

The Impact of Construction Material Selection and Handling on Project Performance: Insights from Built Environment Experts in Kuwait

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Abstract: The result of a survey conducted among professionals in Kuwait, the present paper provides a realistic perspective on the material selection process in the preconstruction and construction phases of a construction project. At the same time, it highlights the appropriate strategies for ensuring a high and lasting quality of construction materials, well after the delivery date of a project. In our opinion, the findings of the study provide a useful framework for improving the material selection process and ensuring the use of high-quality, sustainable materials in construction projects, thus leading to better construction outcomes and a more sustainable built environment.

Keywords: construction, handling, quality, management, materials.

1. Introduction

Quality in construction refers to the degree to which a finished structure meets the requirements and expectations of the client [1], as well as industry standards and codes. This concept is closely intertwined with all aspects of the construction process, from design and planning to material selection and craftsmanship. The importance of quality in construction cannot be overstated, as it plays a crucial role in ensuring the safety, functionality and longevity of a building. In addition to being directly correlated to immediate client satisfaction [2], construction quality is key to improving the overall durability and reliability of a structure [3], reducing the need for repairs and maintenance, and increasing the overall satisfaction of the building's occupants [4]. Additionally, construction quality is paramount in promoting environmental sustainability and energy efficiency, which can lead to significant cost savings over time [5]. Overall, delivering proper quality is vital for the success and longevity of a construction project, as well as ensuring the safety and well-being of its users.

It has already been noted that there is a strong correlation between the quality of construction materials and the performance of construction projects [6]. The quality of materials used in a construction project can have a direct impact on the overall quality of the finished structure. For instance, high-quality materials, such as steel and concrete, can improve the structural integrity and durability of the building, while

lower-quality materials may cause, in time, issues such as leaks, cracking, as well as an increased seismic vulnerability. In addition, choosing high-quality materials plays an important part in improving the energy performance of a building, thus resulting in a reduction of its carbon footprint, as well as in cost savings in its usage over time. A recent study [7] shows that materials impact up to 70% of construction costs – this being an important factor to be considered in any project performance assessment.

On the basis of the above, the aim of the present paper is to examine the material selection and handling strategies in the preconstruction and construction phases of projects in Kuwait, while also providing useful insights into improving the status quo of the local construction industry. While analysing the material selection and handling in projects in the area, we have identified and outlined practical solutions for increasing construction quality throughout the entire life cycle of a building. The objectives of this study are to (1) examine the current methods of material selection in the preconstruction phase, (2) assess the impact of material selection during the construction phase on the quality of construction materials, and (3) propose and evaluate strategies for improving the quality of construction materials throughout the entire life cycle of a structure. Our ultimate goal is to provide valuable insights into improving the material selection process and enhancing the quality of construction materials, thus contributing to better construction outcomes and, overall, a more sustainable built environment.

2. Literature Review

A. Selection of Materials in the Preconstruction Phase

Material selection plays a crucial role in the preconstruction phase of a project, as it can have a significant impact on its overall quality and success. As established by [8], the selection of materials and technology has a direct and decisive impact on the success of projects. The selection of materials should be based on the project requirements and specifications, as well as industry standards and codes [9]. Significantly, making sure the materials selected for a construction project match its design and specifications is crucial for reaching a (more than)

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satisfactory overall quality standard and, thus, ensuring a successful delivery. A mismatch between materials and design can easily cause issues such as compromised quality, lack of client satisfaction, structural failure, leaks and other problems that may result in significant delays and cost overruns [10].

During the preconstruction phase, a series of major requirements – such as structural integrity, durability, fire resistance [11] and energy efficiency [12] – must be considered when selecting materials. For example, the use of fire-resistant materials, such as steel and concrete, will improve the safety of the finished structure and reduce the risk of fire damage. Similarly, the use of energy-efficient solutions, such as insulated walls and windows, plays an important part in improving the energy performance of the building and, also, reducing costs for the future occupants [13]. As such, material selection and decision making in the preliminary stages should be done in strict accordance with the design and specifications [14], as these will have a lasting effect on the overall project quality.

Furthermore, it has been noted that the preconstruction phase is also the perfect time to evaluate the cost-effectiveness and sustainability of the materials [15]. Choosing durable, low-maintenance materials can reduce the need for repairs and upkeep work over time – which, again, will save costs. Also, choosing environmentally-friendly materials will reduce the project's overall impact on the environment [16]. Careful consideration of the project's requirements, industry standards, cost-effectiveness and sustainability of the materials will contribute to delivering a finished structure that is safe, durable and efficient.

