon dioxide emissions and energy use, environmental degradation, and degradation, as well as environmental pollution. Billington et al. [3] conducted construction material development produce some. It dissipates a large amount of energy, compounded at the end of the building's life through the demolition process. Recently, concern has increased about the negative environmental impacts of building waste. Recycling up to 80-90% of the overall C&D is economically feasible in most European countries. The architecture, engineering, and construction (AEC) industry have been experiencing a rising demand for sustainable waste monument used in the past few decades per day in line with the ongoing momentum of sustainable construction trends

The impact of sustainability on design practice is crucial. It incorporates new methods and ways of providing designs and facilities for construction and facility operations. It also provides 9.5% of Malaysia's total workforce, including professionals, skilled workers, and non-skilled workers [4]. The Malaysian industry's significance will develop, and it will change over progressively as a change into a developed nation by 2020 [5]. Recycling of construction waste (CW) is regulated by law and policy to the extent that recycling rates in developed nations have far exceeded 90% [6, 7]. The waste recycling rate in Australia constitutes almost 90 %, while Japan’s recycling rate in 2012 is 99.5%. Moreover, the maximum recycling rate for Singapore was 99.9% [2]. Malaysia's CW recovery rate remains below 50%, lacks institutional support policies, reuses projects, and reuses urban facilities [4].

The idea of environmental sustainability has led to transformative modifications in the construction setting, with reductions in the size of energy use and overall asset consumption needed in traditional life cycles of buildings [1]. In addition to that, Life cycle assessment (LCA) addresses natural perspectives and potential environmental impacts throughout the life cycle of the item, from raw material securing through creation, use, end-of-life therapy, reuse, and final transfer (ISO 14044, 2006) making [6]. Similarly, an Environmental Impact Assessment (EIA) is like an instrument used to identify, predict, and communicate data about a project and assess environmental impacts [4]. It is intended to provide an efficient means of incorporating environmental variables into planning and decision-making [8]. Hanson et al. [9] discussed that a schematic model (SM) performed better than a comprehensive construction model. The SM enables the designers to perform a thorough assessment of the proposed scheme to determine whether it meets the owner's practical and economic expectations and maximizes overall project productivity and quality. Achieving sustainability, addressing global issues, and measuring environmental impacts, forcing the designers to introduce a coordinated framework at the early design stage for performance prediction [1]**.**

Jalaei et al. [10] suggested that ISO 14020 calls for a structured format for communicating product EIs, called the Declaration on Environmental Benefits (EPD). This paper investigated and analysed an approach for integrating EIA to achieve zero-waste capabilities in the construction project at an early design stage. The approach took into consideration of all building construction levels to control waste generation. Effective Implementation of such techniques reflected a significant improvement in achieving a sustainable design and building construction. The innovative approach used an integrated sustainable waste-EIA interface to estimate and measure waste at the construction site generated due to discrepancies in different design disciplines. It enabled respective designers to rectify design discrepancies at an early stage to avoid or minimize the waste at the advanced construction stage. The next section presents a literature review, which focuses specifically on the Review of Environmental Impact toward sustainable Waste Management, concept and application of sustainability, and Integrating Sustainable waste management and EIA in construction projects.

2. Review of Environmental Impact Via sustainable Waste Management

During construction activities in different parts of the world, variable statistics of C&D waste generation (from 18 kg per capita/year to 842 kg per capita/year) observed. This variation in the statistics depends on the construction economy of different countries. For example, developed or rich countries have more mega construction projects than developing countries. It also predicted that the construction & demolition waste C&D will increase in the future with the growth of many countries' construction industry GDP. On average, the projected increase rate of 3.62 kg per capita/year is estimated [7] and Wrong design decisions and sudden design improvements have culminated in a 33% rise in the volume of C&D waste [3].

Eliminated for more efficient waste management, Nitrating Sustainability with waste management can eliminate waste in a construction project. The greenhouse gas effects resulting from CO_2 emissions are expected to increase to 40 billion tons in 2030 if no substantial efforts are made to mitigate them [11]. The construction industry has had a significant effect on the environment. Considering sustainable construction becomes a top agenda at the global level [2-4]. The Malaysian government has promoted sustainable Construction in Malaysia sustainability initiative in the building since the year 2000, leading to several pilot projects. The Malaysian government has introduced the National Green Technology Policy and a proposed RM 1.5 billion (USD 500 million) Green Technology Financing Scheme for promoting green and sustainable technologies [8]. EIA for Building construction also includes the energy incurred in transporting material and components from the production location until reaching the construction sites. Similarly, this study also analysed the scenarios for waste-free construction activities by integrating waste into EIA steps for achieving the relevant, sustainable development goals (SDG). The third section presents the research methodology used, and the fourth section offers a comprehensive analysis and description of the survey data collected. The conclusion of the study and potential provides recommendations for future studies are discussed in the final section.

