

# A Study on Labor Productivity in Construction Industry

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**Abstract:** *Construction is the world's largest and most challenging industry. Labor Productivity performance plays a key role in determining the financial outcome of any construction project. Labor cost generally make up 30 to 50% of overall project cost in construction phase. Productivity improvements achieve higher cost savings with minimal investment. Achieving better labor productivity requires detailed studies of the actual labor cost. For every project, productivity, cost, quality, and time have been the main concern. Better productivity can be achieved if project management includes the skills of education and training, the work method, personal health, motivational factors, the type of tools, machines, required equipment and materials, personal skills, the workload to be executed, expected work quality, work location, the type of work to be done, and supervisory personnel. Productivity has a great significance in construction. Labor productivity constitutes a significant part of production input for construction projects. In the construction industry, many external and internal factors are never constant and are difficult to anticipate. This factor leads to a continuous variation in labor productivity. This paper gives the detail study regarding labor productivity such as its definition, its types, different factors affecting on it, different methods used for its analysis.*

**Keywords:** Labor Productivity, Artificial Neural Network, Relative Important Index, Construction Industry.

**(I) Introduction:** Labor is one of the basic requirements in the construction industry. Labor productivity usually relates manpower in terms of labor cost to the quantity of outputs produced.

Construction industry is divided into three segments such as major contractor, medium contractor, and small contractor. Large project which are being undertaken by both major as well as medium contractors and small scale projects which are undertaken by small contractors. This classification is based on the number of laborers employed. Small contractors are classified as those which employ less than 200 labor, Medium contractors employ 200-500 labor and those which employ more than 500 labor are classified as major contractor.

## **Definition of Labor Productivity:**

The term of "Productivity" has different meanings for different people. Depending on who is explaining productivity, whether he is a politician, accountant, economist, industrial engineer, or construction manager, you will get a wide range of different meanings of the term "Productivity". Some will define it as production rate, efficiency, effectiveness, performance or merely production.

The Concise Oxford Dictionary (9th edn) defines productivity as the "capacity to produce, the state of being productive; effectiveness of productive effort; especially in industry; production per unit of effort". While providing a good starting point, this definition uses the word "productive" in defining productivity but, importantly, three distinct productivity concepts are brought out: (i) the capacity to produce, that is the force behind production itself, (ii) effectiveness of productive effort as a measure of how well the resources are utilized and (iii) the production per unit of effort (or rate) to measure output of the factors of production over a defined period time.

In the construction industry, the meaning of the term productivity varies with its application to different areas. The term productivity usually refers to the output produced per unit input. Thomas (2013) [2], defined labor productivity as the "ratio of the output quantities to the input work hours".

Labor Productivity = Output Quantity / Work Hours

Labor Productivity = Output / Labor cost.

## **(II) Types of Labor Productivity:**

There are three types of productivity, namely single factor productivity, total factor productivity and total productivity which explain as the following:

### **1. Partial productivity:**

is the ratio of output to one class of input. For example, output per man-hour (labor productivity measure) is a partial productivity concept. So are output per ton of material (a material productivity ratio) and interest revenue generated per dollar of capital (a capital productivity ratio) and so on.

### **2. Total factor productivity (TFP):**

is the ratio of net output to the sum of associated labor and capital (factor) inputs. The net output here is sometimes called value-added output. In this ratio, we explicitly consider only the labor and capital input factors in the denominator. Since materials account for as much as 65% of product costs in consumer goods such as LCD's, Laptops, etc. this measure is not the best one in most cases.

In this ratio, we explicitly consider only the labor and capital input factors in the denominator. Since materials account for as much as 65% of product costs in consumer goods such as TVs, VCRs, and computers, this measure is not the best one in most cases.

### **3. Total productivity:**

is the ratio of total output to the sum of all input factors. This is a holistic measure that takes into consideration the joint and simultaneous impact of all the input resources on the output, such as labor, materials, machines, capital, energy, etc. This measure has received much attention over the past ten years, as evidenced by many papers and case studies. Another term

used in recent years is multifactor productivity, which considers more than one input factor in the denominator of the productivity ratio, but is not necessarily a total factor or total productivity measure

Various agencies may modify Eq. 2 by adding maintenance costs or deleting energy or capital costs. Outputs are expressed in terms of functional units.

### (III) Productivity measurement techniques:

#### 1. The direct observation technique:

Direct observation is one of the continuous observation methods. A researcher observes workers activities throughout the work day. Tool time and Noon-tool time activities are easily and accurately identified because the times are recorded to the nearest minute.

The direct observation method is generally considered tedious and time wasting. One technique to increase this methods efficiency is to highlight only the non-tool time activities provided that the workers spend more time on tool time activities than non tool time activities. Another criticism of this method is that the observers presence may disturb workers. It is recommended that the observer could locate himself in a suitable vantage point where there is a full view of all workers but at the same time does not interfere with the operations progress.

