An Assessment of Asset Utilization of Concrete Mixers in Construction Sites in Abuja, Nigeria

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Abstract

Proper utilization of concrete production equipment provides considerable cost saving in construction. However, there is little research evidence on concrete mixer utilization on Nigerian construction sites This limits profitability of concrete production to contractors. This paper aims at assessing the utilization of concrete mixers on construction sites in Nigeria with a view of enhancing cost savings in concrete production. The study was carried out on construction sites operated by small and medium size construction companies in Abuja. A Total of 25 construction sites operated by different contractors were used in the study. The research adopted mixed research methodology. Quantitative data was gathered using structured questionnaire to identify the level of utilization of concrete mixers. Qualitative data was gathered through observation with a checklist on the type of concrete mixers and impediments to performance of the mixers. The study discovered that the commonest type of concrete mixer used by contractors in the study area are reversing drum concrete mixers and tilting drum mixers. The study also found that concrete mixers are underutilized through wrong selection criteria, inability to use only trained personnel to operate concrete mixers, not having spare parts for the mixer before breakdown, and inappropriate methods of operating the mixers. The paper recommends construction managers to select concrete mixers for jobs based on suitability of the mixer for intended job, use trained personnel to operate concrete mixers, have a provision for spare parts for the mixer before breakdown and maintained appropriate operation techniques when operating concrete mixers.

Keywords: Concrete Mixers, construction sites, Construction Equipment, Cost Saving

INTRODUCTION

Globally, Construction companies depends on construction equipment and machinery for basic reason of better efficiency at lower cost (Richard, 2005). With growing complexity in construction works, equipment and machinery become even more vital to productivity, efficiency and safety. Moreover, Waris *et al* (2014) highlighted that the complexity of equipment needed for construction work is subject to the nature of the project. They opined residential construction projects require a low-level usage of machinery, while institutional building require moderate use of machinery, but industrial, commercial and infrastructural buildings require intense use of heavy machinery and equipment.

Similarly, Richard (2005) maintained that to advance construction, processes in construction must be mechanized or automated. Similarly, due to the complexity of the construction industry which is often bewildered by inefficiencies (Kamaruddin *et al*., 2015). They support that

mechanization and automation has become not only necessary in construction, but a must if the industry is to meet the growing demand for housing and infrastructure.

Furthermore, Sani *et al.* (2015) believe the objective of any contractor from inception to completion of any project is to deliver the project with in time, at least possible cost and of acceptable quality. For this reasons, they suggest building contractors to adopt mechanization of works in order to save time and cost and also improve efficiency of construction processes since machines are less prone to making errors when compared to human labour.

Moreover, in the present time, Gransberg *et al*. (2006) observed that construction contractors undertake many types of construction activities that require different types, sizes, and groupings of equipment for concreting earth moving, excavating, and lifting. They further identified that there is a piece of equipment for practically any work activity, large or small. They showed that construction equipment is specifically designed by the manufacturer to perform certain mechanical operations that accomplish a work activity. Furthermore, the working capacity of construction machinery is a direct function of the size of the machine and the power of the motor. These simple relationships exist — the larger the machine, the more power required for the operation, the greater the production capacity, and the greater the cost to own and operate.

Moreover, small scale construction sites in developing nations like Nigeria are characterized by high Labour intensity with application of simple items of machinery particularly concrete mixers (Abosede *et al*, 2019). However, in spite of its wide application on construction site in Nigeria, the requisite attention has not been paid to the utilization of concrete mixers in Nigeria.

Researchers such as Waris *et al* (2014) and Kamaruddin (2015) have agitated for wider use of construction equipment on construction sites. While Abosede *et al* (2019), Danjuma (2014) have observed that concrete mixers are commonest construction equipment found in most small and medium size construction firms in Nigeria.

Moreover, Granberg *et al* (2005) demonstrate that for a construction equipment to be economical, it must be fully utilized in accordance to the instruction of its manufacturer. The situation is the same whether the machinery is owned or hired. Machine economy depends on correct application. It is therefore vital to understand the correct way to use common construction equipment on construction sites. However, though researchers have identified the need for equipment on construction sites, and commonality of mixers on construction sites in Nigeria, little is known on how mixers are utilized especially in small and medium scale construction companies in Nigeria. Consequently, this paper seeks to explore how concrete mixers are utilized in small and medium size construction companies in Nigeria.

