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Decision Making for Purchase/Rental of Road Construction Equipment based on Productivity and Owning & Operating Cost

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Abstract: ***Equipments being a primary requirement for any construction project still it needs major improve & research work. Such as pre-estimation accuracy for productivity and costs for it. Construction equipment is one of the biggest investments carried out in the construction industry. Almost 15-30% of the total project cost has been accounted towards plants and machinery.***
One must have knowledge about owning and operating cost and productivity before equipment utilization. First literature review has been made for understanding the factor affecting the O&O cost and productivity of the equipment.
Afterward, the 10 most used road construction equipment are selected and then the data is collected. Based on the data collected we find the O&O cost of equipment by its life, renting cost of equipment and productivity. Hence, by the value of this discussion, we can compare these three parameters we can arrive at the optimum solution of owning or renting the operational equipment to be utilized at any given construction site. Literature review section has been done in previous paper so this paper continues from data collection and data analysis.
Keywords: Road construction equipment, Productivity, Owning and operating cost, Renting of equipment

I. INTRODUCTION

It is a common fact that we find a wide variety of construction equipments on every construction sites, which make the construction jobs easy, safe and quicker. Good project management in construction must vigorously pursue the efficient utilization of labor, material, and equipment. The use of new equipment and innovative methods has made possible wholesale changes in construction technologies in recent decades. The selection of the appropriate type and size of construction equipment often affects the required amount of time and effort and thus the job site productivity of a project. These act as a backbone in the case of huge construction projects. Proper use of the appropriate equipment contributes to the economy, quality, safety, speed and timely completion of a project.

A. Need for Study

Construction equipment is one of the biggest investments carried out in the construction industry. Almost 15-30% of the total project cost has been accounted for plants and Machinery. [1] One must have Knowledge about owning and operating cost and productivity (25% less than given in the company's manual) [2] before equipment utilization. Also, monitoring of actual owning and operating cost of equipment on a regular basis is necessary for profitability. Fact is, even today many of the contractors aren't well educated and hence they can't decide whether to own or rent the equipment for fulfilling the needs in the construction project. Also, they are unable to judge whether owing will be profitable or renting.

B. Aim

1) Aim of the study is to make a decision whether to own an equipment or rent it for a road project.

C. Objective

1) Identify different types of road construction equipment.
2) Perform the analysis needed to determine the productivity of given construction equipment.
3) Find out owning & operating cost and compare with the renting cost of equipment.
4) To decide whether to go for owning or renting of an equipment.

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II. DATA COLLECTION

A. *List of equipment used for this study.*

TABLE 1 list of equipment

List of equipment used for this study	
1	Excavator
2	The backhoe loader
3	Road(tandem) roller
4	Asphalt mixing plant
5	Paver
6	Concrete plant
7	Tipper truck (dumper)
8	Motor Grader
9	Compact front end loader
10	Bitumen Sprayer

B. *Data collection for Excavator*

TABLE 2 O&O data of excavator

Excavator		
Types of cost	O&O cost	Remark
Model of equipment	Cat 110	
Initial cost	29,25,000 ₹	On road price including all taxes
Maintenance cost	1,50,000 ₹	It requires six service per year
Operator and helper cost	20,000 ₹/month	
Fuel cost	1234800 ₹	7-liter use per hour considering 7 hours daily usage
Insurance cost	70,000 ₹	
Storage cost	20,000 ₹	
Tyre cost	-	
Cost of replacing high-wear items	25,000 ₹	
Cost of mobilization, demobilization, and assembly	20,000 ₹	Considering 1 mobilization per year up to 150km
Total cost (yearly)	45,50,825 ₹	

