Enhancing Efficiency Through Strategic Equipment Management In Highway Construction

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Abstract- *Highway construction projects are capital-intensive, with equipment management playing a pivotal role in determining project efficiency, cost-effectiveness, and timely completion. This thesis investigates the enhancement of operational efficiency in highway construction through strategic equipment management practices. By analyzing current industry approaches, the study identifies inefficiencies such as equipment downtime, underutilization, and suboptimal maintenance schedules, which contribute to delays and cost overruns. The research proposes a comprehensive framework integrating advanced technologies, data-driven decision-making, and optimized resource allocation to address these challenges.*

Keywords- project efficiency, cost-effectiveness, suboptimal maintenance schedules

I. INTRODUCTION

Currently in India, the construction sector plays an important role in short term trends, with more frequent development, not only for the sector itself but also for other economic activities as well. As a result, it is firmly believed that the construction industry needs an effective resource management practice to retain profitability and continue its dynamic contribution to the growth of the country. Before starting any project then, the planning should be done with great care, as the efficiency of the whole project largely depends upon its planning. Planning of a construction project involves deciding about the extent of mechanization, equipment planning, equipment management, and execution planning etc.

The cost of equipment in a project varies from 10% to 30% of the total cost of the project, depending upon the extent of mechanization. In modern fully mechanized projects the cost of equipment goes up to 30%. Proper planning, selection, procurement, installation, operation, maintenance and equipment replacement policy plays an important role in equipment management for the successful completion of the project. With the growing use of machinery it has become necessary for construction engineers to be thoroughly familiar with the construction application and upkeep of the wide range of the modern equipment.

Thus, equipment management integrates and continuously interacts with human, technical, financial and production system in order to achieve top efficiency and cost effectiveness. Like the other major resources, committed equipment are expected to be fully utilized to complete the project in due time. Hence, proper planning and management of equipment is crucial for the success of a firm, especially for the road project construction sector where profit margin is very low.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

Construction is the mobilization and utilization of capital and specialized personnel, materials, and equipment and to assemble materials and equipment on a specific site in accordance with drawings, specifications, and contract documents prepared to serve the purposes of a client. Road construction involves a combination of specialized organizations, engineering science, studied guesses, and calculated risks. Since operations must be performed at the site of the project, often affected by planning and management problems, every project is unique. Furthermore, because of exposure to the outdoors, construction is affected by both daily and seasonal weather variations. It is also often influenced significantly by the poor planning, management and utilization of construction equipment. These factors should be addressed and managed in a competent and professional manner to benefit from the industry.Construction equipment planning aims at identifying construction equipment for executing project tasks, assessing equipment performance capability, forecasting date-wise requirement of number and type of equipment and finally participating in the selection of equipment to be acquired. To derive full benefits from the equipment, there should be proper selection and good planning and management of its operations. This thesis deals with the planning and management procedure for equipment and equipment productivity adopted by a company to achieve its objectives timely in respect of project completion of road construction.

Objectives of Research

- To study the equipment used for four lane highway project ,

- To identify the main causes of equipment planning and management problems,
- To determine the effects due to poor equipment planning and management problems.
- Analysis of cost and time with respect to equipment management

Theoretical Data

Construction equipment management (CEM) is a process, which includes that planning, selection, acquisition, productivity, maintenance, standardization and quality control cycles In many cases, however, most of the aspects of this process are either neglected or skipped over. According to researcher‟-s‟ observations, despite the fact that construction equipment is owned and managed by professionals‟, in frequent occasions managerial process seems to follow traditional CEM practices than scientific conventional approaches. The “equipment managers‟ main task is to reduce downtime of Construction equipment and achieve optimum Construction equipment utilization and increase productivity at minimum cost”. The purpose of equipment planning is to show the separate size and types of equipment required on rent, lease or outright purchase. Construction equipment and plant refers to the tools, instruments, machinery, and other mechanical implements required in performance of construction work. Construction plant is defined as concrete batch plants, aggregate-processing plants, conveying systems. And any other processing plants, that are erected in place at job site and essentially stationary or fixed in place. Equipment is defined as items that are portable or mobile ranging from small hand tools through tractors, cranes, and trucks. Modern construction projects are complex in nature and success of a project depends greatly on proper and scientific planning. Before starting any project it’s planning is done with great care, as the efficiency of the whole project largely depends upon its planning, while planning each and every detail should be worked out in anticipation and should be considered carefully. Planning of a construction project involves deciding about the extent of mechanization, equipment planning, and execution planning etc. while planning a road project, equipment manager should be carefully decided the extent of mechanization so as to minimize the cost of project.

