Scheduling and Resource Management in Sustainable Construction Projects

Segun Aguda *
Missouri State University, 901 South National Avenue, Springfield, Missouri 65897
* E-mail of corresponding author: spa9s@missouristate.edu

Abstract
Construction shapes our world but is taking a heavy toll on our planet. From our energy consumption to carbon emissions, how we build today affects the world in the future. As energy bills rise and our planet deteriorates, builders and developers are rethinking their approach. By embracing greener materials and sustainable construction, they are finding ways to have a lighter carbon footprint. Careful planning and effective resource management are the keys to making this work. These early decisions ripple through the entire project, ultimately determining whether we succeed in building for today and for future generations.

This study explores the significance of strategic scheduling and resource optimization in environmentally friendly construction projects. Its objectives include examining how scheduling methods affect the incorporation and efficacy of green materials and energy-efficient technologies, assessing resource management approaches to minimize delays and budget overruns, and creating a framework that balances sustainability objectives with traditional construction limitations while maximizing long-term investment returns. The research data was gathered through case studies, structured interviews with industry experts, and an examination of life cycle assessments.

The results underscore the necessity of incorporating sustainability considerations into project timelines and resource allocation strategies. This research offers practical insights for construction managers and policymakers, emphasizing how efficient scheduling and resource management can drive environmental and financial advantages in sustainable construction projects.

Keywords: Resource Management, Sustainable Construction Projects
DOI: 10.7176/EJBM/16-9-12
Publication date: November 30th 2024

1. Sustainable Construction Projects – The importance and implication of adopting green building in today's society.

There has been a need to push towards sustainable construction by the present society with concerns on environmental health, resource conservation, and economic efficiency. This minimizes a project's carbon footprint through green building practices, renewable materials, and energy-efficient designs, thus supporting global sustainability goals. Again, green construction enhances the occupants' well-being and lessens the operating expense since it saves energy, therefore practical for developers and occupants alike. Various works also identified that "green building research has already expanded significantly, highlighting its benefits, emphasizing the need for further adaption to address pressing environmental challenges" (Jian & Zhen-Yu, 2014). On the other hand, green building is tough to adopt, especially for developing countries. These are issues related to, yet not limited to, awareness, finances, and lack of governmental support; for instance, in Ghana, "critical barriers to green building technology adoption include financial constraints and inadequate incentives" (Albert et al., 2018). In this situation, the impediments to the diffusion of green-building technologies hurt their benefit. Definitely, the alteration of major challenges will quicken the pace of sustainable construction assisted by policy reforms, financial incentives, and educational programs. The focus on addressing these barriers becomes important for the development of sustainable development at a global scale as countries begin to realize that green buildings will create benefits in the long run.

2. Energy-Efficient Technology Implementation and Scheduling – Managing the installation of energy efficient systems

Applying energy-efficient technologies, like solar panels and HVAC systems, into the project schedules is important to maximize their effectiveness and contribution towards sustainability. Proper scheduling will ensure the installation of these systems during an optimum phase of the project and that they are integrated with other construction activities to avoid any delay or inefficiency. For instance, HVAC systems must be embedded in the structural and insulation phases to achieve maximum thermal performance; solar panels, on the other hand, are generally much easier to install following the completion of roofing. Such a careful installation plan often allows project managers to improve these technologies' functionality, ensuring they work at optimal capacity from the start of operation. A few research studies have estimated that properly scheduled energy-efficient technology can reduce energy costs and improve building performance in the long run (Pelin et al., 2014).

Scheduling also significantly addresses climate change concerns by optimizing the timing and coordination of sustainable construction activities to reduce energy consumption, limit material waste, and lower greenhouse gas emissions. Systems integration concerning energy efficiency can be complicated and perhaps difficult to handle, especially for HVAC projects where schedules are tight and workflows are pretty complicated. It is therefore important to note that project management strategies relating to accelerated HVAC efficiency implementation are of high essence when it comes to increasing climate challenges (Wisdom et al., 2024). These strategies include prioritizing tasks, anticipating supply chain demand, and coordinating with stakeholders in securing resources. In such a way, project managers can ensure that installations are being completed on time and operate at optimal output, which, in turn, leads to minimizing greenhouse gas emissions and maximizing savings from day one.

