International Journal of Engineering and Technical Research (IJETR)
ISSN: 2321-0869, Volume-3, Issue-1, January 2015

Construction Management: A Professional Approach of Factors Affecting the Labor Productivity

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***Abstract*— This study discusses largely on the main factors affecting the important changes in construction productivity. It is difficult to identified reliable data and related information. There are many types of construction changes and each type can have an effect on labor and machinery productivity. But what is the effect of extreme twenty factors and unique project. Labor productivity was estimated through the correlated with the actual labor productivity values, R2 = 0.937 Job size is also estimated. A contractor has established that under a set of "standard" work conditions for building construction, and labor productivity index was 085. This implies that labor is 15% less productive on the large job than on the standard project.**

***Index Terms*— Productivity, Labor Index, Factor Impact, Construction Management.**

I. Introduction

Productivity is an important aspect of the construction industry that may be used as an index for measuring the efficiency of production. Consequently, it can also serve to measure the status of economic growth and related production from industrial and corporate perspectives. Many factors can be used to measure productivity. For example, managers can generate diverse productivity data that take into account the measured productivity and the factors that influence it. These data can then be used to define an index for measuring the performance of a project, which in turn plays an important role in decision making during the project engineering process(1)

Labor productivity in construction is often defined as is the ratio of output to inputs in production; it is an average measure of the efficiency of production. Efficiency of production means production's capability to create incomes which is measured by the formula real output value minus real input value. Construction output may be expressed in terms of functional units or constant dollars. In the former case, labor productivity is associated with units of product per labor hour, such as cubic yards of concrete placed per hour or miles of highway paved per hour. In the latter case, labor productivity is identified with value of construction in dollar per labor hour. The value of construction in this regard is not measured by the benefit of constructed facilities, but by construction cost. Labor productivity measured in this way requires considerable care in interpretation. However, it is important to note that labor productivity is a measure of the overall effectiveness of an operating system in utilizing labor, equipment and capital to convert labor efforts into useful output, and is not a measure of the capabilities of labor alone.

Manuscript received January 23, 2015.
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For example, by investing in a piece of new equipment to perform certain tasks in construction, output may be increased for the same number of labor hours, thus resulting in higher labor productivity.

II. Estimation:

The approximation, which is a value that is usable for some purpose even if input data may be incomplete, uncertain, or unstable. The value is nonetheless usable because it is derived from the best information available. Typically, estimation involves "using the value of a statistic derived from a sample to estimate the value of a corresponding population parameter". The sample provides information that can be projected, through various formal or informal processes, to determine a range most likely to describe the missing information. An estimate that turns out to be incorrect will be an overestimate if the estimate exceeded the actual result, and an underestimate if the estimate fell short of the actual result [2].

In this estimate, as much time is spent on productive work as on delays due to management and inefficiencies due to antiquated work methods (Fig.1).

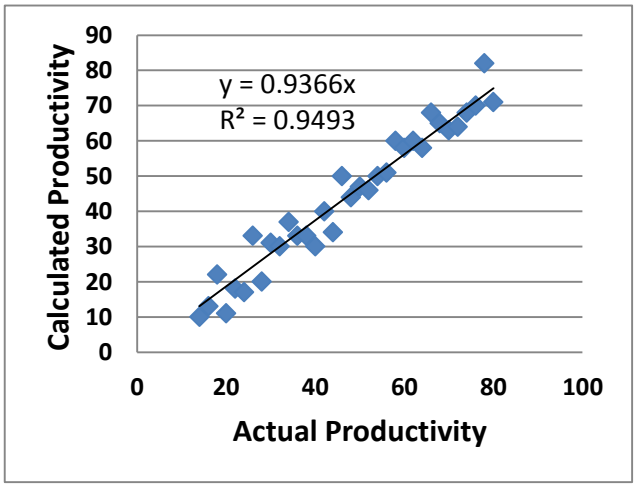

Fig. 1. Relationships between actual and estimated productivity.

