Impact of Equipment Downtime on Construction Projects

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Abstract— The construction industry is the foundation of every country's economy. India is the second largest industry in terms of contribute the maximum percentage to GDP growth. The progress of building operation now depends for a some few days on the supply of tools, system of use, greater breakdown recovery, preparation and management. Invariably, system downtime is regarded as one of the most important concerns facing highway contractors and plant managers. Owing to the complex behavior of equipment maintenance activities and downtime, efforts to minimize downtime frequently result in dismay. A questionnaire survey had to be collect primary data regarding the equipment downtime in the construction industry. The questionnaire is intended to determine the cause of equipment downtime on construction industry with the help of professional opinions about the same. The questionnaire was developed by using extensive literature review. Relative Importance Index (RII) was calculated to rank causes of equipment downtime. This research describe varies types of construction equipment depending on their applications. Also important for site management to possess proper knowledge about equipment in terms of its capacity, complexity and technical suitability to be used under the given conditions. This research study will help construction industry stakeholders to understand barriers, which cause the equipment downtime in construction projects.

Keywords: Relative Importance Index (RII), GDP

I. INTRODUCTION

In today's fast paced world, we live and work in buildings that are made of modern materials and use modern utilities to make our routines easier. These utilities include highways, metros, hospitals, airports and seaports. These present and future developments necessitate construction industries to import the necessary resources, one of the most important being Construction Equipment. This equipment constitutes a major resource in the construction process of various projects. This equipment is very expensive and comprises a major component of a contractor's assets and the country's resources. At the macro level, equipment owned by contractors and dealers represents a good portion of the countries assets. At the micro level, equipment represents a major component of a contractor's or dealer's assets (Mali Pritam A., M.R.Apte, 2015).

Good project management in construction must vigorously pursue the efficient utilization of labour, material and equipment. Improvement of labour productivity should be a major and continual concern of those who are responsible for cost control of constructed facilities. Material handling, which includes procurement, inventory, shop fabrication and field servicing, requires special attention for cost reduction. The use of new equipment and innovative methods has made possible wholesale changes in construction technologies in recent decades. Organizations which is do not recognize the impact of various innovations and not adapted to changing environments have justifiably been forced out of the mainstream of construction activities. All the machines that are usually used to carry out these construction operations are referred to as construction equipment. The basic operations involved in the construction of any project are excavation, digging of small or large quantities of earth and moving them to fairly long distances, placement, compacting, leveling, dozing, grading, hauling, etc. In most cases, they are called heavy equipment especially in road constructions.

Construction firms are often face with problems related to high rate of equipment failure or breakdown and accident resulting from unskilled operator's abuse. Poor training of equipment operators is often claimed as a major cause of equipment related In 1983, Agbo state that the cost of equipment repair, fixed and variable operating cost wasted during the equipment downtime and a myriad of consequential costs that reverberate and surge through the construction business are enormous. The only way to avoid this huge amount of loss that usually lead to accompanies equipment breakdown or failure is to adopting proper equipment maintenance management strategy. This will keep construction equipment fit at all times and allow timely completion of construction project, thereby increasing construction project profitability. Thus, to understand effective construction equipment management, one must also understand effective construction equipment maintenance.

II. METHODOLOGY

Methodology refers to the total sum of techniques of data collection, tool and the methods of analyzing data and theoretical perspective or orientation that govern research. This section provides an overview of research approach adopted in the study (Shodganga, 2012).

A. Research Design

Research design is the blueprint for fulfilling research objectives and answering research questions. In other words, it is a master plan specifying the methods and procedures for collecting and analyzing the needed information (Hatkar K B and Hedaoo N A, 2016).

Three alternative approaches can be used in conducting a given research. The alternative approaches they identify are quantitative, qualitative and mixed research approach. Quantitative research approach focuses primarily on the construction of quantitative data, andquantitative data is a systematic record that consists of numbers constructed by researcher utilizing the process of measurement and imposing structure. The quantitative research approach employ measurement that can be quantifiable while qualitative cannot be measured. In mixed research approach inquirers draw liberally from both qualitative and quantitative assumptions.

