

# Time and Cost Overruns in the Construction Industry due to Downtime of the Construction Equipment and Machineries

Mr. Kaustubh S. Giri, Student, DYPCOE Akurdi, Pune, India, girikaustubh.sa@gmail.com

Mr. B. K. Bhonde, Professor, DYPCOE Akurdi, Pune, India, bkbhonde@gmail.com

Mrs. Ashwini R. Patil, Professor, DYPCOE Akurdi, Pune, India, meashwinipatil2013@gmail.com

**Abstract** Equipment downtime occurs due to planned or unplanned stops. However, the unplanned stops caused by failures and disturbances occurrence are the most common unexpected factors that have the non-trivial influence on the overall productivity. Also, this interrelation between downtime events and productivity lies in gist of economic connotation, in which cost and profit variables are inversely proportional by means of decreasing downtime cost and thereby increasing production profit. To this end, in order to decrease the downtime cost, suitable and developed costing methods are needed to calculate and trace every single cost disbursed during the stoppage juncture. The purpose of this paper is to present a sample of how Construction companies deal with equipment downtime cost, and further how they analyse its reduction. The study will be performed by conducting a survey within construction firms that have maximum employees. This study will perform analysis to assess the construction productivity losses due to downtime of the equipment's by conducting case study on a construction site at Pune. The results will be based on the survey conducted to obtain data and framework and integrated models to manage the construction equipment's efficiently will be presented.

**Keywords** — *Downtime analysis, Management Responsibility, Relative Importance Index (RII), Productivity*

## I. INTRODUCTION

In today's competitive manufacturing market, production efficiency and effectiveness are among top business priorities. Thus, production equipment becoming the central focus of interest as it is the backbone of the manufacturing process and key performance indicator of productivity. The requirements of outstanding performance force companies to substantially consider reducing their machines downtime frequency and its consequential costs. In India, Construction industry is growing rapidly and becoming increasingly competitive. In construction industry, the construction equipment itself is one of the areas in construction operation where significant gains can be made. The success of construction project largely depends on use of available resource in optimal manner such as human resource, machinery, materials, money etc. The industry must manage the construction equipment in a systematic and professional way. If less attention has been given to the maintenance of construction equipment then it leads the construction equipment to a breakdown. The breakdown of construction equipment causes delay in the construction activities and it directly affects the project completion, so downtime tracking information is essential to correct ongoing machinery problems and deficiencies, and to fine

tune the maintenance and operations management systems. It's important to remember that an overall system of maintenance should be required to speed up the construction projects.

## II. BENEFITS OF TRACKING EQUIPMENT DOWNTIME

Benefits to tracking and fixing downtime can be:

- Better prioritization of maintenance staff (lowered amount of unplanned downtime events means more time on PM schedules).
- Gives managers an inside look into necessary replacement and repair priorities.
- More accurate implementation of corrective maintenance tasks.
- Raises profit and lowers maintenance costs (especially on replacement equipment in emergency cases)
- Higher machine uptime, efficiency, and reliability (due to PM/PDM plans being effectively implemented)

### III. CONSTRUCTION EQUIPMENT

The main function of significant earthmoving equipment is to assist within the moving of soil and rock from one location to another location. The cost or investment of this equipment constitutes a huge amount on the part of the buyer. Financial backing is very important for owning these type of equipment. Most machines cost at least Rs 100,000 the largest pieces of equipment can cost millions.

The various equipment used as per the functions are as follows:

1. Earthwork equipment
2. Material hoisting plant
3. Concrete plant and equipment
4. Support and utility services equipment
5. Special purpose heavy construction equipment

### IV. AIM AND OBJECTIVES

This study is aimed to analyse and propose framework for efficient and optimum equipment management for construction sites in Pune, District, and Maharashtra. The following objectives will be fulfilled to achieve the aim-

- To define factors related to time and cost overrun.
- To prepare a framework and propose the result for cost analysis.
- To study the existing utilization and management of construction equipment.
- To recommend solution about downtime.

### V. LITERATURE REVIEW

**Melissa De Iuliis, Omar Kammouh, Gian Paolo Cimellaro, and Solomon Tesfamariam (2018), Downtime estimation of building structures using fuzzy logic-** The author researched on the downtime estimation of building structures using fuzzy logic. The main aim of the author was to introduce a method to predict the downtime of buildings using a Fuzzy logic hierarchical scheme. Thus in this research author divided the downtime into three components:

1. downtime due to the actual damage (DT1);
2. downtime due to irrational delays (DT2); and
3. downtime due to utilities disruption (DT3).