Proper decision making and material selection at this initial stage is also essential to avoiding various problems during the actual construction. That is because the preconstruction phase is when the project requirements are defined, the design and specifications are set and material selection takes place, therefore it is crucial to make sure all these decisions are made with all the necessary care and consideration, so as to avoid any potential problems later on. One of the key ways to avoid problems during the construction phase is by clearly defining the project requirements and specifications during the preconstruction phase [17]. Proper decision making also includes reviewing the design and specifications with the contractor and other stakeholders, in order to make sure that the selected materials are entirely adequate for the requirements of the project and, also, that they can be correctly installed and maintained. A thorough review will help identify any problems that may arise during the construction phase and, thus, provide an opportunity to address them before construction even begins. This includes determining the structural and functional requirements of the building, as well as any specific aesthetic or performance requirements [18]. All this will ensure that the selected materials are appropriate for the project and that installation and future maintenance does not pose any problems.

Another important aspect of proper decision making in the preconstruction phase is evaluating the various materials that are available, in order to confirm they actually meet the project's needs. This means taking into consideration factors such as

cost, durability, sustainability and availability. By properly evaluating the materials, the project team may identify any potential issues early on and make the necessary adjustments before the construction phase begins.

3. Material Handling in the Construction Phase

For a construction project to achieve the desired quality standard, as well as the objective of better energy performance and waste reduction, proper material handling during the building phase is also very important. During the building process, construction material handling entails the efficient and safe transfer of all such materials, so as to facilitate their smooth conversion from production and/or storage to being a seamlessly integrated part in the finished structure. The safety of the construction operatives and the quality degree of the finished structure are also tightly connected to proper material management. On the project site, mistakes and lack of a proper material handling plan can cause accidents, injuries and damage to both the raw materials and the finished construction [19]. Delays and interruptions in the construction process, which can result in cost overruns and timetable delays, can also be partly avoided by making sure material handling is done in a careful and practical manner and by coming up with planning techniques [20].

By ensuring safe and proper material storage, including proper utilisation and handling, the performance of the finished structure can increase significantly [21]. This entails safeguarding the materials from environmental deterioration [22], verifying they are utilised in the correct manner and preserving their quality throughout the construction stage, thus contributing to a high-quality end result.

In addition, proper material handling in the construction phase plays an important part in waste reduction through sustainable material management strategies (SMM), among other techniques [23]. There are several sources of waste that can be of significant concern during the construction phase. Firstly, there is the risk of over-procurement of construction materials – that is, having on site more than what is required at a particular point in time [24] is a significant contributor to wastage. Other causes include damage to materials due to improper handling and storage, as well as inefficiency in material usage resulting in scraps that cannot be used [25]. Inadequate training of the workers and lack of inventory control can also lead to mistakes and inefficiencies that result in waste [26]. Waste may be reduced, and resources can be preserved, however, by using the construction materials in the right way, including when it comes to their storage, as well as their application on site. This can cut expenses and lessen the overall environmental impact of the construction project.

4. Methodology

The primary goal of the present paper was to establish just how tight the correlation is between construction material handling and the performance of construction projects. As can be seen below, we adopted a quantitative study approach, which would primarily collect numerical data, hence allowing for

subsequent analysis. Accordingly, our major research instrument was a survey, which was designed to test each of the objectives. The survey was disseminated among built environment experts in Kuwait, addressing the specific objectives of the proposed study. A total of 54 responses were collected and appropriate statistical measures were employed, in order to obtain relevant insights.

5. Results and Discussion

Out of the 54 participants who undertook the survey, architects represented 42.59%, which was the highest percentage, compared to other professional affiliations. Of the other participants, 22.22% were project managers, 14.81% were engineers, contractors had a share of 12.96% in the total, while quantity surveyors, construction managers and BIM specialists accounted for the remainder. We would like to highlight the high involvement of professionals in the study, which proves that the insights were derived from experienced individuals in the industry – see Figure 1.