2.1. Design optimization

The purpose of the Design optimization approach is a sustainable design with waste reduction. The design should be such that deconstruction rather than demolition would be necessary at the end of the building's life-cycle. This construction consists of mostly steel frame, where all joints would be converted from welding to bolts. This could then be recycled at the end of the building's life; then, those in the cast could be replaced with prefabricated materials to remove all dangerous substances [11].

2.1.1. Concept and application of sustainability

The construction industry is seen as a significant contributor to environmental degradation and is related to construction waste generation; in particular, construction waste (CWM) is identified as a combination of various materials, including inert waste, non-inert non-hazardous waste, and hazardous waste generated from the construction, renovation, and demolition operations [12]. Marquis et al. [13]. The Government has encouraged professional organizations and developers to take concrete steps to promote sustainability within their jurisdiction and respond to higher environmental and social security. Figure 1 displays the Concept and application of sustainability.

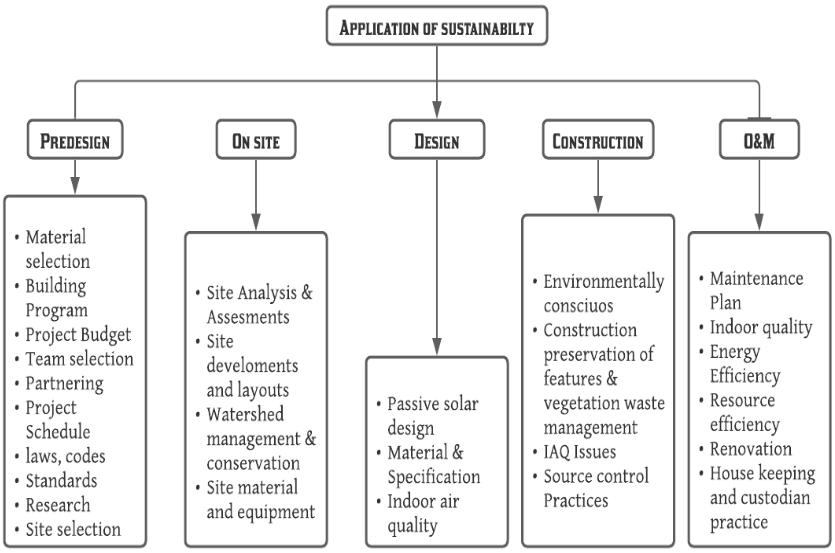

Fig. 1. Application of sustainability [14].

This paper investigated and analysed an approach for integrating EIA to achieve zero-waste capabilities in the construction project at an early design stage. The process took into consideration of all building construction levels to control the waste generation. Implementation can enhance the initial objectives in terms of cost, quality, and time. The research outcome would be helpful for stakeholders in the Malaysian construction industry.

2.1.2. Integrating Sustainable waste management and EIA

EIA is an activity compelling component worried about the potential (or genuine) effects of Proposed (or current) exercises on human subjects (and their choices) and indigenous habitats [3]. Evaluation encompasses such activities as investigation, amalgamation, coordination, and discussion. EIA has explicitly been stretched out to exercises, enactment, strategies, projects, innovations, and items. As a potential instrument of sustainability, EIA should be available, productive, and far-reaching. Whether these qualities are expressed in EIA, practice may depend on how well sustainability and EIA are coordinated [11].

3. Methodology

This portion discusses the study's design, population, information collection methods, and data analysis techniques that can lead to a more concise survey [15]. With a population of 950 having a sample size of 438. This study contained a closed-ended option to a respondent ranging from 1 to 5 rating (Likert-scale) questions and statistical packages for social science software SPSS vision 22.0 and least squares structural equation modelling PLS-SEM were applied in this paper.

