2026 Volume: 02 Issue: 03 www.ijrpa.com ISSN 2456-9995 Research Article

International Journal Research Publication Analysis

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QUANTIFYING THE COST IMPLICATIONS OF CONSTRUCTION PLANT AND EQUIPMENT IN BUILDING PROJECTS WITHIN ENUGU METROPOLIS.

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Article Received: 22 January 2026

Article Revised: 10 February 2026

Published on: 02 March 2026

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DOI: https://doi-doi.org/101555/ijrpa.3456

ABSTRACT

This study aims to quantify the cost implications of construction plant and equipment utilization in building projects within Enugu Metropolis. Recognizing that the efficient deployment of such resources is paramount for achieving cost-effective outcomes, this research meticulously examines the direct and indirect financial impacts associated with various plant and equipment strategies. The investigation identifies prevalent types of construction machinery in the region and analyzes the cost-effectiveness of different selection and procurement methods, including both traditional and modern approaches, specifically in relation to their influence on overall project expenditure and financial viability. Through the rigorous analysis of empirical data collected from ongoing construction projects in Enugu Metropolis, this study demonstrates how optimized equipment deployment directly contributes to mitigating project expenses and enhancing financial efficiency. Employing a descriptive research design, the study gathered data from a purposively selected sample of 52 participants with direct involvement in regional construction activities. Statistical analysis, utilizing the Chi-square test and Spearman's rank correlation coefficient, was conducted to establish and quantify the relationships between equipment use and project costs. Key recommendations derived from these findings include prioritizing the availability of essential equipment (e.g., excavators, bulldozers, dump trucks), implementing continuous training programs to maximize cost-efficient equipment operation, and advocating for environmentally sustainable practices that concurrently reduce operational costs and ecological footprint.

KEYWORDS*: Construction, Equipment, Cost management.*

1.0 INTRODUCTION

Plants and equipment play a pivotal role in determining building project costs in Enugu state, influencing both the operational efficiency and financial outcomes of construction endeavors. According to various definitions, plants refer to large machinery and equipment used in construction, such as excavators, cranes, and concrete mixers (Kumar & Bhaskar, 2019). Equipment, on the other hand, encompasses smaller tools and devices essential for specific tasks within construction projects, including drills, saws, and measuring instruments (Yusoff, Ismail, & Abdul Rahman, 2018)

The efficiency of equipment determines the product of the work being carried out and the ability to meet completion time. Furthermore, the level of competence of operators, familiarity with the type of work, and incentives among others also affect the quality of job output and the time at which a scheduled task is completed (Oluwabunmi, Ezekiel, & Olalekan, 2018). In Enugu State, the management and utilization of plants and equipment are critical due to their substantial impact on construction costs. These resources not only facilitate the execution of tasks but also incur expenses related to procurement, maintenance, and operation (Oyedele et al., 2017). Effective management of plants and equipment is thus essential for optimizing project timelines and controlling expenditure, particularly in the dynamic and challenging environment of the Nigerian construction industry.

The scope of this study extends beyond mere cost considerations to encompass broader implications for project planning and execution. In Nigeria, where infrastructure development is pivotal for economic growth and social progress, understanding how plants and equipment affect building project costs is crucial. For instance, research by Olaniran and Akintoye (2015) emphasizes the strategic deployment of construction equipment to enhance productivity and minimize project delays, thereby reducing overall costs and improving project outcomes. Such strategic insights underscore the significance of efficient equipment management practices tailored to the Nigerian context. Furthermore, the geographical and economic contexts of Enugu State introduce additional complexities. Urbanization, rapid population growth, and varying regulatory frameworks necessitate adaptive strategies for managing plants and equipment effectively (Aibinu & Odesola, 2016). The economic implications of construction project costs extend beyond immediate financial impacts to include broader implications for national development and investment attractiveness (Ogunlana, 2016).