III. Unique Projects

No two construction projects are exactly the same and vary in many ways such as design, size, capacity, utilities, location, orientation, and so on. When projects are planned and budgeted based on historical

data, it is important to consider the differentiators and variables unique to the project and factor them accordingly. All projects are unique and have some variables. Even those with the exact same design will have some differentiators, including [3]:

Design or capacity
Varying site conditions such as soil, drainage, and so on
Weather conditions such as climate and temperature
Season changes
Manpower and labor conditions, such as
union versus open shop, and skilled versus unskilled labor
Experience factors such as learning curve and legacy data from previous projects
Intangible factors such as morale, fatigue, and attitude, which leads to absenteeism, turnover, and crew size inefficiency
Site access
Unplanned errors and omissions, work stoppages, delays, and so on
Source and location of power and utilities
Governmental or regulatory requirements
Material source, supply, and codes
Different project team and supervision
Proximity to transport and logistics

IV. Contractor Productivity Loss Claims

According to the Independent Project Analysis Group, an average of over 35 percent of all construction projects will have a major change. A change in a project of any kind usually means there will be associated productivity impacts that can be attributed to inefficiencies as well.

EPC companies, contractors, and subcontractors usually have contracts with a defined work scope, duration, start date, and other parameters to base their estimate [4]. Often, the design is incomplete or changes are made that will impact the original estimate. The original project may have been planned for partial execution in cold weather and other inefficiencies; however, the changes will probably constitute additional impacts and inefficiencies. One key example is owners will very often demand the same completion date, despite the added work scope. This may require overtime, second shift work, rework, additional crafts, and many other impacts to the original plan and estimate. This increase in man-hours, constraints, and other resources would impact the cost and schedule[5].

Another impact that may occur is the need for new or additional material, constraints, and equipment, which affect the sequence, duration, and schedule of work packages. There could also be an increase in idle time of workers waiting on material .Such changes may cause manpower increases and work areas to be overcrowded with workers who now need to share and occupy the same work space, scaffolding, or equipment with other crafts, causing a further drop in productivity(6).

V. Factors Affecting Labor Productivity

Here are some of the most recognized factors affecting labor productivity :

1. Overtime

Scheduling of extended work days or weeks exceeding a standard eight-hour work day or 40 hour work week lowers work output and efficiency through physical fatigue and poor mental attitude.

2. Fatigue

Fatigue can be caused by prolonged or unusual physical exertion.

3. Absenteeism and the missing man syndrome

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.

4.Acceleration (directed or constructive)

The deliberate or unintentional speeding up of a project may result in lengthy periods of mandatory overtime, the addition of second shifts, or the addition of more labor beyond the saturation point of the site or that can be effectively managed or coordinated, all of which may have distinct impacts on productivity.

5. Availability of skilled labor

To be productive, a contractor must have sufficient skilled labor in the field[7]. 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.

6. Craft turnover

If a crew suffers from continual craft turnover, it is unlikely that they will achieve good productivity simply because one or more members of the crew may be on the learning curve, and thus decrease the overall productivity of the entire crew.

7. Crowding of labor or stacking of trades

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. Additionally, when multiple trades are assigned to work in the same area, the probability of interference rises and productivity may decline.

8.Defective engineering, engineering recycle and/or rework

When drawings or specifications are erroneous, ambiguous, unclear, etc., productivity is likely to decline because crews in the field are.

9. Project management factors A result of poor project

management may be the failure to properlyschedule and coordinate the work. Work that is not properly scheduled, shortage of critical construction equipment or labor, and incorrect mix of labor crews may result in decreased productivity because crews may not be able to work as efficiently as they would otherwise do. Improperly planned and implemented project initiation procedures may also lead to lost labor productivity [8].

10. Rework and errors

When work in the field must be done more than once in order to get it right, productivity may suffer as a result.

11. Schedule Compression Impacts on Productivity(9).

12. Site or work area access restrictions

If a work site is remote, difficult to get to, or has inefficient

or limited access then productivity may suffer because labor, equipment and materials may not be on site when and as needed to support efficient prosecution of the work. In addition, productivity losses may occur when access to work areas are delayed or late and the contractor is required to do more work in a shorter period of time, which may result in overmanning, dilution of supervision and lack of coordination of the trades.

13.Site conditions

Physical conditions (such as saturated soils); logistical conditions (such as low hanging power lines); environmental conditions (such as permit requirements prohibiting construction in certain areas during certain times of the year); legal conditions (such as noise ordinances precluding work prior to 7:00 AM [0700 hours] or after 4:00 PM [1600 hours]) may all negatively impact productivity on a project.

14. Dilution of supervision

When crews are split up to perform base scope work and changed work in multiple locations or when work is continually changed or resequenced, field supervision is often unable to effectively perform their primary task – to see that crews work productively. Field supervision ends up spending more time planning and replanning than supervising. It is probable that productivity will decline because the right tools, materials and equipment may not be in the right place at the right time.