4. Results and Discussion

Data collection was carried out employing a questionnaire survey, a quantitative methodology to reinforce research findings with the theories and results of previous research. Therefore, the study sample frame shown in Table 1 includes 212 Quantity surveyors, 310 Architects, 313 Project managers, and 115 Civil engineers, making 950 populations as the sample frame of the study [16]. Most of the respondents knew about waste management and EIA toward sustainable development goals (SDG); Table 1: shown the respondent profile.

Table 1. Sample frame and sample size of professionals.

Population	Sample frame	Sample size
Quantity surveyors	212	61
Architect	310	89
Project managers	313	91
Civil engineers	115	33
Total	950	274

However, this segment gives out the result of the characteristics of respondents of this study. This section presents the total number of questionnaires administered, the total number recovered, and the number considered valid for further analysis with their corresponding percentages.

Figure 2 shows the distribution of questionnaires to respondents. A RII analysis was performed to investigate and analysed an approach for integrating EIA to achieve zero-waste capabilities in the construction project at an early design stage in the Malaysian construction industry.

Figure 2 explains the stakeholders ' working experience; 45 respondents representing 21%, have only 1-5 years of work experience, while 32 respondents representing 15%, have 5-10 years of work experience. On the other hand, 40 respondents representing 19% of stakeholders had 10-15 years of work experience, while 33 respondents representing 16% had 20-25 years of work experience, and 19 respondents representing 9% have 25-30 years of work experience.

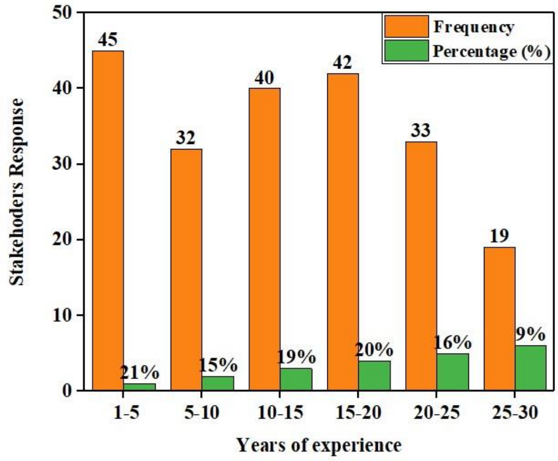

Fig. 2. Working experience.

4.1. Measurement model internal consistency (Reliability)

Various authors recommend a value of 0.7 and above for both the Cronbach's alpha and the composite reliability as the thumb rule for internal consistency. Barroso et al. [17] The Composite reliability of 0.6 is considered acceptable, especially for newly developed scales [17]. The Cronbach's alpha for sustainable waste management (BSC) has 0.958, and life-cycle of environmental (TBSC) has 0.950 reliability of the analysis measurement models is shown in Table 2:

Table 2. Internal consistency.

Code	Cronbach's alpha	Composite reliability
BSC	0.951	0.958
TBSC	0.934	0.950

Although the suggested Level is 0.7 [5], the first field information iteration stated that BSC attained the acceptable values of 0.951 and TBSC has 0.934. Therefore, the alpha of Cronbach is a measure used to determine the reliability or internal consistency of a scale or test item set [16].

4.1.1. Evaluation of measurement model (PLS-SEM)

The structural equation modelling of the least partial squares is used to test the relationship between the studies constructs and check the research hypotheses. The models' internal accuracy by alpha and composite reliability of Cronbach, convergent validity, and the discriminatory validity [17].

4.1.2. Convergent Validity

The AVE is the average of all the squared loadings of the indicator variable. For the measurement model to have convergent validity, its AVE must reach 0.5 [18]. Similarly, the Model would converge before achieving a total of 300 simulations

[16]. Based on the above, the study measurement results are compared and presented in Table 3.

Table 3. Convergent validity.

	Higher Order	ERS	Alpha	Rho_A	C.R	AVE
AVE	0.517	0.572	0.697	0.768	0.516	0.791
GSC1	0.692**					
GSC2	0.595**					
GS1	0.699**					
GS2	0.682**					
EM1		0.758*				
EM2		0.734*				
WM1		0.755*				
EM2			0.756**			
SC1			0.817**			
SC2			0.889**			

** Significant (t-statistics >1.96; p-value <0.05)

Table 3 shows the loading factors and the significance level of the measurement models, and the average variance extracted (AVE). The result shows that all factor loads are above 0.5, and all are significant. The models' AVE varied from 0.517 to 0.791, both of which were beyond the required minimum of 0.5 [4]. The convergent validity of the measurement equations is then achieved.