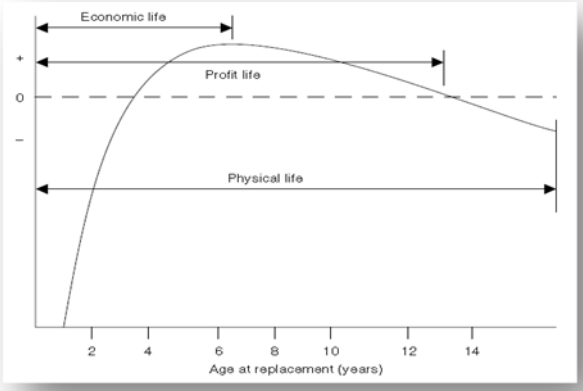
The old adage 'Prevention is better than cure', is the first principle of preventive maintenance. Planned preventive maintenance of construction equipment includes inspection, adjustment or tightening routines of equipment components at prescribed intervals in order to prevent any premature failure. These intervals are usually based on previous performance of equipment and experience gained in the past. Components of construction equipment may fail unexpectedly well before they reach the end of their anticipated life. Inspections at predetermined intervals could, therefore, help to identify such problems and initiate remedial actions before any catastrophic failure occurs. This is important, because damage to a minor component can cause the total failure of a machine. The time interval between inspections could be in days, weeks or even months depending on the type of checks performed in the inspection.

In unscheduled maintenance some maintenance activities such as essential lubrication are performed at unspecified intervals and the repairs are usually undertaken only when a piece of equipment breaks down. However, sometimes Repairs may also be done on a machine when a component is malfunctioning and the mechanical performance of the machine is unacceptable. An unexpected failure of a machine can occur at any time and unscheduled maintenance in such a case is unavoidable. Therefore, all equipment companies will have to carry out unscheduled maintenance to a certain extent. However, a maintenance policy which is completely unscheduled is not usually recommended. This is particularly so when the machines are key items of a construction process or when there is possible safety hazards arising from unscheduled maintenance.

Revenue is a very important factor in deciding the replacement age of equipment, provided that there is direct income from the use of the equipment. This factor may be more relevant to plant hire companies and to subsidiary plant companies which operate as profit centers, however, it is of less importance to contracting companies with no direct income from their equipment. Maintenance costs include expenditure on servicing, replacement of consumables etc. whereas, repair costs are due to labor, spare parts and materials spent on necessary repairs of broken down equipment. As explained earlier downtime costs are the costs such as loss of production, delay in completion of the construction work, extra costs due to substitute equipment and overtime work caused by equipment breakdowns.

Depreciation is the loss of the resale value of equipment as a result of continued use. For example, if a piece of equipment is retained for one more year, the market value of the item would drop because of the deterioration caused by using it. Obsolescence is the fact that the newer equipment is superior, usually in productivity to the older equipment, due to technological development. The obsolescence could be measured in terms of cost per unit output. It is believed that newer models of equipment give less cost per unit output than the earlier models.

Productivity is the ratio of useful work out put to the time spent to complete that work. Productivity in this context represents the volume of earth produced per operator hour and number of work cycles performed per operator minute. To judge the level of performance, the actual productivity must be compared against a desired productivity (estimated). The performance ability ratio (PAR) given as the ratio of estimated productivity to current productivity. A PAR value close to 1 indicates that the current productivity is relatively good, while a PAR value far greater than 1 indicates a poor productivity.
When the machine breaks down, the production drops to zero and the equipment starts costing money to its owner rather than making money. Construction equipment maintenance programs generally consist of three major components: preventive maintenance, routine maintenance, and major repairs. If the first two programs are both aggressively applied and well managed, the major repair program is minimized, and even more importantly, the first two programs occur as scheduled under the owners‟ control whereas major repairs occur randomly and usually at times when they seem to create the most distress to the project. Poor equipment maintenance practices causes the major break on equipment spare parts and increases the down time of equipment, this reduces productivity of equipment and increases project cost.



Delay is generally acknowledged, as the most common, costly, complex and risky problem encountered in construction projects. Because of overriding importance of time for both the owner (in terms of performance) and the contractor (in terms of money) it is a source of frequent dispute and claims leading to lawsuits. In construction, delay could be defined as the time overrun either beyond completion date specified in a contract, or beyond the date that the parties agreed upon for delivery of a project. There is a wide range of views on cause of time delays for engineering and construction projects. Different researchers identified that, most causes of delay is directly or indirectly influenced by poor equipment planning.

Cost in project comprises money and resources (people, equipment and materials). The client usually wants the project to be finished with the possible lowest cost and timely. However, it is the project managers' responsibility to adopt or formulate a performance standard to track cost performance .Several factors that cause cost overruns in road construction projects have been identified in various places and time. Different problems and challenges may happen for the contractors during the working procedure with the equipment such as life cycle of the machines and different financial risks which may cost a lot for the company. Different contactors could not finish their projects without enough financial supports. It has been estimated that 36% of the whole construction project cost refers to the equipment costs. Therefore, poor equipment planning and management is the major cause of project cost overrun.

III. STUDIESAND FINDINGS

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.

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.

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.

a)The final result obtained development of decision tool , Construction equipment profitability .
b)If equipment is hire on the daily rental basis then it will be more than 15% - 25% of weekly rental charges.
c)As result obtained the best way to hire the equipment on Monthly rental basis if the project is of Short Term.
d)If the project is Long Term it is preferred to Own the equipment.

IV. CONCLUSION

- Equipment plays an important role in today's infrastructure projects as they are more demanding and highway projects are need to be completed in stipulated time with best quality.
- The downtime and idle run time of equipment play important role in production. These downtime & idle time factor also effect on total cost of project.
- Factors affecting productivity in construction can be divided into two categories: human-related factors and management-related factors. These factors affect the morale and motivation of individuals.
- Quality of supervision, material management, site planning, constructability, and change management are the most significant management-related factors that influence productivity directly.

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