

# Management of Equipment & Machinery in Construction

Prajeesh. V. P<sup>1</sup>, Mr. N. Sakthivel<sup>2</sup>

<sup>1</sup>P.G. Student, Department Of Civil Engineering, Shree Venkateshwara Hi-Tech Engineering College, Erode, India

<sup>2</sup> Assistant Professor of Civil Engineering Department, Shree Venkateshwara Hi-Tech Engineering College, Erode, India

## Abstract

Construction equipment is a major resource in the building process for a construction project. When equipment is owned by a contractor, it forms a sizable portion of his assets requiring proper management practices. 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. It is therefore important for site managers and construction planners to be familiar with the characteristics of the major types of equipment most commonly used in construction. This thesis is to study the management of equipments 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. The needed data were collected via a structured questionnaire. The contractors were divided into three grades based on their annual work volumes. The collected data were analysed using the SPSS software. The elements of the management policies were cross-tabulated against the grades of contractors for finding possible significant differences in contractors' practices. Hypotheses on some expected results were tested. Finally, the findings of this study were compared with findings of questionnaire conducted for finding significant commonalities and differences in equipment management practices.

**Keywords:** Construction equipment, project management, Delay analysis.

## 1. Introduction

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 Objective of this thesis is to investigate the equipment management practices followed by major construction companies in India and to compare these results with Sobha city, Trissur. Sobha Developers Ltd, a Rs. 15 billion company, is one of the largest and only backward integrated real estate players in the country. Sobha is primarily focused on residential and contractual projects. Company's residential projects include presidential apartments, villas, row houses, super luxury apartments, luxury apartments, semi-luxury apartments and plotted development along with amenities such as clubhouse, swimming pool and shopping complex. In all its residential projects the company lays strong emphasis on environment management, water harvesting and high safety standards. Sobha obtain the ISO 9001 certification. Sobha also received the OSHAS 18001:2007 and ISO 14001:2004 certifications for our Environmental, Health and Safety Management System.

## 2. Machinery in Construction

### 2.1 Types of Equipment

#### 2.1.1 Dozers

Crawler or wheel tractors are the workhorses of the construction industry. They are wheeled or tracked wheeled types are faster and tracked are used in steep slopes. These are equipped with various blades, rippers (etc.), and for towing/pushing.

#### 2.1.2 Wheel type and crawler type bulldozer

These are designed to provide high drawbar pull and tractive effort. The crawler tractor exerts low ground-bearing pressure adding to its versatility. Dozers are tractor equipped with a blade are standard equipment for excavating, tractor equipped with a blade are standard equipment for land clearing and tractor equipped with a blade are standard equipment for assisting scraper loading. A dozer can have a rear mounted ripper for loosening and breaking up rock.

#### 2.1.3 Scrapers

Applications for scrapers are as Dozer for short haul, less than 300ft and as Scraper itself for Medium haul up to 3000ft.

### 2.2 Functional Classification of Equipments

#### 2.2.1 Earthwork Equipment

It includes excavation and lifting equipment which is a back actor (or backhaul, face shovels, draglines, grata or clamshell and trenchers. Another type is earth cutting and moving equipment like bulldozers, scrapers, front-end loaders. Transportation equipment also comes under this category like tippers dump truck, scrapers rail wagons and conveyors. Last types are compacting and finishing equipment like tamping foot rollers, smooth wheel rollers, pneumatic rollers, vibratory rollers, plate compactors, impact compactors and graders.

#### 2.2.2 Materials Hoisting Plant

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

#### 2.2.3 Concreting Plant & Equipment

Concreting Plant & Equipment includes Production equipment for batching plants, concrete mixers, Transportation equipment like truck mixers, concrete dumpers, Placing equipment are like concrete pumps, concrete buckets, elevators, conveyors, hoists, grouting equipment, Pre-casting special equipment like 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 etc comes under this category.

#### 2.2.4 Support and Utility Services Equipment

The equipments for Support and Utility Services are 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.

#### 2.2.5 Special Purpose Heavy Construction Plant

The major equipments comes under this category are Aggregate production plant & rock blasting equipment, Hot mix plant and paving equipment, Marine equipment, Large-diameter pipe laying equipment, Piles and pile driving equipment, Cofferdams and caissons equipment, Bridge construction equipment, Railway construction equipment.

Equipment procurement is an important thing in management. 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.