Table 3 productivity data for excavator

Data required for productivity	Data
Bucket capacity	1.5 m^3

As per above for all equipment data is collected shown in below table

Table 4 O&O cost of all equipment

Equipment name	**Total cost (yearly)**	**Rent of equipment**	**Data require for productivity**
Excavator	4,550,825 ₹	1200 ₹/ hour	Bucket capacity= 1.5 m3
Backhoe loader	40,48,400 ₹	700 ₹/hour	Front bucket capacity = 1.1 m3 Back bucket capacity = 0.24 m3
Road roller	4,987,800 ₹	900 ₹/hour	Width = 1.6 mt, Speed = 3 kmph Thickness = 90 mm, Passes = 4
Asphalt mixing plant	7,464,000 ₹	100 ₹ per ton	This plant able to produce a maximum of 90 ton per hour
Paver	6,379,800 ₹	1500 ₹/hour	Hot mix plant production = 90 tph Paving thickness = 110 mm Paving width = 3.5 m Density of material = 2.2 ton/m3 Volume of material per km =385 m3/km Weight of material per km = 847 t/km Speed of paver = 100 m/hr.
Concrete plant	5,415,000 ₹	300 Rs /cum	Cp-30 plant is able to produce a maximum of 30 m3 of concrete per hour.
Tipper truck	4,376,500 ₹	4000 ₹/day	Truck capacity = 20 ton Bucket filling the truck = 3 m3[6 to 7buckets] Loading time = 3-3.5 min Haul time = 50 min [30km distance and 35kmph speed] Return time = 30min [30km distance and 55kmph speed] Dump time = 2min
Motor grader	11,586,000 ₹	200,000 ₹/month	Passes have to made = 6 Speed = 5 kmph For distance = 1 km
Compact front end loader	1,432,000 ₹	1500 ₹/day	Bucket capacity = 1 m3
Bitumen sprayer	1,115,200 ₹	40,000 ₹/day	Tank capacity = 6000 liters Width = 3.5 m Quantity require for tack coat = 0.5kg/m2

III. DATA ANALYSIS

A. Data analysis for Excavator

1) Productivity of excavator

Assumption

a) Daily working hour is 8hr

b) Working at a minimum efficiency of 40 min per 60 min.

c) For bucket capacity of 1.5m3, fill factor 70%

d) cycle time of 30 seconds including loading bucket

$$\text{PRODUCTION RATE} = \frac{3600\ \text{Sec} * \text{Bucket capacity} * \text{Fill factor}}{\text{Cycle time}} \times \frac{\text{work min}}{\text{hour}}$$

TABLE 5 productivity of excavator

PRODUCTIVITY	**DATA**
Bucket capacity	1.5 M3
Production rate	**84 cum / hr**

$$\text{PRODUCTION RATE} = \frac{3600\ \text{SEC} * 1.5 * 70\%}{30\ \text{SEC}} \times \frac{40}{60}\ \text{cum / hr}$$

2) Rate of excavator from CPWD SOR

TABLE 6 rate of CPWD SOR

Description	**Unit**	**Total rate**
Hydraulic Excavator (3D) with driver and fuel	Day	6500.00 Rs
Adding 15 % Contractor's profit and overheads		**7475.00 Rs**

TABLE 7 difference between O&O cost and rent cost

Description	For O&O	For Rent
Daily production	672 cum	672 cum
Per day rate	7475.00 Rs	13520.00 Rs
Monthly rate	224250.00 Rs	405600.00 Rs
Working year to cover total cost of equipment	7.36 year	4.12 year
Economical up to	18,05,437 cum	

TABLE 8 excavator result table

Life of excavator	12 year	Working year
Total cost by life	20,082,800 Rs	12
Rent cost of 7.36 year	35,822,592 Rs	7.36 year
Difference	3,657,616 Rs	4.12 year

B. *As per above data analysis for all the equipment*

Equipment	Life of equipment	Total O&O cost by life	Productivity	Economical up to year by Rent
Excavator	12 year	20,082,800 Rs	84 cum / hr	4.12 year
Backhoe loader	12 year	18,825,800 Rs	61 Cum / hr 13.44 Cum / hr	5.83 year
Road roller	8 year	14,247,400 Rs	72 m^3 / hr	3.57 year
Asphalt mixing plant	18 year	35,280,000 Rs	63 tph	1.94 year
Asphalt paver	12 year	27,057,600 Rs	40 m^3/hr	4.7 year
Tipper truck (dumper)	12 year	16,765,000 Rs	117 ton/day	6.84 year
Concrete plant	18 year	30,610,000 Rs	21 cum/hr	1.68 year
Motor grader	10 year	11,586,000 Rs	1585 m^2/hr	1.45 year
Compact front end loader	10 year	1,432,000 Rs	56 m^2/hr	1.52 year
Bitumen sprayer	10 year	8,144,200 Rs	9000 m^2/day	6.78 month

IV. CONCLUSION

From this research, it is concluded that: Excavator's total O&O cost by its life is 20,082,800 Rs and productivity is 84 cum/hr and for renting of the excavator it is economical up to 4.12 year. Backhoe loader's total O&O cost by its life is 18,825,800 Rs and productivity is 61 cum/hr for a front bucket and 13.44 cum/hr for a back bucket and for renting of backhoe loader it is economical up to 5.83 years. Road roller's total O&O cost by its life is 14,247,400 Rs and productivity is 72 cum/hr and for renting of road roller it is economical up to 3.57 year. Asphalt mixing plant's total O&O cost by its life is 35,280,000 Rs and productivity is 63 tph considering 70% efficiency and for renting of Asphalt mixing plant it is economical up to 1.94 years. Asphalt paver's total O&O cost by its life is 27,057,600 Rs and productivity is 40 cum/hr and for renting of asphalt paver it is economical up to 4.7 years. Tipper truck's total O&O cost by its life is 16,765,000 Rs and productivity is 117 ton/day and for renting of tipper truck it is economical up to 6.84 years. Concrete plant's total O&O cost by its life is 30,610,000 Rs and productivity is 21 cum/hr considering 70% efficiency and for renting of concrete plant it is economical up to 1.68 years. Motor grader's total O&O cost by its life is 11,586,000 Rs and productivity is 1585 m^2/hr and for renting of motor grader it is economical up to 1.45 year. Compact front end loader's total O&O cost by its life is 1,432,000 Rs and productivity is 56 cum/hr and for renting of compact front end loader it is economical up to 1.52 year. Bitumen sprayer's total O&O cost by its life is 8,114,200 Rs and productivity is 9000 m^2/day and for renting of road roller it is economical up to 6.78 months.