**Michal Krzeminski (2016), Construction Team Downtime Minimization Model Including Efficiency Coefficients:** In this study author mentioned about the precise description of the mathematical algorithm. The model is designed specifically for flow shop construction scheduling, where schedules are created with the assumption that the work will be organized in accordance with the Linear Scheduling Method (LSM).

**Jawad A. Alsuliman (2019), Causes of delay in Saudi public construction projects:** The author researched on the

causes of delay in Saudi public construction projects. The author investigates the causes of delays in Saudi public construction projects. The causes of delay were categorized based on the different stages of a construction project, namely

- (1) Factors before the award of tenders,
- (2) Factors during the award of tenders,
- (3) Factors after the award of tenders, and
- (4) General factors.

**Madhav Prasad, Moonseo Park, Downtime model development for construction equipment management:**

The author researched on the downtime model development for construction equipment management. The author focused on the downtime model to address the issue by explaining the causes and consequences of downtime. The applying of the model framework by the author to the nine roads in Nepal.

**Miss. Kalpana Gangane, Mr. Dipak Patil (2017), Downtime Cost of Equipment Used In a Construction Industry -** The author researched on the downtime Cost of Equipment Used in a Construction Industry. The main aim of the author was to present a sample of how Construction companies deal with equipment downtime cost, and further how they analyze its reduction. The author thoroughly performed the study by conducting a web based survey within construction firms that have at least 200 employees

**Sujit Shivaji Jadhav, Prof. Rohit Salgude (2019), Downtime Cost of Construction Equipment:**

The author researched on the downtime Cost of Construction Equipment. The main focus of the author was to highlight the heavy equipment management practices and downtime in large stone crusher plant them as a framework in constructing a downtime and corresponding cost approach. The finding reveals that, to be successful in downtime identification, plant manager must view their practices on equipment management as an integration of multiple feedback processes, which are inter related and interdependent with downtime. Author mentioned the objectives of the study mentioned below,

1. To identifies various reasons of failure of construction equipment's
2. To determine downtime cost of crusher plant by cox and nunally models
3. To minimize downtime cost of crusher plant and hence to increase production.

**Bhushan B. Malusare, Hemant Salunkhe (2019)-** Implementing a systematic approach towards the downtime cost: The author researched on the implementing a systematic approach towards the downtime cost. The main research of the author was to focus on presenting a sample of how Indian manufacturing companies deal with equipment downtime cost, and further how they analyze its reduction. Author considered a survey of 50 employees.

Results obtained from the investigation show that the estimated downtime costs constitute about 23.00 – 30.00 % from the total manufacturing cost ratio, and 13.00 – 15.00 % from planned production time.

**M.Manikandan, Prof.M.Adhyanan, Dr.K.C.Pazhani (2018)** - A study and analysis of construction equipment management used in construction projects for improving productivity:- The author researched on the analysis of construction equipment management used in construction projects for improving productivity. Author aimed was to elevate the benefits of implementing total Productivity. While purchasing, leasing or renting the equipment, and guide in optimizing the profitability. Author research on the utilization of the machines and match their capacities to specific project requirements

**Abubaker Shagluf; A. P. Longstaff; S. Fletcher, Maintenance Strategies to Reduce Downtime Due to Machine Positional Errors:**

The author researched on analyzing the Maintenance Strategies to Reduce Downtime Due to Machine Positional Errors. Author focused the aim to analyze the increase wasting of the equipment’s in industry. To maintain machine tool, an appropriate technique needs to be finalized by the author that helps in managing the hidden costs associated with production losses. Author used Total productive maintenance (TPM) is a maintenance program that involves concepts for maintaining plant and equipment effectively. The study explains review on the maintenance management to find out perfect decision to overcome the wasting of productive equipment’s.

**Prajeesh. V. P , Mr. N. Sakthivel (2016), Management of Equipment & Machinery in Construction:** The author researched on the Management of Equipment & Machinery in Construction. In this author studied the management of equipment’s practices in Construction Industry and to present the most popular practices of the contractors and to compare the equipment management policies with a Case study of a construction industry.

