

## Experimental Investigation on the Comparative Cost Analysis of Equipment Management in Construction Companies in India

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**ABSTRACT:** Construction Equipment is the important factor to run the project in a successful manner. it is important for both private constructions and also for Trust based organizational Construction projects' success. A large number of quantities of equipment are required in construction even in small construction companies also there is a need to invest high initial cost in equipment. Nearly 40% of construction cost is related to equipment. This paper elevates the elements to be considered while purchasing, leasing or renting the equipment, and guide in optimizing the profitability. Methods of life cycle cost estimating and decision methods were researched and compared. Data was acquired from equipment rental companies, private construction companies, and Trust base organizational projects.

**Key words:** Buying, Construction Equipment, Lease, Maintenance, Rent.

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### I. INTRODUCTION

Construction projects are completely different when compared to other projects. The main operations involved in constructions are excavation, digging, loading, hauling, leveling, etc. construction involves these different set of activities, to execute such activities successfully there is the need to invest a high amount of energy which is related to equipment energy. By acquiring proper equipment at the proper time at proper place, the profitability can be increased. Even small companies also need to invest high budget in acquiring equipment. This research is related to only small construction company and Trust based project.

Here it is important to define the small construction company, if the company is having one to nineteen persons as employees with less annual returns, then the company is called small construction company.

Size of Company	Number of Employees
MICRO	0-4
SMALL	5-19
MEDIUM	20-99
LARGE	>99

Nunnally et al. (1977) described that equipment selection is a critical factor in the execution of many construction projects. This is to be much more critical in heavy construction projects where the equipment fleet plays a vital role in performing the work. In this type of projects, the equipment fleet may represent the largest portion of the bid price. [3]

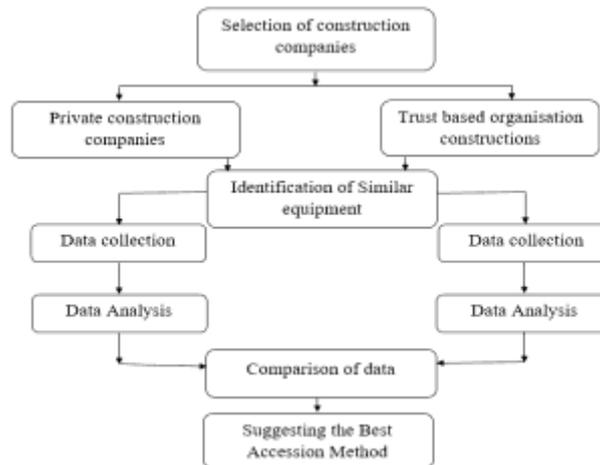
Profitability will get varied when compared to private constructions and government or Trust based constructions. The objective of private constructions will be aimed to get profit where as in the case of public projects its aim is not profitability, it works for Optimization of the given budget to fulfill all requirements. The goal of this study is to show the difference in maintenance of both projects. Nichols et al. (1976) proposed a method of estimating costs that consisted of multiplying a number of factors times a multiple of the initial purchase price of a machine. These factors took into account type of equipment, total hours of use, years of useful life, temperature, work conditions, maintenance, quality, type of use, operator style, equipment quality, pace of work, and luck. In Nichols's model, repair costs increased with the use of the machine. [2]

### II. OBJECTIVE

- The different factors that are to be considered while renting-lease-buying the equipment are identified and listed.
- Maintenance and efficient usage of equipment in private construction and Trust based organization differences are analyzed.
- Equipment rent or buy decision-making method is equipment.

### III. METHODOLOGY

The methodology involved in this paper has started from literature reviews then two different type of Aims of constructions are identified and similar equipment's adopting by both companies are identified, and the required data are collected from both companies and the efficient usage, maintenance costs are analyzed. Comparisons are done between both the companies annually costs and usage and accusing method is suggested.



#### 3.1. Life Cycle Cost

In general construction, equipment cost is calculated on hourly basis. The productivity estimate combined with hourly cost gives required information to derive unit cost for bidding. To find the hourly cost, periodic costs are divided by periodic hours. Another way to look at this quantities is life cycle cost (l.c.c) Life cycle costing has been a common perception for facility maintenance, and is beginning to be seen in many more recent journal articles related to construction equipment (Bennett 2008, Staff2009, and Louisiana Machinery 2010).[1]

##### 3.1.1. Developing Costs

The unit costs and hourly rates are calculated on four areas of costs: ownership cost, operating cost, overhead cost, profit.