A large proportion of work done in traditional construction work is based on skilled artisan work, which is difficult to mechanize. Mechanization of a job is highly dependent on the size and type of the job. Different process plants developed specifically for jobs include; Ladders, wheelbarrows, shovels, scaffolds, and so on. Today's construction projects are highly mechanized and becoming more so every day. With the growing industrialization of construction work, the role of onsite equipment and machinery is vital in achieving productivity and efficiency (Waris, 2014). All construction projects require different types of equipment and machinery, having their level of application. For example, residential projects have a low level of equipment usage. Commercial projects have moderate usage of equipment and machinery. Industrial and heavy construction projects require intense and high utilization of machinery for carrying out site works and many other special activities (Waris, 2014).

By substituting unskilled labour with appropriate plants and equipment, labour costs can be reduced. This can also result in an earlier project completion date, allowing the user or clients to recover their capital expenditure sooner. Good project management must vigorously pursue the efficient utilization of labour, materials and equipment (Oluwabunmi et al., 2018). The top five criteria for the selection of construction plants and equipment include; equipment productivity, safety features, ownership cost, operational cost, and efficiency. During the construction phase, the selection of the right equipment has always been a key factor in the success of any construction project (Waris, 2014).

This decision is typically made by matching equipment available in the fleet with the tasks. Such analysis accounts for equipment productivity, equipment capacity, and cost. However, the emerging notion of sustainability in construction has emphasized energy conservation, efficiency, green environment, economy and human well-being (Akintola, 2014). It is important to remember that introducing plants to a contract does not guarantee a cost reduction. Traditionally, one-off houses were built for small contracts. Using manual labour techniques is typically less expensive when performing construction operations.

The effective use of plants and equipment is essential in the construction industry to achieve cost efficiency and timely project delivery. However, several critical issues must be addressed to optimize their application, particularly in the context of building projects in the Enugu Metropolis. One of the primary challenges is the selection of appropriate plants and equipment for specific construction tasks. The failure to choose the correct plant can lead to significant cost implications, including increased operational expenses, inefficiencies in project execution, and delays in project completion (Agbeno, 2019).

Selecting the right plant for a construction project involves considering several factors, such as the nature of the construction site, the technical specifications of the equipment, and the specific requirements of the project. Inappropriate equipment choices can result in under-performance, frequent breakdowns, and higher maintenance costs, all of which contribute to overall project cost escalation. For instance, heavy machinery might be required for large-scale infrastructure projects, while smaller, more specialized equipment might be better suited for residential or commercial building projects. A poor selection process can lead to inefficiencies, causing delays and increasing costs (Akpan & Igwe, 2021).

In addition to selection challenges, the improper use of plants and equipment is another critical issue that impacts project costs and timelines. Even when the correct equipment is selected, its effective use is essential for maximizing efficiency. Poor maintenance, inadequate operator training, and non-compliance with best practices can result in frequent breakdowns and delays, leading to increased costs and extended project duration. These issues are particularly relevant in Enugu Metropolis, where construction activities are often affected by local challenges such as fluctuating market prices, varying soil conditions, and logistical difficulties (Ogunsemi & Jagboro, 2006).

Moreover, the timing of equipment mobilization is crucial in ensuring timely project delivery. Delays in the arrival of necessary machinery can disrupt construction schedules, leading to idle labour and resources, which further contribute to cost overruns (Ameh & Osegbo, 2011). Addressing these issues requires strategic planning, careful selection of plants and equipment, regular maintenance schedules, and ongoing training for operators to enhance the efficiency and cost-effectiveness of construction projects in Enugu Metropolis.

2. METHODOLOGY

The survey research method was used for the study. According to Osuala (2001), survey research studies large and small populations by selecting and studying samples chosen from the populations. The population of the study consists of construction experts who are actively involved in construction projects in the Enugu metropolis.

