Construction Equipment Management through Selection, Maintenance and Replacement Practice

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***Abstract*— Effective equipment management is a critical success factor for any construction firm to sustain in the industry. In construction equipment management, the equipment selection, maintenance and replacement are the main key areas of attention. Conventional processes of equipment management and bias decisions of equipment managers often result significant losses in construction firms. Inefficient usage of consequential cost in equipment management seriously diminishes the effectiveness of selection, maintenance and replacement decisions of construction firms. It is found in the study that; majority of Sri Lankan construction firms acquire the construction equipment either from leases or loans. Frequency of equipment usage is identified as the main criterion considered when making the decision, whether to hire or buy equipment. It was generally identified that; companies have incorporated scheduled preventive maintenance policies and corrective maintenance policies in construction equipment maintenance. Periodic maintenance is found to be an important practice in equipment maintenance. In the event of equipment failures, it was found that location of the equipment and waiting for spares are the most significant causes for reported downtime. Delays of construction due to equipment breakdowns is the foremost reason to dispose construction equipment. Effective application of consequential costs like downtime costs of equipment management, would certainly improve the construction equipment management processes.**

Keywords—Construction Equipment Management, Selection, Maintenance, Replacement, Consequential Cost, Downtime

I. INTRODUCTION

Thousands of years ago mankind started using equipment to carry out their day today work efficiently and effectivey. People started using animals to ease their construction work until 19th century, because construction was an essential part in human lifestyle. But with the development of steam powered engine and internal combustion engines, construction became more abridged with mechanical construction equipment, replacing traditional methods that used animals and human [3]. Development of equipment made the construction industry what it is today by enabling mankind to undertake projects such as high-rise buildings, bridges, highways and irrigation structures, with few years of completion, which should have taken hundreds of years to complete without the presence of heavy construction equipment.

Construction industry in Sri Lanka had tremendously grown in the recent past and it had developed to a robust level in the national economy. In 2017, composition of GDP from construction industry was Rs.1040 billion when in 2013 it had only been Rs. 621 billion [4] showing an increase of more than Rs. 400 billion for 5 years' time. Management of construction equipment is critical when it comes to construction projects, as cost of equipment hold a major proportion in overall cost of construction. Therefore, proper management of construction equipment becomes utmost important for the sustainability of any construction project in any construction company. Yet, having identified the criticality and importance, no adequate attention

has been given by the researchers on the field of proper management of equipment especially when it comes to Sri Lankan context.

Though there are various studies conducted on equipment management over past 300 years, with the purpose of optimizing the construction profits directly and indirectly through equipment management, in many cases they have paid attention on minimizing equipment costs. It is emphasized the fact that all equipment decisions must be carried out carefully based on the fundamental purpose of facilitating the construction processes [5] either to minimize the costs or optimize the construction profits.

II. AIM

The main aim of this paper is to identify equipment management practices used by companies in the construction industry in Sri Lanka with respect to selection, maintenance and replacement policies adopted construction in organizations.

III. METHODOLOGY

Sixteen in-depth interviews had been conducted with sixteen participants purposively selected from 16 companies in construction industry. In addition to in-depth interviews, an online questionnaire was also circulated among participants to gather some of the specific data related to equipment management practices. Participants were selected purposively based on their capability to contribute to the research objective. The job positions of the participants are illustrated in Fig. 1. As secondary data sources, findings of past researchers, company reports, company records and other publications from various sources were referred.

Data collected from in depth interviews and questionnaire were analyzed manually through content analysis methods. Analyzed data was discussed based on the previous literature and recommendations were given with respect to selection, maintenance and replacement practices.