4.2. Ranking on sustainable waste management at construction sites via EIA

Table 4 shows the RII and the ranking of sustainable waste management at construction sites via (EIA) as postulated by the respondent. Thus, scores above the line selected as the most significant factor from sustainable waste management at construction sites (EIA). The result shows that improved site planning to reduce waste (GSC1) with a RII=0.842 was ranked by the respondents as the most important factors Careful dimensioning of design to avoid cutting to fit (GSC2) with RII of 0.809. Careful dimensioning of design to avoid missing to include (GSC3) and identifying all reusable elements and integrating them into the design ranked at 0.809 and 0.711. Several types of research supported this finding, as shown in the work of [11].

Table 4. Rank for design factors.

		Percentage of respondents scoring		
Code	**Design factors**	**≤2**	**RII**	**Rank**
GSC1	**Improve site planning to reduce waste**	26.22	0.842	1st
GSC2	**Design and construction using standardized materials**	9.52	0.809	2nd
GSC3	**Careful dimensioning of design to avoid cutting to fit**	19.05	0.809	3rd
GSC4	**Identify all reusable elements and integrate them into the design**	14.29	0.732	4th
GSC5	**Design management to prevent over-specification of materials**	23.18	0.711**	5th
GSC6	**Designate a place for storing wastes in the early stage of construction**	13.79	0.674	6th

4.2.1. Waste management

Table 5 illustrate the factors that contribute to wastage management factors on sustainable waste management at construction sites via EIA during site operation and rank the Level of awareness on CWM' significant effects on 3R (GS1), thus as the most important factor under construction waste as an enhancer with an RII = 0.835. The Develop waste management strategy for other particular wastes generated worksite through the 3R's are minimizes, reuse, and recycle.

Furthermore, attitude & perception of stakeholders & behaviour in CWM implementation (GS2) with a RII=0.805. Waste collection sites (15 percent), even as >30 percent duct an environmental evaluation and boost their environmental efficiency at is widely acknowledged. It is important to ensure that workers possess adequate knowledge of the sector and its various technologies to efficiently perform their tasks devoid of such compromise resulting from inadequate waste management knowledge. The high demand for sound quality waste can change consumers, adequate education on CWM's benefits and practices with RII of 0.684 and 0.681, respectively. Several types of research supported this finding, as shown in the work of [11]. The results have a high potential in developing a proper strategy on sustainability to gain a better position in the educational market, such as its attitude towards its employees, as Show in the work of [19].

Table 5. Rank for waste management factors.

		Percentage of respondents scoring			
Code	**Waste Management Factors**	**3**	**≤2**	**RII**	**Rank**
GS1	**Level of awareness on CWM' importance effects on 3R**	76.19	99.52	0.835	1st
GS2	**Attitude & perception of stakeholders & behavior in CWM implementation**	71.43	19.05	0.805	2nd
GS3	**The high demand for good quality waste can change consumers**	61.90	23.81	0.684	3rd
GS4	**Adequate education on CWM's benefits and practices**	66.67	23.81	0.681	4th
GS5	**Availability of training for 3Rs operations**	61.90	23.81	0.659	5th
GS6	**Availability & encouragement of participation channels in CWM activities**	57.14	28.57	0.642	6th

4.2.2. Green and sustainable construction

The respondent rated eight waste minimization steps in alignment with this finding and showed that the factors on stakeholder development (EM1) are very significant in achieving construction waste via EIA as it started before any construction activity begins with an RII of 0.842. Stakeholder development factors can make stakeholder-based life cycle assessment (SBLCA) has been suggested as a novel method to aid growth planning to improve sustainable waste management. Building Information modeling (BIM) (EM2) is the second factor by using Building Information modeling, perform a life cycle environmental impact assessment to control and optimize construction waste (BIM) second with RII of 0.783.

