Logan Journal of Multidisciplinary Earth Sciences, and Sustainability
Volume 1 Issue 1 February 2025
ISSN: Pending…

MANAGING CONSTRUCTION EQUIPMENT FOR OPTIMAL PERFORMANCE: PRACTICES IN ABUJA, NIGERIA

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Abstract: Efficient equipment acquisition and maintenance are critical factors influencing the success of construction projects. However, many construction firms face significant challenges in acquiring and maintaining essential equipment, which impacts project timelines, cost efficiency, and overall productivity. This study explores the extent to which construction firms in Abuja, Nigeria, effectively manage construction equipment acquisition and maintenance. Drawing on relevant literature and industry insights, the research examines financial, managerial, and operational constraints that hinder optimal equipment utilization. The findings highlight that limited access to capital, high maintenance costs, and inadequate managerial strategies are key barriers to equipment efficiency. Additionally, poor maintenance practices often result in frequent equipment breakdowns, leading to project delays and increased costs. The study underscores the importance of strategic investment in construction equipment, improved maintenance policies, and government intervention in providing financial support for firms. By addressing these challenges, construction firms can enhance their operational capacity, improve project delivery timelines, and maximize efficiency in the industry.
Keywords: Construction Equipment, Maintenance, Acquisition, Project Efficiency, Construction Firms

Introduction

Construction projects do not always benefit fully from the potential of construction equipment. One reason is that construction firms are struggling to acquire and maintain construction equipment (Naskoudakis & Petroutsatou, 2016). This concerns investors or project financiers seeking to hire construction firms with more excellent financial or managerial capabilities in handling construction equipment. This is because construction equipment can increase the speed of a project and enable workers to complete tasks easily (Huber et al., 2023; Pracucci et al., 2023).

Maximizing the potential of construction equipment continues to be an area of interest today because construction resources are scarce, and possessing a type of construction equipment can prequalify a firm as capable of certain types of construction work (Adebowale & Agumba, 2023; Huang, 2011). This indicates that exploring the capability of construction firms to acquire and maintain equipment is an important aspect of construction management and raises questions on the issues involved in acquiring and maintaining construction equipment.

Some studies present construction
equipment as construction plants and focus on the maintenance procedures of plants.

For example, Ahamed Mohideen et al. (2011) assessed the most important problems or causes associated with construction plants to know where professionals should focus their maintenance efforts in the event of a breakdown/disruption of service.

Other studies present construction equipment as heavy equipment or heavyduty equipment as opposed to handy equipment. For example, Gai et al. (2013) developed a 3D visualization method to rapidly process spatial information of construction equipment operations in a cluttered construction site. Recent studies present construction equipment as machinery or construction machines. For example, Zeb et al. (2015) examined the

machinery practices used in building projects in Pakistan. The above studies show that the concept of construction equipment is arguable.

Two major themes in the literature on construction equipment dominate the construction management discussions. First is the assumption that there is a link between the outputs and how equipment is operated or managed (Ranjithapriya & Arulselvan, 2020). The second theme in the literature assumes that selecting or acquiring the right equipment is the key to a successful project, and different equipment selection criteria for various projects are proposed (Phogat & Singh, 2013). These two assumptions underline the debate in the literature on construction equipment. However, investigations examining construction firms' equipment acquisition and maintenance capabilities are limited.

Therefore, this study aims to examine the capability of construction firms to acquire and maintain equipment in the Federal Capital Territory, Abuja, Nigeria. In this view, the study outlined the objectives of examining the relative importance of factors that affect the management capability of deploying construction equipment and evaluating the acquisition and maintenance capabilities of construction firms in Abuja.

Literature Review

Managing Construction Equipment. Several authors assume a link between work output and how equipment is operated or managed (Elazouni & Basha, 1996; Fan & Jin, 2011; Gurcanli et al., 2017; Huber et al., 2023). For example, Elazouni and Basha (1996) focused on the relationship between problems in operating construction equipment and productivity loss in Egypt. They discovered that the amount of unproductive time is linked to the difference between actual productivity and the estimated productivity of equipment. In the same vein, Fan and Jin (2011) modelled the cost history or economic life of the equipment and used past equipment data to identify cost-related factors that impact the economic life of the equipment. Their model assists and facilitates decisions in replacing equipment. This approach is prescriptive and based on the analogy that the past can predict the future. Building on this work, Gurcanli et al. (2017) focused on the cycle time outputs of truck crews and compared the outputs of field observations with simulations of the cycle time outputs of 3 and 4-truck crews for excavator-loader-dump trucks in a residential project. Their results showed divergent effects on the duration of project activities. They claim that using simulated techniques and past data of time estimates can assist in developing precise estimates. This claim aligns with Fan and Jin (2011) argument on past equipment data informing future decisions.

