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ENVIRONMENTAL IMPACT MITIGATION PRACTICES AND CONSTRUCTION PROJECT DELIVERY IN AKURE SOUTH L/G AREA, ONDO STATE, SOUTHWEST NIGERIA

Keywords: Construction Project, Environmental Impact Assessment, Construction Project Delivery, Mitigation Practices

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Abstract

The construction industry is an important sector in global economic and social development. This sector significantly impact the environment, contributing approximately 23% of air pollution, 40% of water pollution, and 50% of landfill waste. This study investigated the

INTRODUCTION

Globally, construction project and delivery have become a significant concern for environmental impact assessment. The environmental impact ranges from air pollution, noise pollution, and water pollution, among others (Manisalidis et al., 2020). The quest for housing has tremendously increased urbanizsation and the built environment resulting in various environmental impacts and environmental degradation which is recently being traced to human activities with construction projects/works taking the lion share. The construction industry is one of the largest and most influential industries globally, playing an important role in the economic and social development of nations (Fei et al., 2021). This industry comprises a wide range of activities, including the design, planning, and execution of various construction projects, such as residential and

environmental impact mitigation practices within construction project delivery, particularly focusing on the effectiveness of Environmental Impact Assessments (EIAs) in minimizing adverse effects. Findings revealed that construction activities predominantly contribute to air, water, and noise pollution, soil erosion, habitat destruction, and improper waste disposal, with pollution ranked as the most significant impact with a mid-index (RII) of 4.58 followed by soil erosion (RII of 4.54) and habitat destruction (RII of 4.38). Despite the recognized importance of EIAs in identifying and managing these environmental impacts, their implementation is often inconsistent, with a moderate average index of 3.2 indicating that EIAs are not always conducted consistently before project execution. The study further revealed that financial constraints, stakeholder awareness, and regulatory complexities, are factors that hinder effective environmental management in construction. It emphasizes the need for more rigorous and inclusive EIA practices that engage local communities and incorporate long term sustainability goals. The study therefore suggest that an adequate monitoring system must be put in place to ensure that the mitigation measures outlined in the EIA are followed throughout the construction process.

Commercial buildings, infrastructure, and industrial facilities. The sheer scale and scope of the construction industry's operations make it a significant contributor to the global economy, accounting for a substantial portion of the Gross Domestic Product (GDP) in many countries (Alaloul et al., 2021).

Furthermore, the construction industry is of high importance in the development of essential infrastructure, which is the backbone of modern societies (Berglund et al., 2020). The construction of roads, bridges, transportation systems, utilities, and other public facilities is essential for the efficient movement of people, goods, and services, enabling economic growth and improving the quality of life for citizens. The construction industry's impact on infrastructure development is particularly significant in developing countries, where the need for basic amenities and services is often more pressing (Boadu et al., 2020).

However, the construction industry's immense scale and influence also come with significant share of environmental pollution. The industry's activities, such as resource extraction, energy consumption, and waste generation, can have far reaching consequences on the environment, including the depletion of natural resources, the generation of greenhouse gas emissions, and the disruption of ecosystems (Wang and Azam, 2024). Addressing these environmental challenges has become a priority for the construction industry, as it seeks to transition

towards more sustainable practices and minimize its ecological footprint. According to Elmasoudi et al., (2022), the construction industry is responsible for 23% of air pollution, 40% of water pollution, and 50% of landfill waste pollution. These statistics shows the urgent need to identify, evaluate, and monitor the impacts of construction activities on the environment.

An environmental aspect (EA) of a particular project is described as an element of an organization's activities, products or services that can interact with the environment (Wolniak et al., 2021). These EA are waste generation, energy consumption, water consumption, fossil fuel consumption, land modification, employment generation, people allocation, heritage affectation, landscape modification, raw material consumption, noise and vibration, odor generation, air emissions and many more. Such EA are very common during building construction and operation. Compared to other industries, construction industry is a major source of environmental pollution, since it has massive direct and indirect effects on the environment (Song et al., 2020).). Pollution sources from the construction process include harmful gases, noise, dust, and solid and liquid waste. This pollution issue has encouraged many construction participants to attempt to control the impacts of their activities by adopting environmental management systems.

Environmental Impact Assessment (EIA) is the process of identifying, predicting, evaluating and mitigating the biophysical, social and other relevant effects of developmental proposal prior to major commitment (Bakhit, 2021). According to International Association for Impact Assessment Act (IAIA), the purpose of EIA is to ensure that decision makers consider all possible impacts and their respective effects when deciding a project (Alberts et al., 2021). In view of this, it should be used as a decision making tool rather than decision aiding tool. In Nigeria the activities of the international impact assessment act are not felt which result to increase in pollution and other environmental degradations (Ajidasile, 2019). Environmental protection requires activities on many levels; from preventing global warming to safeguarding living beings. The effects of poor air quality or toxic chemicals and supporting basic necessities must also be considered for the survival of men.

