Management of Materials Handling Equipment Selection Factors for Successful Delivery of High-Rise Building Projects

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Abstract - The study analyzed materials handling equipment selection factors for successful implementation of high-rise building projects. The objectives are to identify and analyze the major factors in the selection of materials handling equipment for successful implementation of high-rise building project delivery, to determine the most important factor in the selection of materials handling equipment for the successful implementation of high-rise building projects for decisive purposes. Survey research design was adopted and data collected through questionnaire design. Descriptive statistics, multiple regression and relative importance index were used to analyze the data collected from 167 respondents. Tower cranes and concrete pumps are mostly used in Imo State. Job requirement, reliability and costs are the major factors that determine equipment selection for high rise building in Imo State. The study recommends tower cranes and concrete pumps as the ideal material handling equipment. Job requirements, equipment reliability and, associated costs should be considered in the selection of appropriate material handling equipment for successful implementation of high-rise building projects.

Keywords: materials handling, equipment selection, successful delivery, high-rise buildings, projects.

I. INTRODUCTION

The cost and efficiency of handling system is been affected by the selection of materials handling equipment, hence, it is a vital management decision. Nevertheless, buildings considered as high-rise are becoming prominent recently base on the fact that there is scarcity of land, high demand for business and residential space, increasing economic and technological advancement, new ideas in structural systems, need for aesthetics in urban areas, cultural importance and prestige which drive human aspiration to build high-rise structures (Proverbs, Holt and Love,)[1]. However, material handling includes procurement, inventory, shop fabrication and field servicing, which need undivided attention in order to reduce cost. The adoption of modern equipment and innovative techniques has led to several changes in construction technologies in recent time. The implication is that organizations that cannot align themselves with the various innovations and have not adapted to changing environments may be pushed out of the mainstream of construction activities.

There is no need emphasizing the fact that every construction project involve one type of materials handling function or the other. Hence, equipment selection remains a major issue in modern construction projects. This is because it assists in ascertaining the best equipment to employ at a particular construction stage of a project so as to avoid failure, breakdown, and injury to human or other equipment in a construction project site while reducing cost. Based on this, maximum attention has been given to selection of equipment for the construction of high-rise building projects. However, high-rise building has been described by the Constructor[2] as a tall building or structure. So building projects that exceed seventy five (75) feet (i.e. 23 meters) high are considered as high-rise. Buildings higher than four hundred and ninety two (492) feet (150 m) are grouped as skyscrapers. This is because the buildings are high which attracts higher vertical and lateral loads due to wind pressure when compared to lower building structures (Constructor)[2].

So the related factors to consider during the selection of equipment for high-rise building projects is a function of the type of equipment, the nature of work and the size of the construction firm. In the past little attention has been given to the relevant factors in selecting materials handling equipment, especially, for the high-rise building projects as most construction operations are done manually. The resultant effects have been frequent accidents, delays, increased cost, building collapse and bad workmanship which characterized most building projects in Nigeria and other developing countries (Afolayan)[3]. Suggestions of numerous authors in the past have been abortive as the identified factors appear to be neglected or given little consideration in the selection of materials handling equipment for high-rise building projects rather manual system of handling material which attracts costs, [causes] delay and accidents in most building construction sites are chosen. Hence, this study is set to evaluate the factors necessary for the selection of materials handling equipment for high-rise building projects with the aim of suggesting the management approach to adopt so as to improve performance in high-rise building projects and economic development of the Nigeria.

Problem Statement

The need for high-rise building cannot be overemphasized. This is because it is a sign of urbanization, and aesthetic values of development. High-rise buildings are critical, especially, where there is scarcity or high cost of land. Unfortunately, most of these high-rise buildings end up not being realized possibly, due to nature of materials handling equipment needed to move construction materials vertically and horizontally in the construction sites and the traditional manual handling of construction materials. These have

resulted in the loss of funds invested, lives and properties and equally discourage economic development. Authors have associated it with the size of Construction Company, relative costs, speed of construction, and site safety. Others blamed non-availability of materials handling equipment, wind pressure, safety consideration, soil capacity, and scarcity of skilled personnel needed to operate the equipment and high foreign exchange rate as most of the equipment are imported. Therefore, evaluation of materials handling equipment selection factors for high-rise building projects will assist to determine a particular equipment to employ in handling a certain material without failure or accident and also guaranty project success and economic development.