## VI. METHODOLOGY

The data collection for the study involved two stages. The primary data was gathered through a questionnaire survey targeted at some contractors, clients, and consultants in construction projects in Pune and some of the local tradesmen’s and businesses. The secondary data were obtained from the literature. Using this approach, some of the causes that are helpful in analyzing the impact of Equipment management on the productivity will be identified. A questionnaire is then developed to assess the perceptions of clients, consultants, and contractors, locals on the relative importance of causes and effects of factors in the Pune construction industry. Respondents will be asked to rank the questions from one to five based on their

importance like very low, low, medium high and very high. Relative importance index was used to determine the relative significance and ranking of the causes.

The data has been collected by interviewing the officials of the construction industry. The study has been broadly undertaken as follows:

- Identified the projects, which are emerged as huge landmarks in the Pune region
- Study all the available Historical cost outcome, estimates, types of equipment used and work procedures in detail and collected all the relevant data about the project.
- Analyzed the data obtained and compared the costs and actual estimates the builder and locals has gained from the purchase and maintenance of equipment
- Examined the reasons for the impact through either personal interviews or questionnaires.
- Listed out all the shortcomings.
- Identify the recommendations for possible negative impacts through a general survey of opinion from Consultants and Contractors and suggest the possible remedial solutions.

This project execution follows the flow chart given below:

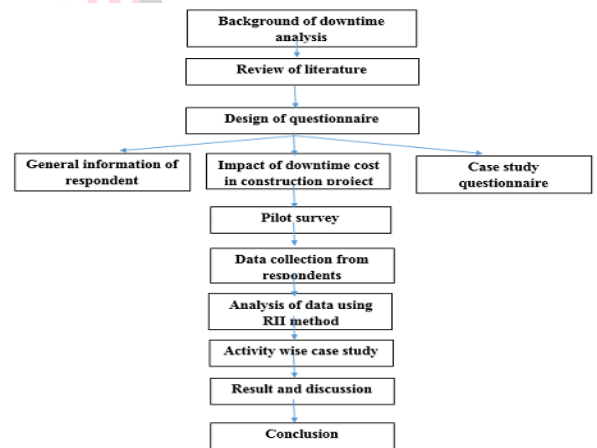


Fig 1. Flow Chart Showing Research Structure

Furthermore, the factors impacting each perspective and the criteria to evaluate these factors will be identified in this chapter. Then the study area and the selection reasons will be simply introduced. The fieldwork and data collection will be also explained followed. And the limitations would be indicated finally as well. Current situation analyses will be conducted in this chapter by the collected primary data and information. In the present study, we are going to do detail to investigate the reasons for time overrun in various projects.

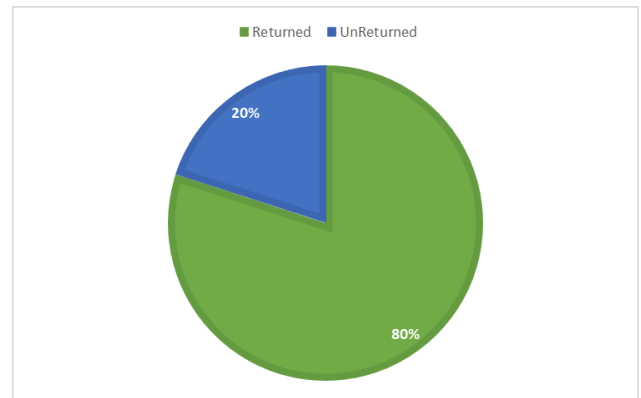
## VII. SURVEY WORK AND DATA COLLECTION

The data collection to Productivity as the primary objective for assessment of the importance of equipment

management in the construction industry will be done through a survey by explorative questionnaire to the respondents involved in construction firms and small business holders in various regions in the central Pune region of India. The questionnaire will be designed so that respondents can give the rank to their answers based on the Likert scale. The analysis of these data will be done by RII method and using Microsoft Excel.

**Table 1. Study Population**

Organization	Project	Address	Selection criteria
Capacite infraproject ltd	Phoenix market city	Wakad	Internship site
Sahyadri associates	Commercial complex	Wadgaon bk	Random
Manoj mandhare and associates	Residential complex	Katraj	Random
Norvica realities pvt. Ltd.	Residential complex	wakad	Random
Bhagirath Narayan construction	Industrial complex	Bhosari	Random
R k Buildcon	Residential complex	Bavdhan	Random



**Fig 2: Return Rate of the Questionnaire**

**RESEARCH DATA AND ANALYSIS.**

**Section A: general information of the respondents and their firms.**

This section consists of 12 questions which are intended to examine the respondent experience, profession, size and type of the firm, his/her current position in the organization and his/her specialization in the construction field. The following are the results with comments on each.