The direct observation method has the following advantages:

- The data collected is accurate and precise.
- The length and pattern of time of each work task can be collected.

The disadvantages of the direct observation method are the following:

- A crew of five workers is the maximum crew size one observer can manage.
- If poorly managed the observation can interfere with the workers carrying out their tasks.

#### 2. Time study technique:

Time study was the fundamental approach to productivity improvement introduced by Frederick W. Taylor and Frank Gilbreth in the late 19th and early 20<sup>th</sup> centuries, and it is the principal technique of work measurement even today. In the current usage, it is not simply the timing of an operation but a process designed to develop standard time or standard output for any construction operation irrespective of the rate of work being observed. Time study therefore involves:

- Timing, to discover how long various operations are taking;
- Rating, to assess the worker being observed against a norm;
- Building up of time standards, by allowing for appropriate relaxation and Contingency allowances.

#### 3. Activity sampling technique:

It is a technique that measures the percent of time craftsmen spend in various categories of tasks, such as direct work, transporting materials, or waiting. In addition, it is physically impossible to observe and record all the minute details of every repetition of any construction operation. Activity sampling refers to any measurement technique for which observations are non-continuous. Thus, the observations represent a sampling of the total activity.

#### 4. Forman delay survey

The objective of this technique is to identify the reasons for delays and the extent of it. In a delay survey, foremen are asked to report any delays greater than a specified time that were experienced during the day. By correlating the reported lost time with the causes of delays, project management can take action to

resolve the problems and to eliminate the delays (Alfeld, 1988).

#### 5. Craftsman questionnaire sampling

Craftsman questionnaire sampling (CQS) was recently developed for performance measurements and productivity improvement at construction sites. The main idea of CQS is to use questionnaires as a means of data collection. CQS provides information regarding the sources of delay, the amount of rework performed, as well as creating a participating atmosphere on site. In performing the CQS, the administrator of CQS walks around the field as the work-sampling sampler does. The administrator

randomly selects craftsmen to answer the questionnaires. Because of the manner of random selection and the determination of the activities, the craftsmen are involved in the immediate post. After the questionnaires are filled out by craftsmen and foreman,

the administrator repeats the cycle until he gets an adequate sample size.

#### 6. Recording methods

A detailed record of the current method must show exactly how the work is being done. This recording can be done in several ways. The most common uses the stopwatch or interval timer. The study consists of recording the times for different tasks or fractions of a task that a man or machine performs. When observing activities of short duration with a stopwatch, an appreciable error is accumulated if the watch is stopped, read, and started each time. This error can be eliminated if the timer runs continuously. A second method of recording the activities of

a crew is time-lapse photography. This method consists of taking single pictures at an interval of one, two, three or four seconds for long periods. Exposures are made at precise intervals so that elapsed times can be computed accurately as a product of the

number of pictures and the photographic time interval. The time-lapse camera has proved an excellent means of collecting information and data for work-improvement studies.

The camcorder technique offers a means to identify productivity problems and provides a systematic procedure to resolve them. A video camera, being a more accurate and superior data collection method, can take the place of several observers because it

captures all concurrent activities. The camcorder technique involves several steps: Collection of video equipment, preplanning for the taping process, conducting brainstorming sessions, analysis of recorded data, and development of recommendations.

#### (IV) Factors Affecting on Labor productivity:

Identification and evaluation of factors affecting labour construction productivity have become a critical issue facing

project managers for a long time in order to increase productivity in construction. Understanding critical factors affecting productivity of both positive and negative can be used to prepare a strategy to reduce inefficiencies and to improve the effectiveness of project performance. For different regions different factors are effects on labor productivity such as environmental, material, safety, quality, project, manpower, time, motivational, leadership etc.

#### (V) Different techniques for Labor productivity Analysis:

Productivity is calculated with the ratio between output and input. The output is nothing but units of work completed and input as no. of man days employed to complete these work. Several techniques are used to analyse the labor productivity such as regression analysis, Artificial Neural Network for predicting of rate of labor productivity, Work Sampling etc. Many modeling technique have been developed for predicting the productions rates for labor that incorporate the influence of various factor. But the Artificial Neural Network has been found to have strong pattern recognition and learning capabilities to get results.

#### (VI) Guidelines for improving labor productivity:

1. Arrange labor training program.
2. Provide on time payment to the workers.
3. Avoid rework.
4. Improve relation between supervisors to labors.
5. Give time to time guidelines to the labor.
6. Provides proper incentive wage schemes as per standard.
7. Proper planning of raw material.
8. Motivate to labors towards the completion of project.
9. Advanced machineries and equipment's at site.
10. Clear all things regarding work.

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