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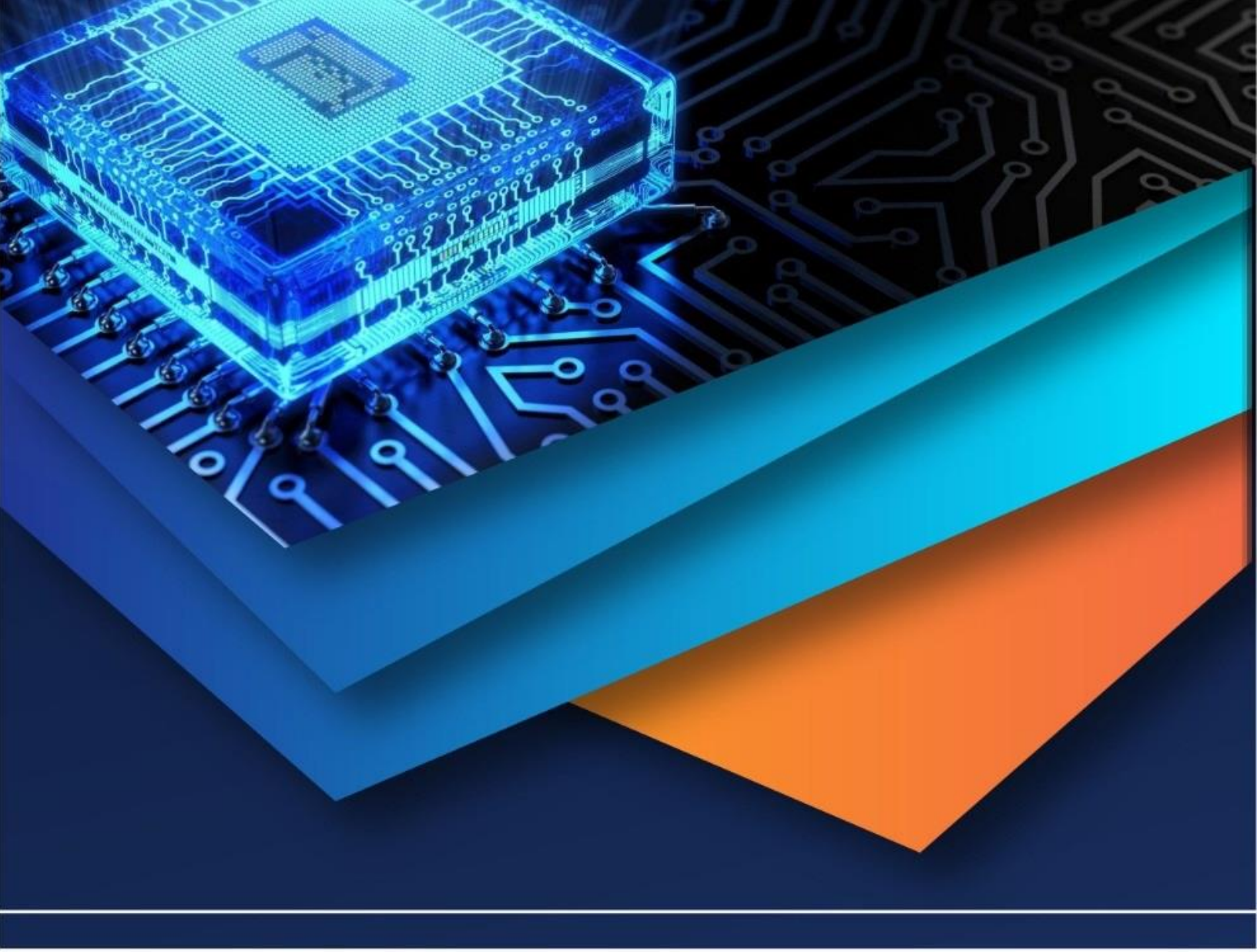

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