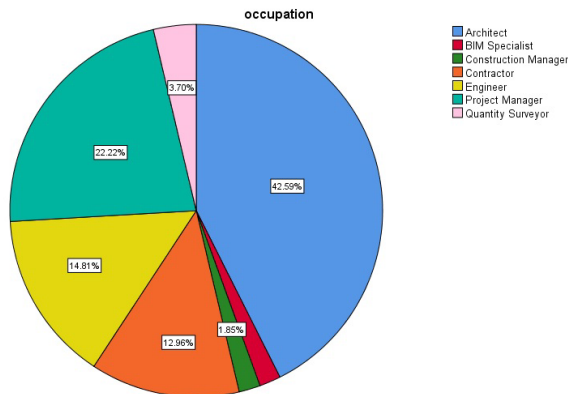


Fig. 1. Professional affiliation of participants in the survey

Most of the participants were also well experienced, with most of them having more than 10 years of practice in the field, as shown in Figure 2. This significantly facilitated our endeavour, since the insights were derived from individuals with a solid industry background.

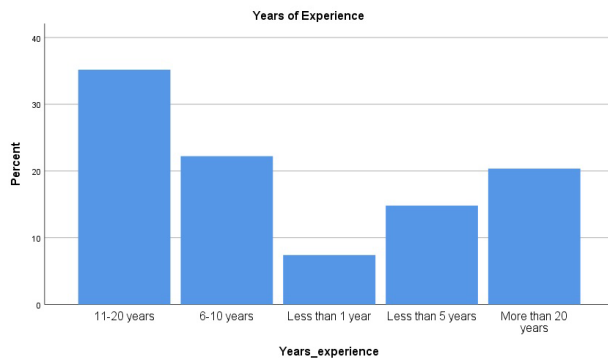


Fig. 2. Years of experience of participants in the survey

A. A. Material Handling in the Preconstruction Phase

The preconstruction phase plays a significant role in the

planning and design of any construction project. As such, during this phase, critical decisions are made that are directly related to the overall success of the construction projects. An important decision that has to be made at this time is material selection, which involves choosing the right materials for the project, based on their availability, cost and suitability for the specific project requirements [8]. In the survey we conducted, participants were asked to express their opinion about the importance of material selection in the preconstruction phase, taking into account its effect on the overall project success. 42.59% of the respondents felt that it was extremely important, while other 22.22% said that it was simply 'important' to ensure proper material selection in order to guarantee project success and overall quality. Figure 3 shows the exact percentage attained by each response option included in the questionnaire.

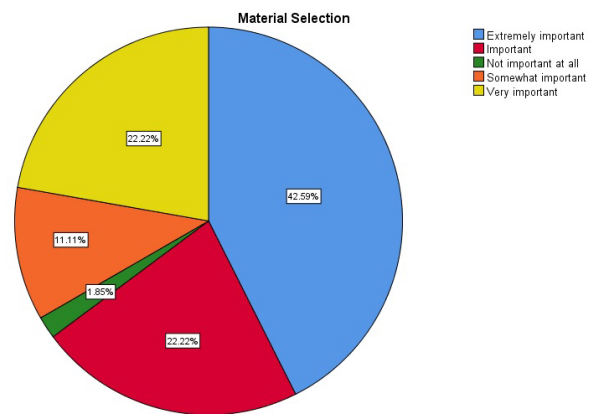


Fig. 3. Perception on the importance of material selection in the preconstruction phase

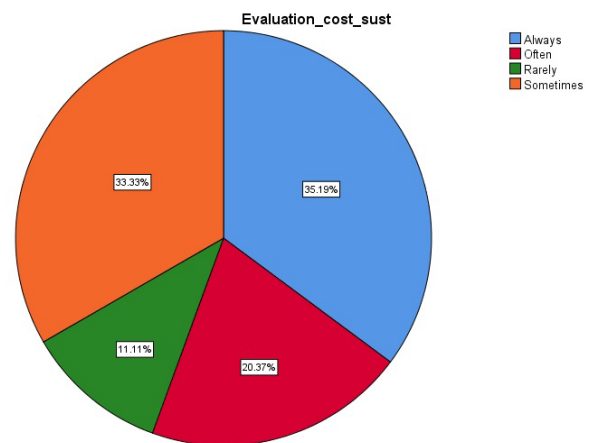


Fig. 4. Cost and sustainability evaluation

At the same time, the evaluation of cost effectiveness and sustainability ratings for construction materials is of great importance at this time [15]. By evaluating the cost-effectiveness of different materials, construction professionals can determine which options will provide the best value for money, taking into account not just the upfront costs, but also the ongoing maintenance and replacement costs [27]. This can help ensure that the project remains within budget. Furthermore, thoroughly referring to current sustainability

requirements and paying close attention to the estimated impact of different materials will make sure that environmental concerns are to be well taken care of in the construction phase. Critical decisions are made at this stage and, by determining the impact of different materials throughout their entire life cycle, including their production, transportation and disposal, construction professionals can make informed decisions. Figure 4 shows that 35.2% of respondents always undertake the evaluation of cost effectiveness and sustainability ratings of construction materials before the execution stages of their projects, while 33.33% said that they only sometimes do that – implying they do so selectively, depending on the project.

