

Monitoring and Control Systems for Resources in Construction Sites

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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.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

Louis Raymond et al (2007) [11] performed an empirical study of the impact of Project Management Information Systems (PMIS) on project managers and project success. The results of the research showed that the use of PMIS is, in fact, advantageous to project managers. Improvements in efficiency and effectiveness in management tasks were observed in terms of better planning, scheduling, monitoring and control. Improvements in productivity were observed in terms of timelier decision making. These systems were found to have direct impacts on project success as they contribute in improving budget control and meeting deadlines. Therefore, it can be concluded that using a PMIS has a significant contribution to project success and should continue to be the object of project management research. Charoenngam et al (2001) [7] conducted a case study on Thai construction organisations on assessment of cost control systems. It was argued that an accurate and realistic estimate can help serve as an effective plan for cost control which can be done by using historical data. For the analysis process, it was recommended that variance and trend analysis can be performed prior to the completion of each activity to allow for corrective action. For reporting, the study found timely and realistic information in reports as an important attribute of a cost control system.

III. OBJECTIVE AND SCOPE OF RESEARCH

To create a software module which has the following applications.

- To monitor the resources (Labour, Material, Equipment) used for various activities in a project by carrying out an analysis of the planned resources and the actual resources being used in site for the stipulated duration.
- To control the productivity of input resources to ensure efficient utilization.
- To analyse the reasons for deviation from the standards and to generate a report to assist the site in taking suitable corrective actions.

The scope of this research work is limited to structural activities in Shear wall construction type Residential building.

IV. 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

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

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.

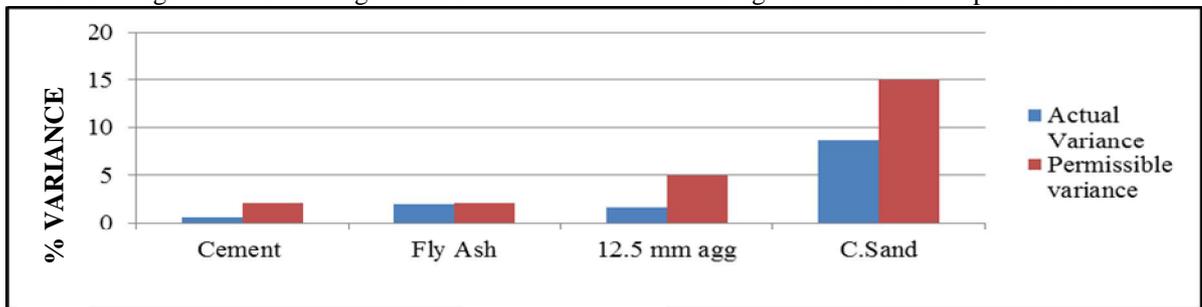


Figure 1: Material Reconciliation Report

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.

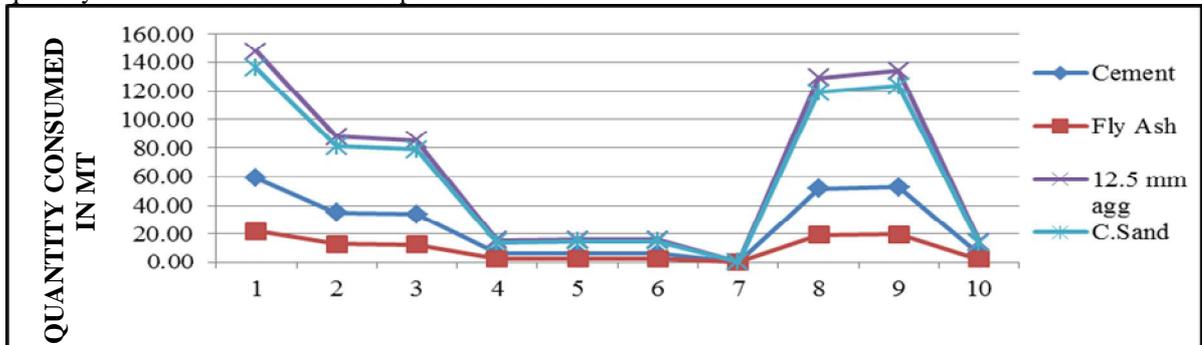


Figure 2: Month - February Consumption

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.

