HOW DOES MANAGEMENT IMPACT CONSTRUCTION PRODUCTIVITY?

By

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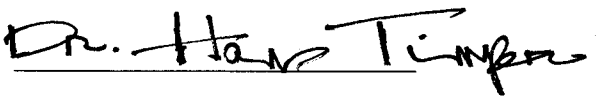

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ABSTRACT

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The main objective of this paper is to present general information on the issues involved in improving the productivity of a construction project, and focuses on management issues. Increased productivity can have a large impact on the overall construction process and consequently can result in significant cost and time savings. This paper deals with various aspects of construction productivity, including basic concepts, factors and major issues affecting productivity.

The construction industry is one of the largest industries that support the economy of every country in the world.

A successful construction project is one that achieves the intended objectives in terms of cost, time, quality and safety. This is possible only when the planned levels of productivity can be attained. However, productivity, or lack of it, is perhaps one of the main problems confronting the construction industry, the construction firm and the construction project. As a consequence of

the importance of the construction industry, the nature of construction projects and the available economic resources, more emphasis should be given to improving productivity.

Productivity improvement is actually a reduction in the non-productive time spent each day by the worker and a transfer of those man-hours to direct productive work. Management is directly related to all those activities. Due to, management involves numerous aspects; this paper is going to be focused just on two management activities in which most of the companies invest considerable amounts of money. Estimating and scheduling have a huge impact and are directly related with almost every activity of a construction project. Its analysis can enhance and make a project easier to deliver on time and within the budget.

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Dedication

I want to thank my wife Maria Silvia for giving me all the support that I needed in the last couple of years.

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Executive Summary

The construction industry is one of the most important industries in the economy of every country. It provides a significant source of employment for the worldwide population. As a result of its importance, it has been focus of multiple studies that have as objective its improvement and development.

This paper presents general information about two management activities (estimating and scheduling), and how they impact the productivity of a construction project. It also provides some recommendations that can improve the construction process in multiple ways.

Information describing how estimating and scheduling can affect the productivity of a construction project is presented in this report. Some important information about the construction industry and its standards of productivity is also presented.

Finally, recommendations and conclusions are given at the end of the report.

Chapter One

Introduction

The construction industry is one of the most important industries in the economy of every country. It provides a significant source of employment for the worldwide population. It has been focus of multiple studies that have as objective its improvement and development.

This paper presents general information about two management activities (estimating and scheduling), and how they impact the productivity of a construction project. It also provides some recommendations that can improve the construction process in multiple ways.

Information describing how estimating and scheduling can affect the productivity of a construction project is presented in this report. Some important information about the construction industry and its standards of productivity is also presented.

Finally, recommendations and conclusions are given at the end of the report.

Purpose of the Study

The purpose of the study is to provide general information on the issues involved in improving the productivity of a construction project and focuses on management issues. It provides an analysis of two management activities (estimating and scheduling) and how they impact the productivity of a project. It also provides information about the construction process and its productivity standards.

The report presents a detailed study of two selected management activities. The selection of these activities was based on its repercussion and relation with the rest of

the activities of the construction process and the time and resources that most of the construction companies spend on these activities. These analyses are going to be the base of the conclusions and recommendations that are provided at the end of this paper. The objective of the recommendations is always the improvement of the productivity of a construction project.

A Sub Problems

1. Sub problem- to individually analyze two management activities (estimating and scheduling) and determine these impact on the productivity of a construction project.

Hypotheses

The hypothesis is to determine how management, in general, impacts construction productivity and in which way it can be manipulated in order to improve productivity standards.

Objectives of This Study

The objectives of this study are to:

1. Evaluate the impact of management on the productivity of a construction project.

2. Determine what action can be taken in order to improve productivity standards.

The Limitations

The analysis will evaluate two management activities, and how they impact construction productivity. This paper does not cover other issues that impact construction productivity, such as those that the industry and labor related.This paper

analyses the construction industry as a whole, without dividing it into its respective types (Residential, Commercial, etc.).