Objectives of the Study

The main objective of the study is to evaluate the materials handling equipment selection factors for successful implementation of high-rise building projects. The specific objectives are;

i.) To determine the major material handling equipment applied in the implementation of high-rise building projects.

ii.) To identify and analyze the major factors in the selection of materials handling equipment for successful implementation of high-rise building project delivery.

iii.) To ascertain the extent of influence that these factors individually have on the selection of equipment for materials handling in the successful implementation of high-rise building projects.

iv.) To determine the level of influence that these factors collectively have on the selection of equipment for materials handling in the successful implementation of high-rise building projects.

v.) To determine the most important factor in the selection of materials handling equipment for the successful implementation of high-rise building projects for decisive purposes.

Statement of Hypothesis

The hypotheses formulated to assist in the realization of the study objectives are;

H_{01}.) All the identified factors have no significant individual influence on the selection of equipment for materials handling in the implementation of high-rise building projects.

H_{02}.) The collective effect of the identified factors on the selection of equipment for materials handling in the implementation of high-rise building projects is not significant.

Justification of the Study

The need for high rise buildings are becoming visible in recent times because of scarcity of land and increasing rural urban migrations which resulted in increasing demand for business and residential space for economic growth coupled with the desire for aesthetics in urban setting. However, these needs cannot be achieved if these high rise building projects are not successfully implemented. To successfully achieve the objectives of high-rise buildings, there is need to ascertain and consider the factors that will influence the selection of equipment for handling materials during the implementation stage of construction.

However, the findings will be of immense benefit to building construction stakeholders, researchers and academicians as the study revealed the critical factors that affect the selection of materials used for building high-rise projects. Socio-economic development will be enhanced as the rate of success in high-rise building projects will increase resulting to urbanization and economic activities.

II. CONCEPTUAL REVIEW

In building science and technology, high-rise building is very important in modern building business. According to Wang, Zhang, Wang, Cui, Chen, Li,[4] great breakthroughs have been made in building function, structural system, building services and other aspects of super high-rise building. There is no doubt that in the construction process, intensive manpower, poor mechanization, long project duration, increase cost couple with environmental pollution still affect the extent of industrial growth and comprehensive benefits. However, construction innovation is mainly concentrated on construction project materials, equipment, process and management. So there is no doubt that equipment innovation is dependent on other issues and it also limit the proper improvement of method and management innovation.

It is worthy of note that high rise building has different definitions by different bodies. Emporis Standards[5] define it as a multi-story structure between 35- 100 meters tall, or a building of unknown height from 12-39 floors is seen as high rise. The International Conference on Fire Safety[6] define high-rise building as any structure where the height can have a serious impact on evacuation. Massachusetts[7], United States General Laws state that a high-rise is being higher than 70 feet (21 m). To the Building code of Hyderabad, India[8], a high-rise building is one with four floors or more, or one 15 meters or more in height. National Building Code (Part 4) also define it as Fire and Life Safety all buildings 15m and above in height shall be considered as high rise buildings. Therefore it is very crucial to adopt proper material handling equipment in the implementation of project tasks or activities in order to assist successful realization of such high rise building projects.

However, there are two outstanding key issues with respect to high-rise building construction. They area vertical transportation and operation environment. A lot of materials, components, labors and equipment must be

moved to high altitude, and that is the core of improving construction efficiency. The traditional method of operation in such project undertaking is limited and inconvenient because of too many construction processes, great engineering quantity and operation requirements of high-rise building project activities. Enhancing task environment is another issue in order to improve the efficiency of construction. Note that in the 19th century when high-rise building projects started, different types of formworks (turnover formwork, climbing formwork, sliding formwork, lifting formwork and jacking formwork) were applied in order to successfully deliver the construction of high-rise building projects. As posited by Wang, *et al*[4], these equipment combine formwork and scaffolding together to form closed and accessible environment. According to them, material yard, tool room, etc. can be mounted on these formworks. So to enhance vertical movement of building materials, the tower crane and construction hoist were used to execute high-rise building projects towards the end of the 19th century in Europe, which greatly improve the capacity of the vertical transportation of building project materials. Since then, further studies have been made on the loading capacity, running speed and attachment. Nowadays, the tower crane is able to lift 100ft with maximum bending moment of 3200 t·m, while the load of hoist is more with a maximum running speed up to 120 m/min (Proverbs, et al,)[1].