Therefore, the best type of research opted for by the research is quantitative approach. This approach is picked because the research aims at identifying the factors causing construction equipment downtime and to prioritize them by ranking and to analyze the impact of these factors on project performance.

III. DATA COLLECTION

The study plans to utilize primary sources of data. Primary sources of data include the questionnaire survey consisting of close ended questions. (Shodganga, 2012).

IV. QUESTIONNAIRE

In order to realize the target, the study plans to use well-designed questionnaire as data collection instrument. The research evidence was gathered by using close-ended questionnaire. With regard to the close ended questions, the respondents will be asked to indicate their level of agreement on a five-point Likert scale with the following ratings. Strongly Agree (SA or 5), Agree (A or 4), Neutral (N; or 3), Disagree (D; or 2), and Strongly Disagree (SD; or 1).

V. PROFILE RESPONDENTS

Questionnaires will be distributed among top and middle management members such as project managers, Construction equipment managers, Civil engineers, Supervisors and Site engineers. They were selected as respondents because they are deemed to be knowledgeable about equipment downtime and could provide important perspective on it. Their response is expected to help understand the factors that could cause construction equipment downtime.

VI. SAMPLE SIZE

There are several approaches of determining the sample size. These include using a census for small populations, imitating a sample size of similar studies, using published tables, and applying formulas to calculate a sample size.

But here, we don't know the population for considering a particular method to decide the sampling size. Therefore, there is a particular formula of determining the sample size for anunknown population. Cohran developed an equation to yield a representative sample for an unknown population,

$$n_{\circ} = Z^2pq/e^2$$

Where $n_{\circ}$ = is the sample size,
Z^2 = abscissa of the normal curve that cuts off an area α at the tails

VII. DATA ANALYSIS

As explained in the preceding part, the research is designed to follow a qualitative analysis.

Data collected using questionnaire will be analyzed by using the Relative Importance Index (RII). Relative index analysis was selected in this study to rank the factors causing equipmentdowntime according to their relative importance. The following formula is used to determine the relative index (Shodganga, 2012),

$$\text{RII} = \sum \frac{ww}{A * N}$$

Where w = weighting as assigned by each respondent on a scale of one to five
(One is the least and five is the highest)
e = desired level of precision
p = estimated proportion of an attribute that is present in the populationq = 1-p
Assuming there is a large unknown population we assume p=0.5 (maximum variability). Furthermore, suppose we desire a 95% confidence level and ±5% precision. The resultingsample size is demonstrated below,

$$n_{\circ} = Z^2pq/e^2$$
$$= (1.96^2 x 0.5 x 0.5)/(0.05^2)$$
$$= 384$$

Therefore, for any survey or opinion poll with an unknown population, the sample size islikely to be 384.

VIII. SAMPLING CRITERIA

We plan to categorize the samples according to the experience of the respondentssuch as 0-5 years, 5-10 years and 10-15 years.

The questionnaire will be floated to respondents from all parts of the country.
A = Highest weight
N = Total number of the sample

Based on the ranking of relative indices, the weighted average for all the factors will be determined. The five important levels are transformed from RI values: high (H) ($0.8 \leq$ RI ≤ 1), High medium (H–M) ($0.6 \leq$ RI ≤ 0.8), medium (M) ($0.4 \leq$ RI ≤ 0.6), medium-low (M-L) ($0.2 \leq$ RI ≤ 0.4) and low (L) ($0 \leq$ RI ≤ 0.2).

IX. RESULTS DISCUSSION

A. Data Collection and Analysis

Data Collection is very significant because this is the bridge that connects the objectives and conclusion of research study. In practice, interview and questionnaire survey are the most commonly adopted methods for collecting the data. Interviews are a more personal form of research than questionnaires. In the personal interview, the interviewer works directly withthe respondent and has the opportunity to probe or ask follow-up questions. But it is not easy to communicate with everyone personally, due to the large sample size required for analysis, distance and time constraints. Hence, we have adopted the Questionnaire Survey technique tocollect the data required for the analysis.