IV. FINDINGS

A. *Equipment Selection and Assignment*

Equipment selection is a crucial factor for the successful completion of any construction project, and it is a complicated process when it comes to financing the equipment acquisition. There are few financing options available for firm such as; cash purchase, bank loans, leasing facilities and hiring equipment [2]. Most of companies (87.5% out of sample) were using leasing facilities in financing equipment acquisition as the top priority option. They also indicated that their most popular second option is financing through a bank loan. Only a minority of companies indicated that they use company reserves in financing. This had been a result of tax benefit that they can gain through debt financing. As most of companies in the sample were family owned or private limited companies, through payments of interest the companies have the potential to avoid tax. Hence, the benefits of tax avoidance have made the companies to prefer more for leasing and loan options.

When it comes to the decision whether to hire or purchase equipment, most of the companies mainly considered two factors; frequency of the usage and the cost of hiring of equipment. Also, it was found that, decisions of construction practitioners are highly influenced by brand loyalty. 'Past experiences on a certain brand' and 'customer service' were identified as major determinants of brand loyalty among decision makers. Some of them indicated 'country of origin' as an important determinant too. The major issue identified here was, the decision makers mostly tend to take acquisition decisions based on their intuition, hence processes had become more complicated.

When considering the personnel who possess the authority of acquiring equipment to a task/project, most of the companies mentioned that it is certainly with the managing director of the company. In some companies there was a distinct position called Equipment manager who was

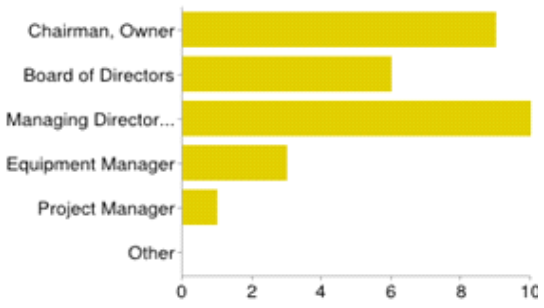


Fig. 1. Authority of Acquisition

authorized to acquire the equipment (Fig. 2). It should be emphasized that, any person who is

assigned to carry out equipment acquisition should carefully consider all related factors regarding that decision well in advance.

Factors like; 'purchase price' and 'reputation of the equipment model' were identified as key factors affecting construction equipment acquisition decisions. Even though, in theory there are many systems developed for equipment assignment processes, it was unlikely they had been used practically in the decision making process [6].

B. Construction Equipment Cost Management

Total equipment costs generally consist of two components; ownership costs and operating costs. Except for the initial capital cost of buying a machine, ownership costs are fixed costs that are incurred each year, regardless of whether the equipment was operated or idled. But operating costs will be incurred only when the equipment is operated [2].

When we consider about the cost of owning equipment, the iinitial cost, interest cost, iinsurance expenses and taxes can be directly measured as sub components of it. But depreciation is considered an estimation for equipment wearing. It was revealed that less than half (44%) of the participants mentioned that they use reducing balance approach to depreciate equipment while, 31% used straight line method with 6.4% of the companies selected the both. Depreciation policy adopted for an equipment can be different based on the nature of equipment. Further, it had been noticed that, some of the participants did not know the exact depreciation policy of their company, and the puzzle about that is, those individuals that could be the personnel who make the acquisition, retiring and replacement decision. Ddepreciation is not tax deductible; hence it is recorded in the company accounts as an expense. Hence, it is recommended for managers to have a clear idea about depreciation and its policy of respective company they work.

Moreover, maintenance of proper records related to operating costs are important. All most all the companies have been maintaining records on fuel and lubricant handling. But only 56.3% companies have computerized their equipment records. But there were certain companies that did not maintain details regarding the operating hours, operator wages and repair details. Surprisingly, there were some (12% of the sample) companies that did not track any of above-mentioned costs at all. But it is critically important to record those costs in order to find any theft, fraud or abuse of equipment.

C. Equipment Maintenance Practices

According to literature, there are three types of maintenance and it was analyzed how companies realistically use following methods in construction industry,

1. Planned preventive maintenance
2. Planned corrective maintenance
3. Unscheduled maintenance due to breakdowns

In theory scheduled maintenance is understood as a combination of 1 and 2 above.

