Improving Labour Productivity in Construction Site through Work Sampling

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Abstract—Labour productivity has a major impact on construction project is completed on time. Therefore, it is important for construction managers to improve the conditions that affect labour productivity on their jobsites. Work sampling is a method that evaluates the amount of productive, supportive and non-productive time spent by the workers engaged in performing their assigned work activities. It also helps identify any trends affecting labour productivity. A review of the literature is done to study about productivity improvement process and workface assessment methods. Activity analysis is a continuous productivity improvement process which efficiently measures the time expenditure of workers onsite and identifies productivity inhibitors that management must reduce or eliminate to provide workers with more time for direct-work activities. The steps involved in activity analysis process are plan study, sample, analyse, plan improvements, and implement improvements. Six case studies were conducted using activity analysis process for feasibility check. The results conclude that activity analysis process is feasible to be conducted in construction site and also significant improvement in direct work rates is obtained.

Key words: Labour Productivity, Construction Site

I. INTRODUCTION

Labour Productivity is the major factor which needs to be improved in construction companies. Workface assessment techniques have been developed in an attempt to identify productivity issues immediately, without waiting for cost information or work completed reports. Methods such as work sampling, foreman delay surveys, craftsman questionnaires and five-minute ratings were developed. Work sampling is a method that evaluates the amount of productive, supportive, and non-productive time spent by the trade workers engaged in performing their assigned work activities. Work sampling also helps identify any factor affecting labour productivity.

A. Objective

1) The primary objective of this study is to improve construction productivity process by identifying productivity issues on their project and provide a solution for the issues.
2) The ultimate goal of the contractor is to reduce site labour costs and increase the direct work rate.

B. Workface Assessment Methods

There are several workface assessment methods. The most common are foreman delay surveys, craftsman questionnaires, five-minute ratings, and work sampling.

1) Foreman Delay Survey

Foreman delay surveys are daily reports by the foreman which summarize issues which are adversely affecting productivity of their crew (Oglesby, Parker, and Howell, 1989) [5].

2) Craftsman’s Questionnaire

Craftsmen’s questionnaires were first developed in the 1960’s, around the same time as foreman delay surveys. Similar to foreman surveys, craftsman’s questionnaires attempt to quantify time lost through asking the opinion of someone intimately involved at the workface.

3) Five Minute Rating

An older workface assessment method that is rarely used is the five-minute rating technique. This method is used to create awareness of delays in a job, measure the effectiveness of a crew and indicate problem areas which require further study (Oglesby et al., 1989) [5].

4) Work Sampling

Work sampling was developed by industrial engineers in the 1930’s. The method slowly gained popularity, eventually being applied to the construction industry. Work sampling is a statistical technique where an observer collects a series of random observations from the worker population.

II. LITERATURE REVIEW

Hans Picard, a productivity consultant working in North America, published an article describing partnerships the Tennessee Valley Authority (TVA) Fossil and Hydro Power established with two major contractors who completed the work. The article indicated the improvement in direct-work rates beginning in the spring of 1993 until fall 1995 in which the direct-work rate increased from 50.3% to 67% (Picard and Seay Jr., 1996). The averages were calculated from 5 to 10 studies for every half year, representing several outage projects on TVA power plants [3].

A paper presented by Daryl L. Orth, Sean Welty, and James J. Jenkins (2006) suggests course of action for implementing work sampling study on a jobsite based on the personal experience of the authors. The objective of this study was to develop a baseline of labour productivity for the three profit centers: insulation, waterproofing and fire proofing. After reviewing the data collected, the observer determined that the contractor is operating with above average labour productivity [2].

A study on minimization of construction waste through work sampling by Pradeep Kumar C (2015). The author believe that work sampling is a useful method for analysing site productivity, providing solutions for existing productivity problems, and establishing a baseline for comparing future studies, due to the value of information obtained from this study. After reviewing the data collected, the observer determined that the contractor is operating with above average labour productivity. From the study, the recoverable worker (non-productive) is 36 percent [6].
III. METHODOLOGY

A. Steps Involved In Analysis

The steps involved in activity analysis of this study are:
1) Plan Study
2) Sample Collection
3) Analysis
4) Plan Improvements
5) Implement Improvements

B. Plan Study

The activity categories used in the activity analysis process are direct work, preparatory work, material handling, equipment, waiting, travel, and personal. The craft workers are distinguished as mason, labourer, plasterer, pipe laying/fitter, plumber, electrician, carpenter, operator, and painter. Each craft worker has one horizontal band of coloured electrical tape around a hard hat. The craft workers are identified by use of coloured hats with number one it.

