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EVALUATION OF MECHANIZATION IN BUILDING PRODUCTION AS A WAY OF COST REDUCTION A STUDY OF SOME CONSTRUCTION SITES IN ENUGU SOUTH LOCAL GOVERNMENT AREA

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ABSTRACT: *Motivated by the need for an empirical evidence to convince local builders in Enugu south of the benefits of adopting mechanization in building production, this study evaluated the place of mechanization in building production. Survey design was adopted involving field survey, questionnaire survey and personal interviews of some registered professionals in building; civil, structural and mechanical engineers; architects; and surveyors. In verifying the impact of mechanization against voted contract sum in the bill of works, a site where activities in excavation and concrete works were mechanized was selected for case study. From the result of the analyses, it was found that the use of plants can bring about 25-35% reduction in cost of labour in excavation and concrete works where a great deal of resources usually goes down in building production. Sequel to the above findings, the study recommended the use of plants and other forms of mechanization should be explored as excellent alternatives to the use of manual labour, especially when the project is a large one. Also that contractors wanting to venture into mechanization should first consider a variety of alternatives available to them and endeavor to embark on a feasibility study and possibly a thorough cost-benefit analysis before the decision to employ mechanization is made.*

KEYWORDS: Mechanization, Building Production, Cost Reduction, Construction Sites, Enugu South, Local Government Area

INTRODUCTION

Background to the Study

Mechanization is the process of changing from working largely or exclusively by hand or with animal to doing that work with machinery. In Nigeria, construction process designers have upscale the worker-equipment system into a cohesive building production system to find solutions to problems such as the aging of workers, a higher training level of employees and the low numbers of young people looking for jobs in construction (Obayashi, 1991). A building production system can be defined as a technical installation that assembles construction elements into a building. In this context, an installation can be seen as a collection of people, tools and machines, computers and telecommunications equipment that may all be working together. If we couple this definition to the various tasks required for the performance of building activity. Physical, Cognitive and organizing tasks – we see production systems subdivided into traditional mechanized, robotized

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and automated building production systems. Table 1: Shows the relationship between the different parameters using human-machine technologies.

CONSTRUCTION SYSTEM TYPE	PHYSICAL TASKS	COGNITIVE TASKS	ORGANIZING TASK
Traditional	Workers Equipment	Workers	Workers
Mechanized	Equipment	Workers	Workers
Robotized	Equipment	Computer and Software	Workers
Automated	Equipment	Computer and Software	Computer and Software

Source: (Sharma 2001; Construction equipment and Its Management).

An automated construction system consist of an assembly area where building work can be carried out regardless of the weather, an automatic hosting system for the assembly area, an automatic vertical and horizontal conveyors system and a centralized information system to execute and manage organization tasks.

Considering all the merits of mechanization of a building process as contained in many literature materials, many still prefer the archaic manual labour considering the cost of procuring or leasing the machines. In Enugu south under study, there has been mixed feelings as to which is more beneficial and cost saving between human / manual labour and mechanization. A study of this sort becomes expedient.

Statement of Problem

The problem of high cost of building production cannot be over emphasized. Its attendant consequences and economic implications with accommodation challenges are numerous. One of the main factors of building production is the method of labour adopted, that is manual or mechanized. Enugu south has lots of labourers available and this reduces the cost of labour in the area and sometimes creates a scene of robust seasonal unemployment. Builders in the area tend to consider human labourers cheaper and profit oriented especially when the project is not sizeable enough to introduce mechanization. Most builders consider the high cost of procurement of machines without running a cost benefit analysis at the end of the project, thus they are scared of investing into mechanization. On the other hand, majority of literature has it that mechanization is more beneficial in building production.

In order to enhance the combat with the rising cost of building production in the country and other related issues such as delay in completion time and low level of productivity of construction projects in the industry, this work evaluates the place of mechanization of building construction against the usual manual labour.