The propounded ways by the UN-Habitat in Nigeria in the year 2004 to protect and save our environment include, the use of environmental effective housing through improved energy efficiency of buildings and an effective economic growth through more efficient use of resources such as re-use, recycling and recovery of waste (Afinowi, 2022). According to Oyewunmi (2022), the National Environmental Pollution Act 1969 (NEP) has empowered many government agencies to actively monitor the air for pollutants, inspect emission sources,

provide compliance assistance to industries as well as initiate enforcement actions such as educating the public about the air quality issues. They are equally involved in the prevention and regulation of water pollution from industries, municipal sewage treatment facilities as well as monitoring constructi0on sites and urban areas. All these are mitigating measures to reduce the impact of construction projects on the environment but their application and enforcement need to be investigated in Nigeria.

Construction project delivery refers to the process of planning, coordinating, and executing the various activities involved in the construction of a project, from the initial design phase to the final completion and handover (AlMunifi and Almutairi, 2021). This process is important in ensuring the successful and efficient delivery of a construction project, as it involves a wide range of activities and stakeholders. At the heart of construction project delivery is the management of the project's scope, timeline, budget, and quality. Project managers and construction teams work closely to develop a comprehensive project plan that outlines the specific tasks, resources, and timelines required to complete the project. This includes the coordination of design, procurement, construction, and commissioning activities, as well as the management of risks and potential challenges that may arise during the project's lifecycle (Ndekugri et al., 2022).

In recent years, the construction industry has seen the emergence of new technologies and approaches that are transforming the way construction projects are delivered. These include the use of Building Information Modeling (BIM), which enables the integration of design, construction, and operational data; the adoption of lean construction principles which focus on reducing waste and improving efficiency; and the integration of sustainability and environmental considerations into the project delivery process (Mellado and Lou 2020). In lieu of this, this study seeks to understand environmental impact mitigation practices in relation to construction project delivery in Akure south L/G area.

Conceptual Review

Environmental Impact Mitigation Practices

Environmental impact mitigation practices are strategies employed in construction and development projects to minimize adverse effects on the environment. These practices can be categorized into two primary types: preventive measures and corrective measures.

Preventive measures are proactive strategies aimed at avoiding environmental harm before it occurs (Baah et al., 2021). These measures focus on planning and decision making processes that reduce potential negative impacts. Site selection is the first step in any construction project, which involves evaluating potential

locations based on environmental, social, and economic factors. This includes assessing biodiversity, existing land use, and closeness to sensitive areas, such as water bodies and wildlife habitats (Musetsho et al., 2021). Additionally, community impact must be considered by engaging with local communities to understand their needs and concerns, ensuring that the project aligns with social sustainability goals. Long term sustainability must also be put into consideration, as selecting sites that gives room for sustainable development is vital for future land use and environmental resilience.

Design considerations is of a great importance in preventive measures. Implementing designs that improves energy efficiency and reduce resource consumption is important. This may involve passive solar design, green roofs, and natural ventilation systems. Conducting environmental impact assessments (EIA) helps to identify potential impacts early in the project lifecycle (Jiang and Wu, 2019). This process typically involves stakeholder consultations and consideration of alternative designs. Furthermore, establishing best management practices (BMPs) is essential to minimize soil erosion, water pollution, and habitat destruction during construction activities (Van-Eldik et al., 2020).

Corrective measures are reactive strategies implemented after environmental harm has occurred, aiming to restore or rehabilitate the affected environment (Onwurah, 2023). Remediation techniques, such as bioremediation, phytoremediation, or soil washing, are employed to clean up contaminated sites. Restoration projects may also be initiated to restore habitats, which can include reforestation, wetland restoration, and the creation of wildlife corridors. Continuous monitoring and evaluation of environmental conditions are important to identify impacts and implement corrective actions promptly (Hussain et al., 2020).

The key practices in environmental impact mitigation include site selection and planning, resource conservation, waste management strategies, and the use of sustainable materials (Hossain, 2019). Site selection involves evaluating potential locations based on various factors, ensuring that the chosen site minimizes ecological disruption and aligns with community needs. Resource conservation focuses on minimizing the consumption of natural resources during construction and operation. This includes implementing rainwater harvesting systems, greywater recycling, and low-flow fixtures to reduce water usage (Ogunmakinde et al., 2022). In terms of energy efficiency, utilizing energy efficient appliances, renewable energy sources, and improving building orientation can significantly reduce energy demand.

Effective waste management is very important for minimizing the environmental footprint of construction projects. This involves designing projects to minimize

waste generation through careful planning of materials and processes (Liu et al., 2020). Implementing systems for recycling construction debris and reusing materials where possible is essential. Additionally, establishing protocols for the safe disposal of hazardous materials ensures compliance with regulations (Chisholm, 2021). The selection of materials is of high importance in mitigating environmental impacts. Sourcing materials locally reduces transportation emissions and supports local economies. Choosing eco-friendly materials with lower environmental impacts, such as recycled materials, sustainably harvested wood, and non-toxic finishes, is also vital. Evaluating the environmental impacts of materials throughout their life cycle using life cycle assessment (LCA) helps in making well informed choices (Barbhuiya and Das, 2023).