Construction plant and equipment

Edward and Holt (2009) define construction plant as self-propelled machines designed to do work. Items of plant includes machines such as excavators, compaction rollers, and specialist apparatus – like trenchers or telehandlers. Edward and Holt (2009) further add that construction plants include machines able to access the public highway, such as concrete delivery lorries and mobile cranes.

On the other hand, Edward and Holt (2009) define construction Equipment as all other types of mechanized construction work apparatus such as static cranes, concrete pokers, hand-held tools and specialist equipment such as floor polishers. To be specific, Edward and Holt (2009) clarify that the plant is often used to also include equipment.

Efficiency of construction plant and equipment

For construction plant and equipment to be effective in cost saving during its operation, Chudley and Greeno (2006) opined that the type of plant to be considered for selection should depend upon the tasks involved, the time when the work is to carried out, the skills of staff available to handle the machine, while Waris *et al* (2014) argues the selection process of a machinery for construction need the most rational criteria that have a positive impact on operational efficiency, productivity, cost minimization and as well as environmental and human wellbeing. Furthermore, Chudley and Greeno (2006) further suggest the person responsible for selecting machinery plant must be competent, and the plant operator must be a trained person in order to obtain maximum efficiency. Furthermore, manufacturer's recommended maintenance schedule for the plant must be followed and, above all, the site layout and organization must be planned with a knowledge of the capabilities and requirements of the plant (Chudley and Greeno, 2006).

Concrete Mixers

A concrete mixer (also commonly called a cement mixer) is a device that homogeneously combines cement, aggregate such as sand or gravel, and water to form concrete. Mixing of concrete is almost invariably carried out by machine for reinforced concrete work and for medium or large-scale mass concrete work. Machine mixing is not only efficient, but also economical, when the quantity of concrete to be produce is large (Shetty 2006). There are two main categories of concrete mixers which are continuous mixers and batch mixers.

Types of concrete mixers

Continues Mixers

Continuous mixers produce concrete at a constant rate (Ferraris 2001). the constituents are continuously entered at one end as the fresh concrete exits the other end. In continuous mixer, the weighing, loading, mixing and homogenizing of concrete ingredients as well as discharge of concrete occur continuously and simultaneously (Shwe-Sin 2018).

Batch Mixers

Batch mixers produces concrete one batch at a time (Ferraris 2001). Here concrete needs to be emptied completely out of the drum after each mixing cycle, cleaned (if possible), and reloaded with the materials for the next batch of concrete. According to Shwe-Sin (2018), Batch mixer is most common types of mixers.

Batch mixers may be of pan type or drum type. The drum type may be further classified as tilting, non-tilting and reversing drum mixers.

Tilting Drum, Batch Mixer

A tilting drum mixer is a type of concrete batch mixer whose drum has two axes: one around which the drum rotates and another that serves to change from loading and mixing position (drum opening up) to discharging position (drum opening down). Material is generally loaded manually, directly into the drum. After being filled manually at ground level, the hopper is tilted up mechanically and dumps the material into the drum (Shwe-Sin, 2018). The discharge action is always good as all the concrete can be tipped out rapidly.

Non-tilting drum, Batch mixer

A non-tilting drum concrete batch mixer have two openings, one at each end of the drum: one for feeding the ingredients, the other for discharging the mixture. Discharge takes place by inserting a chute into the drum because of the rather slow rate of discharge, segregation may occur (Shwe-Sin, 2018).

Reversing Drum, Batch Mixer

A reversing drum, batch concrete mixer have only one opening which is used to add the constituents and to discharge concrete. There are two types of blades attached to the drum. One set mixes the materials when the drum rotates in one direction; second set of blades empties the concrete when the drum rotates in the other direction (Shwe-Sin, 2018).

Pan, Batch Mixer

A Pan type mixer consists of a circular pan in which concrete is mixed. (Shwe-Sin, 2018). It uses mechanical power to combine the constituents, because of this, mixing is much more thorough and all type of concrete can be produced. Generally, the mixture of concrete is discharged from the bottom of the pan. (Ferraris 2001).

Transit Mixers

Shwe-Sin (2018) defined transit mixer as a piece of equipment that is used for transporting concrete or ready mix material from a concrete plant directly to the site. They can be charged with dry materials and water, with the mixing occurring during transport. They can also be loaded from a central mix plant with this process the material has already been mixed prior to loading (Shwe-Sin 2018).