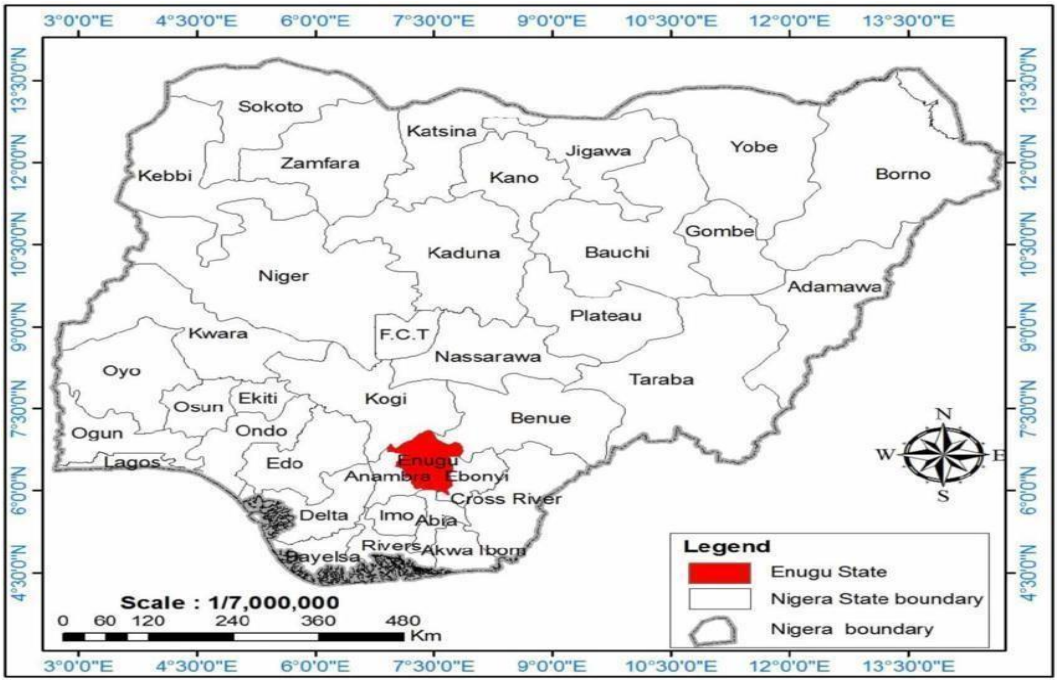

Figure 2.1 Map of Nigeria.

Source: Google Map (2025)

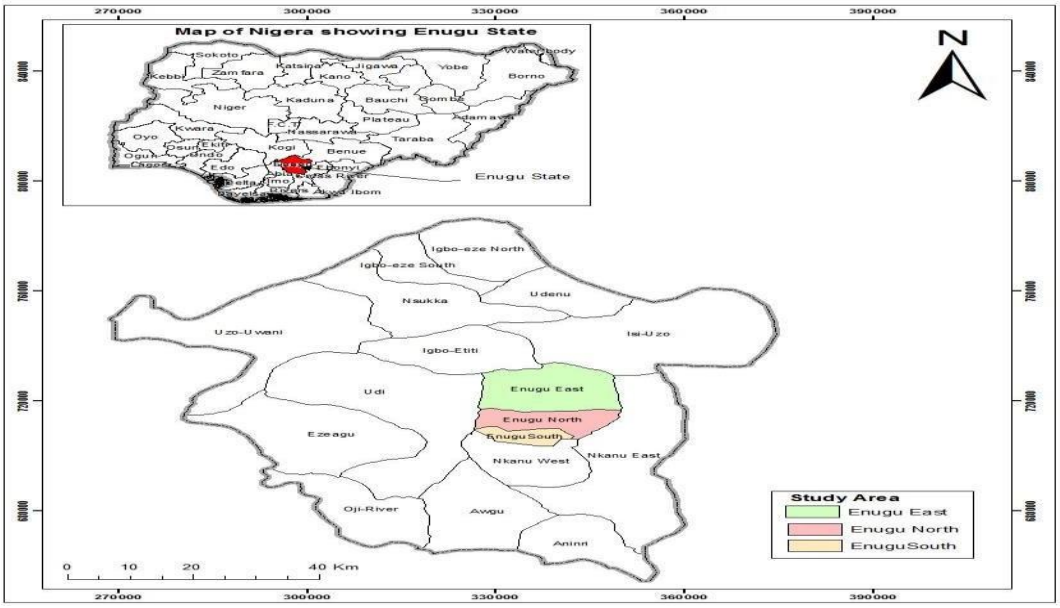

Figure 2.2 Map of Enugu State.