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Aim and Objectives of the Research

The aim of this study is to evaluate the place of mechanization in building production processes as a cost reduction tool.

To achieve this aim, the following objectives have been set out.

i. To understand the concept of mechanization in building production processes.
ii. To identify some of the mechanization process in building production processes.
iii. To compare the cost of manual labour and mechanization of specific building production process.

LITERATURE REVIEW

Several works has been done on the issue of mechanization and manual labour as found in literature. When we compare the efficiency of a labourer, we see that he has an efficiency of about 1% - 5.5% (depending on whether he uses arms or a combination of arms and legs). Internal combustion engines mostly have an efficiency of about 20%, although large diesel engines, such as those used to power ships, may have efficiencies of nearly 50%. Industrial electric motors have efficiencies of up to the low 90% range, before correcting for the conversion efficiency of fuel to electricity of about 35%. Douglas (2001) in his book says; when we compare the costs of using an internal combustion engine to a worker to perform work, we notice that an engine can perform work at a comparative cost. 1 litre of fossil fuel burnt with 1c engine equals about 50 hands of worker operating for 24 hours or 275 arms and legs for 24 hours.

In addition, William, (2003) says that the combined work capability of a human is also much lower than that of a machine. An average human worker can provide work good for around 0.9 hp (2.3mj per hour) while in machine (depending on the type and size) can provide for far greater amount of work. For example, it takes more than one and half hour of hard labour to deliver only one Kwh which a small machine could deliver in less than one hour while burning less than 1 litre of petroleum fuel. This implies that a gang of 20 – 40 men will require an expended food calorie (which is at least 4 to 20 times higher). In most situations, the worker will also want compensation for the lost time, which is easily 96 times greater per day. Even if we assume the real wage cost for the human labour to be at N2000/day, an energy cost is generated of about N5000/Kwh. Despite this being a low wage for hard labour, even in some of the countries with lowest wages.

According to Cooke and Williams, (2003) recommended as cost reduction measures the elimination or minimization of design/specification, delivery and site waste through the formulation and implementation of effective material policy and material management.

In addition, (Ashworth, 2000) observed that profitable firms may be generating their revenue from the elimination of waste at both professional and trade practice levels. Cost reduction measures also include: establishing firmly the requirements and features of the project at the onset before getting started, effective machine management through effective use.

The works of Mass and Van Gassel (2001); Isarc (2003) and Mass and Van Gassel, (2003); all supported that automation / mechanization of building production processes is more beneficial. It should be noted that all building production is ultimately designed to improve performance and

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maximize client's satisfaction, it is therefore always difficult to keep sight of the overall picture and these final goals.

METHODOLOGY

The study adopted the survey design, which involved a field survey of sites, personal interviews, and a questionnaire survey methods in generating the needed data.
The major techniques used for the collection of relevant information regarding this study include the following:

i. Administration of structured questionnaire which was done to extract views and opinions from concerned and targeted professionals whose practice exist within the confines of this research.
ii. Site observation and recording data reflecting cost incurred in employing plants, operating them and deploying them to project activity. Other data collection techniques include:
iii. Oral interview and discussions with resident, builders, site engineers, equipment managers/experts, consultants and clients with much inclination to the aspect of findings.
iv. Equipment records, previous jobs of the selected areas of construction activities, indicating cost incurred on plant procurement (either by hire or direct purchase), cost voted to manual workmanship from which a final comparative analysis of this voted cost was done to justify the importance of one over another in building production.

A sample population of 40 professionals was purposively adopted with at least 2 from each of the following registered professions in the state: Architects, Town Planners, Surveyors, Geotechnical Engineers, Builders, Structural Engineers, Mechanical Engineers and Estate Managers; a total of which served as the study population frame. Out of these, only 25 copies of the questionnaire were successfully administered. The collated data were analyzed in percentages and presented in tables.