Environmental Impacts of Construction Projects

EIA is an important management tool to identify the major environmental impacts of construction projects to improve the effectiveness of environmental management systems (Alberts et al., 2021). Prediction of the environmental impacts of construction project before the construction work, leads to improvements in the environmental performance of construction projects and sites. A construction project causes great impact on environment. It is necessary to provide mitigation measures to minimize the fast growing threat of environmental impacts of building construction projects. Environmental impacts of building construction activities may vary from country to country. Major environmental impacts of construction projects are such as waste disposal, pollution, resource use and habitat destruction, desertification, soil erosion and material wastage (Al-Numan, 2024). Building construction activity involves the use of resources like timber and non- fuel materials. Construction project leads to habitat destruction, loss of arable land, and loss of biodiversity etc. The determination on the major environmental impacts with mitigation measures was studied by studied on environmental impacts and about 26 subcategories of environmental impacts were identified provides the subcategories of environmental impacts across construction process.

Hasan, (2021) provides an in-depth assessment of the Environmental Impact Assessment (EIA) process and the adoption of green building certification within the Indonesian construction industry. The author acknowledge the construction sector's crucial role in economic development while also recognizing its significant environmental impacts. They identify challenges in implementing effective EIA and promoting green building practices, including a lack of awareness among stakeholders, limited data availability, and a tendency to prioritize economic factors over environmental concerns.

Despite these challenges, the author note advancements in EIA methodologies, particularly the integration of digital technologies and the increasing recognition of global green building certification systems. The analysis indicates that while the EIA process has been effective in identifying and mitigating environmental impacts, issues such as a shortage of expert personnel and weak enforcement mechanisms hinder implementation. The importance of stakeholder engagement, data quality, and experienced professionals is emphasized as critical for conducting thorough EIAs and developing robust mitigation plans. The article also addresses the limited adoption of green building certification in Indonesia, suggesting that analyzing construction projects that have adopted these standards could yield insights into their effectiveness and the challenges faced. To enhance EIA implementation and facilitate the adoption of green building certification, the authors advocate for a multifaceted approach that includes education, training, and incentives for developers and contractors. This approach is deemed essential for promoting sustainable practices and supporting Indonesia's sustainable development goals.

Enhancing the identification of the major environmental impacts of construction processes will help to improve the effectiveness of environmental management systems (Kabirifar et al., 2020). Furthermore, prediction of the correlated environmental impacts of construction before the construction stage, will lead to improvements in the environmental performance of construction projects and sites. The determination of major environmental impacts will assist to consider a range of on-site measures in order to mitigate them (Sandanayake et al., 2019).

Challenges and Considerations in Environmental Impact Mitigation

Integrating effective environmental impact mitigation practices in construction projects faces several challenges that can hinder progress. One of the primary barriers to effective mitigation is financial constraints and budget limitations (Koutsandreas et al., 2022). Many construction projects operate under strict budgetary constraints, which can lead to prioritizing immediate costs over long term environmental benefits. Stakeholders may hesitate to allocate funds for necessary mitigation measures, viewing them as additional expenses rather than investments in sustainability. This can result in inadequate resources being devoted to environmental protection, ultimately compromising the project's sustainability goals.

Additionally, the lack of awareness and training among stakeholders is another important challenge. Many individuals involved in construction, including project managers, contractors, and workers, may not fully understand the significance of environmental mitigation practices or how to implement them effectively (Yiu et

al., 2019). This can however lead to inconsistent application of mitigation strategies and missed opportunities for reducing environmental impacts. Providing targeted training and resources is essential to improve awareness and ensure that all stakeholders are equipped to contribute to sustainable practices.

Regulatory and compliance challenges also present obstacles to effective mitigation. The construction industry is subject to a complex array of environmental regulations that can vary by region and project type. Navigating these regulations can be daunting, especially when requirements are unclear or subject to change. The time and effort required to ensure compliance can detract from proactive mitigation efforts, leading to a reactive rather than a preventive approach. Stakeholders must remain informed about relevant regulations and develop strategies to integrate compliance seamlessly into their project planning and execution processes.

Methodology

The research design adopted for this study was a descriptive survey research design to gather quantitative information on the subject matter under study through the use of well-structured questionnaire. The questionnaire was structured on a 5-point rating scale and was self-administered. The study population comprises professional construction workers such as builders, engineers, quantity surveyors, architects, etc. in twenty construction sites in Akure metropolis. The study made of the whole population as its sample size due to the insufficient number of respondents in the study area. Hence, random sampling technique was adopted and respondents whose opinion on the study subject matter was used to generalize the stance of total population. A sample of twenty (20) active construction sites was selected for the study, representing a diverse range of project types, sizes, and locations within the study area. Construction project managers responsible for the 20 selected construction sites were reached out to, to participate in the study, and they are estimated to be more than 20 individuals.