This is consistent with several research types finding that Building information modeling (BIM) has been used to optimize different aspects of design over the last decade. This rate can be reduced by improving the design, building, and manufacturing efficiency. This study further shows that thirds factors among the construct under green & sustainable construction (EM3) to manage sustainable waste management via EIA Energy efficiency improvement of energy consumption during on-site, off-site, and operational activities with RII 0.783. Energy efficiency improvement of energy consumption during on-site, off-site, and operational activities shown that Modular construction is one of the most cost-effective off-site construction methods due to its standardization of design, high energy efficiency, and ease of installation. This finding is sported by the result of [20] that the ability to extract dissolved solids and organic compounds with high efficiency and without the use of chemicals exposed to flame radiation for a while sufficient to ensure a high combustion quality the scenarios involving combustion, as well as the small requirement for nuclear energy import. Table 6: RII ranking for Green & sustainable construction. As seen in the work of [17].

Table 6. Ranking for green and sustainable construction.

	Percentage of respondents scoring				
Code	**Green & sustainable construction Factors**	**≥4**	**≤2**	**RII**	**Rank**
EM1	**Stakeholder's development**	72.43	9.40	0.790	1st
EM2	**Building Information modelling (BIM)**	79.31	6.90	0.783**	2nd
EM3	**Energy efficiency improvement of energy consumption during on-site, off-site, and operational activities**	79.31	10.34	0.782	3rd
EM4	**Material consumption Improved efficiency of building materials and components via new technology**	76.28	9.32	0.763	4th
EM5	**Design management to prevent the over-specification of materials**	74.77	8.25	0.463	5th
EM6	**Industrialize building system (IBS) CWMS benefit**	75.21	8.29	0.401	6th
EM7	**Adequate knowledge, understanding, and education on CWMS benefit**	64.30	14.28	0.400	7th
EM8	**Available CWM strategic policy & plan that drive cwm efforts**	62.95	12.14	4.13	8th

4.2.3. Environmental

Several literature works reveal Waste generation and (minimization, source evaluation, collection, storage, separation, treatment, transportation, and disposal) (WM1) is one of the areas that lead to high-level improvement of sustainable waste management via the life cycle of EIA at a construction site. Waste generation and (minimization, source evaluation, collection, storage, separation, treatment, transportation, and disposal with a with RII of 0.756 as one of the first factor to enhance Environmental by improving sustainable construction waste management via EIA.

Similar studies by Sarstedt et al. [20] stated that the ability to extract dissolved solids and organic compounds with high efficiency and without the use of chemicals exposed to flame radiation for some time sufficient to ensure a high combustion quality of the scenarios involving combustion, as well as the small requirement for nuclear energy import. Secondly, this study revealed that the Review of EIA (WM2) was ranked in the second position with an RII of 0.756 in environmental categories. The life cycle analysis method can be used to assess the impact of activity both cycle Assessment as A Metric to Achieve Sustainable

Development. The Life-Cycle Assessment (LCA) is a management method for measuring solid waste mitigation rather than environmental pollution or energy use. This is followed by Safety training provided (WM3) with an RII = 0.751 at 3rd position as a factor in the Environmental Factors category to achieves sustainable waste management via EIA as illustrated in Table 7, present the ranking for environmental factors.

Table 7. Ranking for environmental factors.

		Percentage of respondents scoring			
Code	**Environmental Factors**	**≥4**	**≤2**	**RII**	**Rank**
WM1	**Waste generation and (minimization, source evaluation, collection, storage, separation, treatment, transportation, and disposal).**	57.60	6.25	0.756	1st
WM2	**Review of (EIA)**	71.43	3.81	0.756	2nd
WM3	**Safety training provided**	76.19	14.29	0.751	3rd
EM4	**Land generation due to construction activities**	76.19	14.29	0.704*	4th
WM5	**Evaluate the health effect and quality of life.**	61.90	19.05	0.704	5th
WM6	**Comprehensive (EIA) reporting**	57.14	28.57	0.642	6th
WM7	**Minimizing negative environmental impacts.**	42.86	47.62	0.712	7th
WM8	**Improve manufacturing process for construction materials to reduce environmental impacts**	68.97	13.79	0.712	8th

This result has been sported by the work of [21] mention that construction projects' environmental effects have requirements for implementing sustainable management practices on construction sites targeted at the building's life cycle, creating multiple environmental impacts. These studies can provide an enhancer of sustainable waste management for better sustainable development goals (SDG).