DATA PRESENTATION / ANALYSES AND DISCUSSION

Data Presentation and Analysis

Data Presentation

Data for Questionnaire

Table 4.1 Respondents Responses on the statement: "You have good knowledge about Mechanization".

RESPONSE	Builder	Architect	Engineer	Q/Surveyor	Frequency	Percentage
Agreed	2	3	2	2	9	45%
Strongly Agreed	8	2	-	1	11	55%
Disagreed	-	-	-	-	-	-
Strongly Disagreed	-	-	-	-	-	-
No Idea						
TOTAL	10	5	2	3	20	100%

Source: Researcher's Field Survey 2016

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The table above shows the number of respondents and a distribution of their profession. The figure illustrates their knowledge on Mechanization. From the table, it is observed that all the professionals out of which a total of 55% strongly Agreed and none disagreed.

Deduction: This means that the set of questions were administered to professionals with adequate knowledge to the area of study.

Table 4.2 Respondents on Mechanization reduces building production cost.

RESPONSE	Frequency	Percentage
Agreed	4	20%
Strongly Agreed	12	60%
Disagreed	3	15%
Strongly Disagreed	1	5%
No Idea	-	-
TOTAL	20	100%

Source: Researcher's Field Survey 2016

The table above shows the spread of responses on mechanization reduces building production cost. Those that said strongly agreed are 60% and those that said Agreed are 20% while Disagreed are 15% and Strongly Disagreed are 5%.

Deduction: About three quarter of the total respondents Strongly Agreed that mechanization reduces building Production cost.

Table 4.3 Mechanization impact positively on the duration of building construction

RESPONSE	Frequency	Percentage
Agreed	2	10%
Strongly Agreed	16	80%
Disagreed	2	10%
Strongly Disagreed	-	-
No Idea		
TOTAL	20	100%

Source: Researcher's Field Survey 2016

The table shows that 80% of the respondents strongly agreed and believed that the use of plants increases the speed of construction while 10% of the respondents agreed. Meanwhile, 10% of the respondents disagreed that Mechanization does not impact positively on the duration of building construction. During the interview, efforts were made to verify the reasons for this, the responses provided are detailed in the next section of the data analysis on the report from interviews conducted.

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Table 4.4 Mechanization helps to maintain quality and helps to keep the standard specified.

RESPONSE	Frequency	Percentage
Agreed	2	10%
Strongly Agreed	15	75%
Disagreed	1	5%
Strongly Disagreed	2	10%
No Idea	-	-
TOTAL	20	100%

Source: Researcher's Field Survey 2016

The table revealed that only 75% of the respondents strongly agreed that mechanization improves the quality of production while 10% agreed. However, 5% disagreed and 10% strongly disagreed.

Table 4.5 Mechanization have a positive impact on the level of productivity of projects.

RESPONSE	Frequency	Percentage
Agreed	3	15%
Strongly Agreed	14	70%
Disagreed	2	10%
Strongly Disagreed	1	5%
No Idea	-	-
TOTAL	20	100%

Source: Researcher's Field Survey 2016

The result shows that 70% of the respondents Strongly Agreed and believed that Mechanization has a positive impact on the level of productivity of project while 15% Agreed. However, 10% of the respondent Disagreed while 5% Strongly Disagreed.

Summary of impact of Mechanization on construction cost, time, quality and productivity as ascertained by respondents.

Table 4.6 Summary of mechanization on cost quality and duration of construction.

Impact Parameter	Strongly Agreed	Agreed	Strongly Disagreed	Disagreed	No Idea	Total (%)
Cost	70	15	5	8	2	100%
Quality	75	18	2	5	-	100%
Time	85	5	7	3	-	100%
productivity	65	10	15	7	3	100%

Source: Researcher's Field Survey 2016

Fig 4.6 Summary of illustration of responses on the impact of Mechanization on construction cost, Time and Quality.