##### 3.1.1.1. Ownership Cost

Ownership cost includes all expenses related to particular equipment whether it is getting operated or even idle. It includes costs related to purchasing license, taxes, insurance, and storage. Depreciation is one of the important factors which are involved in ownership cost. Depreciation is the measurably reduced value of used asset. Equipment is held by the sole ownership entity. It permits the control of availability and Mechanical condition of the equipment (Peurifoy and Schexnayder 2002). [4]

Average annual invest of equipment is required to be calculated in owning equipment. It is calculated by using following formula:

Where  $u$  is useful life in years and  $c$  is initial cost.

##### 3.1.1.2. Operating Cost

Operating costs estimating methods are standard in classifying the input costs. Some of the common input factors are fuel, oil, grease, tires, maintenance. Maintenance is divided into two types that are preventive maintenance and corrective maintenance. Maintenance is the cost that is required to operate equipment throughout its life cycle.37% of life cycle cost is related to equipment maintenance and repair.25% to depreciation.23% to operating cost.15% to overhead. By using following formula, the unscheduled repair cost is calculated.

Where  $T_{so}$  is scheduled operating hours,  $MLC$  is maintenance labor cost,  $MTTR$  is Mean Time to Repair, and  $MTTF$  is Mean Time to Failure. It allows a company to standardize its fleet for efficiency in training, operating, and maintaining (Schaufelberger 1999). [5]

Transportation is one of the important factors that is considered while calculating operating cost. This cost is neglected as a quantitative analysis.

### **3.1.1.3. Overhead Cost**

Overhead cost is getting differed based on the type of equipment and is rarely addressed. Overhead cost is related to storage, security and other direct costs. To the relationship of profitability, this cost is mentioned.

### **3.1.1.4. Profit**

Profit is the additional revenue gained by the private companies. Profit is maximized if the equipment is in proper operating condition, increasing availability hours, decreasing the accident rates. Profit can be calculated by the following formula.

Profit = (Incoming revenue-outgoing revenue-Repair costs-Preventive maintenance).

Day and Benjamin (1973) also introduced a "suitability" factor. This is a Calculation based on a common operating cost and differing ownership cost and Productivity. [6]

## **3.2. Acquisition Methods**

### **3.2.1. Rent**

There are plenty of rental companies are available in the market now a days with different capacities, capabilities, and efficiencies. Construction companies are executing works by renting equipment without the need of financial ability in purchasing the equipment. It is found that weekly rental charges are between 25-40% of monthly charges. The daily charges are 33% of weekly charges. The costs are 10-60% more than owning when compared to hourly charges.

### **3.2.2. Lease**

The term lease is differed from company to company. The lease is the long term contract with an option of purchase or returns the equipment to the final stage of the agreement. In general, the lease includes preventive maintenance in some forms breakdown return coverage. Leasing is done in long term contract equipment such as Tower cranes. It is the short time when compared with purchasing and long term compared to renting.

### **3.2.3. Owning**

Ownership is obtained when the equipment is purchaser whether by financing or by cash. The overall responsibilities of equipment such as all maintenance, transportation are included in ownership. Financing is the best method for owning the equipment instead of investing cash of high capital.

## **3.3. Rent-Lease-Buy Decision**

Rent-lease-Buy decision is complicated and required to consider several factors. Some factors are discussed in previous and further classified into two categories: they are quantitative and qualitative analysis.

### **3.3.1. Method to Decide**

One of the most common methods to decide is a comparison of hourly cost using different methods for the same equipment. Breakeven point method is one of the methods which make hourly rate comparison one step further. It shows required usage to identify the benefit of long term of Rent-lease-buy. Because the average hourly costs are not constant between the daily, weekly, monthly rents and with the lease and ownership options, the break-even method can be used to decide the optimum rental period for the given project use required.

## **3.4. Important Considerations to Owner**

There are several factors that are to be considered by the owner to increase the profitability: cost control and replacement decision are important of all. Minimizing the expenses is one of the major factors to protect the estimated project cost and project profit.