It can be seen that the above authors share the assumption that there is a nexus between work outputs and the way equipment is operated or managed. These studies argue that the secret to productive or economic use of construction equipment is utilising past data to make decisions. However, they failed to focus on the equipment acquisition and maintenance capabilities of construction firms.

Acquiring the Right Equipment.

In contrast to the above discussions on work output/ productivity, other studies assume that the key to a successful project is selecting or acquiring the right equipment and propose various equipment selection criteria for different types of projects (Lashgari et al., 2012; Phogat & Singh, 2013; Temiz & Calis, 2017).

For example, Lashgari et al. (2012) focussed on loading/hauling materials and proposed a multi-attribute decision-making model to select the optimum equipment for loading and hauling materials. This model considered all affecting parameters simultaneously, and their results showed that using a cable shovel and truck fleet is the most economical loading and hauling system. They claim that their model offers chances to choose the best alternative

among possible loading or hauling systems that help equipment managers make an accurate and reasonable decision.

Similarly, Phogat and Singh (2013) focussed on a hilly road construction project and presented five multi-criteria techniques to evaluate the most appropriate equipment for earthmoving operations. This approach considered tangible and intangible factors, and their results showed that the five techniques led to similar solutions. They claimed that the alternative dozer D80 was the best choice among alternatives for the construction of a hilly road length of 26 Km with a maximum output of 48 cum/hr.

Similarly, Temiz and Calis (2017) focussed on excavation works and proposed nine multi-criteria decision-making methods to select one piece of equipment for excavation operations out of four alternatives. Their results showed that the second excavating machine gave the optimum ranking. They claim their method for selecting an excavating machine is consistent with their assessment.

It can be seen that the above studies share the assumption that the secret to a successful project depends on selecting or acquiring the right equipment. These studies propose different methods and argue that the best or most economical equipment can be chosen from among other alternatives. However, they failed to examine the capability of construction firms to acquire or maintain equipment.

Equipment Acquisition and
Maintenance Capabilities

One assumption in the management literature is that firms are a collection of various types of resources and capabilities (Lahiri & Kedia, 2009). These capabilities have been described by Helfat and Peteraf (2003) as the ability of a firm to execute a set of tasks, utilizing the resources of a firm to achieve a specific result. The implication is that the ability of a construction firm to use equipment as a resource to complete a project on an agreed date can be regarded as a capability.

Furthermore, management capability is the ability to assemble, integrate, and deploy various firm-level resources such as human resources, organization, and technology to fulfill a client's contractual requirements (Lahiri & Kedia, 2009). The implication is that the ability of a firm to assemble, integrate, and deploy various equipment, equipment operators, equipment managers, and maintenance provisions to fulfill contractual requirements can be regarded as equipment management capability.

According to Naskoudakis and Petroutsatou (2016), managing construction equipment involves the purchase or acquisition, replacement or disposal, operation and maintenance of equipment to minimize maintenance and repair costs.

From the preceding, how equipment is acquired can be linked to a firm's capability. According to Blank et al. (1992) and Waris et al. (2013), there are three methods through which equipment can be acquired, namely: outright purchase, hire purchase, and leasing or renting. The implication is that each acquisition method increases or decreases access to that equipment and involves financial decisions on collateral and storage space. This is because it is more economical to purchase equipment

frequently used for a longer duration of time and to hire equipment used for a shorter period (Owolabi et al., 2014).

According to Hung and Tang (2008) and Siddharth et al. (2015), purchasing equipment could follow numerous financing options that banks, finance companies, leasing agencies, and equipment manufacturers offer. The implication is that only construction firms with the financial capability, assets, collaterals or, contract award letters, and manpower can convince a financier.

