Monitoring and Control Systems for Resources in Construction Sites

Subraja R¹, Dr.S.Nickolas², Dr.P.Jayabalan³
PG Student, Department of Civil Engineering, NIT Trichy, Tiruchirappalli, India¹
Associate Professor, Department of Computer Applications, NIT Trichy, Tiruchirappalli, India²
Professor, Department of Civil Engineering, NIT Trichy, Tiruchirappalli, India³

ABSTRACT: Precise and timely monitoring of construction resources furnishes necessary information to the practitioner to make project control decisions. Despite the significance, existing systems are chronophagous and expensive. The objective of this research is to develop a software module that will assist the project manager to systematically monitor the resources i.e., Material, Labour and Equipment and also to take effective project control decisions on time. The module generates reports on a daily basis which depict actual variances taking place and the attributing reasons, thereby aiding project managers in taking suitable corrective actions so that resources are used in an optimized way.

KEYWORDS: Resource Monitoring, Project Control

I. INTRODUCTION

Indian construction industry plays an important role in the economic growth of the nation. It employs a workforce of nearly 32 Million and its market size worth is around 2,48,000 crores [22]. This highlights the importance of the role of monitoring and control systems in construction because a small variance in the performance of on-going projects will lead to an enormous loss. In today’s scenario Continuous Process Improvement (CPI) plays a vital role in project success. Project Control, Evaluation, Audit and Monitoring are four processes to achieve CPI in a project life cycle [2]. Monitoring and Control (M&C) refers to measuring the actual values of basic variables of the project, analysing these data, determining if the project is meeting targets of the work plan, and taking necessary actions to meet project objectives if there are any deviations in project performance [4]. Project control dominates the process of monitoring [19]. Monitoring provides quantitative information to support control action. M&C operations are always carried out for a project as a whole. There are no exclusive M&C operations for resources which contribute a major portion in the cost incurred for a construction project. M&C operations have to be carried out on a day to day basis in order to have an effective control over the resources. Manual monitoring on a daily basis is a tedious task and hence, automation becomes mandatory. Observing a gap in the existing system an attempt has been made to monitor and evaluate resource planning by developing a software module using programming language C.

II. RESEARCH BACKGROUND

In the project management literature, IT-based information systems were deemed to be essential to project managers in support of their planning, organizing, controlling, reporting and decision-making tasks [6]. Paul Crawford et al (2003) [8] identified that in designing a Monitoring and Evaluation Information System (MEIS) the following what/who/why elements must be addressed. i.e., what type of data an IS need to capture, analyse and disseminate, who are the stakeholders of IS and why are the key stakeholders interested in the data. The author proposed an extension to conventional Logical Framework Approach (LFA) which enhances project performance by supplying relevant and timely data to support informed management decisions, which ensures accountability through a defined reporting system which leaves the history of management decisions taken, it promotes organizational learning by capturing project histories and attributing reasons to variances between planned and actual implementation.
II. METHODOLOGY

Controlling involves monitoring the performance of the project and applying suitable corrective measures in case of deviations from initial plan. Generally the process of control can be sub-divided into the following stages:

1. Specifying the factors to be controlled
   In this study, the factors to be controlled are resources i.e., Material, Labour and Equipment for structural activities. The parameters that are considered for control and monitoring study are in general the quantity and productivity of resources and attributing reasons for variances between planned and actual usage.

2. Stating the methods of measuring control factor
   In this research study variance method (Staffurth 1975, Harrison 1992, Lockyer & Gordan 1996) is used for controlling operations. It compares what has actually happened on a project against what was expected to have happened on the project and indicates absolute value of the difference and percentage representation of the difference. It indicates how well the project resources have been used to conduct project activities throughout the project lifecycle.

3. Evolving systems for generating performances data
   The main objective of the research work is to create a software module which will assist in monitoring the resources using variance analysis method. It was created using C language. Daily activity progress and resource usage have to be updated in the module. It will be generating a total of 5 reports which will capture project histories and, in particular, the attribution of reasons to deviations between planned and actual implementation which will serve as a record to assist in planning similar projects in future.

4. Monitoring data received and formulating corrective options
   The data that has been updated in the module will be recorded as reports which when analysed cumulatively will give an idea about the root cause of the variances taking place in the project with respect to resources which will help in taking suitable corrective actions so as to make optimum usage of resources.

V. SOFTWARE MODULE IMPLEMENTATION AND DISCUSSION

The software module created was implemented in a site and tested for a period of 10 days. The structure considered for implementation was of shear wall construction type which comprises of 6 towers with 19 storeys each having a total...
built-up area of 1.07 million sqft. Initially, the planned data for the test period was acquired from the site and fed into the system. The progress of the project and the usage of resources were updated on a daily basis. The module compared planned and actuals, performed variance analysis and generated reports which are depicted graphically.

1. Material reconciliation report

This report compares the theoretical consumption of materials against actuals and helps in analysing whether the wastage of materials is within permissible limits and also the reason, in case wastage exceeds permissible limits as in Figure 1. From the figure it is seen that the material wastage is well below the permissible limits.

![Material Reconciliation Report](image1)

This report also gives the day-wise material consumption as in Figure 2 which will help in identifying the quantity of material used within a stipulated duration.

![Day-wise Material Consumption](image2)

This report also provides the quantity of stock remaining at the end of the day as in Figure 3 which will assist in making procurement decisions.

![Day-wise Material Stock](image3)
2. Material receipt report
This report assists in tracking the quantity of materials received from various sources day-wise as in Figure 4.

![Figure 4: Material Receipt Report](image)

3. Labour Daily Employment report
This report helps in controlling the employment of the labours within the project as depicted in Figure 5.

![Figure 5: Labour Daily Employment Report](image)

4. Labour Productivity report
This report helps in assessing the output of manpower activity-wise on a daily basis as described in Figure 6 and the reason for variance was found to be waiting for equipment / material and insufficient supervision.

![Figure 6: Labour Productivity Report](image)
5. **Equipment Utilization report**

This report helps in monitoring the utilization of concreting equipment in terms of productivity as shown in Figure 7. The reason for the actual productivity not meeting the standards was found to be pipeline change and slow down of work during lunch. Commonly the productivity was found to be lower when the concrete production quantity is lower.

![Figure 7: Equipment Utilization Report](image)

The utilization of tower crane in terms of productivity is shown in Figure 8. In tower crane, the productivity was found to decrease when complex reinforcement cages were erected and when wind speed is high.

![Figure 8: Equipment Utilization Report – Tower Crane](image)

VI. **CONCLUSION**

Delays and variances in a construction project are inevitable but with the aid of proper monitoring and control systems timely remedial actions can be taken thereby increasing the efficiency and effectiveness of the project. This paper proposes a software module that will help to monitor the resources on a daily basis which will also provide attributing reasons for the variances taking place with respect to resources. Based on the reasons suitable corrective measures can be taken so that the project can be carried out with optimum usage of resources. The integrated module provides the
user updated information about the actual proceedings of the site which will help the personnel in taking required control decisions so that the project can be completed within schedule and budget. The reports generated in the module will serve as a record for future reference which will help to increase the effectiveness of planning operations in the forthcoming projects. Given the complexity of large-scale construction projects, it is believed that the developed software module can considerably help the project managers to mitigate the loss due to resources in many projects.

REFERENCES

[22] www.cidc.in