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FACTORS INFLUENCING AND AFFECTING PRODUCTIVITY IN CONSTRUCTION COMPANIES

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ABSTRACT

In spite of the development in construction industry; the productivity in this sector still considered as critical factor for most construction firms in developing and semi developing countries. In order to develop the productivity, several measures have been taken for some construction projects. This study highlights the topics of productivity monitoring and measurement in constructing sector. Performance measurements used to monitor the construction processes and activities. Building projects are taken as case study to show how these concepts can be used to analyze and develop the productivity of some options in this sector. Concreting process is taken as case study. The results pointed to the relative importance of this activity in terms of time and cost. A comparative model has been developed to determine the best method of construction, its cost and duration. This model can also be used as a predicting tool for selecting the method during the planning phase of project.

Keywords: model, construction, concrete, productivity, monitoring, method, process

I.INTRODUCTION

Construction is the world's largest and most challenging industry. One of the most generalized definitions of productivity is “effective and efficient utilization of all resources, labour, plant and materials". Construction projects worldwide have been experiencing significant cost and time overruns, with low labour productivity identified as a major reason for project delays and cost overruns. As consultants via specification, control of materials, plant costs, profit and overheads are generally controlled by the competition.

1.1 Defining Productivity

Many definitions of the word “productivity” exist. For the basis of this study the Merriam-Webster definition will be used. Merriam-Webster defines productivity as the quality or state of being productive. Labor productivity is typically measured as output per worker or output per labor-hour. Although there are endless definitions for productivity, they all refer to productivity as a comparison of input versus output. Productivity = Output/ Input. Increased productivity occurs when either

1. Output is constant, while input is reduced, and/or
2. Input is constant, while either the quantity or quality of output has been increased or enhanced.

1.2 Aim and Objective

The aim is supported by the objective stated below.

- Study and discuss various factors affecting labour productivity in construction industry.
- Analyze and calculate the Relative Important Index (RII) of those factors affecting labour productivity.
- To statistically analyse the factors affecting labour productivity.
- To make recommendations to improve labour productivity in construction.

1.3 Features

The construction features that contribute to low productivity in this sector can be outlined as follows.

- Presence of large number of unskilled workers and shortage of suitable trained and skilled workers;
- Poorly developed subcontractors and subcontracting sector role;
- Lack of site management and construction management skills in projects teams; and
- Inadequate mechanization and automation in some sectors of this industry.

II.FACTORS AFFECTING THE SITE PRODUCTIVITY

Order of Factors Influencing Productivity

Factor Overall Order
1 Lack of Materials
2 Crew Interference
3 Repeat Work
4 Supervision
5 Lack of Equipment, Tools
6 Absenteeism

Estimated Time loss per Problem in a 40-Hour Week

Factor Estimated Time Loss
3 Lack of Materials
2 Crew Interference
2.5 Repeat Work

2 Supervision
2 Lack of Equipment, Tools
0.5 Absenteeism

Order of Causes of Lack of Materials

Factor Overall Order
Lack of Planning
Transport within Site
Improper Materials
Interference
Unnecessary Paperwork

Order of Causes of Rework

Factor Estimated Time Loss
1 Change of Instructions
2 Unclear Instructions
3 Complex Specification
4 Poor Workmanship

III. OVEREVIEW TO CONSTRUCTION PRODUCTIVITY

The construction industry frequently constitutes about ten per cent of the Gross Domestic Product, with the figure likely to be higher in developing than developed countries. Although most developing countries tend to adopt the manufacturing industry as the sector for stimulating employment and creating job opportunities, they still place importance on the construction industry for supporting economic development.

Unlike several other industries, the level of technology in the construction industry has remained relatively unchanged over several decades. The lower pace oftechnological development in construction places the industry at a disadvantage when compared with other industries where enhanced productivity is achieved through the use of modern technology. As the construction industry is a diverse sector of the national economy which involves a wide range of scarce resources, its productivity is therefore not only concerned with many individual activities, but the industry as a whole.

The issue of raising the level of construction productivity h'as been discussed time and again. There are many fundamental and wide-ranging topics that need detailed discussion before the industry can improve its status. Such issues have included:

- The impact of raising productivity;
- The factors that affect productivity;
- The need for productivity measurement; and
- The methods of measuring productivity.