Source: Google Map (2025)

The study employed a stratified random sampling method to select respondents from the population of registered construction experts in Enugu metropolis.

3.0. DATA ANALYSIS AND RESULT INTERPRETATION

3.1 Data Analysis and Presentation

A total of 84 Questionnaires were distributed to respondents out of which a total of fifty-two (52) were retrieved representing a 61.90 % response rate. This is higher than the normal 20-30% response rate in most postal questionnaire surveys of the construction industry (Akintoye and Fitzgerald 2010) as stated in Table 3.1, and this was considered adequate for analysis. Table 3.2 shows the responses from the various sectors. The area of coverage of the distribution is the Enugu metropolis. Table 3.2 shows the percentage of respondent's organization. It was observed that a great response was from contracting firms, a percentage of 65.40% followed by consulting firms at 21.20% and Government agencies at 13.40%. Table 3.3 shows the highest academic qualifications of respondents in client organization Analysis shows that a large number of respondents are B.Sc./B.Tech, Which could be inferred that most of the respondents have the necessary educational background to give reliable data for the analysis. Table 3.4 shows that 89.00% of the respondents are members of Nigeria Institute of Quantity Surveyor (MNIQS), a percentage of 30.8% followed by (MNSE), a percentage of 19.20% followed by MNIA, a percentage of 17.30% followed by MNIOB, a percentage of 11.50%. Therefore, it can be concluded that on the basis of the professional qualification of the respondents, they have adequate knowledge to respond to questions related to the appraising of the effects of plant and equipment on building project costs in the Enugu metropolis.

Table 3.1 Response rate.

No of Questionnaire	Frequency	Percentage (%)
Questionnaire Returned	52	61.90
Questionnaire not Returned	32	38.10
Total	**84**	**100.00**

Source: Field Survey July 2025

Table 3.2 Organization of Respondents.

No of Questionnaire	Frequency	Percentage (%)
Contracting Firms	34	65.40
Consulting Firms	11	21.20
Client/Government Agency	7	13.40
Total	**52**	**100.00**

Source: Field Survey July 2025

Table 3.3. Academic qualification of respondents in client organizations.

Academic qualification	Frequency	Percentage (%)
PhD	1	1.90
M.Sc./M.Tech	8	15.40

B.Sc./B.Tech	23	44.21
PGD	1	1.90
HND	19	36.5
Other	-	-
Total Source: Field Survey July 2025	**52**	**100.00**

Table 3.4 Professional qualification of respondents in client organization.

Professional qualification	Frequency	percentage (%)
MNIQS	16	30.80
MNSE	10	19.20
MNIA	9	17.30
MNIOB	6	11.50
Others	11	24.20
Total Source: Field Survey June 2025	**17**	**100.00**

Table 3.5 Years of professional experience in Construction Firms.

Year's	Frequency (F)	Percentage (%)
1-5	19	36.50
6-10	20	38.50
11-15	11	21.20
16-20	1	1.90
20 Above	1	1.90
Total Source: Field Survey June, 2025.	**52**	**100**

3.6 Tables Based on Research Questions

Research Question 1: What are the different plants and equipment used in construction industry in Enugu Metropolis?

This study also assessed the different plants and equipment commonly used for construction work in Enugu Metropolis. The respondents were asked to assess different plants and equipment commonly used for construction work in the Enugu metropolis. The Relative Importance Index (RII) of these factors were calculated and the methods were ranked. The results are presented in Table 3.6 below:

Table 3.6 Different Plants and Equipment commonly and often used For Construction Work in Enugu Metropolis.