After the questionnaire delivery, the collected data underwent compilation and analysis using the Statistical Package for Social Sciences (SPSS), aligning with the research questions of the study. The correlational statistical technique was employed to assess autonomy, ensuring simplicity and accuracy in examining the acquired data. Two statistical methods were used to analyse the data provided by the questionnaire. The first was to acquire percentage values through frequencies of the answers received. The other was to calculate a Relative Importance Index (RII). For this purpose, a rating scale of 1 to 5 was adopted with 1 representing

the lowest level of effect and 5 representing the highest level of effect. The RII was evaluated using the following expression:

Relative Importance Index

$$RII = \frac{\Sigma W}{(A*N)}$$

Where, W is the weighting given to each factor by the respondents (ranging from 1 to 5), A is the highest weight (i.e. 5), and N is the total number of respondents.

Results and Discussion

The questionnaire was divided into sections, and the findings was analyzed and presented in the same format to ensure clear comprehension of the material.

Characteristics of Participants

From Table 1 in the statistics presented, it is observed that majority of the organizations in the construction sector are public entities, accounting for 64% of the total respondents. Corporate organizations represent 20%, while private organizations make up the remaining 16%. This distribution suggests that public organizations plays an important role in shaping and enforcing environmental policies and practices in construction because they are likely to be at the forefront of implementing stringent environmental regulations and standards. They often have the resources and mandate to prioritize environmental sustainability. The Nigerian Construction Industry has the involvement of both the private and public sectors which should encourage the environmental mitigation practices in their respective projects on the environment.

Table 1: Type of Organisation

Organisation	Frequency (f)	Percentage (%)	Cumulative
Private	8	16	--
Corporate	10	20	16
Public	32	64	36
Total	50	100	100

In Table 2, it is revealed that infrastructure projects dominated the responses, accounting for 44% of the total, followed by residential projects at 30%, industrial projects at 20%, and commercial projects at only 6%. Infrastructure projects typically comprise large-scale developments such as roads, bridges, and utilities. These projects often have significant environmental impacts, including land degradation, habitat disruption, and resource consumption. According to Salimi and Al-Ghamdi (2020), infrastructure development is a primary driver of

environmental change, this make effective mitigation practices a necessity in order to minimize adverse effects on ecosystems and communities. This underscores the importance of making environmental impact assessments and mitigation strategies a priority in infrastructure planning and execution to ensure sustainable development.

Table 2: Projects executed by the organization

Project	Frequency (f)	Percentage (%)	Cumulative
Residential	15	30	--
Commercial	3	6	30
Industrial	10	20	36
Infrastructure	22	44	56
Total	50	100	100

In Table 3, the qualifications of respondents is presented. The result shows that the majority of respondents hold Higher National Diplomas (HND), accounting for 50% of the total. Bachelor's degrees (B.Sc/B.Tech) represent 36%, while Postgraduate Diplomas (PGD/Masters) account for 10%, and Doctorates (Ph.D.) has the lowest comprising 4%. This indicates that majority of the respondents have at least a Higher National Diploma or its equivalent in construction/ environmental related projects. The result implies that the Nigeria Construction industry has the involvement of workers with adequate academic qualifications which should practice environmental mitigation practices impact in order to achieve the desired goal of the project.

Table 3: Academic qualification of Respondents

Qualification	Frequency (f)	Percentage (%)	Cumulative
HND	25	50	--
B.Sc/B.Tech	18	36	50
PGD/Maters	5	10	86
Ph.D	2	4	96
Total	50	100	100

Table 4 shows the professional discipline of the respondents and the result indicates that civil engineers represent the largest group, accounting for 40% of the respondents, followed by builders at 38%. Architects make up 12%, while surveyors constitute 10%. This also review that the surveyors really participate in Environmental Impact Assessment since they are neither involved in design

nor the actual building production process. The Builders, Architects, Civil Engineers are more involved in the design and production of buildings in Nigeria.

Table 4: Profession of Respondents

Profession	Frequency (f)	Percentage (%)	Cumulative
Architect	6	12	--
Builder	19	38	12
Civil Engineer	20	40	50
Surveyor	5	10	90
Total	50	100	100

In Table 5, the majority of respondents have between 6 to 10 years of experience (40%), followed by those with less than 5 years (28%). Respondents with 11 to 15 years of experience account for 16%, while those with 16 to 20 years and over 20 years each represent 8%. In total, the numbers of respondents have been practicing in the construction industry for about 10 years is 68%. This implies that most of the workers in the construction industry are experienced and familiar with the environmental mitigation practices in the construction projects. As highlighted by Pham and Kim (2019), experienced professionals are more likely to recognize the importance of environmental mitigation and implement effective strategies, which can improve the sustainability of construction practices.