Materials Handling Equipment for High-Rise Building Projects

There are many equipment for handling materials during the construction of high-rise building projects. These equipment include but not limited to; the cranes used for lifting and placing such building materials as heavy steel beams, pre-stressed concrete sections for buildings or bridges, materials and supplies to the upper stories of a high rise construction, unloading trucks, and a host of other essential jobsite material handling tasks (Sitek)[9].

Proverbs et al [1] in there study, posited that with the concrete pump, concrete is pumped by a diesel powered, static concrete pump, through a fixed 125 mm pipeline, to the folding placing boom. However, the boom is fixed on a steel column of up to 20 metres high. The column is, therefore, supported by a cross base set into the concrete floors. With floor frames, the entire column/boom assembly can climb with the building as the construction activities are being implemented. Nevertheless, using concrete pumping is faster than using a crane and skip which may not be affected by the pressure from wind.

Other material handling equipment include; self-loader, forklift, chain block, lever hoist, lifting belt (flat or round webbing sling), trolley, wire rope sling, lifting jack, etc.

Symptoms of Bad Material Handling

Materials handling is critical because is associated to cost and efficiency of operation. Meanwhile Ubani,[10] lamented that project operators should not lose sight of the bad symptoms of material handling operation which can lead to time and cost overrun in high rise building projects. Hence, he listed some bad symptoms of materials handling system, which includes; (i.) Frequent interruption in operations due to delay in handling and supplying materials to the point of use, (ii.) Skilled labour performing duties like storing, movement, and handling of materials, (iii.) Damages to materials in handling, (iv.) Accumulation of work-in-progress and materials in different locations, (v.) Reworking and rejection due to handling defects, (vi.) Crowded space with scrap and materials, (vii.) Congestion at receipt, operation and inspection areas, and (viii.) Long waiting for material handling equipment to pick up and deliver materials.

Materials Handling Equipment Selection Factors

The following factors are to be taken into account while selecting material handling equipment according to Ubani[10];

a.) Nature of operations: whether handling is temporary or permanent, whether the flow is intermittent of continuous, whether materials flow pattern is vertical or horizontal, the type of layout.

b.) Material to be handled: size and shape of material, quantity and weight of material, material characteristics, susceptibility to damage during handling.

c.) Distance over which the material is to be moved: fixed distance, long distance, or work station.

d.) Installation and operation costs: initial investment, operation and maintenance.

e.) Plant Facilities: type of facility, floor load capacity.

f.) Safety consideration.

g.) Engineering factors: door and ceiling dimensions, floor conditions and structural strength and traffic safety.

h.) Equipment Reliability: use of standard components, service facilities and supplier reputation.

Conceptual Framework

The conceptual framework for this study is shown in the form of a diagram which links the independent (identified) factors, dependent factor, extraneous factors and the material handling equipment for successful delivery of high-rise building projects.

The type of conceptual framework developed in this study explains that to achieve successful implementation of high-rise building projects (dependent factor), the nature of the identified equipment selection factors (independent factors) will determine the materials handling equipment to be selected for the high rise building project under consideration.