### 2.3 Summary of Equipment Selection Considerations

Certain considerations are made in the selection of equipments in the construction procedure. They are task considerations, site constraints, equipment suitability, operating reliability, maintainability, economic considerations and commercial considerations.

## 3. Sourcing Information

#### 3.1. Company Identification

Companies for questionnaire survey are mainly classified in to high level, middle level, and low level companies and certain independent contractors. High level companies have their project cost is more than 10 million. Middle level companies project cost ranges from 5 to 10 million. Low level companies' project cost less than 5 million. Companies for questionnaire survey are mainly classified three levels I, II, III on the basis of their characteristics of the company like experience, types of work performed and owned value

Table: 1. Specification of Heavy Machinery

### 3.2. Design Of Questionnaire

SL No	Equipment / Vehicle
1	Volvo Excavator 240 BLC
2	Volvo Excavator 210 BLC
3	Caterpillar Loader CAT 950 H
4	Hindustan 2021Bar fronted loader
5	Caterpillar Dozer D6G
6	Vibratory Roller - IR SD110/F
7	L&T Case 851 Backhoe
8	Tipper TATA Hyva 2516 C (6 x4)
9	Tata Triple axletrailer with accessories (4 x 2 unit) - 4018 C
10	Bitumen Spray Tanker
11	Piling Machine (Soilmec SR 40) with accessories.
12	Caterpillar Grader - CAT 120H

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

### 3.4 Equipment Management in Sobha Developers Ltd – Sobha City Project a Case Study

Sobha Developers Ltd is a Rs. 15 billion company which is one of the largest and only backward integrated real estate players in the country. With three decades of experience in creating resplendent interiors of palaces and masterpieces in the Middle-East, Mr. PNC Menon founded Sobha Developers in 1995 with a clear vision to transform the way people perceive quality in the real estate sector in India.

Sobha city is the Kerala’s first integrated township in the making spread over 55 acres, Sobha City is a world class township, designed with painstakingly meticulous attention to the smallest of details. Sobha City is conveniently located close to the city, yet far from the madding crowd and the cacophony of the city traffic. Close to Trissur famed educational institutions, hospitals and shopping centre. Nature and technology converge in this green and eco-friendly township. The 6.5 acre lake - one of the biggest rainwater harvesting facilities in the country effectively addresses. About 4.7 acres of land exclusively for play area and open greenery. In addition to this we have a long jogging track all around the lake and a walk way extending from the entrance all through the township.

Equipment Management Practices presents the reported practices of Sobha in managing construction equipment from acquisition to retirement of the equipment. The practices are the following

#### 3.4.1 Equipment Acquisition

In Sobha city, for equipment acquisition they used to rent or lease needed equipment for testing before buying, the results indicated that they directly purchases the necessary equipment to replace old equipment. They identify equipments needs, evaluate alternate proposals and decide on acquisition. The acquisition of new equipment starts with the identification for its need somewhere in the organization. The equipment investment proposals originate by the meeting between the equipment departments, company headquarters in Bangalore and the project managers. The alternative to investment proposals needed which are evaluated quantitatively and qualitatively. They evaluate alternatives quantitatively only for equipment having a value exceeding a minimum mark up value. They evaluate equipment proposals quantitatively by making an economic comparison of costs. They identify and determine their values primarily from in-house data and secondary from rental rates obtained from local dealers. Then use these data for calculating rate of return for alternative proposals by comparing their net cash flows. The accounting return and the payback period were found

to be the most popular methods used for quantitative evaluation of equipment. The calculated rates of return values are compared with minimum rate of returns, which are set by top management and/or determined from in-house historical records. It seems they set a minimum rate of return when the situation calls for such a decision. The set rate/value depends upon the management's expectations from the investment. Renting and Leasing in Sobha, They spend about Rs 100 crores annually for renting and to a lesser extent leasing construction equipment

#### 3.4.2 Equipment economics

Equipment economics is concerned with management practices regarding capital budgeting, economic life and depreciation of equipment. They prepare short- and long-range capital budgets for acquiring construction equipment. Determining the economic life of a piece of equipment is not only important for the equipment replacement decision process, it is also important for calculating annual equipment depreciation. For depreciation calculation, the method they used is the straight line method; Depreciation refers to two very different but related concepts. They are the decrease of value of assets, and the allocation of the cost of assets to periods in which the assets are used

Depreciation and maintenance calculation as follows

- ✓ Plant and machinery
- ✓ Scaffolding
- ✓ Lab equipment

$$\text{Cost of fixed asset} = \text{depreciation cost} + \text{maintenance cost}$$

Depreciation is based on lifespan of machinery and Maintenance means expenses including material and operator cost.