Plate I: Different types of concrete mixers. S*ource: The constructor.org*

Efficiency of concrete mixers

The efficiency of a mixer may be viewed in terms of quantity or quality of concrete produced par unit of time. However, mixer efficiency is used to qualify how well the mixer produce a uniform matrix of concrete in a unit time (Shwe-Sin, 2018). Output Rate as a good indicator used in determining efficiency of mixers. Shwe-Sin (2018) describe output rate as the amount of concrete produced per a time interval. The output rate is not the measure of the homogeneity

of the concrete produce, but a measure of number of batches produced by the mixer in a unit of time.

Mixing energy is another variable used in determining efficiency of a concrete mixer. It is a measure of amount of energy expanded by the mixer to produce each batch. A mixer that require height amount of energy may produce segregated concrete. Therefore, the mixing energy of a mixer should be kept low.

Another important measure of mixer efficiency is wear and tear which determine mixer cleanliness (Shwe-Sin, 2018) . Long usage of a mixer leads to wear of of its components such as the blades. Wear and tear may also lead t build-up of materials such as cement paste) on the drum surfaces. Wear and build –up will change the geometry of the mixer and therefore the flow pattern of the concrete, and may lead to changes in the concrete mixer should be thoroughly cleaned at the end of each day of operation and the blades and/or scraper changed on a regular schedule.

METHODOLOGY

This paper adapted a mix design research design approach for its inquiry. Kothari (2012) define research design as a plan, structure and strategy of investigation so conceived as to obtain answers to research questions or problems. He further added that the plan is the complete scheme or programmed of the research. It includes an outline of what the investigator will do from writing the hypotheses and their operational implications to the final analysis of data. However. Johnson *et al.* (2007) upheld the use of mixed or triangulation where the research objective is to explore why and how. They added that the use of mixed method in research cancelled out bias inherent with qualitative method and lack of rigor associated with quantitative approach. Consequently, this paper adapted mixed research methodology.

Area of the study

The study of this paper was carried out in the Federal Capital Territory (FCT), Abuja, Nigeria. The study was carried in active construction sites owned by small to medium size construction companies. The paper focus on the use of concrete mixers by small and medium size construction companies. Abdulazeez (2012) classified small and medium construction companies as those companies with permanent employee of less than 50, or annual turnover of less than 100 million naira. This class of construction companies were selected because of their frequent use of concrete mixers on construction sites and the impact of concrete production has on construction cost (Hanun, *et al*, 2018).

Population and Sampling

At the time of the study, a total of 450 registers constructions sites were found from the record of the department of development control. Of the total active construction on going, not all are owned by small and medium companies, and also not all are utilizing concrete mixers on site. Therefore, effort was made to identify construction sites that are owned by small and medium size construction companies and that are also using concrete mixers. However, a total of 25 construction sites were found meet the criteria. The 25 construction companies were used in the study. The sampling technique used is the purposive sampling since the research is targeting specific criteria which is not consistent throughout the population.

Data collection

This paper utilized a mixed research methodology. Qualitative data was gathered on how concrete mixers are utilized through observation and a checklist. Quantitative data was

gathered relating to the type of concrete mixers utilized on construction site through structured questionnaire.

RESULTS AND DISCUSSION

In this section presents and discusses results relating to the common type of concrete mixer used in construction site owned by small and medium size construction firms, the level of utilization of the mixers and the asses the impediments that may be responsible for reducing the output of the concrete mixers.

Background of respondents

This subsection presents the background information of the respondents who attended to the researcher in the 25 constructions sites operated by different construction companies which were used in the study. The respondents are onsite professional on construction sites who were responsible managing the construction sites. They oversee usage of concrete mixers on their sites among other duties. The summary of the respondents' background information is presented in Table 1.

Table 1: Respondents background information

Item	Observations	Frequency	Percentage
Highest Academic Qualification	OND	3	12
	First Degree or Equivalent	14	56
	Master Degree	6	24
	PhD.	2	8
	Sum	25	100
Profession	Building	6	24
	Engineering	7	28
	Architecture	6	24
	Quantity Surveying	3	12
	Others	3	12
	Sum	25	100
Years of Work Experience	Less than 5 years	3	12
	5 - < 10 years	4	16
	10 - <15 years	8	32
	15 - < 20 years	6	24
	More than 20 years	4	16
	Sum	20	100

Table 1 presents background information relating to respondents' highest academic qualification, profession and years of on-site work experience with concrete mixers. The purpose of the data is to demonstrate the respondents' capability in responding to the questions.

The results show that all the respondents have at least Ordinary National Diploma (OND). This shows that the respondents are literate enough to understand technical discussion. Furthermore, the result shows that majority (78%) of the respondents have obtained at least first degree or its equivalent. This shows that the respondents have the ability to not only understand the question, but also respond meaningfully to the questions.

