

A Study on the Effectiveness of Various Construction Equipments Engaged in Construction Projects

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Abstract:

Construction equipment and machinery plays a crucial role in the successful completion of the project. Hence, selection and providing of right equipment for a construction project during the construction phase is of utmost important. The study is to find out various parameters that define the effectiveness of the construction equipment which helps in right selection of construction equipment. Equipment needed to be analysed for the effectiveness was selected based on the brain storming session with the industry experts that have significant role in determining the progress of the project were considered. A survey study was undertaken from a selected number of construction projects. Data is collected from the projects on defined equipment parameters which have bearing on the equipment effectiveness as perceived by the industry. Effectiveness is arrived for each equipment by using mathematical expressions considering various factors under each equipment category based on the functional use of equipment. The equipments are ranked according to their effectiveness. The outcome of the study can serve as guiding factor to those construction companies wanting to procure Equipments to be deployed on the projects who have constraints on money resource.

Keywords— Construction, Equipment, Effectiveness

I. INTRODUCTION

Reliability on Equipment's is increasing day to day because of the scarcity of availability of skilled manpower especially in construction industry because of the complexity and scale of the project. With the government initiatives for infrastructure development like smart cities, Highways etc., the role of onsite equipment and machineries plays important role in successful completion of these projects. Hence, procuring of right equipment based on project scope is of utmost important. This decision is made by considering equipment available in a fleet with the project activities to be completed. Such analysis takes care of Cost, equipment capacity, and equipment productivity into consideration.

The nature of production tasks that can be performed with equipment include excavating, hauling, transporting, compacting, grading, hoisting, concreting, pre casting, plastering, finishing, trenching, pipe-laying, cable-laying, etc.

Equipment improves productivity, quality and safety. Equipment planning scope covers-identifying the construction equipment for executing the project tasks, assessing the equipment performance capability, forecasting the date-wise requirement of numbers and types of equipment and participating in the selection of the equipment to be acquired.

II. REVIEW OF LITERATURE

A list of tangible and intangible factors was identified for the selection for construction equipment. The tangible factors include technical specifications, site conditions and cost consideration. Intangible factors narrate to qualitative which consist of, company policies regarding equipment acquisition, environmental constraints, market conditions and safety considerations. Research work brings out the concern of soft consideration while selecting construction equipment for infrastructure projects. Chamzini and Yakhchali (2012) together identified the nine point criteria and classified them into two broad categories i.e. benefit criteria based on cost and technical performance. This gives clear cut picture that environmental as well as social concerns are ignored while selecting construction equipment. Various surveys' also shows that health, safety and environmental issues are being kept at low priority in the process of equipment selection.

Four categories that need to be considered while selecting earth moving equipment are (1) contract provision, (2) logistical considerations, (3) spatial relationships and (4) soil characteristics which were given by Gates and Scarpa (1980). According to Gates and Scarpa, spatial relationships were classified into 7 factors primarily belonging to geographic information of the construction site.

Selection of equipment for the project is usually done during planning and executing a construction project, which describes how the work to be done, amount of time required finishing the work, and the cost required for completing the task. Equipment manager shall identify the pool of equipments available for a particular task. Standard equipment policy and Inventory of equipment in hand play an important role in equipment selection. There it is the responsibility of entire project team which includes equipment managers, project managers, and construction planning group together to select the right equipment from the pool of resources that are available. Once the selection of equipment is made, next task is to decide on mode of procurement of equipment, i.e., either to buy, rent, or lease it. These decisions are given based on the strategy of the organization and economic standing, and the nature and frequency of equipment use as mentioned by Nilesh in his research paper

III. FACTORS CONSIDERED FOR EFFECTIVENESS

Construction Industry deploys variety of equipment to carry out tasks pertaining to projects. Equipments are broadly divided on the basis of work carried by each of the equipment such as Earthwork Equipment, Concreting, Material Hoisting, Support & Utility Services and Special Purpose Heavy Construction Equipment. Each Category of these equipments was further subdivided based on the specific work carried out by each of them. For Example, Earth Moving Equipment were further classified as Excavation & Lifting Equipment, Earth Cutting & Moving, Transportation Equipment and Compacting & Finishing Equipment.

Equipment considered for the present study are selected after having brainstorming session with industry experts by considering the equipments that have significant role in determining the progress of infrastructure project. The equipment undertaken as part of our study are Back Hoe Excavator, Hauls Units or Dumpers, Dozers, Tower Cranes, Pavers. The Effectiveness of the above equipments is calculated based on Delphi Method of Survey. The effectiveness will be determined by several factors. The major factors and sub-factors involved in the effectiveness of construction equipment are given in Table 1.

Table 1 Major Factors and Sub-factors for Effectiveness of Construction Equipment

Major Factors	Sub Factors
Task Considerations	Suitability of equipment for the task Reliability Capability Availability Maintainability
Owning Cost Considerations	Cost of Capital Invested Depreciation Cost Storage Cost Insurance Taxes
Operating Cost Considerations	Fuel Cost Lubrication Cost Operator Skill Requirement Support Staff Requirement Equipment Efficiency
Maintenance Consideration	Routine Maintenance Planned Maintenance Preventive Maintenance Availability of Spares Outages/Breakdowns
Economic Consideration	Availability of used Equipment Availability of Rental Equipment Hire-Purchase Leasing of Equipment Residual Value / Salvage Value / Resale Value

IV. METHODOLOGY

Establishing effectiveness of construction equipment involves various steps as mentioned here. Firstly, A questionnaire survey was established considered major factors and sub factors for each of the equipment as mentioned in 3.0. Secondly, Data is collected through questionnaire survey, circulated to Plant & Machinery managers amongst five mid size construction infrastructure projects in terms of rating on a scale of 0 to 5, of which 5 being excellent against each sub-factor. Thirdly, data received through the questionnaire survey is reviewed through SPSS software. Factor analysis is an analysis technique used as data reduction technique to develop structure and inter-correlation among the decisive factors. The effectiveness is taken as a function of various major factors and sub factors. The weightages are given for various major factors and the equation for calculating the Effectiveness is as follows.