**1. Gender, age and location:**

100% of contributing persons were male. The age average of participants was between 25 to 30 years while the dispersion of the working city of them was as 100% from Pune.

**VIII. QUESTIONNAIRE DESIGN AND CONTENTS**

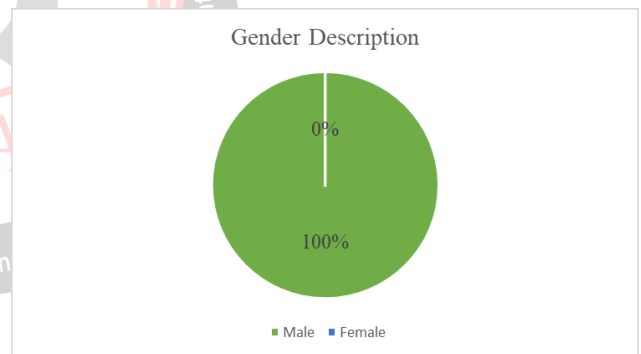
The questionnaire included six parts related to the factors that are critical aspects to analyze the impact of Equipment management in Pune by MSP.

Parts of the questionnaire are:

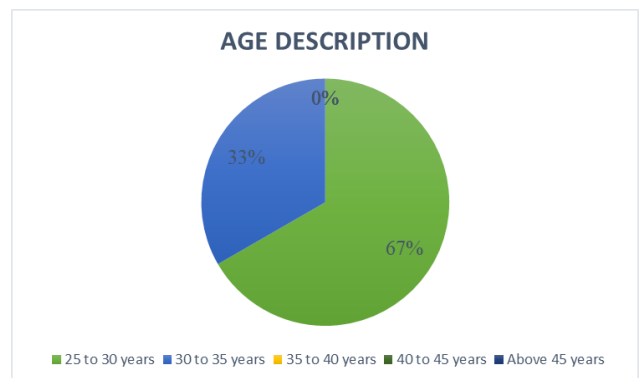
1. Equipment profitability
2. Development of project
3. Equipment analysis
4. Rate of service done by equipment according to market rate.
5. Equipment profitability
6. Factors related to owner.

**IX. RESPONSE RATE AND SURVEY SAMPLE**

The questionnaire is prepared and established through personal interviews. The survey was send to all type of professionals in the Indian CI including client, contractor, government authority, architects, structural engineer, interior designers, developers and builders. After one week of opening the questionnaire 15 were received and after sending reminder to those who didn't respond, 20 more responses were received. Finally, 40 complete responses were received with response rate of 80%. Above fig, no 4.1 shows the response rate of the questionnaire



**Fig 5: Gender Description**



**Fig 3: Age Description**

**2. Nature of the enterprise of the respondents:**

Planning is known to enhance construction project. This question was answered by all respondents which accounts for almost 100 % of response rate. This question is necessary to know the respondent’s association with any industrial institutes. This will help us to know the respondent’s business level. This question describes us the scale of the business involved by the respondents. This will indirectly lead us to know the exposure offered to the respondent at his business. The more the exposure the more experienced will be the respondents

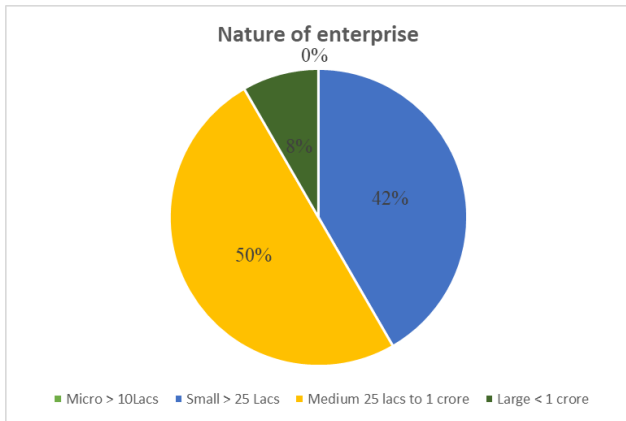


Fig 4: nature of enterprise of the respondents

**3. Educational level:**

Participant’s level of academic studies is another factor which makes the results more reliable. 75% of respondents have a bachelor degree, 16.66% have a Master degree and 8.33% have done HSC.