The cost control is implemented by identifying different factors. Standardization, preventive maintenance, policies, training, supervision, maintaining equipment records are some of the factors that are included in cost control. In replacing decision equipment, physical failure is not only time to replace the equipment. The calculation based on a common operating cost and differing ownership cost and productivity.

Where  $e_o$  is ownership cost.  $e_r$  is rate of return,  $k_v$  is operating cost,  $q_a$  is productivity.

The factors that are included in owning-leasing-Renting tool are listed in below table 3-1

**Table 3.1** Factors Included In Owning-Lease-Renting

Ownership		Rent	Lease	Own
	Depreciation			X
	Salvage value			X
	Tax Benefit			X
	Interest			X
	Insurance	X	X	X
	Tax/Licence			X
	Storage	N/I	N/I	X
OPERATING				
	Fuel	X	X	X
	Fog	X	X	X
	Maintenance Repair	INC	N/I	X
	Tires	X	X	X
	Special Items	X	X	X
	Operator	X	X	X
	Transportation	X	X	X
OTHERS				
	Overhead	X	X	X
	Profit	X	X	X

**Table 4-1** Factors That Influence Profitability of Equipment

Financial	Non-Financial
Oil	company goal
Fuel	Planning
Maintenance	Lag time due to procurement
Insurance	Prestige of company
Inspection	compatibility of staff for operations
External Revenue	Employee morals
Labour	Other investments
Breakdown	Budgeting
Selection of Equipment	

### 3.5. Maintenance Cost

The largest cost factor related to operating is maintenance cost. The maintenance cost is minimized by implementing preventive maintenance which will assist or indicates failure of equipment and reduces the corrective maintenance.

## IV. DATA COLLECTION AND ANALYSIS

The data is received from two different construction companies those are a private construction company and a Trust Based Organization construction. The similar equipment using by both companies are identified those are listed below:

- 1) Backhoe/Loader. - JCB
- 2) Excavator.-Hitachi
- 3) Dozer.-Hitachi
- 4) Fork Lift.-JCB

The following Financial Data is collected to Analysis data:

- 1) Purchase price.
- 2) Maintenance cost.
- 3) Working hours per day.

- 4) The environment of employment.
- 5) Hourly rents.
- 6) Weekly rents.
- 7) Monthly rents.

The collected data is analyzed by using several methods. The performance of equipment is directly related to profits of company; performance will be get varied from following factors.

#### 4.1. Rental Companies

Collecting data from four rental companies it is found that the rental charges include repair and maintenance cost. It does not include the charges of transportation for pick up and drop of equipment and insurance. The following table represents the average rates obtained through data collection from construction equipment rental companies. The average rates are converted into 160 hours for monthly. Data analysis from rental companies. Refer Table 4-2-1.

**Table 4-2-1** Analysed Data from Rental Companies

<b>Rent(Average)</b>						
<b>Model</b>	<b>Day</b>	<b>Day-Hrly</b>	<b>Week</b>	<b>Wk-Hrly</b>	<b>Month</b>	<b>Mn-Hrly</b>
	(8HRS)		(40HRS)		(160HRS)	
BACKHOE	Rs.6800	Rs.850	Rs.23800	Rs.595	Rs.54740	Rs.343
EXCAVATOR	Rs.8000	Rs.1000	Rs.28000	Rs.700	Rs.64400	Rs.403
DOZER	Rs.4800	Rs.600	Rs.16800	Rs.420	Rs.38640	Rs.242
FORK LIFT	Rs.3600	Rs.450	Rs.12600	Rs.315	Rs.28980	Rs.182

Lease rated provided without negotiations is same as monthly rates. It is important to observe that lease rates are equal to monthly rental rates is not covering the factors and values, lease maintenance is scheduled only for preventive maintenance.

The following Table 4-2-2 shows the purchase price of selected equipment.

**Table 4-2-2** Purchase from Dealer

<b>Model</b>	<b>Year</b>	<b>Purchase Price</b>
BACKHOE-3DX	2016	Rs.25, 68,750.
EXCAVATOR-EX110	2016	Rs.32,46,219
WHEELED DOZER	2016	Rs.22,54,964
FORK LIFT 1202	2016	Rs.15, 33,200.

