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Equipment Management in Construction

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Abstract:
This thesis is to study the equipment management practices in construction industry and to present the most popular practices of the contractors and to compare the equipment management policies.

CHAPTER 1
INTRODUCTION
1.1.GENERAL

In the past, people used to live in mud-brick houses and goat, sheep, or camel hair tents and used animals for transportation. Today, they live and work in buildings made of modern materials and use modern transportation facilities to move from one location to another. Highways, roads, and airports and seaports with terminals have been constructed to ease transportation. The government has also built other necessary infrastructures such as hospitals, and utilities.

These and future developments necessitate construction industries to import needed resources, among which is construction equipment. This equipment constitutes a major resource in the construction process of building projects, especially those that are machine intensive such as highways and engineering. This equipment is very expensive comprising 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. The increased size and cost of equipment and the existence of economic factors such as inflation, obsolescence and interest rates have complicated decision analysis of equipment problems. This complicated environment calls for proper management of this asset to optimize the rate of investment and eventually improve profits. Some contractors have developed a uniform equipment policy from which established rules and procedures are drawn for prudent management of their equipment.

Although many researchers have addressed construction equipment, the majority has concentrated on how to improve productivity via engineering modifications. Very few researchers have paid serious attention to equipment management.

The use of equipment in Construction is of recent origin. The necessity of mechanization in construction has been felt due to a variety of reasons such as

- Large size of projects involving huge quantities of materials to be handled.
- Complex design involving high grade concrete
- Shortage of skilled manpower
- Funding agencies, such World Bank and ADB make the use of sophisticated construction equipment a mandatory requirement.

Mechanizations in construction have become necessary at present juncture due to the following reasons.

- Large size of the projects involving huge quantities of material to be handled
- Complex designs
- Quality of work demands special equipment to be used for the project
- Shortage of skilled manpower
- Funding agencies
- Time limits
- Competency among the industries

1.2. OBJECTIVE OF THIS PROJECT

The Objective of this thesis is to investigate the equipment management practices followed by major construction companies in India and to compare these results with another construction company.

1.3. FUNCTIONAL CLASSIFICATION OF CONSTRUCTION EQUIPMENT

1.4.1. Earthwork Equipment

- Excavation and lifting equipment—back actor (or backhaul, face shovels, draglines, grata or clamshell and trenchers.
- Earth cutting and moving equipment—bulldozers, scrapers, front-end loaders
- Transportation equipment—tippers dump truck, scrapers rail wagons and conveyors.
- Compacting and finishing equipment—tamping foot rollers, smooth wheel rollers, pneumatic rollers, vibratory rollers, plate compactors, impact compactors and graders.

1.4.2. Materials Hoisting Plant

- Mobile cranes—crawler mounted, self-propelled rubber-tired, truck-mounted.
- Tower cranes—stationary, travelling and climbing types.
- Hoists—mobile, fixed fork-lifts.

1.4.3. Concreting Plant & Equipment

- Production equipment-batching plants, concrete mixers.
- Transportation equipment—truck mixers, concrete dumpers
- Placing equipment—concrete pumps, concrete buckets, elevators, conveyors, hoists, grouting equipment.
- Pre-casting special equipment—vibrating and tilting tables, battery moulds, surface finishes equipment, pre-stressing equipment, GRC equipment, steam curing equipment, shifting equipment.
- Erection equipment.
- Concrete vibrating, repairing and curing equipment,
- Concrete laboratory testing equipment.

1.4.4. Support and Utility Services Equipment

- Pumping equipment.
- Sewage treatment equipment.
- Pipeline laying equipment.
- Power generation and transmission line erection equipment.
- Compressed air equipment.
- Heating, ventilation and air-conditioning (HVAC) equipment.

- Workshop including wood working equipment.

1.4.5. Special Purpose Heavy Construction Plant

- Aggregate production plant & rock blasting equipment
- Hot mix plant and paving equipment.
- Marine equipment.
- Large-diameter pipe laying equipment.
- Piles and pile driving equipment,
- Coffer dams and caissons equipment.
- Bridge construction equipment.
- Railway construction equipment.
- Equipment procurement
- Equipment resources play a major role in construction activity.
- Provide the right equipment at the right time and place so the work can be accomplished at the lowest cost that yields maximum production.
- Understanding the costs associated with a particular piece of equipment.