There are various factors that influence the occurrences of Construction Equipment Downtime. Some of these factors have more importance, some have less importance and some are in between. From the study of literatures and also from opinion of market experts, we finalized 22 key points and factors affecting Equipment Downtime. Also, 8 factors were identified to study the impact of Downtime on Project Performance. To facilitate the analysis of responses, following numerical values were assigned to the five point Likert scale for each question in the survey.

1) strongly agree
2) agree
3) neutral
4) disagree
5) Strongly disagree

X. QUESTIONNAIRE ANALYSIS

The Questionnaire was divided into 3 sections, Basic Profile, Factors causing equipment downtime that consisted of a total 22 questions affecting the downtime on construction sites and Impact of downtime that consisted of questions related to Time, Cost, Quality and Safety aspects of projects to determine its impact on the performance of a project.

A close end questionnaire survey was carried out and a total of 220 responses were received. The response rate was seen to be 55% indicating that the questionnaire was sent to around400 experienced personnel.

RII of factors causing Equipment Downtime

FACTORS AFFECTING EQUIPMENT DOWNTIME	5	4	3	2	1		A*N	RII	RANK
Equipment downtime is largely caused because of unskilled operators.	37	90	71	18	4	798	1100	0.72545	17
Do the psychological factors of the operators like morale and fatigue affect the equipment downtime?	46	80	60	27	7	791	1100	0.71909	19
Does the past experience of the operator reduce downtime?	89	73	32	19	7	878	1100	0.79818	8
Proper training to operators is influential in decreasing equipment downtime.	108	73	28	6	5	933	1100	0.84818	4
Extended working hours of the operator increases downtime.	49	76	54	33	8	785	1100	0.71364	21
The poor working conditions on the site are responsible in causing downtime.	73	86	46	9	6	871	1100	0.79182	10
The location of the site plays an important role in causing downtime.	60	72	64	19	5	823	1100	0.74818	14
Does the complexity of the machine influence its downtime?	47	82	59	26	6	798	1100	0.72545	17
The usage of modern equipment reduces downtime.	65	74	40	30	11	812	1100	0.73818	16
Breakdown of machinery due to wear and tear has an impact on downtime.	103	80	27	9	1	935	1100	0.85	3
Using the wrong machinery for the wrong job increases the occurrence of downtime.	140	55	20	3	2	988	1100	0.89818	1
The age of the machine being used for a specific operation largely impacts its downtime.	86	81	45	6	2	903	1100	0.82091	6
Various conditions like floods, landslides or accidents affect downtime.	80	69	45	21	5	858	1100	0.78	12
Does keeping equipment spare parts and emergency kits on project site can decrease the downtime?	80	85	37	8	10	877	1100	0.79727	9
Does the location of workshop also increase downtime?	45	81	57	30	7	787	1100	0.71545	20
equipment certifications, so that there are no stoppages in work.	115	77	23	5	0	962	1100	0.87455	2
Hiring authorized equipment dealers to take up maintenance activities reduces downtime.	98	78	33	9	2	921	1100	0.83727	5
Does making a proper investment on equipment can avoid the downtime?	80	83	45	9	3	888	1100	0.80727	7
The equipment procurement system decisions tend to affect the downtime.	47	93	66	11	3	830	1100	0.75455	13
Replacement decisions taken up by the company affects downtime.	47	91	62	18	2	823	1100	0.74818	14
Is there an impact on public safety on construction site because of sudden occurrence of downtime?	40	75	62	33	10	762	1100	0.69273	22
Having standby of equipment at the site helps lower the impact of downtime?	77	86	34	14	9	868	1100	0.78909	11

From the above Table, it is evident that there are 7 factors that are of High importance in causing Equipment downtime. They are listed in the order of their importance:

1) Using the wrong machinery for the wrong job
2) Not checking the equipment specifications
3) Breakdown of machinery due to wear and tear
4) Not giving proper training to operators
5) Not hiring authorized equipment dealers to take up maintenance
6) Age of the equipment being used
7) Not making a proper investment on equipment

XI. CONCLUSION

Brief summery over the results obtained by the current study leads to the below conclusions:

1) Construction equipment plays a very important role in construction projects. It helps the project to be completed on time, and with certain quality.
2) As construction sites are becoming equipment intensive, breakdown of equipment can cause a huge impact on the site's progress.The impact of equipment downtime on construction projects is considerably huge.
3) From our research, we also have found out that, lack of proper skill in operators, their past experience, working hours and site conditions, their psychological state, the

complexity of the machine, and other factors impact downtime considerably.

4) It was also observed that downtime delays the project at 10%, also impacting the frequency of accidents at site.
5) Project performance is affected due to equipment downtime, Leading to time and cost overruns at a nominal scale. Quality of the project is likely to be affected by equipment downtime.
6) This study is an attempt to identify the various factors causing construction equipment downtime by studying various literature and then to assess their relative importance by using the RII analysis.
7) This work will serve as a framework for further study. Future studies can be carried out to develop a downtime model in relation to the Indian construction scenario.
8) Studies could also incorporate the project duration for each category of equipment and will help in the assessment of the relative impacts of downtime.
9) Study could also be expanded to address the dynamics of downtime by using new models and improvising them to suit specific.

REFERENCES

[1] Hatkar K B and Hedaoo N A. (2016). Delay analysis by using relative importance indexmethod in infrastructure projects. Pune: trpubonline.
[2] M.Manikandan, Prof.M.Adhiyaman, Dr.K.C.Pazhani. (2018). A STUDY AND ANALYSIS OF CONSTRUCTION EQUIPMENT MANAGEMENT USED IN CONSTRUCTION PROJECTS FOR IMPROVING PRODUCTIVITY. Chennai: IRJET.
[3] Madhav Nepal, Moonseo Park. (2004). Downtime model development for construction equipment management. Singapore: Engineering Construction & Architectural Management.
[4] Mali Pritam A., M.R.Apte. (2015). EFFECTOF CONSTRUCTION EQUIPMENT ON PRODUCTION IN BUILDING. Maharastra: IJESRT.
[5] Mekdim Mathewos. (2017, June). A Study on Construction Equipment Planning and Management Problems in Road Construction Project.
[6] Mohamad Tabikh. (2008). Downtime cost and Reduction analysis. Swedan: IDT.
[7] Shodganga. (2012). Research Methodology. Maharashtra: https://shodhganga.inflibnet.ac.in/bitstream/10603/2589/12/12_chapter%203.pdf.
[8] K. Prasanth Kumar, T. Chandra Mouli (July 2019). Impact of Construction Equipment Downtime in Indian Construction Sector: IJESRT.
[9] Bhushan B. Malusare, Prof. Hemant Salunkhe [2019] .Implementing a systematic approach towards downtime cost: IJEAST
[10] Sujit Shivaji Jadhav, Rohit Salgude (2019).Downtime Cost of Construction Equipment: IRJET
[11] Bhushan B. Malusare, Prof. Hemant Salunkhe [2019].Implementing a systematic approach towards downtime cost.
[12] M. Waris , Mohd. Shahir Liew, Mohd. Faris Khamidi, Arazi Idrus (2014). Criteria for the selection of sustainable onsite construction equipment:GORD.
[13] M. Manikandan, Prof. M. Adhiyaman, Dr. K.C. Pazhani [2018].Analysis of construction equipment management used in construction projects for improving productivity.
[14] Prasannasangeetha.A, Alan.S (2015). Equipment Management In Construction Sector:IJOSER
[15] Luis F. Alarcón, Andrés Rodríguez, Claudio Mourgues [2012].Impact of machine failure costs on equipment replacement policies: Tunneling company case study: JCEM

