

3D Equipment Management System for Highway Construction Projects: Conceptual Design

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ABSTRACT: Effective management of equipment is crucial for the success of construction firms. Inadequate manual processes of equipment management and the subjective decisions of equipment managers usually result in major losses in construction firms, hence, the economy. Highway construction projects are the yardstick to measure the development of country. Now the highway construction projects are changing their face. Due to “Public Private Participation” in highway projects, it has become a challenging job to complete the project in stipulated time. 3D equipment management system deals with Proper planning, selection and optimum utilisation of construction equipment for highway construction project.

Keywords – equipment management, highway construction, optimum utilisation, proper planning, selection.

I. INTRODUCTION

The infrastructure development is an important aspect for the overall development of country. India is considered as the hub for service industry for which the infrastructure development plays an important role. Highway construction projects are the yardstick to measure the development of country. Now the highway construction projects are changing their face. Due to “Public Private Participation” in highway projects, it has become a challenging job to complete the project in stipulated time. BOT type of contract of highway construction projects enforces the contractors to complete the project as early as possible to start the regaining the investments through the toll. The cost of equipment in a project varies from 10-30% of the total cost of project, depending upon the extent of mechanisation. Proper planning, selection, procurement, installation, operation, maintenance and equipment replacement policy plays an important role in equipment management for successful completion of 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 modern equipment.

Equipment manager’s main task is to reduce downtime, achieve optimum equipment utilisation and increase production at minimum cost. The cost analysis and the will of adopting proper techniques suited to the situation are the basic factors for the success and therefore, there is need for a rational planning, proper selection and judicious deployment of equipment in relation to the conditions so as to achieve optimum utilisation. Modern construction projects are complex in nature and success of a project depends greatly on proper and scientific planning. Before starting any project its 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 mechanisation, equipment planning, and execution planning etc. while planning a highway project equipment manager should be carefully decided the extent of mechanisation so as to minimize the cost of project.

II. CURRENT EQUIPMENT MANAGEMENT PRACTICES

Construction equipment management is concerned with the purchase, retirement, replacement, operations, logistics, and maintenance of equipment. The objective of the firm is to minimize operation, maintenance, and repair costs, while achieve high utilisation of the construction equipment. These responsibilities could be categorized into two groups: operational and strategic responsibilities (Table 1). Operational responsibilities consist of day-today management of construction equipment. Generally, these decisions are given by project managers, who are assigned to specific equipment for specific time by the equipment managers of the firm.

Table 1. Operational and strategic dimensions of equipment management

Operational	Strategic
Maintenance	Equipment selection
Repair	Finance
Logistics	Replacement

Fueling	Disposal
Life-cycle costing	

In most of the construction firms, equipment managers are the sole undertakers of the overall responsibility of equipment management. Based on their experience, equipment managers decide on the day-to-day management of equipment operations, and also on strategic operations such as new equipment procurement. Thus, responsibilities of the equipment managers, ensuring that the equipment is properly used, maintained, utilized and managed, are rather challenging. Effective operation of construction equipment should be maintained to avoid under utilisation of such large capital investment. Also, preventive maintenance and repair should be carefully planned, and high productivity rates should be realized during operations. As the equipment fleet gets larger, maintaining such goals become a big challenge. Most construction firms have centralized equipment management function, but actual operations are geographically dispersed. Even though the equipment manager of the firm is the main accountable, responsibilities are shared with project managers that utilize the equipment during project.

III. 3D EQUIPMENT MANAGEMENT SYSTEM

The concept of 3D equipment management system deals with proper planning, selection and optimum utilisation of construction equipment. An overview of 3D equipment management system is as described below.

1. Proper Planning

Modern highway construction projects are complex in nature and success of a project depends greatly on proper and scientific planning. Before starting any project its 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 mechanisation, equipment planning, and execution planning etc. while planning a highway project equipment manager should be carefully decided the extent of mechanisation so as to minimize the cost of project.

2. Selection

Proper selection of equipment for a highway construction project is of vital importance for it's speedy and economical completion. Problem of equipment selection has become more complicated, because large variety of equipment are being manufactured now-a-days. For selection of equipment, a considerable experience in the operation and maintenance in the field is essential. Records kept for operation, maintenance and actual output obtained under comparable conditions of previous projects will greatly help in taking decision for equipment selection. With the undertaking of new projects and the retirement of old machinery and equipment, it becomes necessary to acquire new construction equipment. In this stage, sufficient knowledge base of current brands and products is necessary. It is also important to determine what sort of equipment and capacity is needed. In fact, selection of equipment for the project is one of the key decisions in planning and executing a construction project, which affects how the work will be done, the time required to complete the work, and the cost that will be accrued. Generally, an equipment manager is responsible of selecting the equipment, whereas it is the responsibility of the construction planning group to select equipment. Nevertheless, both the inventory of equipment in hand and the standard equipment policy play an important role in equipment selection. Therefore, final decision on the equipment required for the projects is generally given by equipment managers, project managers, and construction planning group together. Often, the decision making process can create tensions in the firm. Once the selection of equipment is made, a choice has to be made whether to buy, rent, or lease it. These decisions are given based on the economic standing and strategy of the firm, and the nature and frequency of equipment use.

3. Optimum Utilization

This stage includes operations and maintenance of construction equipment. In this stage, the equipment in use should be maintained properly, by scheduling preventive maintenance periods. Scheduled maintenance reduces the incidents of failure, and thus minimizes costly breakdowns and stoppages on the project site. In manufacturing industry, preventive maintenance has increased the production level around 10–20 %, by reducing the break-down time of the equipment. For high utilization rates, the equipment should be kept in a good condition. Also, proper selection and training of operators and maintenance personnel is part of the responsibility of the equipment manager. In addition, safety of both the operators and the equipment should be considered and properly managed. Furthermore, proper registration and inventory records are part of the inventory process. Besides the equipment life cycle, equipment managers are also responsible or operating the equipment maintenance and storage facilities.

IV. CURRENT INFORMATION TECHNOLOGY (IT) SOLUTIONS FOR EQUIPMENT MANAGEMENT

Most of the construction firms have customized software for equipment management. In addition, standard software like MS Excel, MS Access, FoxPro, and Oracle are used to keep track of equipment data. Also, there are some off-the-shelf software solutions specifically designed for construction equipment management. Most of these solutions include modules to keep track of inventory, operations, and maintenance data, and generate reports in order to aid management decisions. On the other hand, there are some solutions that utilize wireless technology. These solutions include wireless data terminals for collecting data from equipment which is then integrated to the back office systems on real-time basis. This helps to improve the utilisation of equipment and to reduce operating costs. Expert systems have been developed to assist the personnel responsible for equipment selection. VB-Expert was developed to aid equipment selection for earthmoving operations. ESACP was developed to assist planning and controlling of concrete placing operations. There are many other expert systems that have been developed either for academic purposes or for commercial use. Yet, no reference with respect to an integrated equipment management system that includes all functionalities concerning the construction equipment could be cited.

V. 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 cost of equipment in a project varies from 10-30% of the total cost of project, depending upon the extent of mechanisation. Proper planning, selection, procurement, installation, operation, maintenance and equipment replacement policy plays an important role in equipment management for successful completion of 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 modern equipment.

Equipment is one of the important resource of highway construction project. To complete any highway project in stipulated time period, it has become important to manage this vital resource. Use of the right equipment at the right place with minimum operating and maintenance cost is the aim of equipment management, which is necessary to achieve. This paper highlights the importance of 3 dimensions namely proper planning, selection and optimum utilisation for effective and efficient equipment management for highway construction project.

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