1.5.SUMMARY OF EQUIPMENT SELECTION CONSIDERATIONS

Selection of an equipment or plant system to perform an assigned task depends upon many interrelated factors. These factors, are outlined below

1.5.1. Task Considerations

- Nature of task and specifications.
- Daily or hourly forecast of planned production.
- Quantity of work and time allowed for completion.
- Distribution of work at site. .

1.5.2. Site Constraints

- Accessibility to location.
- Maneuverability at site.
- Working space restrictions.
- Altitude and weather conditions.
- Working season and working hours.
- Availability of local resources of manpower, materials and equipment.
- Availability of land, power supply and water supply.
- Availability of equipment hiring, repair and maintenance faculties locally.
- Availability of fuel, oil and lubricants.

1.5.3. Equipment Suitability

- Type of equipment considered suitable for the task.
- Make models and sizes of special purpose, and general purpose equipment that can handle the task.
- Production capability, serviceability condition and delivery time of each equipment
- Equipment already owned by the contractor.
- Usefulness of the suitable equipment available for other and future task

1.5.4. Operating Reliability

- Manufacturer's reputation.
- Equipment components, engine-transmission, brakes, steering operator's cabin
- Use of standard components.
- Warranties and guarantees.
- Vendor's after-sale service.
- Operator's acceptability, adaptability and training requirements.
- Structural design.
- Preventive maintenance program.
- Safety features.
- Availability of fuel, oil and lubricants.

1.5.5. Maintainability

- Ease of repair and maintenance.
- Vendor's after-sale service, repairs, spares and maintenance.
- Availability of spare parts.
- Standardization consideration.

1.5.6. Economic considerations

- Owning costs.
- Operating costs.
- Re-sale or residual value after use.
- Replacement cost of existing equipment

1.5.7. Commercial Considerations

- Buy second-hand or new equipment.
- Rent equipment.
- Hire-purchase equipment.
- Purchase or lease

CHAPTER 2
LITERATURE REVIEW

This chapter presents an overview of literatures collected from various journals. The most noteworthy of them which are relevant to the current study are being reviewed.

Tavakoli A, Taye E.D. and Erktin, M (1989) examined the results of a questionnaire survey that reports the construction equipment policy in the Engineering News Record rated top 400 construction companies are presented. Special attention is paid to equipment financing, replacement analysis, equipment standardization, safety, and maintenance management. The questionnaire responses are cross-tabulated in regard to annual volume and type of construction (heavy versus non heavy)

Prabhu Kumar T K (2002) reported that activity in construction industry has growth to such an extent that it is no longer feasible to depend on manual labour only. Size of projects and time constraints need large scale mechanization. He takes a look at the various types of equipment needed on construction sites, method for selection, management and maintenance for smooth progress

Reddi S A (1995) studied and reported about the progressive mechanization, criticality of management requirements, planning and scheduling, operational research techniques safety aspects and costs of equipment in construction industries

Aviad Shapira & Marat Goldenberg (2005) reported that selection of equipment for construction projects, a key factor in the success of the project is a complex one. Current model offered by the literature fail to provide adequate solution for two majour issues: the systematic evaluation of soft factors and the weighting of soft benefits in comparison with costs. A selection model based on Analytic Hierarchy Process (AHP), a multi attribute decision analysis method with a view to providing solutions for two major issues: the systematic evaluation of soft factors and the weighting of soft benefits in comparison with cost.

Ittiphol Bhurisith and Ali Touran (2002) studied and observed that the change in productivity is studied for six different pieces of earthmoving equipment over a period of 15 years. It is shown that the production rate of this group of equipment has increased 1.58% on average per year. During the same period, without adjusting for inflation and making specific assumptions, the unit price of production has increased at an average rate of 1.77% per year. The results of this analysis may be used in modeling obsolescence costs in equipment replacement analysis.