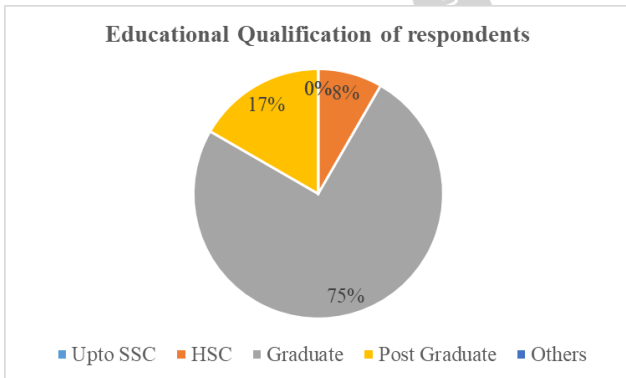


Fig 5: Educational level of the respondents

**4. Member of any industrial association:**

This question was answered by 40 respondents which accounts for almost 100 % of response rate. This question is necessary to know the respondent’s association with any industrial institutes. This will help us to know the respondent’s knowledge level and self - upgradation level.

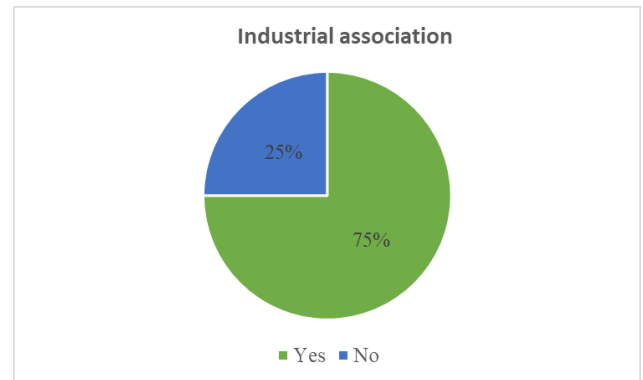


Fig 6: Association of the respondents with any industrial membership

**5. The nature of business activity**

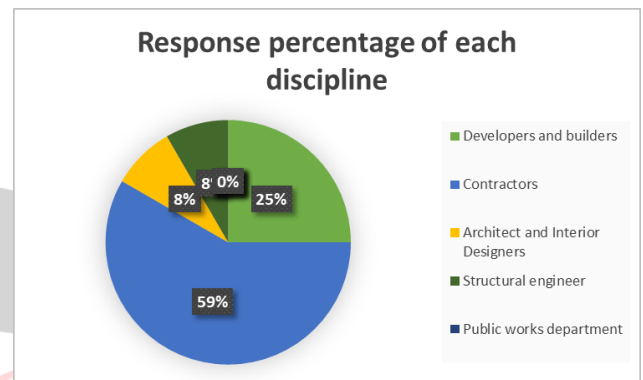


Fig 7 response percentage of each discipline

**6. Respondents information of ownership:**

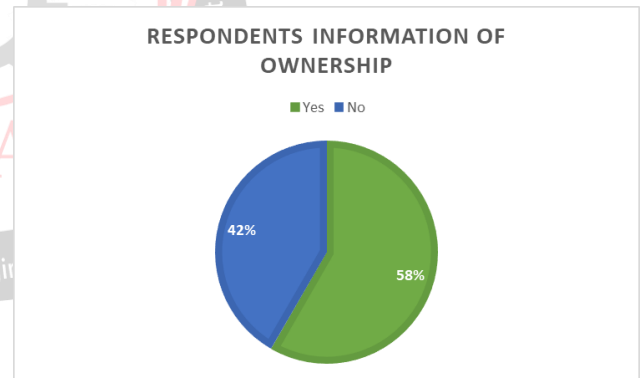