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Deduction: In all the impact parameters used to assess the impact of mechanization on construction; more than 70% of the respondents maintained a positive response agreeing thus that the use of plants:

i. Reduces the cost of building production.
ii. Delivers at greater speed than manual labour.
iii. Increases the level of productivity of Production and;
iv. Delivers at greater quality.

RESULTS FROM CONDUCTED INTERVIEW

As part of the field survey, oral interviews were conducted at the designated construction sites with active mechanized processes most especially in excavation and concrete works.
The following were the underlying reasons for their status, where the respondents stated not "No Idea"

i. Quality of production

Even though machines enhance great level of quality in construction, the following were their reasons why this may not always be so.

- Lack of equipments operational expertise
- Misappropriation of equipments parameters
- Wrong matching of equipments with project tasks.

ii. Time of Production

Interview responses on why the use of plants can at times slow down the rate of project time delivery provided the following reasons:

- Rigorous process of plant procurement
- Situations of lack of space for equipment maneuverability.
- Wrong selection of equipment and bad workmanship

iii. Cost of Production

Respondents of the interview stated that the use of plants can increase the cost of building production owing to the following reasons:

- Huge cost of procurement
- Cost of servicing, repair and maintenance.
- The complicated statutory cost of registrations, taxes, insurance and levies.

Data from Field Survey

In the field survey conducted during the sites visits, the plants used in excavation and concrete works were in consideration as they were peculiar to this research. Details of operation carried out in both excavation and concrete works were extracted from the bills of work. Under excavation, the following works were carried out and the respective plants used placed in front.

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Table 4.7 Details of works in Excavation and Concrete Works

S/N	Description of Work	Unit	Qty	Type of Plant
1	**EXCAVATION**			
	SITE CLEARANCE • Land clearing operations involving haulage and disposal at a distance in excess of 0.5km	m^2	840	Universal dozer with skimmer.
	TRENCH FOUNDATION • Trench digging and basement foundations excavated materials to be loaded and transported to deposit hip.	m^3	362	Multi-purpose excavator with back acter hoe.
	BACK FILLING AND COMPACTING • Backfilling all types of open excavation and ensuring adequate compaction of foundations.	m^3	264	Angle dozers with angle blade.
2	**CONCRETE WORKS**			
	GROUND FLOOR SLAB • Batching & Mixing (Floor Slab= 150mm thick) Concrete mix of 1:2:4 (Grade B25)	m^3	86.4	Tilting drum mixer $V_d = 0.6\ m^3$
	• Transportation and Placing Transporting of mixed concrete to casting position and placing into forms.	m^3	54	Concrete Pump
	REINFORCED CONCRETE COLUMNS • Batching & Mixing (0.3 x 0.3 x 3m) Concrete mix of 1:2:4 (Grade B25)	m^3		Tilting drum mixer
	• Transportation and Placing Transporting of mixed concrete to casting position and placing into forms at height 3m	m^3	54	Mixing /Dumping bucket

Source: Bill of Quantities for works in excavation and concreting, Julius Berger Nigeria Plc

Comparative analysis of cost using plants and manual labour in excavation and concrete works for the building project selected for case study.

The comparative cost analysis conducted to determine the project performance difference (Cost overrun) in using plants and manual labour in selected activities is computed below:

Excavation Works

Selecting from the bill (table 4.7), the clauses that described the works in excavation works, the following analysis were made to assess the cost of mechanization and man power.