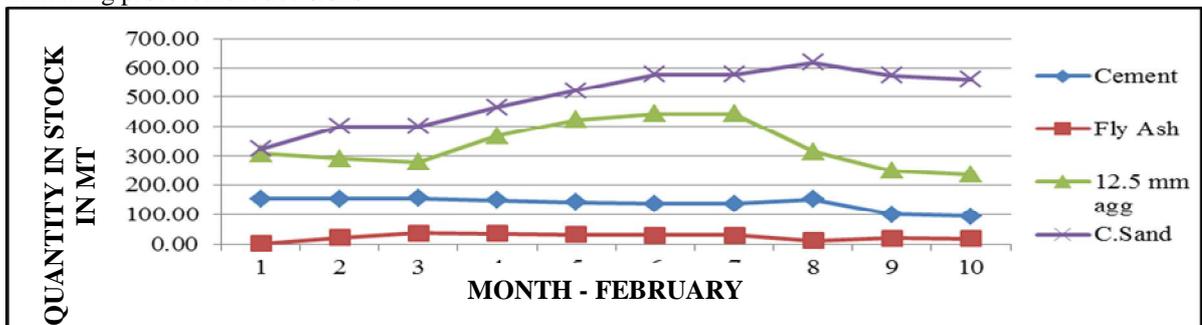


Figure 3: Day-wise Material Stock

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2. *Material receipt report*

This report assists in tracking the quantity of materials received from various sources day-wise as in Figure 4.

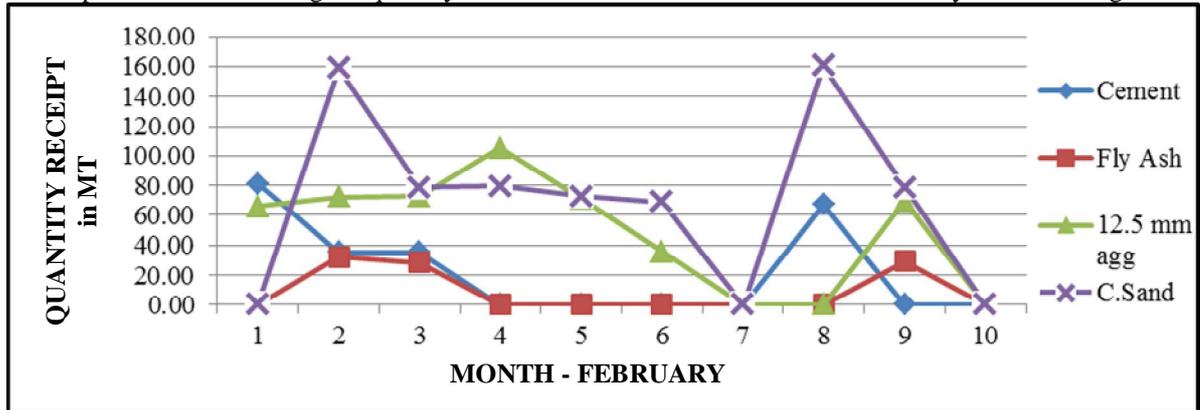


Figure 4: Material Receipt Report

3. *Labour Daily Employment report*

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

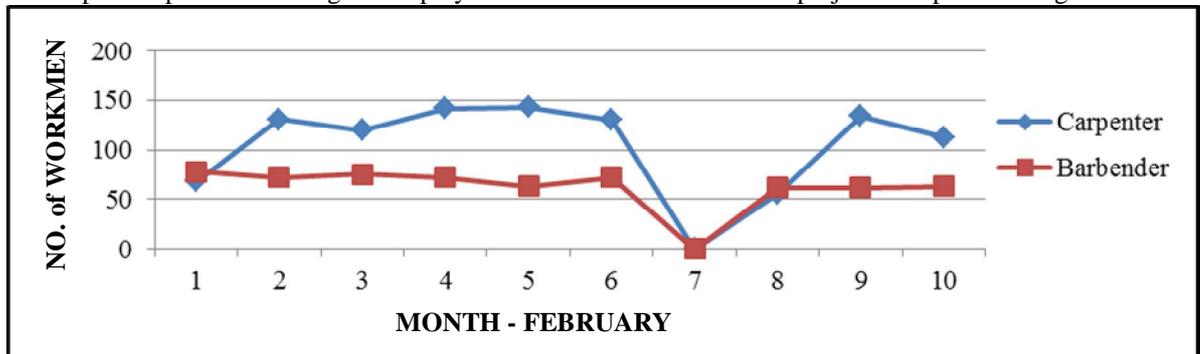


Figure 5: Labour Daily Employment Report

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.