4.2.4. Economic and Socials factors

This is confirmed by Russell-Smith, et al. [21] who specifically intended to improve waste minimization Impact to optimize sustainable waste in construction projects Similar studies by23. Society becomes more aware of green/ sustainable construction (SC1) with the RII of 0.849 as rank in a category of economic and social factors for enhancing sustainable waste management at construction sites via life-cycle of environmental impact assessment and ranked 1st. Nevertheless, enhance a participatory approach by involving stakeholders (SC2) was ranked 2nd with an RII of 0. 805.Whereas (SC3) with RII of 0.805 and was rank as the third factor to improved sustainable waste management at construction sites via life-cycle of environmental impact assessment among the economic and social factors. This study reveals that Life Cycle Cost (LCC) activities are especially appropriate in waste generation in a sustainable construction project, enforcing negative environmental impacts and unnecessary resource use. Involve stakeholders in developing a participatory method. The findings reveal that the circular economy seeks to minimize waste by the effective use of framework” and ISO 14044:2006 “Environmental management life cycle assessment. There is a need for an evaluation to determine the consequences of integrating the environment into the sustainable development process (SDG). As seen in the work of [22] are presented in Table 8.

Table 8. Ranking for economic and socials factors.

		Percentage of respondents scoring				
Code	**Economic and Socials factors**	**≥4**	**3**	**≤2**	**RII**	**Rank**
SC1	**Society becomes more aware of green/ sustainable construction**	72.43	18.19	9.40	0.849	1st
SC2	**Enhance a participatory approach by involving stakeholders**	79.31	13.79	6.90	0.805**	2nd
SC3	**Influence on the existing social framework**	79.31	10.34	10.34	0.805	3rd
SC4	**Assess the impact on health and the quality of life**	76.28	14.40	9.32	0.694	4th
SC5	**Minimizing negative environmental impacts.**	74.77	16.98	8.25	0.679	5th
SC6	**Comprehensive (EIA) reporting**	75.21	16.51	8.29	0.622	6th
SC7	**Environmental technologies**	62.95	24.19	12.14	0.607	7th

Furthermore, the findings show that, in addition to completing the project promptly and improving project quality, sustainable WM through EIA is related to project performance in terms of time, expense, and quality. On the other hand, sustainable WM through EIA can affect project progress, and it has been shown that achieving the sustainable development target can lead to project success. Finally, this study's life cycle assessment emphasized the importance of concrete waste recycling in achieving a sustainable development goal from the construction site and waste reduction assessment, life cycle costing, economic effect, environmental impact, and decision.

4.2.5. Assessment of Structural Model

The hypothesized interrelationships are meant to answer research questions and achieve objectives. Structural model evaluation assessment entails ascertaining the Model-based quality to predict the endogenous models Structural model evaluation assessment entails ascertaining the Model-based quality to predict the endogenous models [23]. The structural model quality is assessed by examining the path coefficients and their significance, the coefficients of determination (R2), the effect sizes (f2); the PLS path model is specified in for testing the hypothesized relationships for this study. The relative significance of each construct on the other is assessed by observing the t-statistics from the t-statistics of the final Model which revealed the relative significance of each exogenous construct on the endogenous constructs. On the other hand, the path coefficients'-statistics show each path's significance in the structural Model. As shown in the work of [24].

The results would also manage the project scope's interpretation to enhance stakeholders' involvement and maximize the outcome of the project; construction projects bring different levels of improvements to the design, and it concluded that a thorough communication approach. It shows that design factors, construction WM factors, and economic factors significantly affect green sustainable construction as indicated by t-statistics values above the recommended minimum of 1.96. Green sustainability has the highest effect, followed by social then economic factors as indicated by t-values of 4.873, 2.652, and 2.386, respectively. However, social factors and environmental factors do not significantly affect green sustainable factors as indicated by t-values of 1.327 and 1.557 below the recommended value of 1.96 [23]. Nevertheless, the economic factor has no significant effect on the mediator, as indicated by the at-value of 0.881. This precludes the existence of the mediation effect of design between economic factors and social factors. The majority of the study's path coefficients were significant and therefore indicated the structural model's quality.