SITE CLEARANCE

Area of Site : $840m^2$
Equipment : Wheel dozer + Skimmer
Type of Soil : CAT D4, Blade Load: $3.5m^3$
Equipment Parameters : Sandy Loam
Expected Duration : 2days

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Cost of Hire : 50,000 per day.
Attendant Personnel : 1 operator + 2 unskilled labour

Breakdown of Cost of Mechanization included:

- Cost of hire per day = N50,000

Expected Duration = 2 days
Total cost of hire = N100, 000

- Personal Wages

Cost of unskilled labour = N1, 000 per day
Cost of Labour (2 days) = N2, 000
Cost of Operator wages = N2, 000 x 2 days = N4, 000
Cost of Skilled labour- foreman = N2, 000 x 2 days = N4, 000
Total cost of Personnel = N10, 000

- Cost of Refueling and Lubrication

Average liter consumption per day = 30 Liters
Cost per liter of diesel = N100
Cost of fueling = N3,000 per day
Cost of Oiling and greasing = N1,000 per day
Total Cost of Fueling & Lubrication = N4,000 x2 days
= N8,000
Therefore total cost of using plants = N (100,000 + 10,000 + 8,000)
= N 118, 000
Total Duration of Operation = 2 days
REMARK: As expected the activity lasted for 2 days with no record of breakdown

Cost of Using Manual Labour

The method devised for the computation of cost of labour involves the use of labour constants. Labour constants provide the parameters that assist in the calculation of optimal labour force that can handle a particular task within a given time frame. It employs the use of the following constants:

Table 4.8 CALCULATIONS OF LABOUR CONSTANTS

Standard Time '$\mathbf{S_t}$'	q/t
Standard Output '$\mathbf{S_o}$'	t/S_t
Labour required '$\mathbf{L_r}$'	Q/S_o
Labour Composition '$\mathbf{P_c}$'	L_r/T_o

Source: Tendering and Estimating in project delivery in Nigeria, Onwusonye 2003.

Where:

q = The quantity of production by a gang of workers
t = Working hours per day (in Nigeria t= 8hrs)
Q= Total quantity of work required
P_c= Required labour in given time frame T.
T = Duration in days

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Therefore, given the following
Volume of Work (Q) = 840m
Expected duration (T) = 2 days
Standard time of Labour (**S_t**) = 1.5h/m^3 (for site clearing)
Duration of Work Per day = 8hrs
The following were computed,
Standard Output '**S_o**' = 8/1.5 =5.33
Labour required '**L_r**' = 840/5.33 = 158.5
Labour Composition '**P_c**' = 158/2 = 79.2
Workers
The total numbers of workers (assume) = 80 workers
Labour wage (unskilled) = 1,000
In a gang of every 80 labourers, there is a foreman
Therefore, total number of workers = 81
The total cost of unskilled labour = 1,000 x 80 x2 days = 160,000
The total cost of skilled labour = 2,000 x 2 days = 4,000
Total cost of manual workmanship = **N164,000**

Pit Excavation

Estimated Volume of Work : 362m^3
Equipment : Crawler back acter hoe
Equipment Parameters : Bucket Capacity: 1.5m^3
Cost of hire : 50,000 per day
Output per day : 200m^3/m-d
Attendant personnel : 1 operator + 2 unskilled labour

Breakdown of cost of mechanization include:

- Cost of hire Per day = N50,000

Expected duration = 2 days
Total Cost of Hire = N100, 000

- Personnel wages = N 5,000

Therefore total cost of using plant = (100,000 + 5,000)
= N105,000
Total duration of operations = 2 days

REMARK: As expected the activity lasted for 2days with no record of breakdown. The use of an excavator with a bucket size equal to the width of the foundation provided excellence in the plant's digging performance.

COST OF USING MANPOWER

Given the following
Volume of Work 'Q' = 362m^3
Expected duration = 2days
Standard time of labour = 2.5m-h/m^3 (for pit excavation)

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Duration of work per day = 8hrs
Therefore, using labour constants
The total number of workers (assume) = 57workers
Labour wage (unskilled) = 1,000
Number of skilled worker = 2 : (2x2 500) x 2 days
And unskilled labour = 55 : (55 x 2)
Total cost of manual workmanship = **N120,000**

3. Backfilling and Compaction

Estimated volume of work : 164m^3
Equipment : Angle dozer
Equipment parameters : Blade Rating : 2.5 m^3 at a push (200m^3/m-d)
Cost of hire : 50,000 per day
Attendant Personnel : 1 Operator + 2 unskilled Labour