Similarly, how equipment is maintained can be linked to a firm's capability. According to Starr et al. (2010) and Slack and Lewis (2022), three main maintenance options are adopted by equipment owners, namely: run to breakdown, preventive maintenance, and condition-based maintenance. The
implication is that choosing a maintenance approach eliminates or reduces the likelihood of equipment failure.
According to Assaf et al. (2011) and Ghadge and Ugale (2013), maintenance decisions on equipment can be affected by seven factors, namely: type of equipment, age of the equipment, size of a project, skill of the operator, maintenance provision or
preference, availability of competent staff, frequency, and level of preventive maintenance.
Furthermore, according to Siddharth et al. (2015) and Alshboul et al. (2024), a critical factor is that construction equipment are assets that tend to depreciate with time as the equipment ages. The implication is that new equipment is likely to have more value than old equipment, and the age of the equipment can be used to measure the financial capability of a firm.
In the same vein, Huber et al. (2023) and Ranjithapriya and Arulselvan (2020) posit that the age of construction equipment is linked to the level of maintenance carried out or provided. The implication is that the amount of maintenance provided for new equipment would be less than the amount of maintenance supplied for old equipment. This is an important factor that affects the capability of firms.
Also, the type of equipment (Temiz & Calis, 2017). This is because some equipment tends to be used more often than others because of the prevalence of certain types of construction work. This is an important factor that affects the capability of firms.
Another critical factor affecting firms' equipment management capability is the size of a project.
According to Zeb et al. (2015) and Pracucci et al. (2023), small-scale projects have fewer funds available for acquiring equipment than large-scale projects. The implication is that large-scale projects are likely to utilize construction equipment more than small-scale projects. This is also linked to the availability of skilled operators and maintenance crew.
According to Slack and Lewis (2022) and Siddharth et al. (2015), skilled operators and staff tend to migrate to larger projects that offer higher wages over a longer period compared to small-scale projects with limited funds and durations. The implication is that large-scale projects with longer durations are more likely to attract skilled operators and staff compared to smaller projects with short durations. The above discussion underlines the assumptions in the literature on the capability of a construction firm.

Research Methodology

This study adopted a survey approach to examine the relative importance of factors that affect the capability of firms to deploy construction equipment and, the acquisition and maintenance capabilities of construction firms in the Federal Capital Territory, Abuja, Nigeria. Abuja was chosen as the study area because of the potential of finding construction firms that acquire, utilize, and maintain construction equipment on their construction projects.
A purposive sampling approach was adopted and 50 construction firms that used or were using construction equipment on their projects were selected. The decision to adopt a purposive sampling approach was to obtain data only from firms that used equipment. Not all construction firms in Abuja utilize construction equipment on their projects. Fifty questionnaires were administered to construction practitioners for each construction firm, and a total of 45 responses were obtained.

The survey was carried out using structured questionnaires that were administered by hand. The questionnaire was developed or structured to address the two study objectives and was divided into three parts. The first part of the questionnaire focused on the characteristics of firms and respondents. The second part of the questionnaire focused on the relative importance of factors that affect the capability of firms in deploying construction equipment.

The third part of the questionnaire focused on firms' capabilities in acquiring or maintaining construction equipment. The relative importance of the factors that affect the equipment management capability of firms was measured with a 5-point Likert scale, namely: 5 very significant, 4 – significant, 3 – moderately significant, 2- slightly significant, and 1- least significant. The capabilities in acquiring or maintaining construction equipment were measured using frequency.

The data obtained on the characteristics and capabilities of the firms was analyzed using frequency and percentage. In contrast, the data obtained on the relative importance of the factors that affect the capability was analyzed using mean score with ranking to address the study objectives.

Discussion of Results

Respondents' Characteristics The characteristics of respondents and firms that work within the Federal Capital Territory, Abuja, that participated in the study are presented in Table 1 and Table 2. The results in Table 1 show that 23% of professionals working in construction firms were site managers, while the least were directors and supervisors, with 13%.

The results also showed that 43% of the professionals had (11 – 15) years of work experience, while those with (1- 5) years and (21 years and above) work experience was

the least with 4 %. Furthermore, the results also indicated that 44 % of the professionals had worked in their current firm for (6 -10) years, while 3 % of professionals had worked for (21 years and above). The implication of these results when compared with the length of work experience, is that some professionals had worked

Table 3: Relative Importance of Factors Affecting the Equipment Management Capability.