15. Over manning

Productivity losses may occur when a contractor is required to or otherwise utilizes more personnel than originally planned or can be effectively managed. In these situations, productivity losses may occur because the contractor may be forced to use unproductive labor due to a shortage of skilled labor; there may be a shortage of materials, tools, or equipment to support the additional labor; or the contractor may not be able to effectively manage the labor due to a dilution of supervision.

16. Start/Stop

This results from a work stoppage or suspension of work, which may cause a break in the schedule, usually triggering a start/stop of work activity. Stop-starts can have an impact on productivity and cost of a project. Work scheduled or reassigned during holidays such as Thanksgiving, Christmas, New Year's, and so on are often impacted with stop-starts. Workers tend to discuss the time off and lose previous momentum with a drop in productivity before they get back in routine.

17. Holidays

If workers work on holidays, there is not only a cost factor for holiday pay, but there is usually a loss of productivity as well. It may be addressed as a morale factor since workers are away from families and working instead of enjoying the holidays, or it can also be factored separately. Either way, there is usually a productivity loss to consider.

18. Weather and Season Changes

Performing work in a change of season, temperature zone, or climate change resulting in work performed in either very hot or very cold weather, rain or snow, or other changes in temperature or climate can impact workers beyond normal conditions.

19. Tool and Equipment Shortage

This is caused when there is insufficient quantity or quality of tools and equipment to meet the needs of the project.

20. Proximity of Work

This is caused by working in a remote area, proximity of tools, break areas, material laydown yard, or other resources causing a loss of time for access[10].

VI. Project Work Conditions

Job-site labor productivity can be estimated either for each craft (carpenter, bricklayer, etc.) or each type of construction (residential housing, processing plant, etc.) under a specific set of work conditions. Abase labor productivity may be defined for a set of work conditions specified by the owner or contractor who wishes to observe and measure the labor performance over a period of time under such conditions. A labor productivity index may then be defined as the ratio of the job-site labor productivity under a different set of work conditions to the base labor productivity, and is a measure of the relative labor efficiency of a project under this new set of work conditions.

The effects of various factors related to work conditions on a new project can be estimated in advance, some more

accurately than others. For example, for very large construction projects, the labor productivity index tends to decrease as the project size and/or complexity increase because of logistic problems and the "learning" that the work force must undergo before adjusting to the new environment. Job-site accessibility often may reduce the labor productivity index if the workers must perform their jobs in round about ways, such as avoiding traffic in repaving the highway surface or maintaining the operation of a plant during renovation. Labor availability in the local market is another factor. Shortage of local labor will force the contractor to bring in non-local labor or schedule overtime work or both. In either case, the labor efficiency will be reduced in addition to incurring additional expenses. The degree of equipment utilization and mechanization of a construction project clearly will have direct bearing on job-site labor productivity. The contractual agreements play an important role in the utilization of union or non-union labor, the use of subcontractors and the degree of field supervision, all of which will impact job-site labor productivity. Since on-site construction essentially involves outdoor activities, the local climate will influence the efficiency of workers directly. In foreign operations, the cultural characteristics of the host country should be observed in assessing the labor efficiency.

Non-Productive Activities

The non-productive activities associated with a project should also be examined in order to examine the productive labor yield, which is defined as the ratio of direct labor hours devoted to the completion of a project to the potential labor hours. The direct labor hours are estimated on the basis of the best possible conditions at a job site by excluding all factors which may reduce the productive labor yield. For example, in the repaving of highway surface, the flagmen required to divert traffic represent indirect labor which does not contribute to the labor efficiency of the paving crew if the highway is closed to the traffic. Similarly, for large projects in remote areas, indirect labor may be used to provide housing and infrastructure for the workers hired to supply the direct labor for a project. The labor hours spent on rework to correct unsatisfactory original work represent extra time taken away from potential labor hours. The labor hours related to such activities must be deducted from the potential labor hours in order to obtain the actual productive labor yield.

VII. Effects of Job Size on Productivity

A contractor has established that under a set of "standard" work conditions for building construction, a job requiring 500,000 labor hours is considered standard in determining the base labor productivity. All other factors being the same, the labor productivity index will increase to 1.1 or 110% for a job requiring only 400,000 labor-hours. Assuming that a linear relation exists for the range between jobs requiring 300,000 to 700,000 = 100,000 labor hours, determine the labor productivity index for a new job requiring 650,000 -500,000 =150,000 labor hours, under otherwise the same set of work conditions.