V Kyong Ju Kim & Kyoungmin Kim (2011) examined to evaluate the effects of traffic flow of construction equipment. A large construction project requires large quantities of construction equipment. This volume can result in traffic congestion in the flow of construction equipment, which also lowers the overall efficiency of construction operations. This study applies a multi agent-based simulation modeling approach to a real project. Through a case study, this study evaluates how traffic flow of construction equipment influences the efficiency of that equipment in construction operations and, moreover, the schedule of a project.

Shlomo Selinger (1983) studied and examined that, Mathematical models are available for determination of the economic service life of earthmoving and transportation equipment. Regular equipment for building construction, such as tower cranes, hoists, concrete production plants, stationary concrete pumps, etc., differ from the former in several regards, mainly in that they are operating in conjunction with labor crews and their production rate is dictated by that of the latter. These differences, and the consequent modeling modifications called for, are discussed. The analysis emphasizes the general aspects of findings and certain elements of proposed models.

Cliff J. Schexnayder & Scott A. David (2002) studied reported that, the development of construction equipment has followed the major changes in global transportation Development of the steam shovel was driven by a demand for an economical mass excavation machine to support the era of railroad construction. The Cummins diesel engine was developed in the early 1900s as the road-building phase of transportation construction began. In the short term, the basic machine frame will not change, but productivity, accuracy, and utility should improve because of enhancements

Marat Goldenberg and Aviad Shapira (2007) studied and examined that, selecting the right equipment for the project is inherently a multifaceted cost and benefit evaluation process that is further compounded by the complexity of today's building projects and the lack of systematic tools for the consideration of soft factors. The method enables project managers and their equipment selection teams to exercise their knowledge, intuition, and professional judgment, and at the same time to address the context and specifics of the particular projects under examination

John Whittaker (1986) studied and observed that, the revenue requirements method which is used by utility companies for determining rates applied to the problem of determining rates for construction equipment. The method follows engineering economy principles and explicitly considers operating costs, recovery and return of capital and income taxes. By expressing the result as the required before-tax revenue that a piece of equipment must generate, the method is intuitively appealing and easily comprehended by management.

Michael C. Vorster and Glenn A. Sears (1986) studied and observed that, Retirement and replacement models for construction equipment have been based on the notion that there is an optimum time to sell a piece of equipment to the competition. One problem with these models is that they do not explain why one's competition may have a need for the equipment when one does not. The model presented here looks at the consequential costs of downtime for each piece of equipment when assigned to specific applications. Old and unreliable equipment therefore carries a significant consequential downtime cost when used in a key production application. Likewise, new and reliable equipment carries a significant capital recovery cost, which makes it less desirable in applications where consequential costs of downtime are low.

Thanapun Prasertrungruang, B.H.W. Hadikusumo, (2007) studied to investigate the current practices and problems in heavy equipment management as well as to identify practices capable of alleviating equipment management problems for highway contractors in Thailand. He had observed that Equipment management practices were identified and analysed by SPSS using a questionnaire survey. ANOVA test was used to reveal significant differences in equipment management practices among different contractor sizes. Relationships between equipment management practices and problems were also revealed.

David J. Edwards, Gary D. Holt, (2009) A thematic review of CPeM academic literature (in the main, refereed journal papers published in English-speaking countries over the last decade) is undertaken; the nature of identified themes is discussed, for instance, regarding why they might have evolved as they have; and based on the foregone, themes for future research in the field are proffered.

2.1 Volvo Excavator 240 BLC

Specifications:	
Bucket Capacity	1.10 Cum
Engine Capacity	168 HP
Swing	360 Degree
Oil change	250 - 500 Hrs Depending upon the oil quality
Type of Coolant	Glycol Based
Weight	24 Tonne
Diesel Consumption	12 Ltr/Hr
Dimensions of the bucket:	
Length	1.39 m
Breadth	1.01 m
Height	0.87 m
Cost of Machinery	Rs.69,14,076/-
Purpose:	
Digging	
Loading	
Leveling to some extent	
Suitable For:	
It will be working in both dry and marshy land.	
Merits:	
Since it can be rotated to 360 degree, efficiency of the machine is much higher.	
The powerful boom can take more load while lifting.	
Tugging and towing of vehicles, stuck in mud.	
The machine will be ideal for all site conditions.	
Economical for large scale work.	
Demerits:	
Efficiency reduces when the depth of the marshy land is more than 1 feet.	