Different Plants and Equipment commonly and often used For Construction Work in Enugu Metropolis	N	RII	Rank
Excavators	52	0.81	1
Bulldozers	52	0.79	2

Dump Trucks	52	0.75	3
Graders	52	0.74	4
Backhoe Loaders	52	0.70	5
Concrete Mixers	52	0.68	6
Pavers	52	0.67	7
Concrete pumps	52	0.64	8
Cranes	52	0.60	9
Tower Cranes	52	0.58	10

Source: Field Research, 2025.

Table 3.6 shows that Excavators (RII=0.81) were ranked first. Bulldozers (RII=0.79) ranked second, Dump Trucks (RII=0.75) ranked third and Graders ranked fourth with (RII=0.74). Backhoe Loaders (RII=0.70) was ranked fifth and Concrete Mixers (RII=0.70) was ranked sixth. Pavers with RII=0.68) ranked seventh, Concrete Pumps ranked eighth with (RII=0.64), Cranes with (RII=0.60) ranked ninth and Tower Cranes with (RII=0.58) was ranked tenth.

Therefore, the most common plant and equipment often used for construction work in Enugu Metropolis are excavators followed by bulldozers then dump trucks.

This study also assessed the different methods of selecting and procuring plants and equipment for construction work in the Enugu Metropolis. The respondents were asked to assess different methods of selecting and procuring plants and equipment for construction work. The Relative Importance Index (RII) of these factors were calculated and the methods were ranked. The results are presented in Table 3.7 below:

Table 3.7 Different Methods of Selecting and Procuring Plant and Equipment for Construction Work in Enugu Metropolis.

Different Methods of Selecting and Procuring Plant and Equipment for Construction Work in Enugu Metropolis.	**N**	**RII**	**Rank**
Renting	52	0.77	1
Leasing	52	0.76	2
Direct Purchase	52	0.74	3
Joint Ventures	52	0.72	4
Outsourcing	52	0.71	5
Equipment Pooling/Sharing	52	0.69	6
Public-Private Partnerships (PPPs)	52	0.67	7
Equipment Financing Options	52	0.61	8
Build-Operate-Transfer (BOT)	52	0.56	9
Equipment Sharing Platforms	52	0.54	10

Source: Field Research, 2025.

Table 3.7 shows that Renting (RII=0.77) was ranked first. Leasing (RII=0.76) ranked second, Direct Purchase (RII=0.74) ranked third and Joint Ventures ranked fourth with (RII=0.72).

Outsourcing (RII=0.71) was ranked fifth and Equipment Pooling/Sharing (RII=0.69) was ranked sixth. Public-Private Partnerships (PPPs) with RII=0.67) ranked seventh, Equipment Financing Options ranked eight with (RII=0.61), Build-Operate-Transfer (BOT) with (RII=0.56) ranked ninth and Equipment Sharing Platforms with (RII=0.54) was ranked tenth. Therefore, the most common method used for selecting and procuring plant and equipment for construction work in Enugu Metropolis is renting followed by leasing then direct Purchase.

Question 3: What are the effects of plants and equipment on project costs in Enugu Metropolis?

Table 3.8: Effects of Plants and Equipment on Project Costs in Enugu Metropolis.

Effects of Plants and Equipment on Project Costs in Enugu Metropolis	N	RII	Rank
Improved project efficiency	52	0.79	1
Increased productivity and output	52	0.74	2
Reduced labour costs	52	0.73	3
Optimized resource allocation	52	0.72	4
Mitigated risk of rework and defects	52	0.70	5
Enhanced safety and risk management	52	0.67	6

Source: Field Research, 2025.

Table 3.8 shows that Improved project efficiency (RII=0.79) was ranked first. Increased productivity and output (RII=0. 74) ranked second, Reduced labour costs (RII=0.73) ranked third and Optimized resource allocation (RII=0.72) fourth. Mitigated risk of rework and defects (RII=0.70) ranked fifth while Enhanced safety and risk management (RII=0.670) was ranked sixth. **Question 4:** What is the relationship between the use of plant and equipment and project completion time?

Table 3.9 Relationship between the Use of Plant and Equipment and Project Completion Time.