Breakdown of cost of mechanization include:

- Total cost of hire = N50,000
- Personnel wages = N6,000
- Cost of refueling and lubrication =N3,500

Therefore, the total cost of using plant = N (60,000 + 5,000 + 3,500)
= **N68, 500**

Remark: The use of dozer fitted with an angle blade was suitably selected for the backfilling operation as it efficiently does this by tilting its angle blade to drift materials sideways. Its effective weight also provided advantage for effective compaction. The operation lasted one day.

Cost of Using Manpower

Volume of work 'Q' =164m^3
Standard Time of Labour = 1.5m-h/m^3 (for site clearing)

Therefore,
The total number of workers (assume) = 31 workers
And unskilled Labour = 30
The total cost for unskilled labour = 1,000 x 30 x 1day = 30,000
The total cost for skilled labour = 2,500 x1 x1day = 32,500
Total cost of manual Workmanship = **N32, 500**

- Cost of compaction using manual compactor

For the compaction of a bulk of 154m^3 of earth, a 10-tonne
Padded-smooth drum roller would be suitable.
Its output rating = 0.15h/m^3
The standard output = 8/0.15 = 54
For a bulk of 163m^3 of soil type: Sandy Clay
No of days required = 164/54 = 3 days
Cost of hire of compactor per day = N20, 000
Cost of hire for 3 days = N60, 000
Operators wage per day = N (60, 000 + 6,000)
= **N66, 000**
Total cost of using manual means

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for backfilling and compaction = N (66,000 + 32,500) = **N98, 500**

Comparative Analysis Of The Cost And Time Of Using Plants And Manual Labour In Concrete Works.

Casting for Ground Floor Slab

Volume of concrete for work : 86.4m^3
Ground floor details : (24 x 18 x 0.2) m
Equipments : Tilting drum mixer, concrete pump.
Volume of mixer drum : 0.6m^3
Output rating : 3.5m-h/m^3
Production of mixer : 60m^3/m-d
Expected duration : 6hrs

Breakdown of cost of plants

- Cost of hire of mixer = 20, 000 per day
- Concrete pump = 30, 000 per day
- Attendant personnel = 4 labourers, 2 Operators

Total cost of hire of equipment (mixer and pump) = N50, 000
4 labourers wage + Operator = N7, 000
Total cost of using plants = **N57, 000**

Breakdown of Cost Using Manpower

From the table of labour constants;
A gang of mason with 1 foreman, 3 labourers mixes 1 m^3 of concretes in 2 hrs. Therefore, 2 gangs mix, transports and casts 1m^3 in 1hr. Therefore to mix 86.4 m^3 a total of (86.4 x 2) will be required.

Total number of workers = 172 labourers, (10 skilled labour)
Labour charge per hour = N100
Cost of skilled labour per hour =N200
Total amount of labour charge for 6 hrs. =N600

Total amount of labour charge = (600 x162) + (1, 200 x 10)
= **N110, 000**

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Percentage Cost Difference between the Use of Plants and Manual Labour in Excavation and Concrete Works.

Table 4.9 Summary of Percentage Cost Difference in Using Plants and Manpower in Excavation and Concrete Works

S/N	Nature of Activity	QTY	Type of Plant	Cost of Using Plants (N)	Cost of Using Manual Labour (N)	% Cost Difference
		1	2	3	4	(4-3/4)%
A	**EXCAVATION**					
	1. Site Clearing	840m^2	Wheel dozer + Skimmer	118, 000	164, 000	28%
	2. Pit Excavation	362m^3	Crawler back acter	105, 000	120,000	12.5%
	3. Backfilling & compaction	154m^3	Angle dozer	68,500	98,500	30%
B	**CONCRETE WORKS**					
	1. Ground floor slab	86.4m^3	Tilting drum mixer, concrete pump	57, 000	110, 000	48%
			Minimum percentage of cost saved using plant over manual labour			15%

Source: Bill of Quantities for works in excavation and concreting for the ongoing project at IMT Enugu.