Table 5: Work Experience of Respondents

Years of Experience	Frequency (f)	Percentage (%)	Cumulative
Less than 5	14	28	--
6 – 10	20	40	28
11 - 15	8	16	68
16 - 20	4	8	84
20 and above	4	8	92
Total	50	100	100

From Table 6, it is observed that majority of the construction companies have executed more than 5 projects (74%). This indicates that the involvement of professionals in this category are likely to have gained a better understanding of industry practices and environmental considerations. They may be more adept at incorporating sustainability measures into their projects.

Table 6: Projects executed by the companies

Number of Projects	Frequency (f)	Percentage (%)	Cumulative
1 - 5	12	24	--
6 – 10	18	36	24
11 - 15	14	28	60
16 - 20	4	8	88
20 and above	2	4	96
Total	50	100	100

Environmental Impact caused by Construction Sites

Table 7 provides results from respondents on various environmental impacts related to construction activities, with the degree of occurrence measured. The mean values were calculated to summarize the responses, providing a concise understanding of the perceived frequency and significance of these impacts.

During analysis, the questionnaire was basically categorized into Pollution (Air, Noise, and Water), Waste management and disposal, Biodiversity and habitat impact, Soil and land impact, and lastly Visual impact. It indicated that out of the five (5) categorized impacts in the questionnaire the four most important impacts were pollution, soil erosion, habitat destruction and improper waste disposal. On the other hand, monitoring and management of environmental was ranked lowest while the mean responses of all items are above the mid- severity index of 0.5 suggesting that there are all significant environmental impact of building construction projects.

The highest environmental impact of construction is felt in terms of pollution. According to Mir et al (2023), the construction industry is a major source of pollution responsible for about 4% particulate emissions, more water pollution incidents than any other industry, and thousands of noise complaints every year. Although, construction activities also pollute the soil, the main areas of concern are: air, water and noise pollution. There was a simple general equation between the amount of pollution and the amount of energy in process. On the whole, the more energy required, and the more processes, the more waste and the more pollution is generated (Shah et al., 2021).

Table 7: Perspectives on environmental impact mitigation practices in construction sites

Environmental Impacts	Degree of occurrence					% Score	Mean
	5	4	3	2	1		
Air pollution (dust, fumes, etc.) is frequently observed at construction sites.	22	20	3	3	2	207	4.14
Construction activities significantly affect the surrounding community through noise pollution.	30	15	3	2	--	223	4.46
Construction activities result in contamination of nearby water sources (e.g., runoff, chemicals).	25	20	--	2	3	212	4.24
Construction waste materials (e.g., debris, plastic, metal) are often improperly disposed of at construction sites.	28	20	1	1	--	225	4.5
Construction activities significantly impact local biodiversity (e.g., loss of vegetation, wildlife disruption).	23	22	3	2	--	216	4.32
Construction activities result in the destruction of green spaces or natural habitats.	25	21	2	2	--	219	4.38
Construction activities contribute to soil erosion or degradation in the surrounding areas.	28	21	1	--	--	227	4.54
Pollution from construction machinery (e.g., fuel or oil spills) is a frequent problem on construction sites.	29	21	--	--	--	229	4.58
The construction process increases the risk of flooding in nearby areas.	20	22	3	3	2	205	4.1
Construction sites are managed in a way that prevents the spread of invasive species.	25	20	3	1	1	217	4.34
Construction activities negatively affect local air quality due to emissions from equipment and machinery.	15	15	10	5	5	180	3.6
Construction sites contribute to visual pollution of the surrounding environment.	21	20	3	3	3	203	4.06
Groundwater contamination is a common problem at construction sites.	26	20	2	1	1	219	4.38
Construction sites often generate hazardous materials (e.g., asbestos, chemicals) that pose risks to the environment.	22	18	5	3	2	205	4.1
Construction sites are well-monitored and managed to reduce negative environmental impacts.	10	5	20	7	8	152	3.04

Processes such as the processing of plastics for PVC, PU and PI, the manufacture of Titanium Dioxide, the galvanizing of metals were all very polluting. And again,

not surprisingly, the construction industry has the biggest effect on all sectors because of the quality of materials used in construction.

Construction activities that contribute to air pollution include: land clearing, operation of diesel engines, demolition, burning and working with toxic materials. All Construction sites generate high level of dust (typically from concrete, cement, wood, stone, silica) and this can carry a large distance over a long period of time. Sources of water pollution on building sites include: diesel and oils; paints, solvents, cleaners and other harmful chemicals; and construction debris and dirt (Joshi et al., 2022). When land is cleared, it causes soil erosion that leads to silt-bearing runoff and sediment pollution. Construction sites produce a lot of noise mainly from vehicles, heavy equipments and machineries and also people shouting as well as radio turned up too loud. Mohamed (2021), is of the opinion that excessive noise is not only annoying and distracting, but can lead to hearing loss, high blood pressure, sleep disturbance and extreme stress.

Another environmental building construction activity of great impact is the use of resources like timber and non- fuel materials. This leads to habitat destruction, loss of arable land, loss of arable land and loss of biodiversity. While the three greatest and most imminent threats to the survival of our civilization are global warming, peak oil (the growing energy gap between supply and demand) and resource depletion. Sometimes, these can also have a global impact.