Assumptions

1. The first assumption – Issues related with management can be manipulated in order to improve productivity standards.

2. The second assumption- Estimating and scheduling are directly related with almost all the activities of the construction process.

Definition of Terms and Abbreviations

CPM: Critical Path Method

Chapter Two

Literature Review

Construction Productivity

Productivity is a ratio between input and output. It is important to indicate the input and output to be considered when calculating productivity because there are many inputs, such as labor, materials, equipment, tools, capital, and design relating to a construction system. Transforming inputs into outputs is also complex. This process is influenced by the technology used, by many externalities such as government regulations, weather, unions, economic conditions and management, and by various internal environmental components. Nevertheless, productivity is often associated to only a particular input (*e.g.*, worker-hour) and a particular output (*e.g.*, floor area in m2), and the simple productivity ratio/index of this input and output is calculated. It has been assumed as a closed system with all factors held invariable except for the identified input and output. This simplified model can be useful, as long as one does not lose vision of the complexity of the real world (Fisk, 2000).

Improving Construction Productivity by Management

When construction management is worried, good planning, scheduling and controlling can improve productivity on a construction project. Several other components associated to construction management must also be considered when a persistent effort is made to increase productivity (Fisk, 2000). Some of these components are as follows.

- Allocate or recruit the right people to do the job or provide training to improve workers' capability and skill.
- Adopt motivational or personnel management measures to increase workers' morale. For example, tie compensation to performance; guarantee that pay, fringe benefits, safety, and working conditions are all at least plenty; and enlarge the jobs to include challenge, variety, wholeness, and self-regulation.
- Use project scheduling techniques such as computer-aided construction project management (CPM) to optimize the times of connected activities and make sure that works, tools, and materials let continuous task performance so as to reduce the joblessness of the labor force to a minimum.
- Remain simple and efficient the communication among employees as well as with linked parties.
- Make the workers know that they are important to the organization and engage them in the making of decisions affecting their jobs such as technique improvements.
- Conduct productivity/performance study at the activity/operation level to create benchmarks and to develop scientific models

Six Measurement Dimensions

Three categories of measurements, encompassing six dimensions, are enough to describe every aspect of construction performance (Alfeld, 1988).

Quality

- *Accuracy*: measures how narrowly the job conforms to plans, specifications, code requirements, and established industry standards for workmanship.
- *Workmanship*: measures important differences in the worth of the finished job shaped by master-craftsmanship skills.

Quantity

- *Productivity*: measures differences in the rate at which the work is accomplished over time.
- *Schedule*: measures how closely the job adheres to a best possible construction schedule.

Resources

- *Manpower*: measures differences in labor cost not reflected in the measurements of productivity.
- *Material, Tolls, and equipment*: collect measurements of construction resources other than manpower.

Methods Engineering Model

The engineering model provides the requirements needed in order to have superior jobsite performance and a simple method for discovering the real reasons for performance deficiencies (Heap, 1997).

Environmental Requirements

- Management is obligated to provide information, normally the drawings and specifications, necessary for doing the work plus feedback necessary to maintain the work on track
- Management is obligated to provide the *resources* necessary for doing the job.
- Management is obligated to offer the *incentives* necessary for doing the job.

Behavioral requirements

- Worker must possess a body of *skills* necessary for doing the job.
- Worker must possess the physical and mental *capability* necessary for doing the job.
- Worker must possess the *motives* necessary for doing the job.

Productivity Standards and Facts (Adrian, 1990)

Construction Work Day

- Productive time: approximate 50%
- Non-productive time: approximate 50%

Reasons for Non-productive Time:

- Industry related: assume 1/3
- Management related: assume1/3
- Labor related: assume 1/3

Examples of Reasons for Non-productive Time:

Industry

- One of a kind project.

- Unpredictable weather.
- Decentralized production process.
- Owner/Designer/Builder conflicts.
- Building codes.

Management

- Poor planning.
- Inadequate estimates.
- Lack of training.
- Lack of productivity standards.
- Poor project control.