2.2 VOLVO EXCAVATOR 210 BLC

Specifications:	
Bucket Capacity	0.90 Cum
Engine Capacity	143 HP
Swing	360 Degree
Oil change	250 - 500 Hrs Depending upon the oil quality
Type of Coolant	Glycol Based
Weight	21 Tonne
Diesel Consumption	12 Ltr/Hr
Dimensions of the bucket:	
Length	1.17 m
Breadth	1.07 m
Height	0.84 m
Cost of Machinery	Rs.57,95,995/-
Purpose:	
Digging	
Loading	
Levelling to some extent	
Suitable For:	
It will be working in both dry and marshy land.	
Merits:	
Since it can be rotated to 360 degree, efficiency of the machine is much higher.	
The powerful boom can take more load while lifting.	
Tugging and towing of vehicles, stuck in mud.	
The machine will be ideal for all site conditions.	
Demerits:	
Efficiency reduces when the depth of the marshy land is more than 1 feet.	

2.3 Caterpillar Loader CAT 950 H

CATERPILLAR LOADER CAT 950 H

Specifications:	
Bucket Capacity	3.2 Cum
Engine Capacity	216 HP
Swing	
Front Bucket End	37 Degree
Rear Bucket End	21 Degree
Oil change	250 - 500 Hrs Depending upon the oil quality
Type of Coolant	Glycol Based
Weight	23,445 Kg
Tipping Load	11,302 Kg
Straight Load	12,883 Kg
Diesel Consumption	18 Ltr/Hr
Dimensions of the bucket:	
Length	2.77 m
Breadth	1.20 m
Height	0.84 m
Cost of Machinery	Rs.95,41,306/-
Purpose:	
Digging to some extent	
Loading	
Levelling	
Transporting	
Suitable For:	
It can work in dry and marshy land.	
Merits:	
Loader bucket has got very high capacity and hence it can carry more load.	
The machine will be ideal for all site conditions like irregular, temporary roads, etc.	
Demerits:	
Efficiency reduces when the depth of the marshy land is more than 1 feet.	

2.4 CATERPILLAR DOZER D6G

Specifications:	
Engine Capacity	160 HP
Oil change	250 Hrs
Type of Coolant	Glycol Based
Operating Weight	15,780 Kg
Cost of Machinery	Rs.72,68,971/-
Dozing	24,000 Kg/ 2.5Km/Hr
Diesel Consumption	15 Ltr/Hr
Purpose:	
Dozing	
Levelling	
Surface Trimming	
Suitable For:	
It will be working in both dry and marshy land.	
Merits:	
The machine will be ideal for all site conditions.	
It has got very high dozing power	
Demerits:	
Efficiency reduces when the depth of the marshy land is more than 1 feet.	

2.5 VIBRATORY ROLLER - IR SD110/F

Specifications:	
Operating Weight	11,640 Kg
Engine Capacity	106 HP
Swing	40 Degree
Oil change	250 Hrs
Type of Coolant	Glycol Based
Cost of Machinery	Rs.32,72,033/-
Frequency of Vibration	0 - 30 Hz
Diesel Consumption	6.40 Ltr/Hr
Purpose:	
Soil Compaction with vibration	
Suitable For:	
It will be working in both dry and wet land, but not in marshy land.	
Merits:	
A high degree of compaction can be attained through the use of the roller.	
The operating weight is very high and hence the compaction is attained mainly due to self weight of the roller.	
The vibration of the roller can be controlled depending upon the specific requirement of the subgrade.	
Demerits:	
It cannot be used in hot mixes, since the wheels will get damaged.	
If the land is marshy, this equipment cannot be used.	
Roads with uneven boulders can damage the drum, when operated in vibratory mode.	