Relationship between the Use of Plant and Equipment and Project Completion Time.	N	RII	Rank
Equipment Maintenance and Reliability	52	0.79	3
Equipment Availability and Utilization	52	0.88	1
Equipment Integration and Coordination	52	0.75	4
Technology and Automation	52	0.73	5
Resource Planning and Scheduling	52	0.70	6
Contingency Planning and Risk Management	52	0.66	7

Source: Field study, 2025.

Table 3.8 shows that Equipment Availability and Utilization (RII=0.88) was ranked first. Training and Skills Development (RII=0.80) ranked second, Equipment Maintenance and Reliability (RII=0.79) ranked third. Equipment Integration and Coordination with (RII=0.75) ranked fourth. Technology and Automation (RII=0.73) was ranked fifth, Resource Planning and Scheduling (RII=0.70) was ranked sixth and Contingency Planning and Risk Management with (RII=0.68) ranked seventh.

3.2 DISCUSSION OF FINDINGS

The findings indicate that excavators (RII=0.81) are the most used plant and equipment in the construction industry in Enugu Metropolis, followed by bulldozers (RII=0.79) and dump trucks (RII=0.75). Graders (RII=0.74) rank fourth, with backhoe loaders (RII=0.70) and concrete mixers (RII=0.70) in fifth and sixth positions, respectively. Other notable equipment includes pavers (RII=0.68), concrete pumps (RII=0.64), cranes (RII=0.60), and tower cranes (RII=0.58). This ranking highlights the prominence of heavy earth-moving equipment like excavators and bulldozers in construction activities in the region.

The findings also revealed that renting (RII=0.77) is the most used method for selecting and procuring plants and equipment for construction work in Enugu Metropolis, followed by leasing (RII=0.76) and direct purchase (RII=0.74). Other notable methods include joint ventures (RII=0.72), outsourcing (RII=0.71), and equipment pooling/sharing (RII=0.69). Public-Private Partnerships (PPPs) (RII=0.67) and equipment financing options (RII=0.61) rank lower, with Build-Operate-Transfer (BOT) (RII=0.56) and equipment sharing platforms (RII=0.54) being the least preferred. This shows a preference for short-term commitments like renting and leasing over long-term ownership or partnerships.

The findings indicate that the most significant effect of plant and equipment on project costs in Enugu Metropolis shows that Improved project efficiency (RII=0.79) was ranked first. Increased productivity and output (RII=0. 74) ranked second, Reduced labour costs (RII=0.73) ranked third and Optimized resource allocation (RII=0.72) fourth. Mitigated risk of rework and defects (RII=0.70) ranked fifth while Enhanced safety and risk management (RII=0.670) was ranked sixth. These results show that plants and equipment significantly impact project costs and productivity in building projects.

The findings show that the most significant factor influencing the relationship between the use of plant and equipment and project completion time is equipment availability and utilization (RII=0.88), followed by training and skills development (RII=0.80) and equipment maintenance and reliability (RII=0.79). Equipment integration and coordination (RII=0.75)

ranks fourth, with technology and automation (RII=0.73) in fifth. Resource planning and scheduling (RII=0.70) and contingency planning and risk management (RII=0.68) rank lower. This indicates that ensuring equipment availability and proper utilization is key to improving project completion times.

4.1 CONCLUSION

In conclusion, this study successfully achieved its aim by addressing four key objectives related to plant and equipment use in the construction industry in Enugu Metropolis. The research identified key machinery like excavators, bulldozers, and dump trucks as essential for construction, improving efficiency in the industry.

Renting emerged as the preferred method for procuring equipment, followed by leasing and direct purchase. This highlights the industry's focus on short-term solutions to enhance project efficiency and cost management. The study revealed that plant and equipment significantly influence project costs, with factors like revenue generation, government expenditure, and private-sector investment playing major roles. A strong link was found between equipment use and timely project completion, with equipment availability, maintenance, and modern technology integration critical to minimizing delays and ensuring project success.

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