Labor

- Lack of adequate training.
- Work jurisdiction conflicts.
- Work attitude.
- Worker is working for a "job" rather that a "firm".
- Work rules.

Misconceptions about construction productivity

- Labor is the main cause for low productivity in the construction industry.
- Productivity cannot be considerably improved in the construction industry because it is impacted or controlled by the weather.

- The construction process "is different" owning to it's one of a kind production process, its sensitivity to an open environment, etc. Therefore it follows that a good manager or "leader" cannot notably impact construction productivity.
- The construction industry will always be an unfavorable relationship process.

Three needs of every worker (Adrian, 1990)

Measuring system

- Know what productivity or work is expected versus productivity or work that is achieved.
- Knowledge of overall project plan and schedule.
- Knowledge of what work is to be performed after current work is completed.

Communication system

- Be able to input knowledge/ideas about a work process.
- Be involved in planning work.
- Enabling a worker to input "what they know" as well as "be told" what to do.

Pride in work

- Be told what one is doing correct as well as what one is doing wrong.
- Get recognition.
- Be "recognized" in the eyes of family or fellow workers.

Little known facts about productivity (Adrian, 1990)

Man's ability to do work

- A worker is more productive on a Tuesday than any other day of the week.
- The most productive time of the day for a worker is around 10 am.

- Studies have shown that a worker is more productive over the entire day if he is given personal time (break time) of approximately 10 to 15% of a work day
- If a worker is required to perform work that is repetitious, there will be a noticeable decrease in his productivity after 60 to 70 minutes of doing the work.
- A worker is capable of lifting approximately 94 pounds by himself.
- The least productive time for a worker is right before finishing time.
- After Tuesday, a worker's productivity decreases each day, resulting Friday being the least productive day.

Overtime and Construction Productivity

- Normally, the highest productivity is reached when a worker works 5-eight hours days.
- A second shift of work, one that starts after the normal 8 to 4.30pm day, results in less productivity than the normal work shift.
- When a worker is required to work more than eight hours in a single day, the impact of overtime impacts the productivity performed each and every hour of the day.
- The impact of overtime on productivity is more adverse if a worker is required to work for a long period of time.
- The negative impact of productivity increases as the temperature increases.

The Environment and Construction Productivity

- The ideal or best productivity occurs when workers are performing work at a temperature in a range of 65-70 degrees Fahrenheit.

- The adverse productivity effect of extreme cold weather from the ideal range is not as great as is the adverse productivity effect of extreme hot weather from the ideal range.

Productivity and Safety

- Most construction accidents occur during a period of non-productivity.
- A newly employed worker that is in the process of learning his job and the means of being productive is more likely to have an accident.
- A construction worker who tends to want to work in isolation is more likely to have an accident than a worker who prefers to work in groups.
- The frequency of accidents increases as overtime hour increase.

Estimating

Definition

According to Pratt (1995), estimating is frequently defined as a process. A process is a group of dissimilar individual events, sub processes, and/or items linked together to produce a final product. Processes normally have a stat and an outcome, or final result. The estimating process takes on different forms depending on the final outcome one is looking for, e.g., buying material, bidding a project, costing a value engineering proposal, or evaluating a change order. The number of levels, the detail, and the complexity of the problem can alter the method or estimating process to be used.

Estimating is a process of generating, analyzing, and summarizing projected costs by combining the knowledge and judgment of a team of construction professionals. The professionals review the requirements of contract documents so as to the project

methods, materials and the costs that will be required to construct the project. This approach to estimating is meticulous and systematic. Decisions are made with judgment based on the experience of the professionals involved (Pratt, 1995).

Estimating can supplementary be categorized as factual or conceptual when discussing how it relates to business development (procurement of work). Additional construction work is gained through the bid process or the negotiated process. The estimating process is further defined or modified by the kind of contract being proposed, such as stipulated sum, guaranteed maximum price, cost plus, unit price, or target contracts. The estimating process brings precise information on costs and the methods together. Profit, risk, and competition also play large roles in the estimate process (Pratt, 1995).