To achieve energy efficiency, the integration of scheduling, resource allocation, and stakeholder collaboration is of utmost importance. Every stage of the installation, right from procurement to commissioning, must be well-planned to avoid delays and ensure system effectiveness. Energy-efficient rebuilding or re-installation and adoption of new technology benefit from a structured, integrated decision-making approach, which helps synchronize project timelines with sustainability objectives (Pelin et al., 2014). Hence, it is in tune with the global goals of sustainable development, integrating such technologies within the project schedule for energy efficiency, thus granting long-term benefits to the environment and society.

Task Name	Duration	Start	Finish	Predece	Resource Names
Typical Schedule for Energy-Efficient Systems Project	**66 days**	**01/11/2024**	**31/01/2025**		
Signing of Contract and Kick-off Meeting	1 day	01/11/2024	01/11/2024		
Initial Planning for Sustainable Construction	15 days	04/11/2024	22/11/2024	2	
Hiring and Mobilization of Skilled Labor	7 days	04/11/2024	12/11/2024	2,3SS	
Design of Building - Calculation of Minimum Energy Requirement	15 days	13/11/2024	03/12/2024	4,2	
Installation of Energy-Efficient Systems	26 days	04/12/2024	08/01/2025	5	
Testing and Quality Assurance	10 days	09/01/2025	22/01/2025	6	
Final Inspections	6 days	23/01/2025	30/01/2025	7	
Project Handover	1 day	31/01/2025	31/01/2025	8	

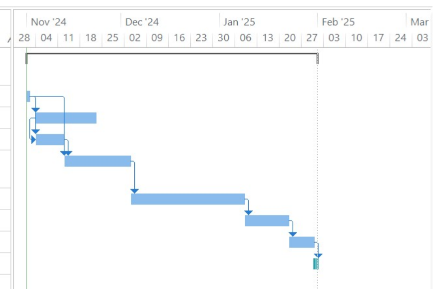

Fig. 1 above shows an example of a schedule (with a Gantt chart showing the activity path) to help guide and monitor the progress of sustainable construction. This simple schedule was done with Microsoft Project.

3. Resource Optimization in Sustainable Projects

Efficient use of resources is essential in sustainable construction projects to meet the objectives within project duration and budgeted costs effectively. Ensuring that labor, equipment, and materials are utilized efficiently helps minimize wastage and preserve energy from the project's start to its completion. Strategies like on-time delivery of materials, accurate forecasts, and scheduling, with the help of digital tools for tracking resources, empower project managers to avoid excess resource delivery on site, which could lead to disruption, lack of space, and inadequate storage spaces to keep the materials, leading to issues such as greenhouse gas emissions, operational inefficiencies, and so on. Hence, multi-objective optimization models that consider time management, emissions, and resource allocation play a role in construction projects by striking a balance between sustainability and cost-effectiveness (Altaf & Iftikhar, 2023). Improving labor efficiency involves detailed scheduling and assigning skilled workers appropriately to promote effectiveness and sustainability within the project framework. For instance, utilizing a matrix for resource allocation aids in selecting skilled workers for specific tasks, like the installation of energy-efficient HVAC systems or solar panels.

Energy-conserving design and construction emphasize using eco-friendly and energy-efficient materials to minimize the project's ecological footprint significantly. A study conducted in Nigeria found that optimizing material resources can improve sustainability by lowering waste generation and preserving resources (Garba et al., 2015). Construction teams can achieve sustainable goals without sacrificing project timelines by correctly predicting material needs, selecting low-impact resources, and incorporating recycled materials when feasible. Efficient workforce management, through scheduling and assigning properly skilled workers, helps in completing tasks promptly and minimizing delays in construction projects while also ensuring resource efficiency and environmental sustainability in line with green building goals without compromising project success.

Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
	Typical Schedule for Energy-Efficient Systems Project	66 days	01/11/2024	31/01/2025		
	Signing of Contract and Kick-off Meeting	1 day	01/11/2024	01/11/2024		Project Director,General Fo
	Initial Planning for Sustainable Construction	15 days	04/11/2024	22/11/2024	2	Project Manager,General Fo
	Hiring and Mobilization of Skilled Labor	7 days	04/11/2024	12/11/2024	2,3SS	HR Team,Project Manager
	Design of Building - Calculation of Minimum Energy Requirement	15 days	13/11/2024	03/12/2024	4,2	Design Team, Project Manager
	Installation of Energy-Efficient Systems	26 days	04/12/2024	08/01/2025	5	Electrical Engineer,Labour
	Testing and Quality Assurance	10 days	09/01/2025	22/01/2025	6	QAQC Team
	Final Inspections	6 days	23/01/2025	30/01/2025	7	QAQC Team
	Project Handover	1 day	31/01/2025	31/01/2025	8	Project Director,Project Mai

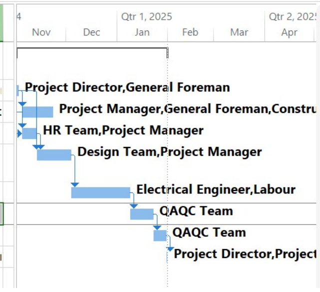

Fig. 2. Showing the project schedule now with assigned resources.
Note: To fully maximize resources, all the project data must have been fully analyzed and considered. This is just a demonstration of resource assignment.

4. Balancing Sustainable Construction and Cost Control

The project manager can successfully balance sustainable construction and cost control through strategies that allow both environmental and financial efficiency. Earned Value Management (EVM) is an effective tool because it permits the project manager to track actual resource utilization and costs incurred in real time against planned values. This comparison between actual and planned values enables project managers to take corrective actions about cost overruns as soon as possible, ensuring that sustainability goals are achieved without deviating from the budget. Indeed, extended observation during years of on-site experience showed that planning and cost estimating are very important in weighing green objectives against budget limitations, mainly since green materials and methods are often much more expensive at the outset, leading to high front-load costs in the project schedules (Joseph et al., 2011).
EVM may also be integrated with other tools, such as Building Information Modeling (BIM), to give the project manager more accurate estimates of material requirements and usage to avoid resource wastage. For example, planning for manpower can be done to optimize productivity without overworking for extra hours, while bulk-buying eco-friendly materials can reduce environmental impacts and consequently reduce costs. With EVM, project managers can revise the budget and schedule considering sustainable metrics, ensuring that the green building initiatives align with financial constraints to achieve a sustainable project within the budget limits.

5. Minimizing Delays, Cost Overruns, and Other Challenges in Green Projects

Mitigating delays, cost overruns, and other challenges, including socio-economic issues in green projects, necessitates addressing unique obstacles, such as supply chain disruptions and increased initial costs associated with sustainable materials. It is noteworthy that the majority of green projects exhibit greater complexity compared to traditional projects. Green construction projects frequently encounter distinct delay factors due to the utilization of unique materials and technologies not commonly employed in conventional construction (Bon-Gang et al., 2015). Project managers can mitigate these issues by implementing proactive risk management strategies, such as early supplier engagement and establishing multiple supply sources to prevent or minimize such delays. These issues warrant individual consideration, as they stem from diverse causes and require distinct solutions.