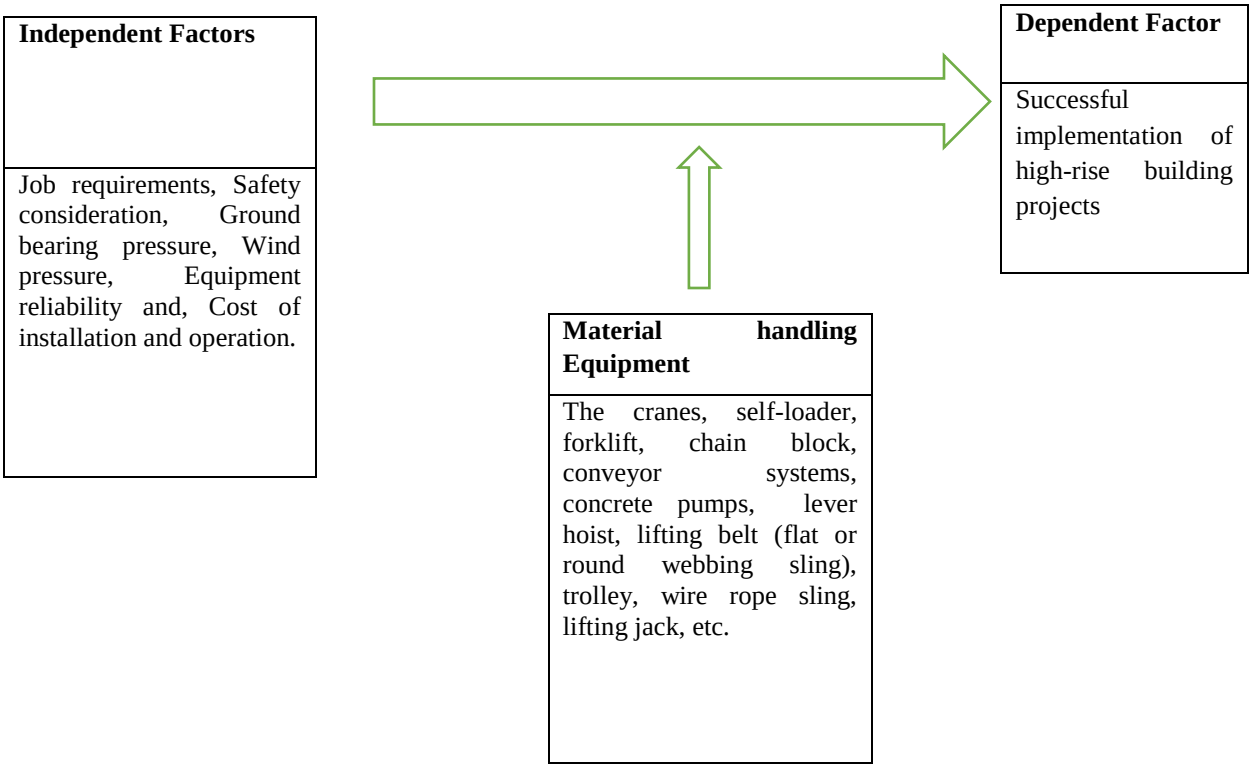

Fig. 1: Conceptual Framework

Source: Content Analysis

Empirical Review

Numerous authors have in the past considered some factors for selecting materials handling equipment for project execution, especially, high-rise building projects. In line with this, Femi[11] studied the factors responsible for selection of equipment for handling materials in the construction of telecommunication mast in Ogun State, Nigeria. The study aimed at analyzing and determining the best strategy for selecting material handling equipment for mast project execution. Three major factors were considered and they include; stability of the equipment, safe working load, and soil bearing capacity. He analyzed the factors with the aid of t-test technique. The ranking of their t-test values show that soil bearing capacity is the major factor to consider in the construction of telecommunication masts in Ogun State. However, the study failed to identify other important factors that should be considered in the selection of material handling equipment for the construction of mast projects.

Oluwatosin and Gbenga[12] in their study on the problem of lifting of construction materials in high-rise building projects in the Southwest, Nigeria. They identified factors like bulky nature of the load, stability, hydraulic hose, space for movement of equipment, soil holding capacity, hoisting system, skilled operators, wind pressure, and cost of maintenance. The Relative Importance Index show that soil holding capacity and wind pressure are the most important factors to determine the adoption of materials handling equipment in building construction projects in the Southwest geopolitical zone of Nigeria.