The impact of raising productivity can be identified by the following:

- Positive influence on people, capital, equipment and materials;
- Increase in competitiveness;
- Increase in profitability;
- Increase in market sales; and
- Decrease in unit cost.

Identification of the factors that affect construction productivity could place theindustry in a better position to take up the issues and find ways to improve it. Inaddition to presenting solutions to overcome problems affecting productivity, theissues cannot be fully understood and resolved until the industry is able to identifyways of measuring productivity. The industry knows that measurement is needed tojudge whether productivity has improved, and if so, by what extent. Productivitymeasurement is therefore necessary to:

- provide management with an effective means of directing and controlling theproductivity performance of a company;
- offer feedback to employees on their productivity performance;
- generate a system for sharing the gains of higher productivity; and
- compare the performance of the company with that of its competitors or relatedcompanies.

Productivity measurement is a complex issue and there is no universal formula tomeasure it under all conditions. Indeed, there still exist operational areas in industrywhere the methods of measuring productivity have yet to be established.

IVLITERATURE REVIEW

1. In the USA, Borcherding and Garner (1981) used questionnaire surveys and interviews to identify and rank factors influencing construction labour productivity. The major problems influencing productivity that emerged in the study were material *Factors Influencing Construction Labour Productivity PENERBIT UNIVERSITI SAINS MALAYSIA/***55** availability, tool availability, rework, overcrowded work areas and inspection delays.Alinaitwe, Mwakali and Hansson (2007), Enshassi et al. (2007), Jarkas and Bitar (2012), Kadir et al. (2005), Kaming et al. (1997), Makulsawatudom, Emsley and Sinthawanarong (2004), Mojahed and Aghazadeh (2008), Olomolaiye (1988) and Rivas et al. (2011) have also conducted similar surveys in various parts of the world. The ranking of the productivity-influencing factors observed in the various studies are presented in Table 1. The ranking of the factors is based on different indices and involved different categories of respondents, including craftsmen, supervisors, contractors, project managers, consultants and developers.

As shown in Table 1, the majority of the studies identified material-related problems among the most significant factors impacting productivity. However, in Kuwait, material problems were not discerned to have a decisive effect on productivity, mainly due to the financial strength of local contractors and the availability of materials locally or by direct imports (Jarkas and Bitar, 2012). The study in Uganda rated the factors affecting construction productivity with respect to time, cost and

quality, and, although material shortage was ranked first with respect to time, it was rated only seventeenth based on the overall importance index and hence does not appear among the critical factors (Alinaitwe, Mwakali and Hansson, 2007). Other factors that were deemed important in the previous studies are lack of tools and equipment, rework, incompetent supervisors, lack of labour supervision, lack of skills and experience of the workforce, design/drawing alterations and interference. Though similarities exist, the major productivity factors vary from country to country, necessitating research into productivity factors relevant to a particular region.

2. Chan and Kaka (2007)'administered a questionnaire survey in the United Kingdom to understand the difference in perception among project managers and construction workers of factors affecting construction labour productivity'. The white collar sample ranked supervision, simplicity of building design, level of site experience, information flow and communication with sub-contractors as the top five factors. However, quality requirements, health and safety management, communication within gangs, utilisation of plant and health and safety and Construction Design and Management (CDM) were considered important by blue collar workers. This study provided insight into factors important to the two groups and emphasised the need for integrating the differences in opinion between the two groups to achieve productivity improvement.

Except for the studies in the UK and Chile (Chan and Kaka, 2007; Rivas et al., 2011), the productivity factors identified in the previous research efforts were from the perspective of one of the project participants, with no attempt to understand the difference in perception among the project participants on factors influencing productivity. The study in the UK did not capture the perception of the supervisors (Chan and Kaka, 2007), while the opinion of the project managers was not sought in the Chilean study (Rivas et al., 2011). An understanding of the relative importance of productivity factors from the perspective of various project participants is essential to make effective plans for productivity improvement. In this study, therefore, the input of all project participants (project managers, site engineers, supervisors and craftsmen) has been sought to identify problems impacting productivity.

3. Herbsman and Ellis (1990) studied the effects of project conditions termed bythem as Construction Influence Factors on the variation of productivity rates forconstruction items and described the development of a statistical model thatillustrated quantitative relationships between influence factors and theproductivity rates. However the study was conducted on past records from siteand not freshly collected data. They concentrated on the construction influencefactors classified into technological and administrative factors. These wereproject based conditions. Effects of the company wide environment were notconsidered.