2.6 HINDUSTAN 2021BAR FRONTED LOADER

Specifications:	
Bucket Capacity	2.60 Cum
Engine Capacity	124 HP
Swing	21 Degree (Front Bucket End)
Oil change	250 Hrs
Type of Coolant	Glycol Based
Weight	12,135 Kg
Diesel Consumption	8 Ltr/Hr
Dimensions of the bucket:	
Length	2.30 m
Breadth	1.02 m
Height	0.70 m
Cost of Machinery	Rs.45,00,000/-
Purpose:	
Digging to some extent	
Loading	
Levelling	
Transporting	
Suitable For:	
It will be working in both dry and marshy land.	
Merits:	
The machine will be ideal for all site conditions.	
Loader Bucket has got medium capacity and hence it can carry medium loads.	
Demerits:	
Efficiency reduces when the depth of the marshy land is more than 1 feet.	

2.7 TIPPER TATA HYVA 2516 C (6 X4)

Specifications:	
Engine Capacity	111.8 KW
Oil change	9000 Km (250 Hrs)
Type of Coolant	Glycol Based
Capacity	16 Cum
Operating weight	25,000 Kg
Cost of Machinery	Rs.18,97,465/-
Diesel Consumption	3.75 Km/Ltr
Purpose:	
Transporting of materials & tipper applications	
Suitable For:	
It will be working in both dry and wet land, but not in marshy lands.	
Merits:	
It can carry materials to a long distance with mileage.	
Stacking of materials in a heap can be done easily.	
Four wheel drive enables to drive through moderate marshy lands as compared to normal tippers.	
Demerits:	
If the land is too marshy, tipper cannot be used.	
Flat bed applications not possible, as only backside are openable.	

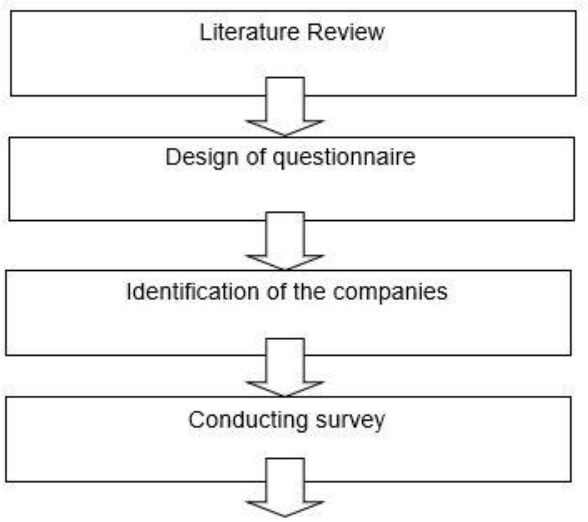
2.8 CATERPILLAR GRADER - CAT 120H

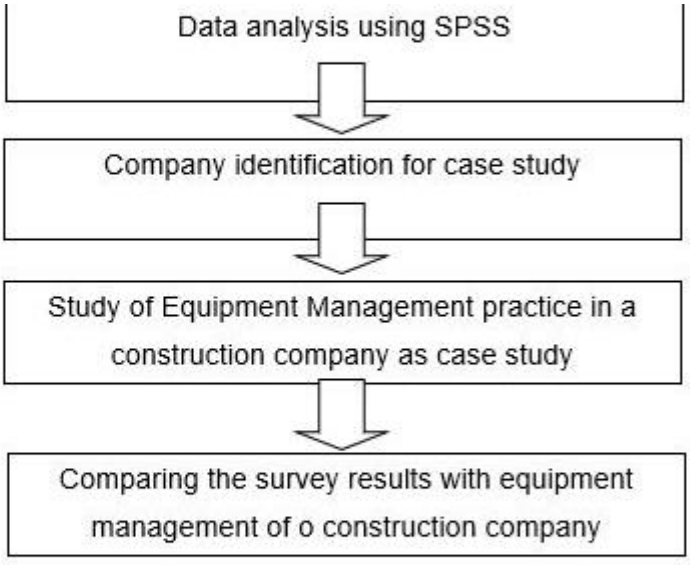
Name	Grader
Make	Caterpillar
Model No.	120 H
Capacity	12 Ft Blade