Oppong[13] studied the factors for identifying the equipment for materials handling in 7-Storey Building Project in Ghana. He identified eight major factors which include the nature of job, bulk of load, wind pressure, cost of hiring and maintenance, project location, strength of the building, skilled labour, and soil bearing capacity. The aim is to analyze and identify the critical factors to consider in selecting material handling equipment for improve project performance. Multiple Regression technique show that all the six factors are significant. After ranking them, soil bearing capacity is the most critical factor, this is followed by bulk of the load while strength of the building is the least critical factor to consider in the selection of material handling equipment in Ghana.

In a related study in Istanbul, Seren and Rickman[14] studied the variables responsible for the choice of material handling equipment in the construction of Istanbul Carnival Tower in 1962. The aim of the study is to ascertain the variables that led to the choice of certain material handling equipment in the tower construction project. They identified seven factors which include the bearing capacity of the ground, atmospheric pressure, installation and disassembly costs, safety requirement, bulk of the material, reliability of equipment, and distance of material movement (both vertical and horizontal distances). The ranking of the factors using the Relative Importance Index (RII), show that the most important factor is atmospheric pressure as the

area is known for strong wind and rainfall. The second important factor according to the study is the bearing capacity of the ground, equipment reliability, safety requirement bulk of the material, distance of movement while, installation and disassembly costs ranked least. They however made conclusions based on this findings.

Proverbs et al[1], in their international investigation concerning the selection of materials handling methods for high rise in-situ concrete buildings by contractors' planning engineers in France, Germany and the UK identified the terrain and if the crane will be working on- or off-road, pick-and-carry considerations, single or repetitive lifts, travel time and distance, and relative costs, speed of construction, and site safety as the major criteria for selection of material handling equipment in the three Countries. Their findings indicate that materials handling methods differ in each international location. Tower cranes still dominate for high rise in-situ concrete buildings, although contractors will also frequently utilize concrete pumps in conjunction. Company size has little impact on the materials handling method selected. Eight predominant (construction method) selection factors are identified, and ranked for each international group of contractors. Statistically, the rankings are shown to be almost the same for each country. Relative costs, speed of construction, and site safety are the principal selection criteria. Correlation analysis reveals a degree of association between the selection factors.

Mudgil[15] considered the factors that materials handling equipment manufacturers consider in the production crane in India. He identified the following; whether the proposed high-rise is coming within clusters or in vicinity of other building, other critical factors, like wind pressure where the tower crane is working, and ground bearing pressure, if the crane has to be fitted internally or externally. However, he concluded that the material handling equipment factors are meant for India construction sites as they may not apply to other countries.

Aviad, Asce, & Goldenberg[16] studied the issue of "soft" considerations in the selection of equipment for building construction projects in Delhi India. The paper aims at increasing the awareness: (1) to the nature, variety, and richness of soft factors; (2) to their significant role and potential impact on the outcome of decision making; and (3) to the inherent difficulty of evaluating them and integrating them within a comprehensive selection process. Existing state-of-the-art equipment selection models were analyzed and found to be inadequate in terms of both considering soft factors and providing mechanisms for their systematic evaluation. Six cases of large-size, complex construction projects were investigated to obtain an extensive list of typical soft factors. This investigation revealed that the consideration of soft factors in current practices is essentially unstructured and is not integrated within the selection process in a systematic manner. A desirable selection process is outlined that generally responds to the needs identified in the study.

Zhang, et al[17] during the design of the auto-lifting and rotating platform with Cranes Group in South Korea identified; bulk of the load as bulky load may require a larger crane to handle physical dimensions in order to obtain lift height required at a given radius, cost of installation and operation, equipment reliability, nature of material to be handled, and operational safety as the factors to consider in the manufacture of material handling equipment. However, they insisted that associated costs and safety of operation are the most important factor to consider in material handling equipment manufacture and operation.

Research Gap

Most of the studies reviewed in this study failed to correlate equipment selection factors with the material handling equipment to guide proper selection for successful implementation of high-rise building projects.

They also failed to ascertain the most critical factor that determines equipment selection for high rise building projects

This study intend to close these gaps and proffer solutions that will assist in the selection of material handling equipment for improve delivery of high-rise building construction projects and socio-economic development.