Fig 8 Respondents information of ownership

**Section B: Analysis of factors affecting cost and time:**

**1. Factors related to Manpower (owners):**

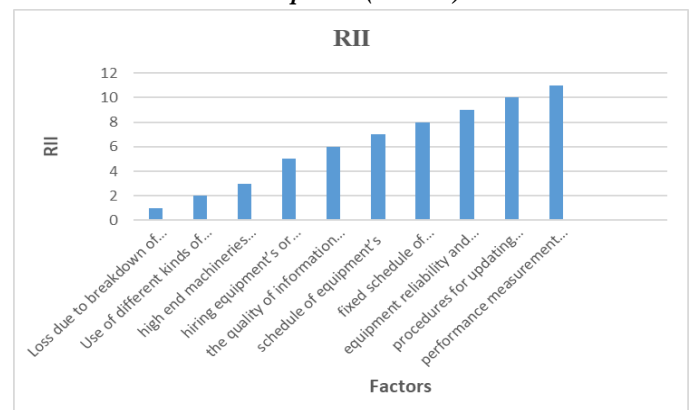


Chart 1. RII for Factors related to Manpower

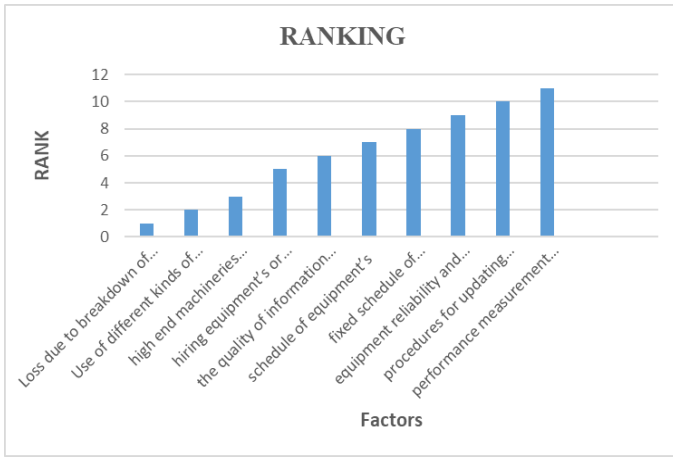


Chart 2. Ranking of Factors related to Manpower

2. Factors related to Equipment analysis:

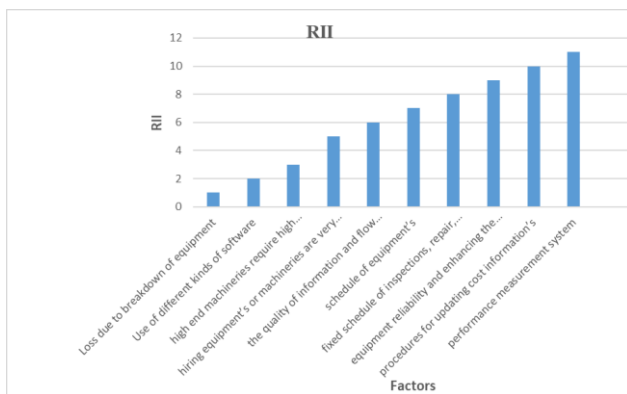


Chart 3. RII for Factors related to Equipment analysis

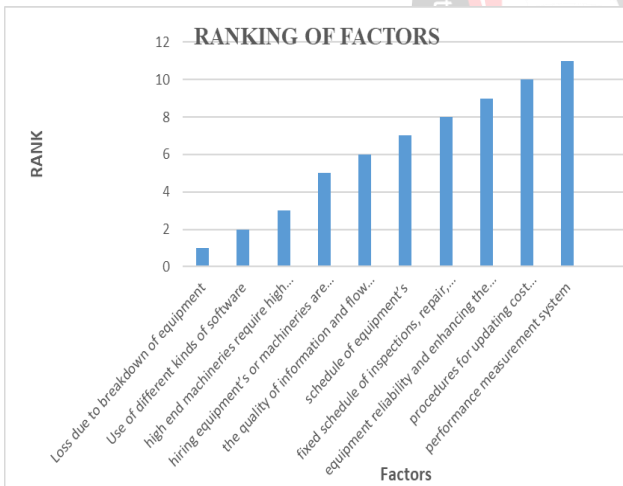


Chart 4. Ranking for Factors related to Equipment analysis

3. Rate of service done by equipment according to market rate:

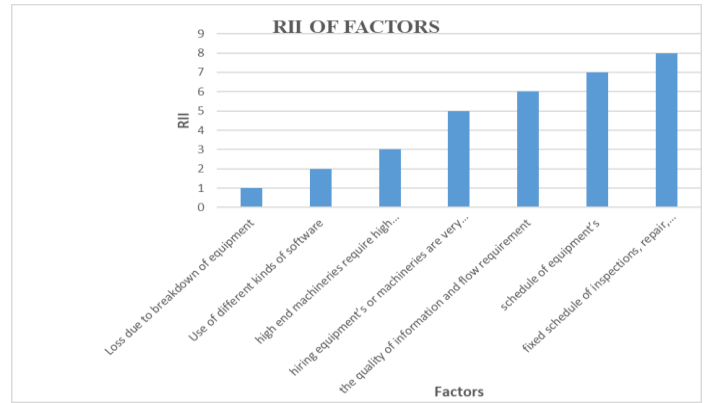
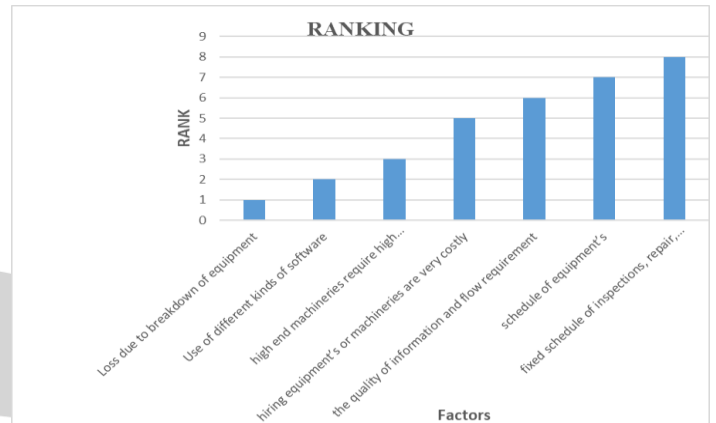