5.1. Delays in Green Projects

Several studies have confirmed that green projects possess numerous factors that could potentially delay the process. One such investigation was conducted by Bon-Gang Hwang et al. In their research, they ascertained that green building design and construction typically require more time than traditional projects due to project team members needing additional time to comprehend and implement green practices, as well as the increased time necessary to integrate green requirements into architectural and engineering designs. They further noted that green requirements would impact the schedule of procurement, construction, and project closeout. Moreover, they identified thirty causes of delay in Hong Kong construction projects, categorized into seven groups, which include factors relating to clients, engineers, contractors, human behavior, projects, resources, and the external environment (Bon-Gang et al., 2013).
Delays in green projects represent a significant challenge, often attributed to the complex nature of sustainable construction. In contrast to traditional projects, green projects utilize advanced materials and technologies that may not be readily accessible. For instance, the procurement of renewable materials such as bamboo or recycled steel can be time-intensive, particularly when suppliers are limited. Furthermore, the design phase for green projects frequently necessitates extensive iterations to integrate energy-efficient systems and renewable technologies effectively. These prolonged design processes can extend project timelines.

Another contributing factor is the scarcity of skilled labor. Green construction requires expertise in areas such as renewable energy systems, eco-friendly material handling, and sustainable architecture. In regions with limited expertise in these fields, projects experience delays as contractors and project managers encounter difficulties in securing qualified professionals. Moreover, regulatory processes often impede timely project execution. Green buildings must adhere to stringent environmental standards; obtaining the necessary permits can be a protracted process, potentially spanning months or even years. In the absence of a streamlined approval process, even well-planned projects face delays.

An additional issue is inadequate collaboration among stakeholders. Green projects necessitate integrated input from architects, engineers, sustainability consultants, and contractors. Insufficient communication or lack of alignment regarding sustainability goals can disrupt timelines, underscoring the need for cohesive project management strategies to mitigate delays.

5.2. Cost Overruns in Sustainable Construction

Throughout a project's lifespan, cost is an important and very delicate factor to consider. Regrettably, many projects exceed their budgeted costs before completion. The construction industry faces significant challenges with both schedule delays and budget overruns. This issue is not limited to any particular region because it affects both industrialized and emerging economies. The situation is particularly more serious in developing nations, with cost overruns occasionally surpassing 100% of the initially projected cost (Jamilus et al., 2013). In sustainable construction, cost overruns are a frequent worry, mainly due to the substantial upfront expenses linked to eco-friendly technologies and materials. For example, incorporating solar energy systems, establishing geothermal heating, or employing high-efficiency insulation typically demands considerable initial financial resources. Although these innovative solutions promise future cost savings, their upfront costs often surpass project budgets, especially for smaller-scale developers.

Unforeseen technical challenges also contribute to cost overruns. For example, there are reports of contractors avoiding additional tasks necessary for sustainable building because this novel construction method requires specialized expertise and equipment they do not typically possess (Queena et al., 2015). Incorporating modern techniques into conventional building methods for sustainable construction can often result in unforeseen challenges. A good illustration of this is when an existing building is adapted to incorporate green energy solutions, which may uncover underlying structural issues that require additional financial resources. Supply chain issues further exacerbate the problem. The limited availability of sustainable materials can result in price volatility. When demand surpasses supply, project costs escalate, compelling developers to delay construction or exceed budgets. Additionally, the lack of economies of scale for green technologies renders these projects more expensive than traditional construction.

Longer payback periods for green investments also strain budgets. Stakeholders may face difficulties justifying the immediate financial outlay required, even when long-term benefits are evident. Addressing these issues necessitates innovative financial models, government incentives, and widespread adoption to reduce costs through economies of scale.

5.3. Other Challenges: Socio-Economic Issues in Developing Countries (Sub-Saharan Africa)

Green construction encounters unique socio-economic hurdles in developing areas such as Sub-Saharan Africa, parts of the Middle East, and Southeast Asia. These regions grapple with resource limitations, infrastructure deficiencies, and policy constraints that create substantial obstacles. Poverty remains a critical issue, compelling governments and private developers to prioritize low-cost housing over eco-friendly alternatives. For instance, despite an urgent need for affordable housing in Nigeria, developers still utilize conventional, inexpensive materials, sidelining sustainability objectives. They do this because the substantial initial cost required for green projects frequently makes this new construction method unfeasible in these societies, where financial resources are already limited (Ikechukwu & Iwuagwu, 2016).