#### 3.4.3 Equipment operation and maintenance

Equipment is acquired to perform desired activities. During its operation, policies are set to regulate its performance for keeping it in excellent shape and to prolong its economic life Operation and maintenance of equipment are an important element of equipment management, which is concerned with the usage of equipment. In Sobha, routine and overhaul maintenance were undertaken. Assign equipment operators to perform the necessary routine maintenance. It seems when equipment is on site, they prefer to perform routine maintenance on site, thus preventing loss of time from transporting the equipment to the dealer or the workshop. When it is possible, the equipment owner's mechanic

performs the routine maintenance. Routine maintenance is usually done by the equipment user's mechanics. If there is any special requirement for maintenance, it is performed by the equipment dealer's mechanics.

#### 3.4.4 Equipment record keeping

For equipment record keeping in Sobha record keep and maintain not accurately. They only maintain the description of all the equipment they owned. The operator's daily report is an important record for following the condition of equipment. But in Sobha there is no daily report maintained by the operator. Due to his close relation with a piece of equipment, the person who knows best the behavior of that piece of equipment is the operator. He can spot any performance variation that he can report to maintenance before it becomes a major problem. The equipment management policy delegates the responsibility of keeping equipment utilization records.

#### 3.4.5 Replacement Analysis

The timing of replacement is as important as the selection of a piece of replacement equipment. In Sobha they replace their equipment when it becomes inefficient. The optimum replacement time for a piece of equipment is determined when the repairs become too high. They perform economic analysis before deciding to replace equipment. Experience and formal analysis play a major role in replacement decision analysis. They evaluate many factors affecting the decision to replace equipment is downtime costs depreciation and obsolescence costs. The obtainable salvage value (net resale price) has an influence on the replacement decision. It seems that they sell old equipment if an attractive price is offered.

#### 3.4.6 Use of computers

Computers are also used in equipment management to serve various purposes. In Sobha computer is used in equipment management. They used software such as MS Excel for asset control, for maintaining schedules, for allocation of equipments to specific sites, to update repair cost and to record usage of equipments. Hence, the computer as a tool is recognized by the contractors and is used extensively for record keeping.

#### 3.5 Delay Analysis

The material and the research methodology of the study are presented in this chapter. The survey material includes the case study of Multi storied residential and water front apartments at Thrissur Kerala. This part describes time impact analysis method for delay analysis and how it was applied to the case study project.

The Time Impact Analysis method (TIA) was selected to analyze the construction delays in the work-schedule of the case-study construction project in order to determine the delays and apportion the responsibility of such delays amongst all parties. The aim was to identify construction delays, to quantify their net impacts on the project completion date and to allocate responsibility to all parties. Accurate allocation of liability is very important in schedule delay analyses in order to prevent delay claims amongst project parties. From the literature survey it was seen that the TIA would be the most appropriate technique to be used in this study. Therefore, for the successful application of this method, the daily records and diaries during the construction process had been used. This study was conducted in three stages; which are explained in detail in the following sections.

- Collection of information and data;
- Determination of causes, types and liability of delays; and
- Conducting the schedule delay analysis with TIA

#### 4. Result and Discussion

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.

Sobha city is included in the level I as per our classification. In Sobha there is a separate section for the equipment management. This department there is a group including labours, mechanics and engineers led by a project manager. The project manager is responsible for the decision in coordinate with the head office. The project manager is the decision maker and the team leader.

In comparing the study of equipment management on Sobha city with the survey result of equipment management in the other participated company is that, almost all the management of equipments the level I 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.

In Sobha 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. They used to resale their old equipment if an attractive price is offered.

#### 5. CONCLUSIONS

1. 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.
2. This indicates that there is a policy for management although it is not properly documented.
3. The fact that industries or contractors claim a gain from the resale of their equipment indicates that the equipment is managed profitably.
4. The main goal of any management policy is to enable optimization of resources and maximization of profits.
5. The management practices of the contractors and construction industries of India suggest that they achieve the goals of good management, and they follow the best practice suited to their conditions.
6. 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.

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