Additionally, improper disposal of construction waste, including debris and plastic, is one of the most commonly identified environmental impacts. Improper disposal of construction waste, especially debris and plastics, also poses a significant challenge for urban areas. Soni et al, (2022) discuss the growing issue of urban construction waste, stating that improper disposal practices often result in large piles of debris left in abandoned sites or unregulated landfills. This however disrupts the aesthetic quality of urban areas and also reduces the available land for other uses and contributes to the formation of illegal dumping grounds.

Effectiveness of Environmental Impact Assessment (EIA) Practices in Mitigating Environmental Impacts

Table 8 presents the perception of respondents on the effectiveness of Environmental Impact Assessment (EIA) practices in mitigating environmental impacts in construction projects. One of the key areas highlighted in this section is the consistency of EIA implementation in construction projects, where a moderate average index of 3.2 indicates that EIAs are not always conducted consistently before project execution. Despite the apparent effort to implement EIAs, the result suggest that in certain contexts, particularly smaller scale or less

regulated projects, EIAs might be bypassed or poorly integrated into the planning process. The inconsistency can be attributed to various factors, including lack of awareness, limited enforcement, or perceived cost benefit imbalances by developers. According to a study by Alberts et al. (2021), the proper integration of EIAs into project planning is important for preventing long term environmental degradation, as it allows early stage environmental evaluations to avoid significant negative outcomes.

In terms of addressing social and environmental concerns of local communities, the table reflects a relatively favorable outcome with an average index of 3.7. This suggests that while EIA procedures generally address local concerns. The positive role of EIA in promoting local participation has been widely acknowledged, with Nederhand and Klijn, (2019), pointing out that a more participatory approach can improve the legitimacy and public support for projects. However, the relatively lower average index in this category also highlight the challenges in truly integrating local perspectives into the formal assessment process, especially in large scale projects.

Table 8: Respondents Perspectives on the effectiveness of Environmental Impact Assessment (EIA) practices in mitigating environmental deficits

Effectiveness of EIA Practices	Degree of occurrence							
	5	4	3	2	1	% Score	Mean	
Environmental Impact Assessments (EIA) are consistently conducted for all construction projects before execution	10	10	15	10	5	160	3.2	
EIA procedures effectively address the social and environmental concerns of local communities.	10	25	10	--	5	165	3.7	
The EIA process is transparent and allows adequate public participation and consultation before the approval of construction projects.	15	28	7	--	--	208	4.16	
EIA practices have significantly helped in identifying potential environmental risks before construction projects begin.	16	29	--	3	2	204	4.08	
The EIA process is thorough in assessing the environmental impacts of construction activities, such as air, water, and soil pollution.	14	30	2	2	2	202	4.04	
The EIA process ensures that mitigation measures are put in place to prevent or reduce negative environmental impacts.	27	20	--	2	1	220	4.4	
EIA reports effectively incorporate baseline environmental data to evaluate the impacts of construction projects.	23	22	3	--	2	214	4.28	

Effectiveness of EIA Practices	Degree of occurrence 5	4	3	2	1	% Score	Mean	
Environmental Impact Assessments have led to the successful mitigation of environmental impacts, such as soil erosion, water contamination, and habitat destruction, in the study area.	16	24	8	2	--	204	4.08	
The implementation of mitigation measures recommended in the EIA reports is effectively monitored during construction projects.	10	12	15	6	7	162	3.24	
Environmental monitoring during construction is consistent with the recommendations provided in the EIA.	18	15	10	6	1	193	3.86	
Construction projects in the study area tend to follow the recommended environmental mitigation measures from the EIA process.	19	16	10	5	--	199	3.98	
The EIA process in the study area contributes to the long term sustainability of environmental resources (e.g., water, air quality, wildlife).	20	18	5	5	2	199	3.98	
The enforcement of EIA recommendations during construction projects is sufficiently regulated by government agencies.	8	12	20	5	5	163	3.26	
The effectiveness of EIA practices in mitigating environmental impacts could be improved with more rigorous enforcement and monitoring.	18	17	--	7	8	180	3.6	

The transparency of the EIA process and the adequacy of public participation are indicated as being relatively strong, with a high average index of 4.16. This implies that the public generally feels involved and informed before project approval. Transparency and participation are foundational to the success of any EIA process and execution. Bahadorestani et al., (2020) underscores that meaningful public engagement ensures that the diverse values and concerns of stakeholders are addressed. Nonetheless, despite the favorable average index, the absence of full public consultation in some instances points to the need for more inclusive and structured engagement strategies.

Another significant finding relates to the ability of the EIA process to identify environmental risks, with a relative index of 4.08, reflecting the effectiveness of the EIA in anticipating potential harms like pollution or habitat destruction. This aligns with the central aim of EIA, which is to identify risks before they occur, giving room for preventive measures. Fang et al., (2022) assert that effective impact prediction significantly reduces the likelihood of severe environmental

degradation, particularly in projects involving land use changes or construction in ecologically sensitive areas.

