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An improved methodology for selecting similar working days for measured mile analysis

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Abstract

Quantifying economic losses on construction projects caused by labor inefficiencies is often a difficult and tedious task. A widely accepted way to quantify such losses is by using the "measured mile" approach. This technique compares the productivity achieved during an unimpacted or minimally impacted time period with productivity realized during an impacted period. The dependability of the periods that are chosen is vital and plays a key role in the determination of merit, liability and quantum. The work performed during the measured mile period should be substantially similar to the work that was affected. As currently practiced though, choosing the periods for measured mile analysis is usually made in a largely subjective manner.

The objective of this article is to introduce and illustrate the statistical clustering method as a tool for selecting the similar working periods. This new approach is advocated because it determines similarity of work condition using objective criteria. The method is agile and can be easily applied in practice by project managers or construction consultants. In this paper the factors that affect the similarity of work are identified, and the clustering procedure is developed. An example is also included to show how the method works in practice.

Keywords: Construction management; Construction claims; Construction; Labor productivity; Measured mile; Statistical analysis; Similar workdays

1. Introduction

Lost productivity is a primary contributor to cost and schedule overruns that affect many construction projects (Jones, 2003). Lost productivity can increase labor cost, which constitutes a large share of the total costs of most construction projects. For example, electrical and mechanical construction projects can have a high labor component, 40–60% of the total project cost (Hanna et al., 1999). In addition, lost productivity may also result in higher equipment and material costs and drive up field and home office overhead since productivity loss can potentially cause project accelerated, delayed and disrupted (Ginsburg and Bannon, 1985). The impact gets stronger as construction material prices have increased significantly since 2002. For example, iron and steel prices have increased by 31% from 2004 to 2005 (Martin and Budzik, 2007). When it comes to recovering lost productivity costs, the least subjective, and therefore a more reliable and widely accepted method is the measured mile approach (Finke, 1998; Loulakis and Santiago, 1999; Presnell, 2003). This technique compares the productivity achieved during an unimpacted (or minimally impacted) time period with the productivity realized in the impacted period (Jones, 2003).

The success of a contractor's measured mile approach relies primarily on the dependability of comparable periods selected (Loulakis and Santiago, 1999). In choosing a measured mile, the analyst should be guided by several factors. First, the work performed during the mile should be substantially similar in type, nature, and complexity to the work that was affected. It is

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unlikely that perfect comparisons can be found but every effort should be made to find largely similar work. Next, the composition and level of skill of the crews should be comparable (Thomas and Sanvido, 2000).

However, selecting comparable periods and proving the similarity of work within those periods can be quite challenging. Even for the same type of operations in construction projects, they are very often unique in the terms of difficulty level, complexity, and location. Also, many complicated, subtle, and uncertain factors might affect crew performance. Each of these factors can happen at any time during the whole construction process and their influence on the production performance can be different. This makes the selection process even harder when there is more than one dynamic and complicated factor occurring at the same time. Therefore, the complexity associated with the selection decision suggests that an effective procedure is needed to aid project managers and consultants in claim preparation and to minimize the subjectivity associated with the selection decision.

The objective of this article therefore is to introduce and illustrate one such method: the statistical clustering method. The factors that affect the similarity of work are identified, and a clustering procedure is developed. An example about how to apply the method is also presented to show the mechanics of the technique.

2. Factors affecting similarity of work

There are a number of variables to consider when choosing similar work for the measured mile analysis. First, the work performed during the measured mile period should be substantially similar to the work that was affected (Loulakis and Santiago, 1999; Thomas and Sanvido, 2000). It includes the type of work, work means and methods, work character, work complexity, work location, crowding of work area, and work locations (see Table 1). For example, in a pipe rigging project, the pipes that need to be installed can have different length and diameter. The different complexities of pipe shape can affect the productivity performance (Fayek and Oduba, 2005). Also the crowding of work area and ground conditions can vary throughout the whole project. To achieve good productivity each member of a crew must have sufficient working space to perform their work without being interfered with by other craftsmen. When more labor is assigned to work in a fixed amount of space it is probable that interference may occur, thus decreasing productivity (AACE, 2004). Previous research has shown that productivity inefficiencies are correlated with square feet of work area per worker (Schwartzkopf, 1995).

The second main factor that must be considered is the labor crew itself (Loulakis and Santiago, 1999; Thomas and Sanvido, 2000). This includes crew size and composition, skill level, number of foremen on site, supervisor vs. workman ratio, crew experience on similar type of work, absenteeism and learning curve (Schwartzkopf, 1995; MCAA, 1994). For example, a crew with more experienced and higher skill level workers is likely to have better productivity than a crew consisting of a large number of apprentices. In order to be productive a contractor must have sufficient skilled labor in the field. To the extent that skilled labor is unavailable and a contractor is required to construct a project with less skilled labor it is probable that productivity will be impacted (AACE, 2004).

Absenteeism can have a negative effect on labor productivity as well. When a crew hits its productive peak the absence of any member of the crew may impact the crew's production rate because the crew will typically be unable to accomplish the same production rate with fewer resources or, perhaps, a different mix of skill and experience levels.

The learning curve is also an important factor that must be included in the selection decision. Zink (1986) suggested cutting the first 10% of total work hours in a project, because they are "build-up" and are not representative of an expected or average sustained production performance. Presence of a learning curve indicates that a crew is reaching its proficiency through practice. Generally speaking, a crew might have to spend some low productivity times in the beginning of a project to get familiar with the operation method and work environment, define each worker's task, and set up a working procedure. The learning rate is usually high during the first few days of work and then that rate arrives at a plateau. As a consequence, the learning curve is one of the important factors affecting labor productivity performance in construction projects.

From a practical viewpoint, finding an area of work that has not been disrupted at all can be impossible on some jobs. In such situations a modified measured mile approach may be

Table 1
Factors need to be considered in similarity decision-making for measured mile analysis.

Main factors (1)	Detailed level factors (2)	Include in consideration? (3)
Work factor	Type of work, work means and methods, work character, work complexity, work location, crowding of work area, and work locations	Yes
Labor skill factors	Crew size, crew composition, skill level, number of foremen on site, apprentice/journeyman ratio, crew experience on similar type of work, absenteeism, and learning curve	Yes
Project factors	Project type, project location, project size, work schedule, unions, safety, management efficiency, site layout, and constructability	Only when compared between different projects
Other factors	Weather	Depending on the contract