Further, the influence factors were quantified using three methods: direct, indirectusing alternate indicators (such as labour turnover for measuring motivation) andquantification using non parametric ranking. The non-parametric rankinginvolved ranking the elements to a scale of 1 to 10 based on an individual'sexperience, knowledge and judgment. Also the construction industry influencefactors were based on interviews with various participants in the constructionindustry, determined by a group of experts and not through questionnaires.Finally, a stepwise effect of the influence factors was adopted where each of thefactors was introduced in the model one at a time and the resultant R2 – theFactors Affecting Productivity in the UAE Construction Industry, Nabil Ailabouni, 2010coefficient of determination - was reviewed for model adequacy. The SAS(Statistical Analysis Software) software was used for model formulation. Theproductivity model they presented contained a regression equation that utilizedthe identified influence factors and gave the productivity of the particularactivity. The study however did not contain validation of the models, and it wasonly suggested that the models could predict the productivity for that activity infuture projects.

4. Sanders and Thomas (1991) in their study of the factors affecting masonry labourproductivity identified inadequacies in previous similar studies to accuratelyidentify the factors. Their methodology involved the data collected from 11masonry projects between 1986-1988 in central Pennsylvania. Data collectionwas standardized in a procedures manual for consistency. Data sets wereconverted to equivalent units to take care of different sizes of bricks being laidand regression analysis was performed to develop models to relate theproductivity to the physical characteristics of the masonry units. Potential factorsidentified and used in the models were based on experience, observations anddata reconciliation procedure. The project related factors identified were 'worktype, building elements, construction methods, and design requirements. Furtheranalysis of variance was done on each of these factors. The conclusions includedthat 30% improvement is expected if the design is repetitive and 40%improvement could be realized if design is improved. Expected percentageimprovement resulting from each parameter in isolation was suggested; thecombination effect of all the parameters was not studied.

V.METHODOLOGY

A survey was administered to the ENR Top 400 Construction Companies (2006). The goal was to identify and assign a weight to the top 12 factors affecting labour productivity in the construction industry. Each factor is

defined and the potential problems within each factor are identified and explained within the literature review section of this study. The study was based upon the following 12 major productivity factors:

- Tool Management
- Equipment Management
- Access Planning
- Management Skills
- Safety
- Quality Control
- Scheduling
- Employee Training/ Skills
- Employee Age
- Temperature/ Humidity
- Employee Motivation
- Degree of Bilateral Communication

The survey was distributed to 200 contractors from the ENR Top 400. The survey gives a brief description of each factor and the contractor is asked assign a weight to each of the factors based on his or her knowledge and past experience in the construction industry. A complete copy of the survey can be found in Appendix A. The following are the descriptions as they appear in the survey:

1 .Management of Construction Tools: In order to maintain large amounts of tools, tool rooms should be used to store non-permanently used tools. Periodic reports should be performed by tool room supervisors. Tool kits should be issued on the basis of trade and each person should be held accountable. A record should be kept of all tool kit assignments, as well as tools not included in the kits. Periodic site inventories are necessary to control loss, theft, and breakage. Some common problems associated with tool management include lack of tool availability, lack of the proper tools, poor tool maintenance, etc.

2. Managing Construction Equipment: Productivity of construction equipment is directly linked to how the equipment is used and how the crews and operators are assigned. Advanced planning is necessary to establish the length of time the equipment will be utilized. Strong efforts should be made to keep the same crew and operator on the same piece of equipment as much as possible. Some common equipment management problems include lack of equipment usage reports, lack of equipment's safety checklists, and lack of proper scheduling of equipment.

3. Access: Site drawings should be available indicating where dense areas of labour are working and indicating their route to and from the site. Alternate plans to cut roads should only be made when other acceptable routes are ready. A common problem on construction sites is poor or disrupted access caused by holes and barricades and time spent finding alternate routes.

4. Management Skills: Management often times obscures progress on a project. Good management is required for profitability and success

5. Safety Management: Everyone involved with a project should be concerned with the level of safety that is maintained. At a minimum, the level of safety on a project must comply with legislated criteria. Some common safety problems include lack of safety in the design, lack of safety training, lack of management support, lack of preventative maintenance on tools and equipment, etc.