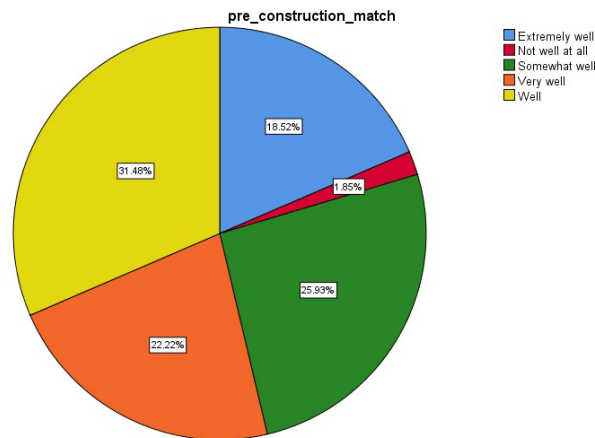


Fig. 5. Alignment of materials to design specifications

The participants in our survey also received an inquiry on whether the material selection corresponds to the design and specifications in the typical projects they undertake. Results show that 31.48% of respondents feel that their selection corresponds well to the above, while, according to 18.52% of

them, it corresponds extremely well. Interestingly, a small percentage (1.8%) actually feel there is a significant mismatch in the alignment of materials to design specifications. See Figure 5 for the detailed results.

B. Construction Material Management in the Construction Phase

The construction phase involves the actual execution of the construction project, including the mobilisation of construction materials and labour on site. At this point, the participants in our survey received several questions that sought to provide actual measurable data about their material handling approaches in the construction phase (see Table 1). In Table 2, the results indicated are ranked using mean values, based on responses from participants. Apparently, most respondents make sure materials are shielded from weather damage, with a mean of 3.87. In addition, they ensure that workers are well trained in material handling, followed by tracking and management of material inventory, proper storage and handling and, finally, the proper utilisation of materials, in order to minimise waste.

C. Strategies for Improving the Quality of Construction Materials throughout the Life-Cycle of a Building

At the same time, a Likert scale was also used to rate the responses regarding the best strategies that should be implemented in order to improve the quality of construction materials during the entire life cycle of a project. The results are as shown in Table 3.

Looking at our ranking of strategies by mean values, it becomes apparent that most of the interviewed professionals feel that ensuring the conformity of materials to the required design and specifications is of utmost importance, as indicated by the mean score of 4.46. Furthermore, respondents generally

Table 1
Likert scale responses

Questionnaire item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
We ensure proper storage and handling of materials during the construction phase	3.7%	11.1%	16.7%	38.9%	29.6%
We ensure that the materials are used in an efficient manner to minimize waste during the construction phase	1.9%	9.3%	22.2%	44.4%	22.2%
We ensure that the materials are protected from weather damage	3.7%	3.7%	20.4%	46.3%	25.9%
We ensure that workers are properly trained in material handling techniques	3.7%	7.4%	22.2%	31.5%	35.2%
We track and manage material inventory during the construction phase	3.7%	3.7%	27.8%	33.3%	31.5%

Table 2
Descriptive statistics

Questionnaire item	N	Mean	Std. Deviation	Variance
We ensure that the materials are protected from weather damage	54	3.87	.972	.945
We ensure that workers are properly trained in material handling techniques	54	3.87	1.100	1.209
We track and manage material inventory during the construction phase	54	3.85	1.035	1.072
We ensure proper storage and handling of materials during the construction phase	54	3.80	1.105	1.222
We ensure that the materials are used in an efficient manner to minimize waste during the construction phase	54	3.76	.970	.941
Valid N (listwise)	54			