3.0 Research Methodology

The study was designed to be a survey research because of the field survey conducted to physically study the use of material handling equipment in the building construction projects in Imo State and its environs. Though several research design do exist but the survey technique was adopted base on the nature of the study. It assisted the researcher to actually determine the constraints in the utilization of material handling equipment in the execution of high-rise building projects and the factors to consider when trying to choose a particular equipment for construction purposes. Also the survey technique adopted assist the researcher see the extent to which the t-test, analysis of variance and relative importance index techniques can be applied in the analysis of the data collected through questionnaire.

Population of the Study

The study population is estimated at three hundred and fifty (350). They comprise of seventy (70) building contractors in Imo State (private and government), building consultants (70), estate managers & valuers (70), structural engineers (70) and civil engineers (70). This was done to ensure that only those involve in the use of material handling equipment in the implementation of high-rise projects were targeted. However, due to the difficulty in accessing all the population of the study, the researcher embarked on sampling procedure.

Sampling Procedure and Sample Size

Taro Yamane sample size formula was adopted in determining the appropriate sample size that is the true representation of the total population. Hence, by applying the sample size formula;

$n = N/I+Ne^2$

Where, n = sample size, N = population size, e = error term estimated at 5%.

So, $n = 350/1+350(0.05)^2$

n = 350/1+350(0.0025)
Therefore n = 350/1.875 = **187**.
The study sampled one hundred and eighty seven (187) respondents (participants) in the high-rise building projects using material handling equipment.

Method of Data Collection

The study made use of both the primary and secondary sources of data for the study. The secondary source of data include the learned journals, textbooks, related published and unpublished articles, internet, etc. While the primary source of data is the basically, the questionnaire and discussions with some professionals in the study area regarding the influence of the identified factors in the study.

Validity Test of the Research Instrument

This was done in conjunction with the study supervisor and other professionals in the area of the study. The drafted questionnaire was administered to them for input and /or correction. However, there contributions and comments were taken care of and redistributed to them. Their reply show that the research instrument is valid both in content and frame.

Reliability Test of the Research Instrument

The reliability test for the study was conducted by adopting the test retest method. By this, the questionnaire (research instrument) was administered to this same group of respondents for their responses. Then after four months, the research instrument was also administered to the selected group for the second time. The two data collected from them were correlated using Pearson correlation (r). The value of r = 0.91 which show that the research instrument is reliable for collecting data for analysis.

Method of Data Analysis

The data collected from the target respondents were analyzed using descriptive statistics involving frequency and percentage, multiple regression (the t-test, Analysis of Variance (ANOVA)), and the Relative Importance Index (RII) techniques. The descriptive statistics was used in the analysis of the major material handling equipment applied in the implementation of high-rise building projects. The t-test was used to test hypothesis one in order to achieve objective two. ANOVA was adopted in testing hypothesis two in order to achieve objective three while the relative importance index was used to rank the factors in order to achieve the research objective four.

To determine the relative ranking of the factors, these scores is to be transformed to importance indices based on the formula below:

Relative Importance Index (RII) $= \frac{\sum WR}{A.N} = \frac{3R_3+2R_2+R_1}{3N}$

Where; W = weight given to each factor by the Respondent ranging from 1 –3, n_1 = Number of respondents for not important (NI), n_3 = Number of respondents for highly important (HI),

R = Response rate, A = Highest weight (i.e. 3), N = Total Number of Respondents

However, the scale is rated as follows: Highly important (HI) = 3; Important (I) = 2; Not important (NI) = 1.

Decision Rule

Accept the null hypothesis (H_0), if the p-value is less than 0.05, otherwise reject it and accept the alternative hypothesis (H_A). This is because the tests are done at 5% level of significance which is acceptable in the field of social science research.