6. Quality: Traditionally, generic quality tolerances are used on most projects. Therefore, experienced operators should be periodically reviewing quality on the project and interpreting the quality expectations on the project. Lack of quality control leads to increased costs associated with rework.

7. Schedule Management: Project schedules should establish guidelines as to when and how the project should be executed. Schedule requirements need to be communicated and properly managed throughout the entire project. Some common scheduling problems include outdated schedules, lack of schedule communication, lack of detail, trade stacking, etc.

8. Employee Training/Skills: Overall, there is a lack of formal training in the construction industry. High employee turnover rates deter investments in employee training. Lack of training causes delays due to rework and overall capability levels among workers.

9. Employee Age: Some studies have claimed that the working age is beginning to decline and impacts are becoming evident within the labour market. As the working age diminishes, new young labourers could become harder to come by.

10. Temperature/Humidity: High temperatures and humidity tend to slow down worker productivity. Jobsites should have appropriate rain gear and inclement weather planning.

VI. QUESTIONARIE SAFETY:

- Workers normally wear safety helmets in site?
- Workers normally wear safety shoes in sites?
- Workers normally wear gloves which handling sharp and hot materials in site?
- High accident rates on construction site are due to?
- The major reasons of accident on site are that the management?
- The major reasons of accident on the site are that the workers?

VII. LABOUR:

- Average working hours/ day?
- Overall, how satisfied are you working for the company in this site?
- Will you recommend this site as a good place to work?

- Has the Engineer clearly conveyed the works to employees?
- Is there a good communication from Employees to supervisor
- Is there a good communication from Supervisor to employees
- Are you having the right tools and Resources to do your job
- Are you having the right Safety measures to do your job safely?
- Got proper training to do my job?
- Received the right amount of recognition for my work?
- The amount of work expected is reasonable?
- Supervisor actively listens to employee's suggestion?
- Supervisor enables the worker to perform at the best?
- Supervisor treating everyone as a human?
- How satisfied are you with your allowances?
- How satisfied are you with your Camping conditions?
- How satisfied are you with other benefits offered by the Company?
- Chances of accident in your job
- How satisfied are you with your overtime work wages?

Table1: Difference between productivity with high productivity and low productivity:

Projects with high Productivity	Projects with low productivity
Well-thought out,realistic plan	Poor planning, inexperienced planner
Building design that enables the use of trade skills	Repetitive, simple design that uses very little or none of the trade skills
Good communication between senior management and operatives	Them' and Us' attitude between senior management and operatives
Training investment	Lack of training
Experienced staff	Inexperienced staff
High staff morale	Low staff morale
Good welfare	Little or no welfare
Experienced and self-motivated site manager	Inexperienced site manager
Site near to home	Site far away from home
Job security and retention of staff	Subcontractors or Labour only Subcontractors

VIII. CONCLUSION:

This study highlights the basic concepts of construction productivity and its characteristics through work study, then summarize how and where it can be improved through construction management concepts especially performance measurements and benchmarking. The issues that discussed are those related with time interval available for the activity, total cost with the technique and labour skills needed for implementation in site.

Practical procedures are set for choosing the best method of construction, calculating the demand of time needed and the cost of construction method. The remote knowledge of construction methods with its main parameters; time, cost and productivity will give the project manager or the site engineer opportunity of taking the accurate decision in suitable time. This means; in brief words, successful project with successful construction management.

IX. RECOMMENDATIONS

What should be Done Differently?

In the event that this study is to be recreated, some parts of the study would yield more accurate results if done differently. The answers from the different respondents yielded very little correlation for most of the factors. One adjustment to this study that may change the results is to conduct multiple surveys with the same respondents, allowing them to see where their answers differed from other respondents, giving them the opportunity to explain. Another beneficial change would be to increase the number of surveys distributed. These changes would require a large increase in the amount of time allotted for the study.

Future Works

In the future, a similar, but more focused study could be done. Instead of only limiting the survey to upper level construction managers and owners, focus on different levels throughout the construction industry and compare the results between the levels. In addition, this study could also be done focusing on multiple smaller regions across the United States and then checking the correlation between them. In regards to this current study, in order to make the weights useful to the construction industry, checklists must be created that will enable construction managers to apply the weights to the scores they have given themselves and target their productivity weaknesses early on in the project.

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