In addition, major infrastructural deficits hinder the implementation of sustainable building practices in developing countries. Many areas within Sub-Saharan Africa still struggle with inconsistent power supply, insufficient transportation systems, and limited availability of potable water and waste disposal facilities. These infrastructural shortcomings create huge problems in improving the adoption and incorporation of eco-friendly technologies within the construction industry.

In Kenya, the progress of environment-friendly construction faces challenges due to the scarcity of renewable energy resources, such as solar and wind power. Despite the country's considerable potential for generating renewable energy, inadequate infrastructure to harness and distribute it hinders construction professionals from fully implementing sustainable practices in their building projects. Research by Peter Khemba indicates that Kenya's high poverty rates may impede the promotion of green building practices. This is partly because some individuals cannot afford even basic housing, while those who can build often do so simply to have a place to live (Peter, 2013). The scarcity of advanced technology further complicates sustainable construction efforts. Many developing nations lack the sophisticated equipment, materials, and expertise required for green building initiatives. Importing these resources increases expenses and causes delays, making eco-friendly projects less viable. Moreover, insufficient policy frameworks and government support impede progress. Without financial incentives like tax reductions, grants, or subsidies, developers have little motivation to invest in sustainable practices.

Additionally, the absence of supportive policies and weak governance structures hinder sustainable construction. Ineffective planning and legal systems limit access to solid regulatory measures, failing to encourage sustainable building initiatives. Although regulations require all commercial or individual developers to submit plans and seek planning permission, this rarely occurs. The government's inability to enforce planning rules and regulations largely contributes to the dysfunction of sub-Saharan Africa's built environment, with serious consequences for the natural environment. In Khartoum, Sudan, the building plans submitted for approval often differ significantly from the actual structures built (Ebohon & Rwelamila, 2014). Many developing countries' governments have not established clear guidelines or incentives to promote green building practices. Corruption and bureaucracy also discourage private developers from pursuing sustainable projects.

In Ghana, despite growing awareness of the need for sustainability in construction, the lack of strong regulatory frameworks and financial incentives restricts progress. Developers face obstacles in obtaining certifications for green projects, which slows adoption rates and discourages innovation in the sector (Opoku et al., 2020). Similarly, in South Africa, despite being a relatively advanced economy within Sub-Saharan Africa, the country still encounters challenges in implementing sustainable construction due to socio-economic disparities. While the Green Building Council of South Africa (GBCSA) has advocated for green certification standards, these are typically embraced only by upscale developers. The majority of the population, served by affordable housing initiatives, often find themselves without the necessary resources or motivation to implement sustainable practices in their projects.

Finally, cultural and societal influences contribute to the adoption of sustainable construction practices. Many communities in Sub-Saharan Africa and the Middle East favor traditional building techniques due to their familiarity and cost-efficiency. Research indicates that socio-cultural values mostly impact sustainable building design in developing areas, including Gaza. One particular study reveals that these values are key factors affecting sustainable housing in the region. Despite the increasing global prevalence of modern, western-influenced building designs, Palestinians tend to maintain their historical housing styles and inherited cultural values (Shehab & Khandar, 2021). This explains the typical and expected resistance to change, mainly because the advantages of eco-friendly construction are not widely recognized or understood.