In findings, 87.5% of the companies found to be using scheduled maintenance in their maintenance policy out of which majority had been given attention on preventive maintenance. Time duration between maintenance was found to be from 3 months to 6 months and periodic maintenance was rated as very important factor.

D. Failure of Equipment

Poor maintenance, abuse and misuse of equipment were some of the critical reasons for construction equipment failures and majority of the failures were related to breakdowns in engine [7].

Vorster & Sears (1987) had introduced a new method in equipment management using 'failure cost profiles.' They had pointed out consequential costs like failure costs plays a major role in retiring, replacement and reassigning of construction equipment. But failure cost consists downtime cost which often has not paid considerable attention by the practitioners. In analyzing causes for the downtime cost, it was found that 'location of the equipment' and 'waiting for spares' were playing a significant role. As most of the small to middle range construction companies, usually tend to outsource their repairing and maintenance of equipment, arriving time of the repair crew may vary with the distance of the construction site.

In Sri Lanka spare parts can be hard to find when it comes to uncommon equipment and the repairing of equipment will be stopped until specified spares are imported. 'Lack of repair personnel' and 'problems in communication problems' were also recognized as some other

issues. According to the findings, timely and proper maintenance at site and knowledge and experience of the operators are indicated as the important factors. Additionally, the 'availability of repair facilities' at construction sites was, identified as a significant factor to reduce downtime according to many literature [8].

E. Equipment Replacement

When any equipment had been used overtime, it has the potential to break down, hence need to repair. But if the equipment usage time increases, repair cost may also increase significantly. Hence, there is a point of time in any equipment which it needs a replacement.

It is suggested in literature that there can be several factors that can influence on replacement practices such as revenue, maintenance costs, downtime cost, cost of capital, depreciation, past experience and reputation of brands [1]. Early studies had made attempts in developing policies for equipment replacement, using dynamic programming and functional equation technique to arrive at a more realistic and detailed decision making [9]. Over the last 80 years gradual development of quantitative models for equipment replacement and there were evidences for more realistic models developed using computers [10].

When making the decision, whether to keep or to replace a certain equipment with a more new and advanced equipment, decision maker should consider both current technology available and future technological advances [11]. The findings revealed some of the reasons where construction firms decide for replacement of equipment. Delays of construction due to breakdowns was the critical reason ranked by respondents at the top to make the decision of replacement. Also, they mentioned, loss of income due to equipment downtime, as another reason. Yet, it was noticed that companies in Sri Lanka, were more focused on scheduled delays of projects due to equipment downtime, rather than cost factors.

Many researchers have developed models and systems to determine the optimum time for the replacement because it is generally complicated to evaluate as so many factors should be considered concurrently. But according to findings of the study, in Sri Lanka most of construction companies just make their decisions only limited to few factors, such as high maintenance cost and repairs and when equipment becomes low productive. Therefore, lack of knowledge exiting among construction practitioners about modern and advanced methods of equipment management is a major issue faced by the construction industry in general.

V. CONCLUSION

In summary, majority of construction firms were taken the option of leases and loans in financing acquisition of equipment. When equipment owning costs are considered, the depreciation is the only cost that cannot be determined. Surprisingly, decision makers in the top management were not directly aware about this depreciation cost. It was indicated that all companies keep fuel and lubricant records but literature suggests it is critically important to record and control other costs as well. It was identified that, companies have scheduled preventive and corrective maintenance policies. Repairing is anyhow will be done at the equipment breakdowns. Periodic maintenance, training and experience of equipment were recognized as critical factors in equipment maintenance. With respect to equipment failures, it was found that location of the equipment and waiting for spare parts are the most crucial causes for downtime. Delays of construction due to breakdowns was the main reason for disposing equipment. Equipment replacing decision of construction firms was taken buy top management generally by the intuition, but there can be exceptions. The mainly identified reason for equipment replacement, is delaying of construction work. Most of the companies limit their decision to several factors but it is recommended to use advanced models and computer technology to assist decision making process for the effective and efficient utilization of construction equipment.

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