Deduction

Having confirmed from the results of findings in the field survey, with figures that have emerged from the analysis illustrating the cost impact of use of mechanization in building production processes; there exist sufficient reasons to make the following deductions:

- For a given project, an average cost reduction of 35% can be realized with the use of plants over manual labour in building production process most especially in excavation and concrete works where a great deal of resource input is often required.
- More so, the use of plants enhances greater level of productivity in building production going by the measure of ease with which it handles difficult tasks in building projects.
- Judging by the responses expressed in the questionnaire, the use of plants delivers a greater speed than by manual means in building production. This consequently poses significant impact on completion and delivery time of construction projects.

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- Further analysis using the project performance parameters (cost & time over run) was devised to assesses the differences in initially voted sum and time against final cost and time expended using plants during interviews was replied with details confirming that the cost of plants does not overrun cost voted labour neither does it overrun the final time of production.
- Finally, it is therefore right to infer from the findings and analysis that the impact of mechanization on construction cost is significant and cannot be over-emphasized as it has been confirmed here that the use of plants can bring about an excess reduction of 35% of cost of labour in both excavation and concreting operations.

CONCLUSION AND RECOMMENDATION

Summary of Findings

The study which was conducted to assess the impact of mechanization of building production processes on construction cost based on the findings and results from distributed questionnaire and conducted field surveys among which were interviews, site visits and so on. The results from these surveys were however analyzed presentation with the use of graphs and table analyses.

In the final analysis, a summarized percentage cost impact of mechanization against the use of manual labour was presented in both excavation and concrete works from which a modal cost effective value was computed to present the overall impact in figures. The following final summary is a presentation of these summarized values.

Summarized values of percentage cost impact of mechanization in excavation and concrete works.

(A) Excavation works

i. Site Clearing

Percentage Cost Impact 6%

ii. Trench Excavation

Percentage cost impact 7%

iii. Backfilling and Compaction

Percentage cost impact 36%

(B) Concrete Works

i. Ground Floor slab and reinforced concrete column

Percentage cost impact 45%

Table 5.1 Modal Cost Effects of Using Plants in Excavation and Concrete Works

Construction Activity	Modal Cost Effect
Excavation	
Surface Excavation	15-20%
Trench Excavation	5-10%
Backfilling and Compaction	30-40%

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Concrete Works	
Ground Flour Slabs	40-45%
Reinforced concrete column	5-10%

Summary of results of designated site observation

The site visit which was conducted with the aim of carrying out a cost and time based assessment of mechanization over the use of manual labour using project performance parameters (cost and time overrun) revealed the following facts.

i. That the use of plants enhance greater speed in project delivery; the time overrun of mechanized activities is shorter than that of manual labour.

ii. The use of plants in excavation and concrete works brought about a realization of significant reduction in cost of works against the initial voted contract sum.

Final Deductions

Following the results from the analysis, the following deductions have been made to summarize the impact of mechanization as obtained from the data collected through distributed questionnaire conducted field surveys and visits to designated sites selected for case studies.

i. For a given project, an average cost reduction of 35% can be realized with the use of plants over manual labour in building production process most especially in excavation and concrete works where a greater deal of resource input is often required.

ii. More so, the use of plant enhances greater level of productivity in building production going by the measure of ease with which it handles difficult tasks in building projects.

iii. From responses expressed in the questionnaire, the use of plants delivers at greater speed than by manual means in building production. This consequently poses significant impact on completion and delivery time of construction projects.

Finally, it is therefore right to infer from the findings and analysis that the impact of mechanization of construction cost is significant and cannot be over emphasized as it has been confirmed here that the use of plants can bring about an excess reduction of 35% of cost of labour in both excavation and concreting operations.