Effectiveness E =

$$W_{\text{Task Consideration}} (F_{\text{Suitability}} + F_{\text{Reliability}} + F_{\text{Capability}} + F_{\text{Availability}} + F_{\text{Maintainability}}) + W_{\text{Owning Cost}} (F_{\text{Cost of Capital}} + F_{\text{Depreciation Cost}} + F_{\text{Storage Cost}} + F_{\text{Insurance}} + F_{\text{Taxes}}) + W_{\text{Operating Cost}} (F_{\text{Fuel Cost}} + F_{\text{Lubrication Cost}} + F_{\text{Operator Skill Requirement}} + F_{\text{Support Staff}} + F_{\text{Equipment Efficiency}}) + W_{\text{Maintenance}} (F_{\text{Routine}} + F_{\text{Scheduled}} + F_{\text{Preventive Maintenance}} + F_{\text{Spares Availability}} + F_{\text{Outages/ Break Downs}}) + W_{\text{Economics}} (F_{\text{Used Equipment}} + F_{\text{Rental}} + F_{\text{Hire-Purchase}} + F_{\text{Leasing Equipment}} + F_{\text{Residual/ Resale/ Salvage Value}})$$

Based on the value obtained from the formula the equipment can be categorised into the following categories as mentioned in Table 2

Table 2 Effectiveness Categorization

S.NO	VALUE OF EFFECTIVENESS	INFERENCE
1	125-100	High
2	99-75	High-Medium
3	74-50	Medium
4	49-25	Medium-Low
5	24-1	Low

V. ANALYSIS

Effectiveness of various equipments considered for study is as mentioned in Table 3 & Figure 1

Table 3 Effectiveness of Various Equipment

EQUIPMENT	EFFECTIVENESS	MEASURE OF EFFECTIVENESS	EFFECTIVENESS RANKING
Haul Units	100.16	High	1
Back Hoe Excavator	93.36	High-Medium	2
Bull Dozer	84.36	High – Medium	3
Tower Crane	83.64	High -Medium	4
Paver	72.6	Medium	5

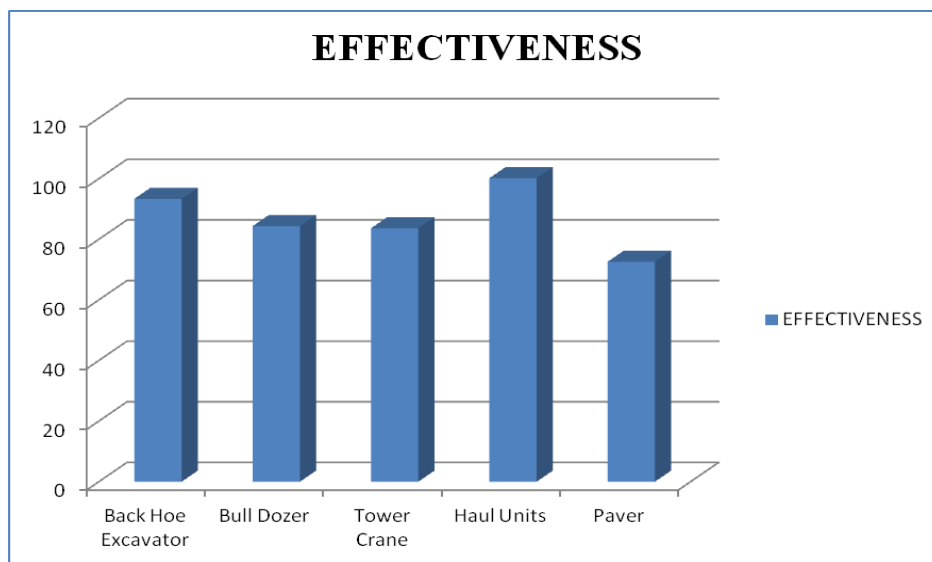


Figure 1 Effectiveness of Various Equipment

VI. INTERPRETATION AND CONCLUSION

Hence, Effectiveness of equipment can be measured based on the 5 broadly classified factors based upon our study. Their effectiveness values indicate:

Haul Units: The measured effectiveness of this equipment is 100.16 which represents that the equipment is Highly Effective in Construction Projects.

Back Hoe Excavator: The measured effectiveness of this equipment is 93.36 which represents that the equipment is High-Medium Effective in Construction Projects.

Bull Dozer: The measured effectiveness of this equipment is 84.36 which represents that the equipment is High-Medium Effective in Construction Projects.

Tower Crane: The measured effectiveness of this equipment is 83.64 which represents that the equipment is High-Medium Effective in Construction Projects.

Pavers: The measured effectiveness of this equipment is 72.6 which represents that the equipment is Moderately Effective in Construction Projects.

Based on their effectiveness values of the above equipments, we could infer that the capability of producing the desired result is greater for HAUL UNITS than the other construction equipments.

A similar criterion of effectiveness is being followed by Construction industry professionals to make decisions while selecting equipment for Purchase.

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