Table 3
Strategies for improving material handling

Questionnaire item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Matching materials to design and specifications	1.9%	5.6%	1.9%	25.9%	64.8%
Evaluating materials on the cost effectiveness and sustainability criteria	1.9%	0.0%	11.1%	38.9%	48.1%
Ensuring workers are trained on material handling	1.9%	3.7%	20.4%	38.9%	35.2%
Proper storage and handling on site	0.0%	1.9%	11.1%	37.0%	50.0%
Efficient utilisation of construction materials	0.0%	1.9%	5.6%	46.3%	46.3%
Tracking and ensuring a proper material inventory on site	0.0%	0.0%	16.7%	42.6%	40.7%

Table 4
Descriptive statistics

Questionnaire item	N	Mean	Std Deviation	Variance
Matching materials to design and specifications	54	4.46	.926	.857
Efficient utilisation of construction materials	54	4.37	.681	.464
Proper storage and handling on site	54	4.35	.756	.572
Evaluating materials on the cost effectiveness and sustainability criteria	54	4.31	.820	.673
Tracking and ensuring a proper material inventory on site	54	4.24	.725	.526
Ensuring workers are trained on material handling	54	4.02	.942	.886
Valid N (listwise)	54			

agree that the correct utilisation of construction materials, which subsequently prevents wastage, is an important strategy for achieving a proper handling and management of construction materials. Additionally, other strategies include proper storage, evaluation of materials on cost and sustainability criteria, tracking and inventory management, and, finally, effective training of the site operative regarding the proper handling of materials. See the detailed results in Table 4.

6. Conclusion

A. Overview

The purpose of the present study was to analyse the decisions that are made during the preconstruction and construction stages as far as construction material handling is concerned. We feel the evaluation of the key decisions comes with the recognition of the fact that construction materials have a huge role to play in terms of the overall performance of construction projects. At the same time, we have sought to identify and evaluate strategies that can be used in improving material handling in the construction phase. The study findings suggest that while the handling of construction materials plays an important role in quality determination, not all professionals adhere to strict decision making in the preconstruction phases, such as material evaluation and comparing against sustainability criteria. By examining the current methods of material selection in the preconstruction phase and the impact of material selection during the construction phase, our study highlights the importance of considering both the technical and economic aspects of material selection. The proposed strategies for improving the quality of construction materials throughout the construction life cycle provide a road map for raising the bar in the material selection process and ensuring the use of high-quality, sustainable materials in construction projects.

B. Limitations

The study was focused on Kuwait, a country distinguished from others, even in the same region, by its unique geographical characteristics. Regional studies could be conducted so as to better understand decision-making in the construction industry and how this may be influenced by cultural traits unique to a certain population and their consequent effect on general behaviours, which could have an impact on material handling in our field of activity. We also admit to not having done an in-depth comparison of the different variables in the study and the impact they had on each other.

C. Suggestions for Future Studies

We believe future research should be conducted in order to

evaluate the impact of material handling decisions in the life cycle of construction projects, based on the performance aspect, both from an economic and environmental point of view. Moreover, other regions of the world can be used for comparison, so as to bring to light any striking differences in the professionals' material handling approaches.