5.4. How to Minimize or Solve Issues Affecting Sustainable Construction

Addressing delays, cost overruns, and socio-economic challenges in green projects requires a multifaceted approach. Project managers must prioritize efficient planning and stakeholder collaboration to mitigate delays (Zavvar et al., 2023), as explored in point 2 of this article above. Adopting digital tools like Building Information Modeling (BIM) can help streamline design processes and improve communication (Zhen et al., 2023). Governments and regulatory bodies should also establish clear and expedited permitting processes for green projects, ensuring smoother workflows. Effective communication and regular schedule review must be prioritized in green projects to ensure that these projects stay on course toward both the sustainability and economic objectives of such projects.

Cost overruns can be tackled by promoting economies of scale through the widespread adoption of green technologies. As demand rises, production expenses will decrease, making these materials and systems more cost-effective. Government bodies can significantly contribute by offering financial support, such as tax incentives or grants, to companies and individual builders to offset the huge upfront costs associated with eco-friendly construction.

Additionally, developers should explore value engineering methods to identify budget-friendly solutions that align with sustainability goals. Project managers must also consider premium costs for sustainable materials for accurate budgeting and provide contingency funding accordingly. Monitoring cost and resource usage through techniques such as Earned Value Management allows managers to view the project's real-time financial status and take corrective actions when necessary (Mahadik & Mahadik, 2015).

In developing regions like Sub-Saharan Africa, international collaboration is essential. Knowledge transfer programs can bridge the gap in expertise, while financial aid from global organizations can help fund green projects. Localized solutions, such as using region-specific sustainable materials, can also reduce costs and increase accessibility. Awareness campaigns are crucial to educate communities about the long-term benefits of green construction, fostering cultural acceptance.

6. Long-Term Environmental and Financial Benefits of Green and Sustainable Construction Projects

Green and sustainable projects provide several environmental and financial advantages, especially if resources are properly scheduled and managed. Concentrating on energy-efficient materials and incorporating streamlined schedules can significantly reduce the project's carbon footprint. Therefore, it is imperative to emphasize that through sustainable scheduling, resources will be managed well enough to minimize waste and emissions, further optimizing energy conservation. Researchers have stated that the business case for high-performance green buildings is rooted in both environmental and fiscal results because of long-term cost savings associated with operations, and these improve ecological efficiency (Paul, 2003). Furthermore, energy-efficient designs reduce energy usage, and incorporating renewable materials decreases dependence on non-renewable fuel resources, therefore, lessening the harmful impact of greenhouse gases on the environment.

The financial benefits of green construction are powerful, with a positive return on investment (ROI) over time. Life cycle assessments and cost-benefit analyses increasingly indicate that operational savings associated with reduced energy and maintenance costs can often balance off high costs related to the actual sustainable materials. It is, therefore, noteworthy, after considering all factors, to confirm that green buildings tend to offset the initial higher costs with their increased asset value and long-term financial stability through operational savings (Kathy et al., 2006). Naturally, sustainable buildings return better market values since their operational efficiencies and compliance with green standards make them more attractive to investors. These benefits only point toward the value of sustainable construction practices, proving green projects to be economically viable, long-term investments.

The table below compares the benefits of green construction to traditional construction in the United States, based on data from 2010–2020 and projections for 2021–2030 (USGBC, 2024).

Impact Area	**Green Construction (2010–2020)**	**Traditional Construction (2010–2020)**	**Green Construction (2021–2030)**	**Traditional Construction (2021–2030)**
Reduced Carbon Footprint	*34% reduction in CO_2 emissions	Baseline	40% reduction (projected)	10% reduction (projected)
Energy Conservation	*25% less energy consumption	Baseline	30% less energy consumption (projected)	10% less energy consumption (projected)
Lower Greenhouse Gas Emissions	34% lower CO_2 emissions	Baseline	**40% lower CO_2 emissions (projected)	10% lower CO_2 emissions (projected)
Waste Minimization	Diverted over 80 million tons from landfills	Baseline	90 million tons diverted (projected)	20 million tons diverted (projected)
Energy Savings	10.5% average operating cost savings in the first year	Baseline	15% savings (projected)	5% savings
Long-term ROI	4-6 times payback over 20 years	Baseline	5-7 times payback (projected)	2-3 times payback (projected)
Higher Market Value	Higher rents and occupancy rates	Baseline	10% higher market value (projected)	3% higher market value (projected)
Reduced Maintenance Costs	Extended roof lifespan by over 200%	Baseline	250% extension (projected)	50% extension (projected)
Reduced Operational Costs	10.5% average operating cost savings in the first year	Baseline	**15% savings (projected)	5% savings (projected)

Source: USGBC and others.