Chart 6. Ranking for Factors related to Rate of service of equipment



4. Factors related to cost of maintenance of equipment's:

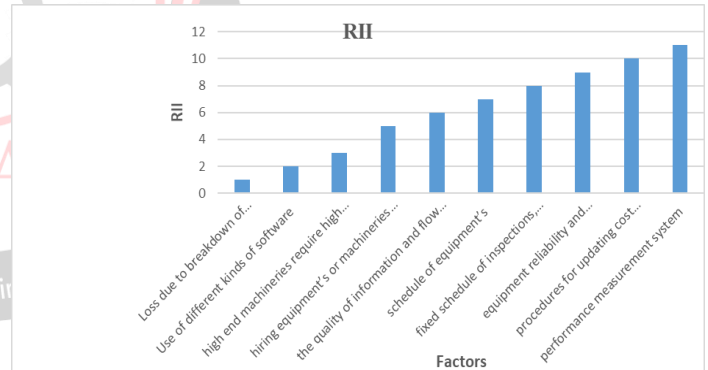


Chart 7. RII for Factors related to cost of maintenance of equipment's

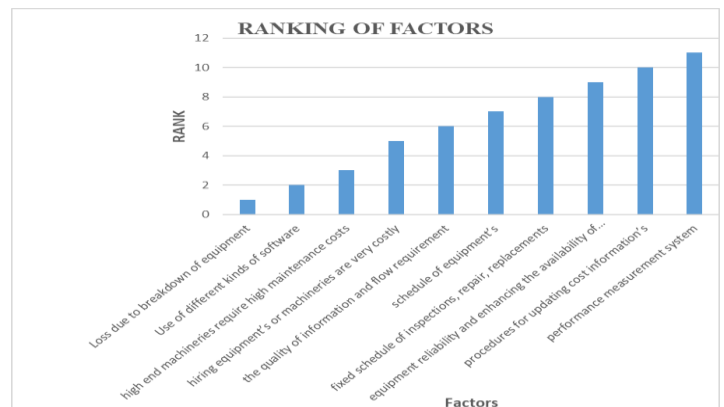


Chart 8. Ranking for Factors related to cost of maintenance of equipment's

5. Factors related to Project development characteristics:

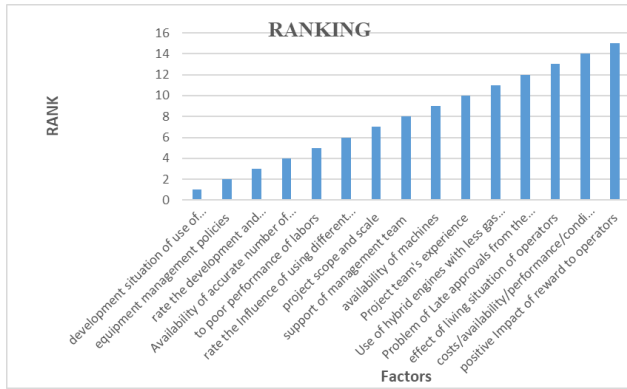


Chart 9. Ranking for Factors related to Project development characteristics

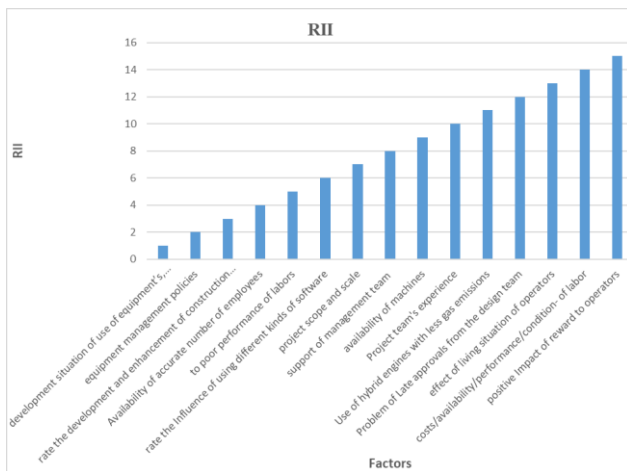


Chart 10. RII for Factors related to Project development characteristics

X. CONCLUSION

Machine and equipment management has not transferred as easily when compared with other technologies because it is a production technology or knowledge based and not a consumption technology or product based. Technology transfer of prefabrication and Machine and equipment management is not as pertinent to architects as it is to manufacturers of building products, but we are caretakers of culture in the construction industry. A questionnaire was designed to understand more about the Equipment management practices in the construction industry. Questionnaire mainly focused about the company details, personal knowledge, and documentation details and about Equipment acquisition, economics, operation, replacement, standardization and management policy. A total of 40 responses were received for our questionnaires. A comparative survey found that use of Machine and equipment reduced activities associated with repetitive body movements, ergonomic challenges and ergonomic problems. The survey found that 92% workers reported that the use of prefabrication! Preassembly and Machine and equipment would reduce hazards related to material handling on site and that the reduction of scaffolding

through the use of prefabricated /pre-assembly or precast components would lead to less falls on sites.

The survey material includes the case study of Multi storied residential and water front apartments at Pune. In comparing the study of equipment management in Pune city with the survey result of equipment management in the other participated company is that, almost all the management of equipment's the higher companies are almost same. They are all having the one aim, maximize the profit and minimize the cost. There is a same management proceeding in all the level one companies in the acquisition of the equipment, economics of equipment, operation and maintenance of equipment.

From the survey analysis conducted we can draw the following conclusions:

1. Quality of supervision, material management, site planning, constructability, and change management are the most significant management related factors that influence productivity directly