Factor Definition

In course of analyses, the six identified factors were represented with the following acronyms;

S/No.	Factors	Symbol
1	Job requirements	A_1
2	Safety consideration	A_2
3	Ground bearing capacity	A_3
4	Wind pressure	A_4
5	Equipment reliability	A_5
6	Cost of installation and operation	A_6
7	Successful implementation of High-rise Building Projects	H

IV. DATA PRESENTATION

Table 4.1 Analysis of Questionnaire Distributed and Retrieved

Respondents	Private Building contractors	Civil Engineers	Estate managers	Building consultants	Government Building contractors	Total
Number Distributed	42	40	43	31	31	**187**
Number Returned	39	38	39	30	29	**175**
Number not Returned	3	2	4	1	6	**16**
Number Discarded	2	3	2	1	0	**8**
Number Used	37	35	37	29	29	**167**

One hundred and sixty seven (167) were found to be properly filled and were used for the analyses made in this study. The 167 represents eighty nine percent (89%) of the total sample selected which is a true representation of the population of the study.

Analysis of Choice of Material Handling Equipment Selection for High-rise Building Projects

The rate at which building operators use material handling equipment in the implementation of high-rise building projects in Imo State as extracted from the questionnaire

Table 4.2 Choice of Material Handling Equipment in Imo State

S/No.	Material handling Equipment	Frequency of Use	Percentage
1	Tower Cranes	99	59.3
2	Self-loader	2	1.2
3	Forklift	3	1.8
4	Chain block	0	0
5	Conveyor systems	0	0
6	Concrete pumps	48	28.7
7	Lever hoist	6	3.6
8	Lifting belt	0	0
9	Trolley	0	0
10	Wire rope sling	7	4.2
11	Lifting jack	2	1.2
Total		**167**	**100**

The result in Table 4.2 show that most high-rise building operators normally select tower cranes and concrete pumps as the major material handling equipment in the execution of their building projects in Imo State. The factors normally considered for the selection of material handling equipment for the implementation of high-rise building projects as dictated by the content analysis are Job requirements, Safety consideration, Ground bearing pressure, Wind pressure, Equipment reliability and, Cost of installation and operation. These are the factors that form the basis for designing questionnaire for data collection.

Analysis of the Factors for the Selection of Material Handling Equipment for High-rise Building Project

The data from the questionnaire were used to develop a relationship model and test of the hypotheses formulated.

Table 4.3 Coefficients for Relationship Model

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	42.018	3.477		12.084	.000
	A1	.468	.077	.449	5.912	.000
	A2	.297	.080	.213	2.638	.009
	A3	.157	.073	.171	2.149	.033
	A4	.014	.093	.170	0.297	.059
	A5	.340	.082	.337	3.489	.001
	A6	.391	.079	.351	4.018	.000

Dependent Variable: H

The relationship model from Table 4.3 was a developed as follows:

$$\mathbf{H = 42.018 + 0.468A_1 + 0.297A_2 + 0.157A_3 + 0.014A_4 + 0.340A_5 + 0.391A_6}$$

This model show that there are positive relationship between performance of high-rise building in Imo State and the six material handling equipment factors. It implies that any increase in each of these material handling equipment factors leads to increase in the successful implementation of high-rise building construction projects.

However, the job requirements (A_1) seem to be the factor that have the highest relationship or effect in the selection of material handling equipment for successful implementation of high-rise buildings in Imo State, Nigeria. This is based on its coefficient (0.468) which is the highest coefficient among the six identified factors. Zhang, *et al.*[17] also confirm this result as they posited that the only factor that determines the type of material handling method to adopt is the job requirement. This factor determines the strength, size, and type of material handling equipment to select for construction projects involving high-rise construction activities.

Analysis of the Hypotheses Formulated

The t-calculated values in Table 4.3 were used to test hypothesis one as shown below;

H_{01}: All the identified factors have no significant individual influence on the selection of equipment for materials handling in the implementation of high-rise building projects.

From Table 4.3, the t-calculated values show that all the factors are significant at different level of significance except wind pressure (A_4). This is because the p-values of A_1, A_2, A_3, A_5 and A_6 are less than 0.05 which means that they are significant. Whereas A_4 has a p-value more than 0.05 level of significance and this makes wind pressure not significant.