How To Make a Good Estimate?

According to Johnston and Mansfield (2001), two considerations determine the quality of an estimate process and the estimate itself:

- How complete the estimate is.
- How accurate the items are within the estimate.

Complete and accurate are not the same. A complete estimate could be defined as an estimate that is whole in its entirety or has no parts missing. An accurate estimate, on the other hand, shows level of accuracy or precision, and is correct or free from faults.

The answer to the following questions will determine how complete an estimate is

- Has the estimator determined who is responsible for which items, and is everything is included that should be? Are the work and materials described by the specifications and drawings all covered?
- Have all the items that are shown been taken off the drawings?
- Are the labor productivity rates in the estimate based on sound historic information, and has a through analysis of the work, the job, and the conditions been done?
- Have there been a sufficient number of subcontract and vendor quotations to provide coverage and analysis? Is everything covered, and are all exclusions incorporated into the estimate if they are part of the project?
- Is the company using a system and a set of standards to put the estimate together? Does the system allow for cross-checking of items and mathematics? Can one estimator understand and read the other estimators' work?
- Does the estimate include all the end-of-bid factors, and does it provide adequate markup (profit and main office overhead)? Has the risk of the project been thoroughly analyzed and the costs reflected in the work items and the profit of the project?
- Does the estimate reflect the methods and techniques that will be used, the accountable conditions, the cost that will be incurred, and the job site management that will be used during the project?

The level of accuracy of an estimate depends on a different set of questions and guidelines:

- Before the estimate is started, has the company's data base of costs been updated to reflect any increases in prices?
- Is the estimator using the most recent labor costs from accounting? (Have there been any new labor contracts?)
- Are the costs and productivity rates being used reflective of the marketplace? Is skilled labor available?
- How accurate are the quantities?
- Is the estimator pricing and analyzing the installation of the right type of permanent materials, those that the specification calls for?
- Is the estimator analyzing subcontractor quotes with due care?
- Are the phone quotations take from subcontractors accurate and complete as to what the subcontractor is proposing?
- To minimize math errors, estimators should check math as they go, back checking from the drawing immediately.
- At the completion of the estimate, check every item over again.
- The estimator should have someone else recheck extensions, carry-overs, and additions.
- Read all sheets and reread.
- Check that the bond costs have been updated and are current.
- Main office overhead should be recalculated on a quarterly basis.

Impact of Estimating over Productivity

According to Johnston and Mansfield (2001), the final examination of an estimate's completeness and accuracy is in a way determined only after a project is finished. Profits in construction can only be made on a project through a complete and accurate estimate and following performance by a field team that is experienced and efficient in the task of building. Projects need to be thoroughly analyzed through an estimate and well managed in the field.

It has been believed that companies fail because of poor management and poor judgment. Not many construction companies go bankrupt simply from be short of technical competency, lack of business, bad luck, or inefficient operations. These contribute to failure; however, estimating problems frequently are the most easily identified reason for companies going out of business.

Scheduling

According to Popescu, (1995), scheduling is the determination of activities and follows reasonably from the planning process. Many forms of schedules exist, from bar charts to critical path methods. Each has it advantages and disadvantages. Each has its unique applications. As the plan for a project become more complex, the need for critical path method schedules to embody the plan increases.

A construction project schedule may signify different things to the designers, contractors, suppliers, subcontractors, and owners involved in the construction process. The schedule may mean the completion date stated in the contract, or temporary completion dates required for phases of the work. The schedule may mean the schedule

of values the contractor submits against which monthly progress payments will be calculated, or any of the many other lists itemized or needed by the contract. The schedule may also refer to the process of sequencing and phasing individual activities required to complete the project (Popescu, 1995).