Specifications:	
Engine Capacity	125 HP
Oscillation Angle	32 Degree
Circle Drive	360 Degree
Wheel Lean Angle	18 Degree
Steering	50 Degree
Articulation Angle	25 Degree
Turning Radius	7.2 m
Operating Weight	11,358 Kg
Type of Coolant	Glycol Based
Maximum Forward	42.6 Km/Hr
Maximum Speed Reverse	33.7 Km /Hr
Cost of Machinery	Rs.1,25,00,000/-
Diesel Consumption	12 Ltr / Hr
Purpose:	
Grading	
Levelling	
Suitable for:	
Can work in specified dry, wet and slightly marshy lands.	
Merits:	
Since it can be rotated to 360 degree, efficiency of the machine is much higher.	
Demerits:	
Efficiency reduces when the depth of the marshy land is more than 1 feet.	

CHAPTER 3
METHODOLOGY
3.1.GENERAL STEPS

Table: 3.1 Steps of methodology





3.2.DESIGN OF QUESTIONNAIRE

Developing the structured questionnaire, this was divided into three sections.

- General information about the company such as, its size and the value of its equipment fleet etc.
- Information related to the contractor's practices in equipment acquisition, equipment economics, replacement, operation and maintenance, record keeping and standardization.
- Miscellaneous questions on safety policy, classification methods and the utilization of computers for the management of equipment.

3.3.COMPANY IDENTIFICATION

Companies for questionnaire survey are mainly classified three levels I, II, III on the basis of their

- Characteristics of the company
- Experience
- Types of work performed
- Owned value

3.4.QUESTIONNAIRE ANALYSIS

Collected data to be analyzed using statistical tools analysis method, SPSS (Statistical Package for Social Science) is a statistical analysis and data management software package. SPSS can take data from almost any type of file and use them to generate tabulated reports, charts, and plots of distribution and trends, descriptive statistics, and conduct complex statistical analyses.

3.5 SURVEY RESULT AND INFERENCE

A total of 18 responses were received for our questionnaires. Therefore a total of 8, 5 and 5 completed questionnaires were received from the level I, level II and Level III companies respectively. The received data's were analyzed using SPSS software

Table: 3.2 INITIATION OF EQUIPMENT INVESTMENT PROPOSALS ORGANIZATIONAL LEVEL		
	Frequency	Percent
Headquarters	8	47.1
Project Manager	10	52.9
Total	18	100.0

Many companies stated that project managers are usually charged with the responsibility of making requests for equipment investments on their respective projects.

Table: 3.3 ARE EQUIPMENT PROPOSAL ALTERNATIVES SEARCHED?		
	Frequency	Percent
Yes	8	47.1
Net cash flows	4	17.6
No response	6	35.3
Total	18	100.0

Acquisition process is to identify alternatives to satisfy the identified need. The results indicate that almost all the companies consider alternatives to investment proposals that are evaluated quantitatively and qualitatively.

Table: 3.4 FINANCING TYPE UTILIZED		
	Frequency	Percent
Outright purchase	8	47.1
Short term bank loans	4	23.5
Long term bank loans	3	17.6
Service leases	3	11.8
Total	18	100.0

Table:3.5 EQUIPMENT BUYING DECISIONS		
	Frequency	Percent
Full economic utilization	11	65
Less cost of using equipment	3	17
Increase in company assets	4	18
Total	18	100.0

While companies rent or lease needed equipment for testing before buying, the results indicated that companies directly purchase necessary equipment to replace old equipment.

Table: 3.6 DEPRECIATION ACCOUNTING METHOD		
	Frequency	Percent
Straight line method	8	41.2
Percent of life	10	58.8
Total	18	100.0

The results indicated that the majority of the participants do depreciate their equipment for pricing and taxes on the equipment. The most popular methods for depreciating equipment are the straight-line method (level I) and the percentage of life method (level II and III).

Table: 3.7 FACTORS DETERMINING ECONOMIC LIFE		
	Frequency	Percent
Depreciation and replacement costs	5	29.4
Maintenance and repair costs	10	58.8
Downtime costs	3	12
Total	18	100.0

It seems that the major decisive factor in determining the economic life of equipment is maintenance and direct and indirect repair costs. Determining the economic life of equipment is not only important for the equipment replacement decision process, it is also important for calculating annual equipment depreciation.