The following 4-2-3 Table represents the Average annual usage hours, annual maintenance cost, and maintenance per hour cost in a private construction company.

**Table 4-2-3** Analysed Data from Private Construction Company

<b>Model</b>	<b>Quantity</b>	<b>Usage Hours</b>	<b>Maintenance Cost</b>	<b>1 Hour Maintenance Cost</b>
BACK HOE	1	946	Rs.2,97,685	Rs.314
EXCAVATOR	2	1365	Rs.10,07,645	Rs.738
DOZER	2	1832	Rs.17,21,010	Rs.939
FORK LIFT	1	713	Rs.1,83,810	Rs.258

#### 4.2. Trust Based Organization Construction

The organization provides 6 months data regarding equipment usage hours and maintenance cost on equipment. A total number of equipment available are not all in an active condition. Some equipment is inactive. Those in active equipment are neglected and considered as excess equipment. Equipment usage analysis from trusted organization is calculated as follows in 4-3-1.

**Table 4-3-1** Analysed Equipment Usage from Trusted organisation

Model	Qty	Item	6 Months Use(Hrs)	Avg Annual Use(Hrs)	Item Adjusted Annual Use	Annual Use(Hrs)	%
BACKHOE	8	1	3846	962	1099	57.10%	
EXCAVATOR	5	0	2963	1185	1185	61.70%	
LOADER	4	1	2132	1066	1421	74%	
FORKLIFT	2	0	1488	1488	1488	77.50%	

Table 4-3-2 represent Equipment maintenance cost from trusted organization.

**Table 4-3-2** Analysed Equipment Maintenance Cost from Trusted Organisation

Model	Qty	6 Months Maintenance	Annual Maintenance use (RS)	Maintenance Rs/Hr.
BACKHOE	7	Rs.1,22,408	856	286
EXCAVATOR	5	Rs.2,45,365	683	718
LOADER	3	RS.1,28,493	716	359
FORKLIFT	2	Rs.96,354	864	223

#### 4.3. Data Analysis

The data analysis include determining the equivalent time to purchase based on the average Rents, comparing average equipment usage between small private construction companies and Trusted organization constructions. Maintenance Comparison is done between Private constructions and trust-based organization. The Table 5-6 shows that the most equipment are less than 5 years of monthly rents would have purchased the same item. This analysis suggests the over expected life of the equipment. If the demand for equipment is equal or greater than the equipment time to purchase. Then it is better to purchase. Shown in 4-4-1.

**Table 4-4.1** Equivalent Time to Purchase Based on Average Rental Rates

Model	Rent(Average)		Purchase	Equivalent	
	Month	Month/Hr		Month	Year
BACKHOE	Rs.54740	Rs.343	Rs.25, 68,750.	47	3.9
EXCAVATOR	Rs.64400	Rs.403	Rs.32,46,219	50	4.1
LOADER	Rs.38640	RS.242	Rs.22,54,964	58	4.8
FORKLIFT	Rs.28980	Rs.182	Rs.15, 33,200.	53	4.4

Here is a comparison of average annual usage of construction equipment between small private construction company and trusted organization constructions. Shown in table 4-4-2.

**Table 4.4.2** Comparison of Usage Annual Hours

Model	Private Company	Trusted Organisation
BACKHOE	946	962
EXCAVATOR	1365	1185
LOADER	1832	1066
FORKLIFT	713	1488