A construction schedule means an instrument to find out activities necessary to complete a project and the succession and the time frame within which the activities must be completed in order to obtain timely, productive, and economical completion. Construction schedules offer time-phased plans that permit portions of the work to be organized, sequenced, and controlled so that the entire project is completed in an organized and efficient manner. Most schedules are presented as graphs that show the association between planned starting and finishing dates for the elements of work the comprise the project.

Used as a tool to manage time, the primary benefit of a schedule is to produce the necessary planning which all successful projects required. Formal schedule systems such as the critical path method (CPM) achieve this by forcing the scheduler, superintendent, and project manager to think through the entire process in detail at the beginning. This detailed thought process avoids ineffective and poor sequencing of the project. Understanding how the whole project will be completed also permits project personnel to identify the effect that unexpected event or alternatives actions have on progress. Sequences can be changed to overcome or reduce the impact (Popescu, 1995).

Purposes of Construction Schedules

According to Callahan, Quackenbush & Rowings, (1992), construction schedules

can be used for a number of dissimilar purposes. Among the ways a construction schedule can be used is to forecast project completion. Timely completion of the project is particularly significant when failure to complete within the time required by contract carries a financial penalty or liquidated damages. By using construction schedules to forecast project completion, contractors can adjust crew sizes, shifts, or equipment to speed or slow the progress. Productivity rates play a main role in this process. A contractor should be able to determine the ability of his crew, and also be familiar with all the factors that can affect their productivity. An accurate schedule which can reflect realistic completion dates and the crew's ability is one of the main bases of a construction project.

As part of the design effort, architects or engineers may prepare a construction schedule to find out how long design and construction will take in order to complete the project when wanted by the owner. By sequencing a unique set of detailed activities it is possible to arrange an estimate of time with a higher probability of achievement than by examining the overall project scope.

The project schedule has many uses and provides a service to the project which alternate methods cannot. The effort required to produce a quality project schedule and keep its accuracy throughout the project is a most worthwhile investment. This effort is going to have an enormous impact on the overall performance. The management of every activity is going to be easier, making everybody knowledgeable about what they need to do in order to deliver the project properly (Callahan, Quackenbush & Rowings, 1992).

Impact of Scheduling Over Productivity

There is no doubt that the industry has made more use of formalized schedules in recent years. This use has been improved by the availability of many computer software programs that have reduced the time and cost of preparing such schedules.

According to Callahan, Quackenbush & Rowings, (1992), there are in fact three different types of plans or schedules that can be used by the supervisor to improve onsite productivity:

- Short interval planning, or a one-day plan;
- One- to three-week revolving schedule;
- Master schedule

Jobsite productivity can be considerably increased if the supervisor would plan the next day's work one day ahead of time. This could be accomplished if he/she made use of a form at the end of each day that required him/her to set out each of the following:

- The kind of work that is to be accomplished tomorrow.
- A work quantity goal for each type of work to be performed tomorrow.
- The resources (labor, tools, material and equipment) that will be required to accomplish the established work goals.

The idea is to set the resources before they are needed. This process can play a significant role in reducing or eliminating the nonproductive waiting time that characterizes many work processes. The use of a one- to three-week revolving schedule has the same purpose as the one-day short interval schedule. The difference is that by setting out what work will be done over the next few weeks, the supervisor can begin

the process of securing tools, material, labor or equipment that may have a few days or a few weeks lead time in procuring.

Chapter Three

Methodology

This chapter is based on the issues identified in the review of literature from the last chapter. The review of literature provides support for the impact that estimating and scheduling can have over construction productivity. The analysis focuses on the possibility of improvement on construction productivity, going through the estimating and scheduling processes.

In order to do so, an analysis of the estimating and scheduling processes was made. Also construction productivity characteristics and standards were analyzed, always looking for relationships between productivity and management.

The data provided in the literature review was used to verify the impact of management on construction productivity, and also, to see how the estimating and scheduling activities are related to the entire project delivery process.