Note that "Baseline" is the value of the standard performance of traditional construction buildings during the period stated in the table above.

*Reports from USGBC

** Projections from USGBC

Findings

This work has shown that proper scheduling and resource management are crucial for achieving sustainable construction goals. Timely incorporation of energy-efficient technologies, such as HVAC systems and solar panels, considerably reduces delays and boosts system efficiency. Optimizing resources ensures effective use of workforce, materials, and machinery, thereby minimizing waste and lowering greenhouse gas emissions. Life cycle analyses underscored the enduring environmental advantages of eco-friendly projects, including decreased carbon footprints and enhanced energy efficiency, along with financial benefits like reduced operational costs and higher asset values. Moreover, socioeconomic hurdles, especially in developing areas like Sub-Saharan Africa, hinder the implementation of sustainable practices due to high upfront expenses, limited expertise, and insufficient infrastructure. Approaches such as early involvement of stakeholders, monetary incentives, and policy changes can tackle these obstacles. The results underscore that incorporating sustainability into project planning improves productivity, ensures financial feasibility, and yields substantial environmental benefits, making green construction a worthwhile long-term investment.

Conclusion

Sustainable building practices offer a viable approach to tackling environmental issues while ensuring economic practicality and long-term gain. This research stresses the importance of efficient planning and maximizing resource allocation to reduce delays and budget overruns when embarking on environment-friendly materials and energy-saving technologies in construction. Although socioeconomic and infrastructural obstacles remain, particularly in less developed nations, regulatory changes, monetary incentives, and stakeholder cooperation can help overcome these challenges. The results demonstrate that incorporating sustainability into building methods lessens environmental impact and yields long-term financial advantages. The construction sector can shift towards more sustainable practices by addressing key obstacles and working towards an eco-conscious future in line with global environmental and economic objectives.

References

1. Albert P. C. C., Amos D., Ayokunle O. O., and Ernest E. A. (2018). Critical barriers to green building technologies adoption in developing countries: The case of Ghana. Journal of Cleaner Production https://doi.org/10.1016/j.jclepro.2017.10.235.

2. Jian Z. and Zhen-Yu Z. (2014). Green building research – current status and future agenda: A review. Renewable and Sustainable Energy Reviews Journal https://doi.org/10.1016/j.rser.2013.10.021.

3. Wisdom E., Nwakamma N., Favour O. U., Kehinde A. O., Emmanuel C. A., and Danny J. P. M., (2024). Project management strategies for accelerating energy efficiency in HVAC systems amidst climate change. International Journal of Management & Entrepreneurship Research https://doi.org/10.51594/ijmer.v6i3.841.

4. Pelin G., Chimay J. A., and Robert M. L. (2014). Case study of integrated decision-making for deep energy-efficient retrofits. https://doi.org/10.1108/IJESM-12-2013-0002.

5. Altaf H. and Iftikhar H. (2023). Modeling and multi-objective optimization of time, greenhouse gas emissions, and resources for sustainable construction projects. Sustainable Production and Consumption (vol. 39). https://doi.org/10.1016/j.spc.2023.05.019.

6. Garba A., Olaleye, Y.O., Jibrin, N.S. (2015). Material resources optimization for sustainable construction in Nigeria. http://hdl.handle.net/10059/1733.

7. Joseph M., Mark K., and Andy W. (2011). Green Building: Project Planning and Cost Estimating (3rd ed.) RSMeans Publishers.