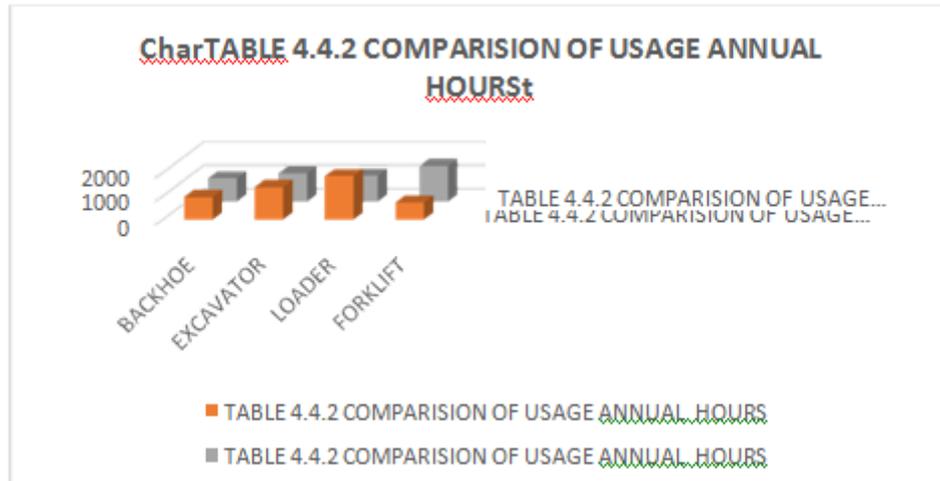


Figure 4-4-2 Chart

It is observed that the use of trusted organization is typically low, the use of Backhoe has almost same because backhoe is versatile equipment. Forklift is used more efficient in the organization because it is versatile and its fork can be replaced with loader, so it is utilized more efficient. A comparison of average maintenance cost is shown in Table 4-4-3. These costs are calculated for private constructions and trusted organization.

Table 4.4.3 Comparison of Average Maintenance Cost Per Hour

Model	Private Company	Trusted Organisation
BACKHOE	314	286
EXCAVATOR	738	718
LOADER	939	359
FORKLIFT	258	223

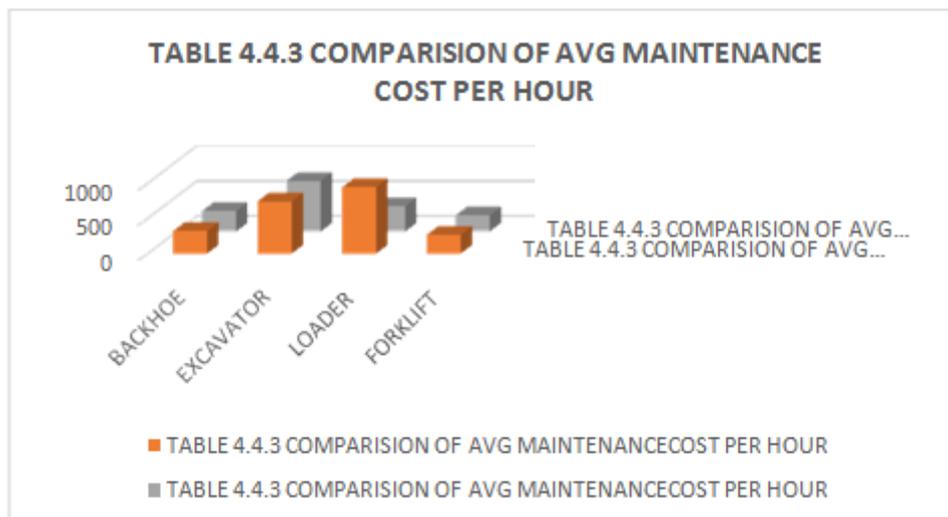


Figure 4.4.3 Chart

This data does not include any transportation requirements or any personal charges.

## V. RESULTS & DISCUSSION

The final result obtained development of a decision tool, Construction Equipment Profitability Optimization Model, This can be implemented for both private and public projects. A description of this study and results is applicable for small private constructions and public organizations. Construction Equipment Profit Optimization Method is the one of the best decision-making Tool for Equipment profitability. There are classified into two steps those are quantifying demand and identifying policies.

It is accepted that the hourly equipment production is one of the key factors in construction projects. It is also well known that the actual hourly production of the equipment differs from the nominal hourly production provided by the manufacturers.

It is observed that Rental charges are between 25% - 40% that of weekly Rental charges. The daily charges are about 33% of weekly charges.

The costs are 10-60% more than owning when compared to hourly charges.

When the working hour's requirement of equipment is more in project, hiring equipment for weekly or monthly is better than hiring per hours.

For short-Term (equipment requirement hours in the project is low) projects Renting is preferred by considering all parameters included above.

When the project is long-term (equipment requirement for several years) it is preferred to own the equipment.

A backhoe loader is the versatile equipment, which is used for multi purposes.

Compared to trusted organization, private constructions are maintaining and using equipment efficiently.

Note: Factors that are influencing the profitability of equipment are to be considered while bidding.

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