The study therefore accept the null hypothesis (H_{01}) with a conclusion that all the identified factors have no significant individual influence on the selection of equipment for materials handling in the implementation of high-rise building projects.

The F calculated value in the Analysis of Variance (ANOVA) was used to test hypothesis two

Table 4.4 Analysis of Variance (ANOVA)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	299.397	6	49.899	3.056	.007(a)
	Residual	2612.256	160	16.327		
	Total	2911.653	166			

a Predictors: (Constant), A6, A3, A1, A5, A4, A2
b Dependent Variable: H

H_{02}: The collective effect of the identified factors on the selection of equipment for materials handling in the implementation of high-rise building projects is not significant.

With the F-calculated value of 3.056 which is significant at 0.007 level of significance, it means that all the factors have collective significant influence on the selection of material handling equipment for the successful implementation of high-rise building construction projects in Imo State. With respect to this, the study reject the null hypothesis and accept the alternative hypothesis and conclude that the collective effect of the identified factors on the selection of equipment for materials handling in the implementation of high-rise building projects is significant.

In order to rank of the factors to determine the most important factor in the selection of material handling equipment for successful implementation of high-rise building construction projects, the relative importance index (RII) was adopted.

Table 4.5 Relative Importance Index (RII) of the Factors

Factors	**Respondents Scores**			**Number of Respondents**	**∑W**	**A.N (3*167)**	**RII**	**Rank**
	VI 3	**I 2**	**NI 1**					
Job requirements	104	63	0	167	438	501	0.874	1st
Safety consideration	98	61	8	167	424	501	0.846	4th
Ground bearing capacity	96	59	12	167	418	501	0.834	5th
Wind pressure	32	43	92	167	274	501	0.547	6th
Equipment reliability	97	70	0	167	431	501	0.860	2nd
Cost of installation and operation	103	54	10	167	427	501	0.852	3rd

The result of the ranking in Table 4.5 show that job requirement is the most important factor in selecting material handling equipment for the successful implementation of high-rise building construction projects in Imo State. The second most important factor is equipment reliability while the least important factor for the selection of these material handling equipment in Imo State and other Southeast States of Nigeria is the wind pressure. However, this is surprising. The pressure of wind is supposed to influence the selection of these equipment as oppose to the finding in this study.

V. CONCLUSION

Material handling equipment is necessary in high-rise building construction to ensure easy and fast movement of construction materials both vertically and horizontally to facilitate successful building project delivery. Hence, the study concludes with the following recommendations;

i. Tower cranes and concrete pumps should be selected in Imo State as the ideal material handling equipment given its effective application in the implementation of high-rise

structures. This is based on the availability and usage of the equipment. This will assist in facilitation and easy handling of construction materials for the successful implementation of high rise building projects.

ii. Job requirements, Safety consideration, Ground bearing capacity, Equipment reliability, Cost of installation and operation are the significant factors that should be individually considered in the selection of appropriate material handling equipment for successful implementation of high-rise building projects.

iii. There is also the need to consider the collective effect of the factors on the selection material handling equipment for the successful implementation of high-rise building construction projects in Imo State. Contractors and stakeholders of high-rise building projects give consideration must evaluate the five significant factors in the selection of material handling equipment rather than relative costs of the equipment.

iv. In an attempt to consider these selection factors for material handling equipment for the successful implementation of high-rise building, the order of priority should be in the following arrangement: job requirement, equipment reliability, cost of installation and operation, safety consideration, ground bearing capacity, and Wind pressure.

In summary, tower cranes and concrete pumps should be selected as material handling equipment for high-rise building projects in Imo State and other Southeastern States based on the job requirement, then the reliability relative costs of installation and operation should equally be considered. Safety and ground bearing capacity should be checked and the wind pressure.

Contributions to Knowledge

The following contributions have been made by this study to the body of knowledge;

i.) The most important factor in the selection of material handling equipment is the job requirements and tower cranes and concrete pumps are the major material handling equipment for the implementation of high-rise building projects in Imo State, Nigeria.

ii.) The study has been able to establish the factors for the selection of material handling equipment for improved delivery of high-rise building projects in Imo State and Southeastern States of Nigeria in general.

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