Table: 3.8 FREQUENCY OF UNDERTAKING ROUTINE MAINTENANCE		
	Frequency	Percent
Periodically	13	71
Whenever the machine needs	5	29
Total	18	100.0

The majority of the companies indicated that maintenance is performed periodically for all their equipment.

Table: 3.9 TYPE OF ROUTINE MAINTENANCE		
	Frequency	Percent
Preventive	11	65
Scheduled	7	35
Total	18	100.0

Preventive and scheduled maintenance are found to be the most popular programs among the majority of the companies.

Table: 3.10 REPLACEMENT TIME		
	Frequency	Percent
Economic study	2	5.9
Inefficient equipment	12	70.6
Usually replace before major overhaul	2	11.8
Good financial position	2	11.8
Total	18	100.0

The companies use different methods for determining the proper replacement time. Most of the companies replace equipment when it becomes inefficient.

Table: 3.11 INFLUENCE OF OBTAINABLE SALVAGE VALUE		
	Frequency	Percent
Yes	3	11.8
No	4	23.5
Sometimes	11	64.7
Total	18	100.0

Table: 3.12 FREQUENCY OF REPLACEMENT		
	Frequency	Percent
High competition	4	11.8
Low competition	2	16.8
No change	12	70.6
Total	18	100.0

The optimum replacement time for equipment is determined by various methods. The results indicated that the most popular method is to replace it when the cost for necessary repairs becomes too high.

Table: 3.13 REPLACEMENT DECISION ANALYSIS		
	Frequency	Percent
Formal economic analysis	7	35.3
Experience and formal analysis	11	64.7
Total	18	100.0

The participating companies indicated that they perform economic analysis before deciding to replace equipment. Experience and formal analysis play a major role in replacement decision analysis

Table: 3.14 METHOD OF DISPOSITION		
	Frequency	Percent
Trade to dealer	5	23.5
Auction sale	4	23.5
Sell to third parties	9	52.9
Total	18	100.0

Table: 3.15 FACTORS IN REPLACEMENT ANALYSIS		
	Frequency	Percent
Downtime cost	9	52.9
Obsolescence	4	23.5
Depreciation	5	23.5
Total	18	100.0

The effects of many factors, such as inflation, downtime costs, obsolescence, depreciation, taxes, and time value of money, are considered in the replacement analysis. The most influential factor that a company uses to make replacement decisions is downtime costs. This is followed in importance by depreciation and obsolescence costs. In addition, the results indicated that most of the companies are of the opinion that the obtainable salvage value (net resale price) has an influence on the replacement decision. It seems that contractors sell old equipment if an attractive price is offered.

Table: 3.16 METHOD OF STANDARDIZATION		
	Frequency	Percent
By brand	12	64.7
By engine family	6	35.3
Total	18	100.0

Table: 3.17 DISADVANTAGE OF STANDARDIZATION		
	Frequency	Percent
Higher competition	12	70.6
Dealer rejection	6	29.4
Total	18	100.0

Table: 3.18 ADVANTAGE OF STANDARDIZATION		
	Frequency	Percent
Savings in spare parts	7	41.2
Lower maintenance cost	4	23.5
Lower operation cost	2	11.8
Better safety	2	11.8
Better dealer relationship	2	5.9
Easier administration	1	5.9
Total	18	100.0

The utilization of equipment with identical components is a desire for many companies for spare parts, storage, repairs, etc. More than two-thirds of the companies standardize their equipment. The results indicate that the most popular standardization methods among companies are purchasing from one manufacturer and purchasing the same family of engines.

Table: 3.19 SECTION OF WRITTEN POLICY		
	Frequency	Percent
Usage	2	11.8
Maintenance	2	11.8
Cost-production record	2	5.9
Operators	2	11.8
Security	5	29.4
Standardization	5	29.4
Total	18	100.0

An equipment management policy is a set of procedures for setting the framework for managing equipment. Usually this policy is kept in a loose-leaf binder named the "equipment management policy manual." This allowed for effective communication within an organization. The results indicated that a majority of the contractors manage their equipment through unwritten policies.

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