8. Bon-Gang H., Xianbo Z., and Lene L. G. T. (2015). Green building projects: schedule performance, influential factors and solutions. Engineering, Construction and Architectural Management Vol. 22 No. 3. https://doi.org/10.1108/ECAM-07-2014-0095.

9. Bon-Gang H. and Lay P. L. (2013). Comparison of schedule delay and causal factors between traditional and green construction projects. https://doi.org/10.3846/20294913.2013.798596.

10. Jamilus M. H., Ismail A. R., and Aftab H. M. (2013). The Way Forward in Sustainable Construction: Issues and Challenges. International Journal of Advances in Applied Sciences (IJAAS). Vol.2, No.1, March 2013, pp. 31~42.

11. Queena K. Q., Edwin H. W. C., and Khalid A. G. (2015). Challenges in Delivering Green Building Projects: Unearthing the Transaction Costs (TCs). Sustainability, 7(4), 3615-3636. https://doi.org/10.3390/su7043615.

12. Ikechukwu O. and Iwuagwu B. U. (2016). Traditional Building Materials as a Sustainable Resource and Material for Low-Cost Housing in Nigeria: Advantages, Challenges, and the Way Forward. Int'l Journal of Research in Chemical, Metallurgical and Civil Engg. (IJRCMCE) Vol. 3, Issue 2 (2016). http://dx.doi.org/10.15242/IJRCMCE.U0716311.

13. Peter K. (2013). Adoption Of Green Building Practices And Rating System In Kenya: Potentials And Barriers. https://digital.library.ncat.edu/dissertations/138.
14. Ebohon O. J. and Rwelamila P. M. D. (2014). Sustainable Construction in Sub-Saharan Africa: Relevance, Rhetoric, and the Reality.
15. Opoku A., Agyekum K., Oppon A. J., & Opoku D. G. J. (2020). Obstacles to green building project financing: an empirical study in Ghana. https://www.academia.edu/76311095.
15. Shehab A. M. A and Kandar M. Z. (2021). . Socio-Cultural Values Influences on the Housing
Design towards Sustainable Community in the Gaza Strip. International Journal of Academic Research in
Business and Social Sciences, 11(10), 452–464. http://dx.doi.org/10.6007/IJARBSS/v11-i10/11133.
17. Zavvar K., Mohammad S. & Akil A. (2023). Strategies for Reducing Construction Project Delays and Cost Overruns. International Journal of Civil and Structural Engineering Research. Vol. 11, Issue 1, pp: (91-98). https://www.researchpublish.com/papers/strategies-for-reducing-construction-project-delays-and-cost-overruns.
18. Zhen Y., Meihong L., Chen E. D., Hao L., Shi C. C. & Fang Z. (2023). Research on the application of BIM-based green construction management in the whole life cycle of hydraulic engineering. https://doi.org/10.2166/ws.2023.190.
19. Mahadik, U., & Mahadik, A. (2015). Value Engineering Tool for Sustainability in Construction Projects. Civil Engineering Systems and Sustainable Innovations, 381-387.
20. Paul von Paumgartten (2003). The business case for high performance green buildings: Sustainability and its financial impact. Journal of Facilities Management. https://doi.org/10.1108/14725960410808096.
21. Kathy O. R., Jeffrey L. B. (2006). Justifying sustainable buildings – championing green operations. Journal of Corporate Real Estate. Journal of Corporate Real Estate, Vol. 8 No. 2. https://doi.org/10.1108/14630010610679899.
22. USGBC (2024). Benefits of green building. https://www.usgbc.org/press/benefits-of-green-building.
23. USGBC (2024). New Report from U.S. Green Building Council Details Data on Three Decades of Impact – Accelerating Green Buildings to Improve Lives and Livelihoods. https://www.usgbc.org/articles/new-report-us-green-building-council-details-data-three-decades-impact.