The thoroughness of the EIA in assessing environmental impacts also received a solid average index of 4.04, highlighting that, for the most part, the EIA process considers essential environmental factors such as air, water, and soil pollution. This thorough assessment is key to ensuring that all potential impacts are adequately understood and managed. The effectiveness of EIA in ensuring mitigation measures is among the most positively rated aspects, with a high average index of 4.4. This indicates that, in general, EIAs lead to the development of effective mitigation strategies, which are important in preventing adverse environmental consequences. The table also reveals that baseline environmental data incorporation into EIA reports is generally seen as effective, with an average index of 4.28. This supports the idea that accurate baseline data is essential for evaluating the actual impacts of construction projects.

Despite the overall positive feedback, monitoring and enforcement of EIA recommendations received lower scores, with an average index of 3.24 for effective monitoring and 3.26 for government enforcement. Aung et al. (2020) discussed how inconsistent monitoring and lack of stringent enforcement can undermine the success of the EIA process. Without continuous oversight, projects may inadvertently cause environmental harm despite a well-designed mitigation plans.

Finally, the long term sustainability contributions of EIA in promoting environmental resources, such as air and water quality, scored 3.98, suggesting that while EIAs contribute positively to sustainability, further improvements are needed to fully integrate long term environmental goals into project planning. Roos et al., (2020) emphasizes that the real benefit of EIA lies in its ability to integrate long term sustainability considerations into development processes, ensuring that projects contribute positively to environmental conservation over time. Across this section, the effectiveness of EIA practices in mitigating environmental impacts is generally positive, but there are several areas for improvement. These include ensuring consistent implementation, better integration of local community concerns, more thorough monitoring of mitigation measures, and stronger enforcement of recommendations.

Quality of EIA and Project Delivery Outcomes

Table 9 presents the analysis of how the quality of Environmental Impact Assessments (EIAs) influences the success of construction project delivery, based on a series of factors. Each statement evaluates various aspects of the EIA

process, including thoroughness, data quality, integration into project planning, and sustainability, alongside their effect on project timelines, costs, and outcomes. The first factor assessed is the direct influence of EIA quality on the success of construction projects, with an average index of 4.04, indicating strong agreement. This aligns with the established understanding that a well conducted EIA identifies potential risks early, giving room for proactive management. According to Rathi, (2019), the primary goal of an EIA is to foresee and mitigate environmental harm, ensuring smoother project execution. Furthermore, the thoroughness of the EIA process, rated at 4.0, indicates that addressing all potential environmental risks before project implementation is essential for avoiding complications.

Table 9: Respondents perspective on the relationship between the quality of EIA and project delivery outcomes

Quality of EIA and Project Delivery	Degree of occurrence					% Score	Mean
	5	4	3	2	1		
The quality of the Environmental Impact Assessment (EIA) process directly influences the overall success of construction project delivery.	20	21	3	3	3	202	4.04
The thoroughness of the EIA process ensures that all potential environmental risks are addressed before project implementation.	20	18	6	4	2	200	4
High-quality EIA reports contribute to a clear understanding of potential environmental challenges, enabling better project planning.	25	21	4	--	--	221	4.42
The quality of data used in EIA reports (e.g., baseline data, impact predictions) significantly influences the success of project delivery.	16	22	8	4	--	200	4
EIA reports are regularly updated to reflect new environmental challenges and ensure project delivery aligns with sustainability goals.	14	30	1	3	2	172	3.44
The findings and recommendations of the EIA are effectively integrated into the project planning process.	27	20	3	--	--	224	4.48
Timely integration of the EIA findings into project planning helps avoid delays and costly adjustments during construction.	16	31	--	3	--	210	4.2
The quality of EIA implementation (i.e., following the mitigation measures) positively affects the completion time of the project.	20	25	5	--	--	215	4.3
EIA findings are considered as a key factor in determining project delivery timeline and cost efficiency.	18	30	2	--	--	216	4.32

Quality of EIA and Project Delivery	Degree of occurrence					% Score	Mean
	5	4	3	2	1		
High-quality EIA practices contribute to the sustainable management of natural resources during project delivery.	18	20	5	5	2	197	3.94
Effective EIA practices lead to better environmental quality outcomes, such as improved air, water, and soil quality after project completion.	20	15	6	7	2	194	3.88
EIA contributes to positive social outcomes (e.g., community well-being, health, and safety) during and after the construction project.	20	21	9	0	0	211	4.22
The quality of the EIA is directly linked to the successful completion of projects within the specified time and budget.	12	15	18	3	2	182	3.64
Projects with higher quality EIAs tend to experience fewer environmental setbacks or regulatory issues during their delivery.	19	22	5	2	2	204	4.08

The quality of data in EIA reports, such as baseline data and impact predictions, also plays an important role in project delivery, with an average index of 4.0. High quality data ensures that project planning is based on accurate environmental assessments, leading to more reliable decision making and fewer surprises during construction. As noted by Aung (2020), the success of an EIA depends heavily on the quality of baseline data, which influences the predictability of environmental outcomes and the identification of mitigation strategies.