Factors affecting the equipment management capability of Mean firms		Rank	Decision
Age of Equipment	2.73	8th	Significant
Maintenance preference and provision of a firm	3.90	4th	Significant
Skill and experience of the operator	3.22	7th	Significant
Type of construction equipment	4.60	2nd	Very significant
Method of acquisition	4.71	1st	Very significant
Size of project	3.60	6th	Significant

Availability of competent staff	4.01	3rd	Significant
Frequency and level of preventive maintenance	3.90	4th	Significant

in Table 2 above show that 33% of construction firms engaged in both building and civil engineering projects, while 18% of construction firms were the least engaged in landscaping projects. The implication is that many construction firms assembled and deployed firm-level resources to acquire and maintain construction equipment to execute building and civil engineering projects or contracts. The results also showed that 44% of construction firms had staff sizes that ranged between 10 and 20 people, while 5% of the construction firms had a staff size of 41 and above. The implication of this result, when combined with the length of years that professionals have worked in a firm, is that construction firms are struggling to retain and grow the skilled human resources they have assembled that might have experience operating construction equipment that is deployed to construction projects.

Acquisition and Maintenance

Capabilities

The results in Table 4 show that 56% of construction firms resort to renting as an acquisition capability for construction equipment, while 9% of construction firms resorted to hire-purchase to acquire equipment. The implication is that most construction firms have not fully developed the financial capability to purchase construction equipment for their projects outright and rely on renting or leasing to fulfil their contractual requirements. Also, the results show that 51 % of construction firms relied on condition-based maintenance as a maintenance capability to maintain their construction equipment, while 20 % of construction firms relied on run to break down as a maintenance capability to maintain their equipment. The implication is that a higher percentage (i.e. 56 %) of construction firms only performed maintenance when specific indicators showed decreasing performance or upcoming failure and were unable to leverage their projects to adopt a proactive maintenance approach. Furthermore, the results show that 47% of construction firms relied on equipment operators or the people who operated the equipment to handle the servicing and maintenance of their construction equipment. Meanwhile, 5% of construction firms relied on equipment dealers or equipment sellers to be responsible for servicing and maintaining construction equipment. The implication is

that a greater number (47%) of construction firms cannot service or maintain construction equipment in-house and so collaborate with equipment sellers or operators to prevent equipment failure. This finding agrees with Ghadge and Ugale (2013) suggestion that construction work should be handled with economy of equipment that involves proper planning and management of equipment.

Conclusion

The study analysed the equipment acquisition and maintenance capability of construction firms in Abuja. More specifically, the study focussed on examining the relative importance of factors that affect the management capability of deploying construction equipment and, the acquisition and maintenance capabilities of construction firms in Abuja. The results showed that the method of acquisition ranked the highest factor with a mean score of 4.70 which affects the equipment management capability of firms. The results also showed that 65% of firms cannot outrightly purchase construction equipment, 56% rely largely on renting and 62% often adopt an outsourced maintenance approach rather than in-house maintenance. This explains why many construction

Table 4 Acquisition and Maintenance Capabilities of Construction Firms.

		Equipment acquisition/maintenance capability	N	%	Rank
Acquisition capability	Acquisition type	Equipment leasing or renting	25	56	5th
		Equipment hire purchase	4	9	7th
		Outright purchase of equipment	16	35	2nd
			45	100	
Maintenance capability	Maintenance options	Run to break down	9	20	3rd
		Scheduled preventive maintenance	13	29	2nd
		Condition-based maintenance	23	51	1st
			45	100	
Maintenance provisions	Maintenance provided	In-house	17	38	1st
		Operators	21	47	2nd
		Equipment dealers	7	15	3rd
			45	100	

projects do not always benefit fully from the potential or output of construction equipment.

A significant implication of the results of this study is that every construction firm regardless of their size has a level of capability in acquiring and maintaining construction equipment and can develop these capabilities that will promote their productivity and competitive advantage. The study contributes to knowledge by shifting the debate in the literature on equipment and focusing on the capabilities of firms in acquiring and maintaining construction equipment.

The study argues that many construction projects do not benefit from the potential or output of construction equipment because a lot of construction firms are unable to leverage fully available resources to deploy construction equipment profitably to fulfil their contractual requirements.

A limitation of this study is that the survey approach did not give participants plenty of room to fully express themselves with structured questions and for future studies, a longitudinal approach is encouraged.

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