Similarly, the indicates that majority (78%) of the respondents are professionals in the built environment. Therefore, they are knowledgeable enough to understand construction related discussion and also provide reasonable responses in relation to subject of concrete mixers.

Furthermore, the years of experience of the respondents working on site with concrete mixers shows that majority respondent (78%) have a work experience of 5 or more years. Therefore, the respondents are expected to have experience in the operation pf concrete mixers on site.

Type of concrete mixers used by small and medium size construction companies

The first objective of this paper is ascertaining the common type of concrete mixer used on construction sites operated by small and medium sized construction firms. The Data on type of mixer used on construction site was gathered through observation using a checklist. Result of the common type of mixer used is presented in Figure 1.

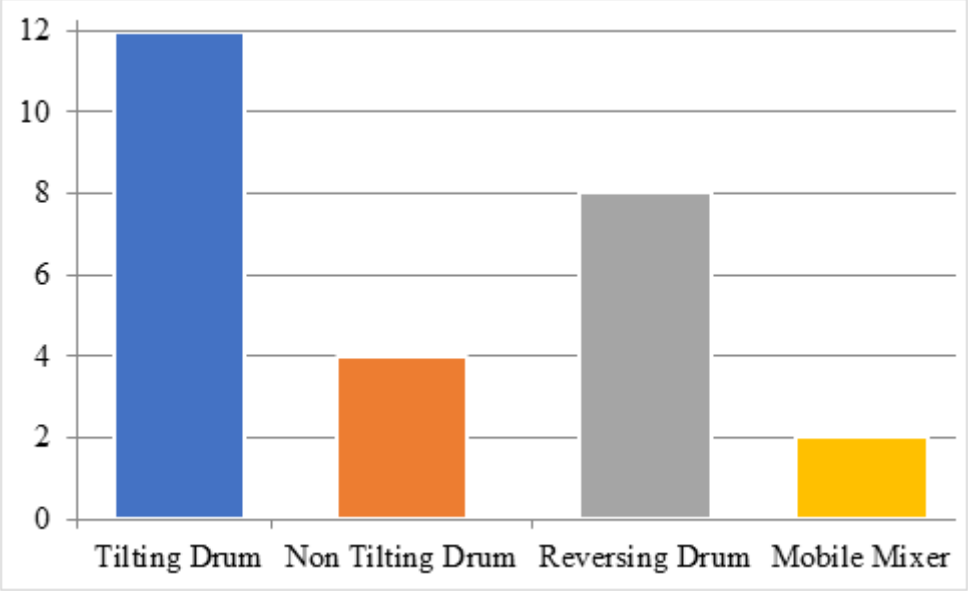

Figure: Common type of concrete mixers used on construction sites

Result in Figure 1 shows that the common concrete mixers used on construction sites operated by small and medium size construction companies are Tilting drum mixers (46% of the sites), Reversing drum (31%), Non tilting drum (14%) and mobile mixers (4%). Moreover, the result also shows that the commonest mixer found on the site are Tilting drum then reversing drum concrete mixers. This could be attributed to that this type of mixers are relatively less expensive, are readily available to hire and are easy to operate and maintained.

Level of utilization of Concrete Mixers

The level of utilization of the mixers used on the construction sites was investigated in order to understand whether the machines were used optimally or not. Teletrac (2022) provided that equipment utilization can be assessed through observing time of operation and number of batches the machine produces in unit time. Consequently, the operating hours of the mixers and number of batches produced in an hour where recorded through observation.

Table 2 presents result on the utilization of the mixers on respondents' construction sites based on standard International Labor Organization (ILO) 8 hour working day. Operating hours for the concrete mixers were calculated only for period when work is available for the mixer and

it was able to perform the work. period when there is no work for the machines where not considered.