2. Labor cost and installation time is evaluated equally by all workers.
3. In Pune, the respondents believed that Traditional building system is a flexible construction approach with regard to the design and construction process. Clients often prefer the traditional building system as they can easily make design changes to suit their requirements during the design as well as the construction phase
4. The proportion of the value of prefabrication components compared to the overall value of a project could have some influence on the observed prefabrication benefits
5. The design and estimation should be freeze before commencement of any activities on site for efficient use of machines and equipment's on construction.
6. The study focused on the productivity improvement and the cost saving and time saving associated with the use of machines and equipment's. Other benefits of machines and equipment's include improved quality, reduced wastage and environmental sustainability
7. At this stage conventional construction is economical and comfortable when compared to the advanced construction.
8. In Pune, the use of computers in managing the equipment for the allocation of different equipment in different sites, to update their maintenance, repair and also update their costs is widely used.
9. The main goal of any management policy is to enable optimization of resources and maximization of profits.

10. The fact that industries or contractors claim a gain from the resale of their equipment indicates that the equipment is managed profitably.
11. Even though there is no written policy with most of them, the implementation of sound principles of management as well as the influence of experience leads to profitable management of equipment.
12. Only one third of the construction industries were found to have documented policies, it was found that there is a uniform practice of management among industries.

### Recommendations:

- It is recommended that all the old and outdated Equipment should be disposed off and modern equipment must be purchased by the Contractor in order to smoothly run the Projects.
- The contractor or the builders should perform equipment economics before purchase of plant/machinery/prefabrication
- The employees should be properly trained to work on the advanced equipment's.
- The employees should be provided with upgraded software's and computers for maintenance of records and data collections
- The downtime of the equipment's should be noted before making the buy/rent decision on site.
- If the builder purchases the equipment's, periodic maintenance and services should be done on site.

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