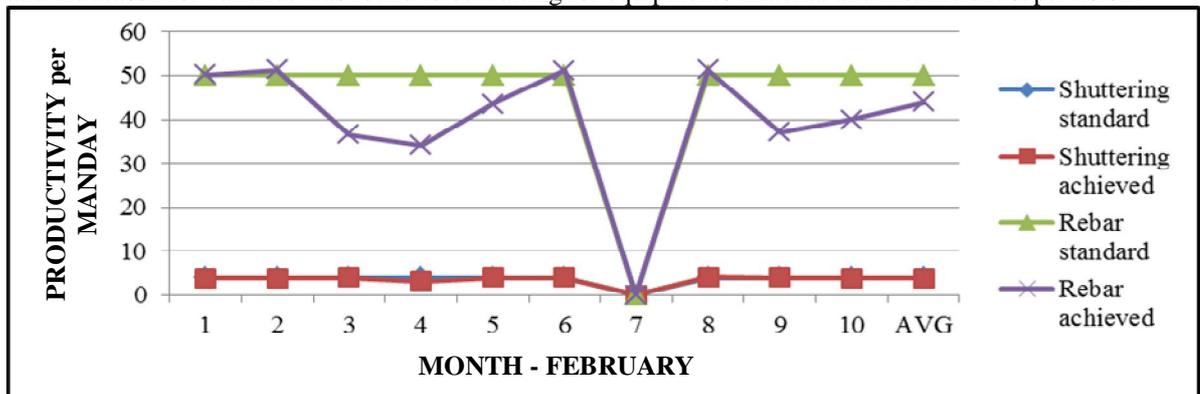


Figure 6: Labour Productivity Report

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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.

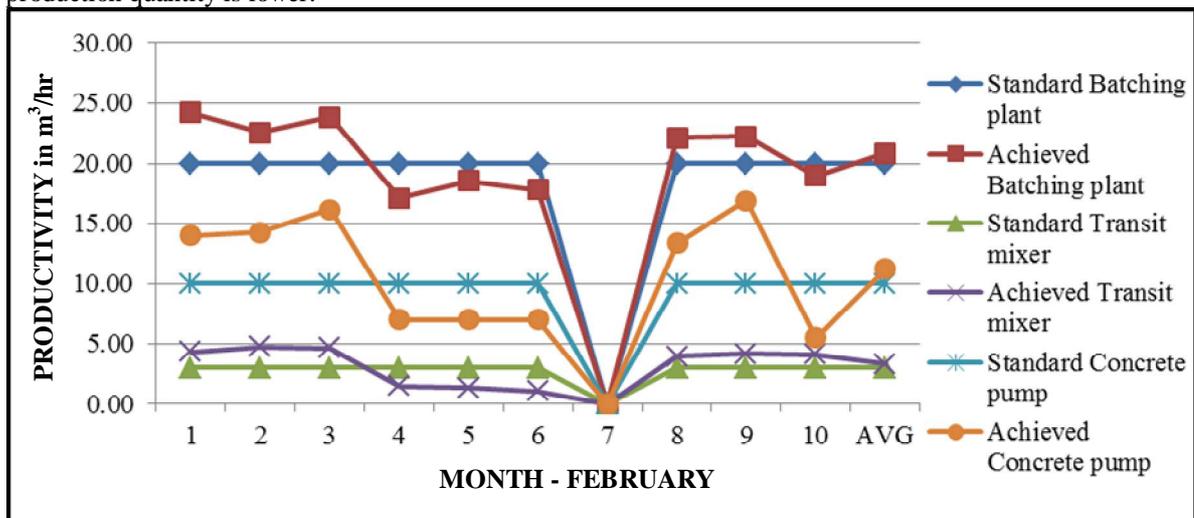


Figure 7: Equipment Utilization Report

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.

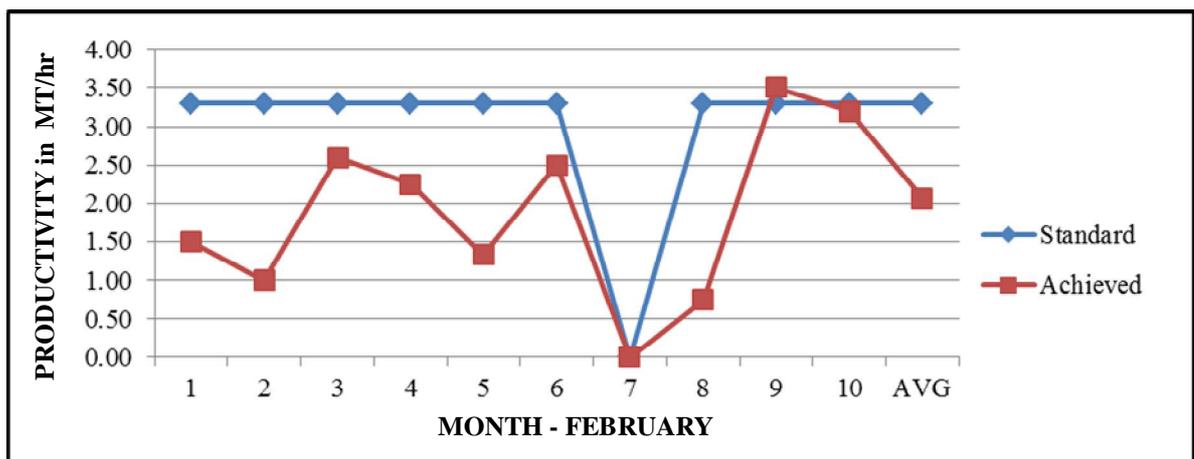


Figure 8: Equipment Utilization Report – Tower Crane

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

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

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.

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