4.2.6. Assessing R2

The coefficient of determination R2, provides information on how the exogenous constructs explain endogenous constructs' variance. The values of R2 range from 0 to 1, with values closer to one signalling a better fit of the Model. For example, Chin et al. [25] stated that in the EIA discipline, the R2 value of 0.2 is considered high, but in other fields, R2 values of 0.25, 0.5, and 0.75 are considered to be weak, moderate, and substantial. Table 9 illustrates the R2 degree of the endogenous constructs and the mediator constructs. The endogenous construct, ED, has an R2 value of 0.266, which means that the exogenous structures interpret around 26.6 percent of the difference in WM. GSCD mediators have R2 values of 0.436 and 0.270, respectively. Both R2 in the structural equation model are above 0.20 and are considered acceptable. Therefore, the quality of the structural Model based on the R2 Level is confirmed. The R2 values in the structural Model presented in Table 9.

Table 9. R2 assessment.

Constructs	R Square
ED	0.266
WM	0.436
GSC	0.270

4.2.7. Assessing Goodness-of-Fit (GoF)

The goodness of fit sets out global criteria for assessing the overall quality of the PLS model. However, Mohammed et al. [26] proposed a global measure of the goodness of fit called the "GoF" index. This can be determined through the formula below:

$$\text{GoF} = \sqrt{\overline{\text{Com}}\ \text{X}\ \overline{\text{R2}}} \quad (1)$$

where $\overline{\text{Com}}$ is the AVE communality extracted from the significance value, $\overline{\text{R2}}$ is the mean *R* Square value.

Maydeu-oliveres and Garcia-Foreo [27] submitted a rule of thumb for the GoF test. It is called low, medium, and high if the values are 0.1, 0.25, and 0.36. The GoF of the systemic paper model is then estimated below

$$\text{GoF} = \sqrt{0.6435 \times\ 0.324}$$
$$\text{GoF} = \sqrt{0.2085}$$
$$\text{GoF} = 0.47$$

The GoF of 0.47 is considered to be high. The study framework, therefore, fitted very well which indicates a strong model [28].

5. Conclusions

This study examined the workability and effectiveness of achieving sustainable waste management by a life-cycle environmental impact assessment (EIA) at construction sites. Though many studies have been proposed in this field, one of this study's most advanced and innovation is quantifying the practically suggested earlier concepts to minimize waste over most of the building's lifetime with (EIA) incorporated. The following are some closing conclusions from the investigation. The following parts illustrated these findings' impact on academic and practical implications:

- In this paper, various strategies for enhancing the life cycle of three phases of construction have been extensively studied, and the way (EIA) affects these factors has been investigated and quantified. Applying design to this building, calculating the amount of waste production, and applying it to the available waste Records generated using the conventional method provide opportunities to demonstrate the impact of using (EIA) in reducing C&D waste.
- Sustainability integrating waste and (EIA) associated frameworks must be adjusted to suit local and regional conditions. The multiple attempts to tackle environmental and social issues regarding planning and basic manufacturing, interfacing, and accommodating natural, social, and economic perspectives Sustainability and (EIA) will also evolve as evaluation and execution regions.
- There have been more studies that have measured the embodied impacts of building materials and product combinations than studies that have looked at the entire construction process.
- Full life-cycle assessment studies are required to evaluate the impact of alternative materials on building energy efficiency and determine the best relationships.
- More has been done to assess the environmental impacts of residences at the building scale, likely due to their greater prominence in the building stock and lower complexity than non-residential buildings, especially offices, which are considered to be of high importance in terms of greenhouse gas emissions.
- Finally, all of the studies studied were conducted in developed countries, and no published papers investigating the achievement of sustainable waste management at construction sites through the environmental impact of construction in developing countries were discovered. This should be tackled as soon as possible, considering the immense potential for building construction in the developing world. Despite the limitations and critiques, this paper is a valuable guide for assessing sustainability (WM) at construction sites by building environmental impacts. It has the potential to contribute to the objective of long-term sustainability substantially. The EIA scheduling process recognizes methods for integrating sustainability into each activity EIA, and waste management is a viable approach to enhancing sustainable development goals (SDG).

Nomenclatures

(f2)	Effect sizes (f2)
R2	The coefficient of determination R2
t-values	Significant values

Greek Symbols

β	$\text{GoF} = \sqrt{0.6435 \text{ X } 0.324}$

Abbreviations

AVE	Average Variance Extracted
BIM	Building Information Modelling
C&DW	Construction & demolition waste
C.R	The acceptable value
CWM	Construction waste management
EIA	Environmental Impact Assessment
ERS	Error Resolution System
GOF	Assessing Goodness-of-Fit
GSC	Waste Management Factors
ISO	International Organization for Standardization
SDG	Sustainable Development goals

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