The labor productivity index I (Fig. 2) for the new job can be obtained by linear interpolation of the available data as follows:

$$I = (1.1 - 1.0) * \{-150000 / 100000\} + 1.0 = 0.85$$

This implies that labor is 15% less productive on the large job than on the standard project.

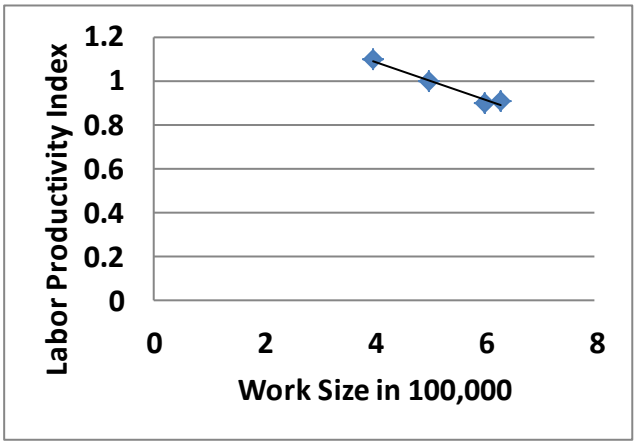

Fig. 2. Relationships between the work size and labor productivity index

VIII. Materials Management

Materials management is an important element in project planning and control. Materials represent a major expense in construction, so minimizing procurement or purchase costs presents important opportunities for reducing costs. Poor materials management can also result in large and avoidable costs during construction. First, if materials are purchased early, capital may be tied up and interest charges incurred on the excess inventory of materials. Even worse, materials may deteriorate during storage or be stolen unless special care is taken. For example, electrical equipment often must be stored in waterproof locations. Second, delays and extra expenses may be incurred if materials required for particular activities are not available. Accordingly, insuring a timely flow of material is an important concern of project managers.

Materials management is not just a concern during the monitoring stage in which construction is taking place. Decisions about material procurement may also be required during the initial planning and scheduling stages. For example, activities can be inserted in the project schedule to represent purchasing of major items such as elevators for buildings. The availability of materials may greatly influence the schedule in projects with a fast track or very tight time schedule: sufficient time for obtaining the necessary materials must be allowed. In some case, more expensive suppliers or shippers may be employed to save time.Materials management is also a problem at the organization level if central purchasing and inventory control is used for standard items. In this case, the various projects undertaken by the organization would present requests to the central purchasing group. In turn, this group would maintain inventories of standard items to reduce the delay in providing material or to obtain lower costs due to bulk purchasing. This organizational materials management problem is analogous to inventory control in any organization facing continuing demand for particular items.

IX. RECOMMENDATIONS

The following recommendation are made based on the data of that discussed in previous chapters with considering the conclusion listed above:

1.Increase the wages of workers with commensurate with the effort from him and give them with extra wages when you increase the number of working hours where we did not notice this during the study.
2. Undertake a study of the productivity of labors in the plants for the production of curved stone.
3. account the factors affecting the productivity of labors in(on site precast) in the edge of pavement.
4. Study must be spaced at intervals of the year at the expense of worker productivity curve for a stone to be taken into consideration temperature.

X. CONCLUSIONS

1. the width of road significantly impact on the productivity of labors and the wider road allows workers to move easily and also facilitates the transport of materials within the work site. .
2.The form of the way of the factors affecting significantly because we noticed through our follow-up in the workflow where the straight path is accomplished quickly unlike the road curved or actuate.
3.Age of labors and the age of skilled labors play an important role in the productivity and to varying susceptibility physical and mental ability.
4.The absence of one of the workers for work after a few percentage compared with the previous factors and this is going to occur under exigent circumstances relating to the employees and did not talk much during work
5.Working hours have increased significantly during the final stages of work so as to compress the work schedule and thus the completion of the work on time, but this factor did not significantly influential.
6 Stone was used in one of the three projects included in the study was the length of 50 cm For a short period, so this is little an influential factor.
7.Were not the study period during intervals so were not temperature on the productivity of workers.
8. There are some individual cases and that greatly affected the productivity of workers, such as the late arrival of materials and rain.

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