The following data was used to gather relevant information pertinent to the purpose of the study and to meet the objectives of the study:

1. Construction Productivity
    a. Improving construction productivity by management
    b. Six measurement dimensions
    c. The methods engineering model.
    d. Productivity standards and facts

2. Estimating

    a. Definition

    b. How to make a good estimate

    c. Impact of estimating over productivity

3. Scheduling

    a. Definition

    b. Purposes of construction schedules

    c. Impact of scheduling over productivity

Chapter Four

Analysis

Construction Productivity

- Scheduling and estimating can improve productivity on a construction project.
- Measurement is a fundamental activity in the construction industry.
- Approximately 50% of a construction day is non-productive time.
- Approximately 1/3 of this non-productive time is due to management issues.
- Estimating and schedules processes are main part of management.
- Labor is not the cause of low construction productivity.
- Every worker has needs that need to be fulfilled in order to make him/her able to meet desired productivity rates.
- There are a lot of simple facts that affect construction productivity.
- Managers need to be aware of those facts.
- Estimating and scheduling are direct related to most of those facts.

Estimating

- Estimating is a process.
- A group of tools and individuals work together in order to come with a final estimate.
- Experience plays a main role in the estimating process.
- Poor estimates are often the reason of why companies go out business.
- In order to have a good estimate, this needs to be accurate and complete.
- Complete and accurate are not the same.

- An estimate can be complete and accurate at the same time, only when a series of goals are met.
- After the project is built, managers can analyze how accurate and complete was the estimate.
- The estimate process has a huge impact over construction productivity. If an estimate is not accurate and complete, lack of resources can take place during the construction process.
- When a company passes the budget limit, productivity rates can lower due to the inability to fulfill workers requirements.

Scheduling

- Scheduling is also a process.
- There are many forms of schedules.
- A construction schedule may mean different things to the people involved in the construction process.
- Schedules are tools to manage time, and the primary advantage is to produce the necessary planning that every project required.
- Jobsite productivity can be improved with good short term schedules.
- Good schedules can reduce or eliminate nonproductive waiting time, because the needed resources can be in place when they are needed.
- The supply chain process is directed related with scheduling.
- Productivity rates can lower when schedules do not reflect realistic dates.
- Unrealistic schedules can impact every single activity of a construction process.

Chapter Five

Conclusions and Recommendations

Conclusions

The construction process is not easy to analyze due to all the facts that it includes. This paper analyzed two processes that take place during the construction process. Those processes (estimating and scheduling) have been identified as very important activities that are directed related to almost every single part of a construction project. This relationship makes this paper a useful tool to those construction managers that want an improvement in their productivity rates.

Poor management is not the only reason of low productivity rates. However, the construction industry and the labor also have their impact over productivity, management can be the easier to handle, and with not too much actions, reasonable improvements can take place. Due to the relationship of scheduling and estimating with almost every activity of a construction process, an improvement of those processes can result on a chain reaction that is going make a company more profitable.

As almost every industry in the world, the construction industry has changed and is going to change more in the future. That's why continuous improvement is something that every manager needs to keep in mind every day. A company needs to be able to adapt to unknown future conditions. Continuous improvement of important activities, such as estimating and scheduling, not just can elevate productivity standards; it also can make a company stay in business for a long period of time.

After going through each process individually, and also analyzing construction productivity fundamentals, we can see that estimating and scheduling are among the activities that have more impact over construction productivity. Each process can be improved, and in this way a company can reduce nonproductive time. This is not the only way to improve productivity rates, but specific goals can be easier to reach when a company goes through its management processes with continuous improvement in mind.

Recommendations

- Managers need to be aware of all the facts the can affect construction productivity. Little correction can drive a company to excellent results.
- Companies need to actualize their data bases continuously, in order to come out with more accurate estimates.
- Unrealistic schedules may look good to the owner's eyes, but the consequences can be catastrophic. Companies need to make owners understand what it takes to deliver a project.
- Supply chain and scheduling are totally linked; they need to be develop together in order to reduce nonproductive waiting time.
- Statistical analysis can be use in future studies in order to go deeper in this topic. Also, obtaining data from construction contractors can complement the ideas provided in this paper.

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