



ORIGINAL ARTICLE

# Towards improving construction labor productivity and projects' performance

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**Abstract** Proper management of resources in construction projects can yield substantial savings in time and cost. As construction is a labor-intensive industry, this paper focuses on labor productivity in the construction industry. This study considers the current state-of-the-art issues relevant to this subject. It covers the construction labor productivity definitions, aspects, measurements, factors affecting it, different techniques used for measuring it and modeling techniques. The main outcome from the literature is that there is no standard definition of productivity. This study provides a guide for necessary steps required to improve construction labor productivity and consequently, the project performance. It can help improve the overall performance of construction projects through the implementation of the concept of benchmarks. Also, it gives an up to date concept of loss of productivity measurement for construction productivity claims. Two major case studies, from the literature, are presented to show construction labor productivity rates, factors affecting construction labor productivity and how to improve it.

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## 1. Introduction

Inefficient management of construction resources can result in low productivity. Therefore, it is important for contractors and construction managers to be familiar with the methods leading to evaluate the productivity of the equipments and the laborers in different crafts. To achieve the income expected from any construction project in general, it is important to have a good controlling hand on the productivity factors that contribute in the integrated production composition, like labor, equipment, cash flow, etc. In Egypt, literature revealed that the second performance criteria, out of 12, by which construction managers would like their performance to be evaluated is “the efficient utilization of resources” [1]. Also it showed that young site

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engineers working in contracting organizations ranked in utilization of resources the second out of 12 factors that affect the performance of construction organizations in Egypt (Abdel-Razek, 1998, cited in Abdel-Razek, 2004, p. 4) [2].

## 2. Productivity definitions and concepts

Productivity can be defined in many ways. In construction, productivity is usually taken to mean labor productivity, that is, units of work placed or produced per man-hour. The inverse of labor productivity, man-hours per unit (unit rate), is also commonly used [3].

Horner and Talhouni [4] stated "A popular concept in the USA, and increasingly in the UK, is the concept of earned hours. It relies on the establishment of a set of standard outputs or "norms" for each unit operation. Thus, a number of "earned" hours are associated with each unit of work completed. "Productivity" may then be defined as the ratio of earned to actual hours. The problem with this concept is in establishing reliable "norms", for setting standards. It also depends on the method used to measure productivity, and on the extent to which account is taken of all the factors which affect it."

## 3. Construction labor productivity measurement

Different measures of productivity serve different purposes. It is important to choose a measure that is appropriate to the purpose [5].

Thomas et al. [5] defined different aspects of measures as follows:

### 3.1. Economic models

The department of Commerce, Congress, and other governmental agencies use a productivity definition in the following form:

$$\text{Total factor productivity (TFP)} = \frac{\text{Total output}}{\text{Labor} + \text{Materials} + \text{Equipment} + \text{Energy} + \text{Capital}} \quad (1a)$$

$$\text{TFP} = \frac{\text{Dollars of output}}{\text{Dollars of input}} \quad (1b)$$

TFP is really an economic model measured in terms of dollars, since dollars are the only measure common to both inputs and outputs. Various agencies may modify Eq. (1) by adding maintenance costs or deleting energy or capital costs. Outputs are expressed in terms of functional units. For example, the Federal Highway Administration may be interested in:

$$\text{Productivity} = \frac{\text{Output}}{\text{Design} + \text{Inspection} + \text{Construction} + \text{Right-of-way}} \quad (2a)$$

$$\text{Productivity} = \frac{\text{Lane mile}}{\text{Dollars}} \quad (2b)$$

The definition is also useful in policy-making and for broad program planning. Eq. (2) is also subject to significant inaccuracies when applied to individual projects.

### 3.2. Project-specific models

A more accurate definition that can be used by governmental agencies for specific program planning and by the private sector for conceptual estimates on individual projects is:

$$\text{Productivity} = \frac{\text{Output}}{\text{Labor} + \text{Equipment} + \text{Materials}} \quad (3a)$$

$$\text{Productivity} = \frac{\text{Square feet}}{\text{Dollars}} \quad (3b)$$

Design professionals use productivity data in this form.

### 3.3. Activity-oriented models

A contractor is more likely to define productivity using a narrowly defined version of Eq. (3), where the units of output are specific for generic kinds of work. Typical units are cubic yards, tons, and square feet. Various related activities, such as formwork, steel reinforcement, and concrete placement, can be combined using the earned-value concept (Thomas and Kramer, 1987, cited in Thomas et al., 1990, p. 706) [5]. Productivity is expressed as units of output per dollar or work-hour.

At the project site, contractors are often interested in labor productivity. It can be defined in one of the following ways (Thomas and Mathews, 1985 cited in Thomas et al., 1990, p. 707) [5]:

$$\text{Labor productivity} = \frac{\text{Output}}{\text{Labor cost}} \quad (4)$$

or

$$\text{Labor productivity} = \frac{\text{Output}}{\text{Work-hour}} \quad (5)$$

There is no standard definition of productivity and some contractors use the inverse of Eq. (5):

$$\text{Labor productivity} = \frac{\text{Labor costs or work-hours}}{\text{Output}} \quad (6)$$

Eq. (6) is often called the unit rate. Still other contractors rely on the performance factor as a measure of productivity

$$\text{Performance factor} = \frac{\text{Estimated unit rate}}{\text{Actual unit rate}} \quad (7)$$

Other terms, such as efficiency, are often used synonymously with labor productivity."

The Construction Management Research Unit at Dundee University measures labor productivity in three different ways [4]:

- (1)  $\frac{\text{Output}}{\text{Total time}}$ , where total time is total paid time.
- (2)  $\frac{\text{Output}}{\text{Available time}}$ , where available time is total time minus unavoidable delays, principally meal breaks and weather.
- (3)  $\frac{\text{Output}}{\text{Productive time}}$ , where productive time is available time minus avoidable delays

### 3.4. The baseline productivity

Thomas [6] stated "Because disruptions adversely affect labor productivity, the best productivity occurs when there are few

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