References

- [1] O.R. Aluko, G.I. Idoro, G.I. and M.C. Mewomo, "Relationship between perceived service quality and client satisfaction indicators of engineering consultancy services in building projects," *J. Eng. Des. Technol.*, 19(2), pp. 557–577, 2021.
- [2] S. Hussain, Z. FangWei and Z. Ali, "Examining influence of construction projects' quality factors on client satisfaction using partial least squares structural equation modeling," *J. Constr. Eng. Manag.*, 145(5), p. 5019006, 2019.
- [3] Y. Chen, "Research on engineering quality management based on PDCA Cycle," in *IOP Conference Series: Materials Science and Engineering*, IOP Publishing, 2019, p. 62033.
- [4] M.B.C. Da Silva *et al.*, "Perceived quality of built environment, service, satisfaction and value in use, in the context of residential buildings," *J. Facil. Manag.*, 18(4), pp. 451–468, 2020.
- [5] C. Maraveas, "Production of sustainable construction materials using agro-wastes," *Materials*, 13(2), p. 262, 2020.
- [6] M.N. Shamsiddinovich, A.S. Axmatovich and K.A. Latifjonovich, "The Role of the Technical Regulatory System In Ensuring Product Quality And Safety In Enterprises Producing Construction Materials," *Am. J. Eng. Technol.*, 2(12), pp. 44–49, 2020.
- [7] S. Donyavi, "The impact of effective material management on construction site performance for small and medium sized construction enterprises," Sept. 2009.
- [8] J. Roslon. (2009). Materials and Technology Selection for Construction Projects Supported with the Use of Artificial Intelligence. *Materials*, 15(4).
- [9] V. Mechtcherine *et al.*, "Large-scale digital concrete construction–CONPrint3D concept for on-site, monolithic 3D-printing," *Autom. Constr.*, 107, p. 102933, 2019.
- [10] K. Gharouni Jafari, E. Noorzai and M.R. Hosseini, "Assessing the capabilities of computing features in addressing the most common issues in the AEC industry," *Constr. Innov.*, 21(4), pp. 875–898, 2021.
- [11] D. Kumar *et al.*, "Comparative analysis of building insulation material properties and performance," *Renew. Sust. Energ. Rev.*, 131, p. 110038, 2020.
- [12] A. Kawuwa *et al.*, "Development of Strategies for Sustainable Energy Efficient Building Codes in Nigeria," *I. J. Sci. Res. Publ.*, 5(1), pp. 2250–3153, 2015.
- [13] M.K. Urbikain, "Energy efficient solutions for retrofitting a residential multi-storey building with vacuum insulation panels and low-E windows in two European climates," *J. Clean. Prod.*, 269, p. 121459, 2020.
- [14] I.Y. Wuni and G.Q. Shen, "Critical success factors for modular integrated construction projects: a review," *Build. Res. Inf.*, 48(7), pp. 763–784, 2020.
- [15] A.J. Kadhim, Q.S. Banyhussan and A.K. Jameel, "Cost-effectiveness analysis of a road improvement proposal based on sustainability Indicators: Case study Al-Nebai-Baghdad highway," *Period. Eng. Nat. Sci.*, 8(2), pp. 916–932, 2020.
- [16] J.K.W. Wong and J. Zhou, "Enhancing environmental sustainability over building life cycles through green BIM: A review," *Autom. Constr.*, 57, pp. 156–165, 2015.
- [17] A.N.C. Nen *et al.*, "Complexity factors during pre-construction stage affecting quality performance in infrastructure projects," in 11th IEEE

- Control and System Graduate Research Colloquium (ICSGRC), IEEE, 2020, pp. 253–258.
- [18] S.G. Abramyan, S.G. *et al.*, “Methodology for selecting energy efficient and environmentally safe technologies and materials used in construction,” in *IOP Conference Series: Materials Science and Engineering*, IOP Publishing, 2020, p. 52057.
- [19] D.P. Sah *et al.*, “Occupational accidents in cement industries of Nepal, in Journal of Advanced Research in Alternative Energy,” *Environ. Ecol.*, 6, pp. 22–28, 2019.
- [20] A.A. Shash and F.M. Abu Alnaja, “Causes of material delays in capital projects in Saudi Arabia,” *Int. J. Constr. Manag.*, pp. 1–9, 2021.
- [21] M.O. Sanni-Anibire *et al.*, “A risk assessment approach for enhancing construction safety performance,” *Saf. Sci.*, 121, pp. 15–29, 2020.
- [22] K.W. Shah and G.F. Huseien, “Biomimetic self-healing cementitious construction materials for smart buildings,” *Biomimetics*, 5(4), p. 47, 2020.
- [23] M.S. Aslam, B. Huang and L. Cui, “Review of construction and demolition waste management in China and USA,” *J. Environ. Manage.*, 264, p. 110445, 2020.
- [24] A.O. Daoud *et al.*, “Quantifying materials waste in the Egyptian construction industry: A critical analysis of rates and factors,” *Ain Shams Eng. J.*, 12(4), pp. 4275–4289, 2021.
- [25] C.E. Eze *et al.*, “Assessment of the triggers of inefficient materials management practices by construction SMEs in Nigeria,” *INTREST*, 14(1), pp. 38–56, 2020.
- [26] A.H.M.H. Al-Aidrous *et al.*, “Critical factors influencing inventory and procurement system of infrastructure projects,” *J. Civ. Eng. Manag.*, 28(8), pp. 634–645, 2022.
- [27] L. Golsteijn. (2018). Life Cycle Assessment (LCA) explained - PRé Sustainability. [Online]. Available: <https://pre-sustainability.com/articles/life-cycle-assessment-lca-basics/>