CONCLUSION

In verifying the impact of mechanization against voted contract sum in the bill of works, a site where activities in excavation and concrete works were mechanized was selected for case study. From the result of the analyses, it was found that the use of plants can bring about 25-35% reduction in cost of labour in excavation and concrete works where a great deal of resources usually goes down in building production.

RECOMMENDATIONS

From the above findings and conclusion, the following were recommended:

1. The use of plants and other forms of mechanization should be explored as excellent alternatives to the use of manual labour, especially when the project is a large one. This is because the rigors attached with the organization of labour intensive construction can be cumbersome and the cost usually overshoots in recruiting and coordinating a well populated labour force can be

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outrageous. Therefore, there exist the need for contractor to consider the underlying advantages that mechanization offers in terms of how much time and cost difference can be realized in employing plants over manual labour.

2. Contractors wanting to venture into mechanization should first consider a variety of alternatives available to them and endeavor to embark on a feasibility study and possibly a thorough cost-benefit analysis before the decision to employ mechanization is made.

3. An integrated and well planned approach to the use of plants guarantees great benefits in cost, time and quality of production. Efforts should therefore be intensified in ways of developing a cost effective approach to the use of plants in order that the numerous inherent advantages can be realized.

REFERENCES

Al Fajil, A.H. (2006). "The alternative in labour intensive construction and the imperatives of mechanized construction". *A paper delivered at the conference of building, civil and allied Engineers Conference (2006). Bombay Institute of Technology*, Bombay, India.

Ashworth, A. (2000). "Business failure in industry" *Journal of construction Engineering Management.* 115 (2) 173-187.

Chudley, R. and Greeno, R. (1998). *Building construction Handbook*. Butterwork – Heinemann Publishers, Linacre house, Jordan Hill, Oxford.

Cooke and Williams (2003). *Construction Planning, Programming and Control*, *2nd edition.* palgrave, New York.

Deodhar, S. V. (2001). *Construction Equipment and Job Planning*. Romesh Changder Khanna Publishers. Nai Sarak, New Delhi.

Doro, G. I. (2008): "Effect of Mechanization within the Nigeria construction industry". *A paper delivered at the construction and Buidling Research (COBRA) Conference of the Royal Institute of Chartered Surveyors held at Dublin Institute of Technology, September 2008.*

Douglas, D. (2001). "Construction cost factors in Nigeria". *Journal of Construction Engineering and Management* 119, C41 698-714.

Mbachu and Nkado (2004). "The Effect of construction delays on project delivery in Nigeria construction Industry". *International Journal of Project Mnaamgenet* 20, 593-599.

Obayashi (1991). "The needs and problems of the Building industry in Nigeria. A quantity surveyors view".

Onwusonye, S. I. J. (2003). "Tendering and estimating in project delivery in Nigeria". Intercontinental Education Books and Publishers. FSP Park, Owerri.

Peurifoy, R. L., Schexnayder, C. J. U. and Shapira, A. (1995). Construction equipment, Planning and Management. Mc Grw Hill Publishers. Bay Bridge, Oakland, California.

Shapira (1969). Construction delays in a fast growing economy: comparing Thailand with other economics. International Journal of Project Management 14 (1) 37-45

Sharma, S. C. (2001). Construction Equipment and Its Management: Romest Chander Khanna Publishers. Maisarak New Delhi.

Geddes, S. and Williams, J. (1996). *Estimating for building and civil Engineering works*. Butterworth. Heinemann publishers, Linacre, Jordan Hill, Oxford.

ISSN 2055-0219(Print), ISSN 2055-0227(online)

Stjepan, B. and Zdravkol (2000). "Methodology for determination of cost of mechanical works". *Assembly of Croatian constructors. Catat. 2000*. www.google.com/the impact of Mechanization on construction cost.

ISSN 2055-0219(Print), ISSN 2055-0227(online)