Table 2: Utilization of Concrete Mixers

Item	Observations	Frequency	Percentage
Average Operating Hours in a Day	5 hours per Day	5	20
	6 hours per Day	5	20
	7 hours per Day	2	8
	8 hours per day	8	32
	More than 8 hours	5	20
	Sum	25	100
Number of Batches per hour	10 < 15 Batches	11	44
	15 < 20 Batches	8	32
	20 < 25 Batches	6	24
	25 < 30 Batches	0	0
	Sum	25	100

The data shows 40% of the respondent were under utilizing the mixer by operating it for 5 to 6 hours daily, 40% of the respondents were adequately utilizing their mixers for 7 hours and 8 hours. 20% were found utilizing concrete mixer for more than 8 hours daily. Therefore, it can be said some construction sites are underutilizing concrete mixers by not using their machines. The number of batches produced in an hour shows that more (44%) of the construction site that uses concrete mixers were able to produce less than 15 batches of concrete in an hour. 32% of the sites were found to produce 15-20 batches per hour, while 24% of sites were producing 20-25 batches of concrete with the mixer per hour. However, Shetty (2006) observed that an optimum use of concrete mixer is that which is able to produce 20-25 batches of concrete per hour. Consequently, it can be said few of the construction sites were optimally utilizing their concrete mixers with regards to number of batches they produced in each hour.

Impediments to Optimum utilization of Concrete Mixers

This paper also investigated impediments which reduces the efficiency of concrete mixers during operation. These altercations reduce either the number of batches produced per hour or number of hours the machine is operational in a day. Gupta and Amit (2012) observed that impediments to proper utilization of concrete mixers are due to choice of mixer, mixer operator, availability of spare parts and operation of the mixer. Table 3 present result of impediments to effective utilization of concrete mixers as a result of choice of mixer, choice of mixer operator and availability of spare parts, while Impediments which arose during operation of concrete mixers are presented in Table 4.

Table 3 shows impediments to optimal utilization of concrete mixers relating to the choice of the mixer, the mixer operator and availability of spare parts. The choice of mixer refers what how users select mixers for their projects. The result shows that only 28% of the respondents consider suitability of the mixer for the work. The result shows that construction company mostly consider availability of the mixer and cost when selecting concrete mixer for jobs. Consequently, since the concrete mixers were not selected based on their suitability for a given work, it is one of the reasons why their performance is below optimum. Moreover, Shetty (2006) opined that the choice of construction machinery should be guided by nature of the work and suitability of the machine for the work.

Similarly, the result also shows that most (76%) of the construction sites do not use trained personnel to operate concrete mixers. Consequently, this is also another reason which limit the performance of concrete mixers. In addition, Table 3 also shows that majority (76%) of the

Table 3: Impediments to Effective utilization of concrete mixers

Impediments	Observations	Frequency	Percentage
Choice of Concrete Mixer	Availability	13	52
	Cost	5	20
	Suitability for the Job	7	28
	Sum	25	100
Mixer Operator	Trained Operator	6	24
	Experienced Foreman	13	52
	Available Labour	6	24
	Sum	25	100
Availability of Spare parts	Readily available before break down	6	24
	Source after break down	19	76
	Sum	20	100

construction sites do not have spare parts of concrete mixer they are using readily available on site. They source the spare parts only after breakdown of the machine. Therefore, this is also another reason which increase down time of the mixers since more time is needed to source spare parts in the event of breakdown. Table 4 presents impediments to effective utilization of concrete mixers when the mixers are in operation. The impediments are positioning of the mixer, speed of the mixer, inspection and during operation.

Table 4: Impediments to effective utilization of concrete mixers during operation of the mixers.

Impediments	Observations	Frequency	Percentage
Positioning of Mixer	Always in a level position	10	40
	Not always in level position	15	60
	Sum	25	100
Speed of the Mixer	Set maximum speed of 20 rev/min	10	40
	Has no speed limit	15	60
	Sum	25	100
Inspection during and after Operation	Always	8	32
	Occasionally	17	68
	Sum	20	100

Table 4 present result on key aspect of concrete mixer operation which affects the performance of the mixer. The results shows that most (60%) of the construction site do not always place concrete mixers on level position and also do not set maximum speed limit for rotation of the mixer drum. Therefore, this also affects the performance of the mixer. In addition, it can also be seen that only 32% of the site always perform routine inspection of the concrete mixer before and after operation.

CONCLUSION

The paper concludes that the common type of concrete mixer found on construction sites of small and medium construction companies in Nigeria are tilting and reversing drum mixers. The study found that concrete mixers on the construction sites were underutilized as a result of wrong selection criteria for concrete mixer which was based on availability or cost of the mixer instead of suitability for the job, the inability to use only trained personnel to operate concrete mixers, not having provision of spare parts for the mixer before breakdown, and inappropriate methods of operating concrete mixers.

Consequently, the paper recommends construction managers to select concrete mixers for jobs based on suitability of the mixer for the work, use trained personnel to operate concrete mixers, have a provision for spare parts for the mixer before breakdown and maintained appropriate operation techniques when operating concrete mixers.

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