When it comes to the integration of EIA findings into the planning process, the average index of 4.48 underscores its importance. Effective integration of EIA recommendations ensures that potential environmental challenges are embedded within project planning, facilitating smoother execution. A study by Johnson (2020), highlights that when EIA findings are considered early in the planning phase, construction projects are less likely to face regulatory hurdles or environmental setbacks. This is corroborated by the significant average index of 4.2 for timely integration of EIA findings, which emphasizes the importance of incorporating EIA insights into decision making at the earliest stages to prevent costly delays or revisions during the construction phase.

The implementation of the mitigation measures identified in the EIA also has a marked impact on project completion times, with the average index of 4.3. Effective EIA implementation contributes to the timely and efficient completion of projects by ensuring that necessary environmental safeguards are in place from the outset. This observation is consistent with findings by Malik et al., (2019),

who noted that projects adhering to a well-designed mitigation strategies tend to experience fewer environmental disruptions, thus maintaining their schedule and budget.

In terms of sustainability, high quality EIA practices are linked to better environmental and social outcomes. With an average index of 3.94, high quality EIA practices promote the sustainable management of natural resources and contribute to positive social outcomes, such as community well-being, health, and safety. This finding is supported by environmental sustainability research, which shows that EIAs that consider long term environmental impacts and social considerations lead to more sustainable project outcomes (Nita et al., 2022). The positive social implications, with the average index of 4.22, reflect the growing recognition of EIAs in safeguarding communities from negative construction-related impacts.

Finally, the link between EIA quality and project success is underscored by an average index of 3.64, which suggests a moderate agreement that higher quality EIAs lead to projects being completed within time and budget constraints. Moreover, projects with better EIA practices experience fewer environmental setbacks or regulatory issues during construction, as indicated by the average index of 4.08. These findings echo the conclusions of objective 2 that highlights the important role of effective environmental planning in minimizing risks and promoting efficient project delivery.

Correlation Statistics

The correlation coefficients indicate the relationships between various factors influencing the effectiveness of Environmental Impact Mitigation in construction project delivery. In Figure 10, there is a moderate positive correlation between EIA challenges and both operational efficiency (0.215) and overall construction project delivery (0.310). This suggests that as challenges in the EIA process increase, there is a corresponding impact on operational efficiency and project delivery.

The correlation with project performance is stronger (0.365), indicating that improvements in operational efficiency are likely to lead to better project outcomes. The correlation with both operational efficiency (0.365) and project performance (0.310) suggests that effective cost management in EIAs contributes positively to both operational processes and overall performance. These findings shows the interconnected nature of challenges, operational efficiency, cost-effectiveness, and project delivery in Environmental Impact Assessments, emphasizing the need for targeted strategies to address these challenges for improved project outcomes.

Table 10: Correlation coefficient between challenges, operational efficiency, cost effectiveness, and performance

			EIA Challenges	Operational efficiency	Cost effectiveness	Construction Project delivery
Spearman's rho	EIA Challenges	Correlation Coefficient	1.000	.197	.282	.079
		Sig. (2-tailed)	.	.029	.002	.390
		N	122	122	122	122
	Operational efficiency	Correlation Coefficient	.197	1.000	.124	.328
		Sig. (2-tailed)	.029	.	.172	.000
		N	122	122	122	122
	Cost effectiveness	Correlation Coefficient	.282	.124	1.000	.243
		Sig. (2-tailed)	.002	.172	.	.007
		N	122	122	122	122
	Construction Project delivery	Correlation Coefficient	.079	.328	.243	1.000
		Sig. (2-tailed)	.390	.000	.007	.
		N	122	122	122	122

Conclusion

This study focused on understanding how environmental impact mitigation practices are applied in construction projects, particularly looking at how effective Environmental Impact Assessments (EIAs) are in reducing negative environmental effects. The study found that pollution (in the form of air, water, and noise pollution), soil erosion, habitat destruction, and improper waste disposal are the most serious environmental issues caused by construction activities. This study shows the importance of environmental impact mitigation practices in construction. The construction sector has significant negative effects on the environment, with pollution, habitat destruction, and waste management being the top chart. Although EIAs have proven to be effective in identifying and managing these impacts, the process is inconsistent and often lacks proper monitoring and enforcement. This inconsistency, combined with challenges in integrating community input, points to the need for more rigorous and inclusive approaches to environmental protection in construction. When EIAs are carried out well, they can greatly improve the efficiency of projects, prevent

environmental damage, and contribute to sustainability. However, for EIAs to be truly effective, they need to be more consistently implemented, involve local communities more deeply, and consider long term environmental goals. Improving these aspects will ensure that the construction industry can reduce its environmental footprint while delivering projects successfully.

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