C. Minimum Sample Size Determination

- The determination of sample size is important to the accuracy of the results.
- From the sample size table in the literature review, it is known that for a 95% confidence and an error of 5%, a total of 510 samples are required.

D. Sample Collection

The author should prepare enough observation sheets for each one-hour period of study. The observation sheets contain spaces to write the date, time of each one-hour observation period, and spots for each craft’s name, identifier and number of workers. The sheet also has a right-hand column, where the author can make comments. Just before starting the first study period of the day, the author goes to the random start location in construction site and he selects a random route for surveying. The author then walks along the route and he will note the activity of each worker seen. This is done from a distance of between 15 to 30 metres and this is enough to make an accurate recording. The author will not move close enough to worker because it will cause discomfort for them.

E. Analysis

When all one-hour observation periods have been completed, the results are tabulated, the distribution of time spent on activities is calculated, graphical presentations of the total overall results and the hourly breakdown are illustrated, and the results are analysed to find out factors affecting labour productivity.

F. Plan Improvements

The most important factor which affects implementing improvements is negative thought to adopt the change. Most of the construction managers doesn’t come out of their negative perception in adopting changes. The process of planning improvements has three steps: listing the causes, analysing alternatives, and create a new plan for improvement implementation.

G. Implement Improvements

After discussing with various labour productivity industry experts and construction contractors, the following list of activities need to be undertaken to implement the improvements in construction site:
1) Effective communication with management.
2) Training labour about each activity schedule and timeline to finish the work.
3) Considering labour workers issues and Updating documents related to changing work processes.

H. Case Study

Activity analysis studies were completed on six construction projects located in Tamilnadu. Several details of the projects such as results of the studies and the data analysed. The results of the case studies are summarized in pie charts below (Fig. 2 to 7).

Fig. 1: Steps Involved in Analysis

Fig. 2 Activity Percentage of Study A
After analysing all case studies, it is clear that direct work rate is higher in case study C when compared to the six case studies, which is good. Preparatory-work rates in case study B is high. Management should consider if there is a way to decrease this percentage, which should increase the direct work rate. The excessive tools/equipment and waiting percentage in case study E could be caused by a poor tool management. The material-handling and travel activity percentages are excessive in case study A. Workers may be travelling long distances to tool rooms which is recorded as a travel observation when walking back there empty handed. The personal activity percentage is quite high at case study D, more than an hour of personal activities is taken each day by every worker. Management should consider if there is a way to decrease this percentage, thus direct-work rate must be increased.

IV. RESULT DISCUSSION

The six case studies have illustrated that the workface assessment methodology to the activity analysis process. The case studies have proven activity analysis process improves the direct work rate by finding factors affecting productivity in construction site. The analysis of the case studies it has been determined that sample size needs to be a minimum of 510 samples per observation period. At the beginning of the observation it was determined that identifying work activities and craft identifiers are slow because it is difficult to
determine craft workers in dark areas of construction sites. Management should take necessary action to improve direct work rate in construction site.

V. CONCLUSIONS
The objective of this study was to develop a labour productivity for the six case studies. The feasibility of activity analysis was verified through six case studies performed at construction sites in Tamilnadu. Each jobsite has site-specific factors that affect worker productivity.

We conclude the following from results obtained from the activity analysis process:
1) A second study need to be conducted by the contractor focussing on achieving 510 sample per observation.
2) The activity analysis process is feasible to conduct and helps to improve direct work rate in construction site.
3) The direct work rates of each case study show contractors are working above average percent in labour productivity.

ACKNOWLEDGEMENT
The authors express grateful acknowledgment to Dr. M. Ramalingam, Principal, Jerusalem College of Engineering, Dr. N. S. Elangovan, Head of Department, Department of Civil Engineering and our Project Coordinator Ms. S. Geetha, Assistant Professor, Department of Civil Engineering who helped whole heartedly to carry out this study.

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