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Construction Labor Productivity and its Improvement

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ABSTRACT *The most challenging issue in Construction industry is to improving the production efficiency. Many research have been done in the past, however a deeper understanding is still needed to improve the labour productivity. The main outcome from the literature is that there is no standard definition of productivity. It covers the construction labour productivity definitions, aspects, factors affecting it. The productivity of labour is particularly important especially in developing countries, where most of the building construction work is still on manual basis. The aim of this study is to get the latest information and to identify the key factors that affect the labour productivity in and around Coimbatore. So survey is carried out through questionnaire and distribute to respondents who work at various projects in wide area in Coimbatore and the questionnaires are rated by project managers, experienced engineers and also with labours using their past experiences. And the data's are collected and analysed; using this the affected factors are identified and ranked, through this necessary steps are provided to improve the labour productivity.*

1.INTRODUCTON

1.1 GENERAL Construction industry faces lots of challenges with regard to problems associated with productivity. Productivity is one of the most important factors affecting the overall performance of any organization, whether large or small and the problems are usually associated with performance of labour. The performance of labour is affected by many factors and is usually linked to the performance of time, cost, and quality.

Inefficient management of construction resources can result in low productivity. Therefore, it is important for construction managers to be familiar with the methods leading to evaluate the productivity of the equipments and the labourers 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 labour, equipment, cash flow, etc... While there are several input resources in a transformation process, labour productivity plays a particular role. A deeper comprehension of the factors influencing labour productivity can enable managers to more effectively allocate limited resources, provide workers with better support, or increase workers' motivation.

1.2 OBJECTIVE

The objective of this study focuses on views from the construction industry about various factors affecting labour productivity, Analyzes factors affecting the labour productivity, impact and suggests appropriate measures that can be taken to improve labour productivity. 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 of those factors affecting labour productivity
- To statistically analyze the factors affecting labour productivity
- To make recommendations to improve labour productivity in construction

1.3 BACK GROUND OF LABOUR PRODUCTIVITY

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

Productivity is the ratio of output to all or some of the resources used to produce that output. Output can be homogenous or heterogeneous. Resources comprise: labour, capital, energy, raw materials, etc.

Productivity may then be defined as the ratio of

earned to actual hours. The problem with this concept is in establishing reliable, 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. At a project site, contractors are often interested in labour productivity. It can be defined in one of the following ways.

Labour Productivity = (Output / Labour Cost)

Productivity measures can broadly be placed into two categories. Single factor, or partial, productivity measures relate a particular measure of output to a single measure of input, such as labour or capital. Multi-factor or total productivity measures (MFP) relate a particular measure of output to a group of inputs, or total inputs used. Productivity measures can also be distinguished by whether they rely on a particular measure of gross output or on a value-added concept that attempts to capture the movement of output. Of the most frequently used MFP measures, capital-labor MFP relies on a value-added concept of output while capital labor- energy- materials MFP relies on a particular measure of gross output.

The five most widely used productivity concepts are

Labour productivity, based on gross output: This productivity measurement traces the labour requirement per unit of output. It reflects the change in the input coefficient of labour by industry and is useful for the analysis of specific industry labour requirements. Its main advantage as a productivity measure is its ease of measurement and readability; particularly, the gross output measure requires only price indices on gross output. However, since labour productivity is a partial productivity measure, output typically reflects the joint influence of many different factors.

Labour productivity, based on value-added: Value-added based labor productivity is useful for the analysis of micro-macro links, such as an individual industry's contribution to economy-wide labour productivity and economic growth. From a policy perspective, it is important as a reference statistic in wage bargaining. Its main advantage as a productivity measure is its ease of measurement and readability, though it does require price indices on intermediate inputs, as well as to gross output data. In addition to its limitations as a partial productivity measure, value-added labour productivity have several theoretical and practical drawbacks including the potential for double counting production of benefits and double deflation.

Capital-labour MFP, based on value-added: This productivity measurement is useful for the analysis of micro-macro links, such as the industry contribution to economy-wide MFP growth and living standards, as well as, for analysis of structural change. Its main advantage as a productivity measure is the ease of aggregation across industries. The data for this measurement is also directly available from national accounts. The main drawback to the value-added based capital-labour MFP is that it is not a good measure of technology shifts at the industry or firm level. It also suffers the disadvantage of other value-added measures that have been double deflated with a fixed weight Laspeyres quantity index.

Capital productivity, based on value-added: Changes in capital productivity denote the degree to which output growth can be achieved with lower welfare costs in the form of foregone consumption. Its main advantage as a productivity measure is its ease of readability but capital productivity suffers the same limitations as other partial productivity measurements.

Table 1.1 Factors affecting the human capacity for work

Multi-factor productivity: It is used in the analysis of industry-level and sectoral technical change. It is the most appropriate tool to measure technical change by industry because it fully acknowledges the role of intermediate inputs in production. Domar's aggregation of MFP across industries renders an accurate assessment of the contributions of industries to aggregate MFP change. The major drawback to MFP is its significant data requirements, in particular timely availability of input-output tables that are consistent with national accounts. It is also more difficult to communicate inter industry links and aggregation across industries using MFP than in the case of value-added based MFP measures.

1.3.1 Productivity and Labour

On any construction site the contractor's financial gain is dependent, amongst other things, on completion of the work in good time and at the least cost, and the productivity of labour has a direct bearing on this being achieved.

The factors affecting the performance of labour generally fall into three categories.

i. The human capacity for work
ii. The competence of site management
iii. The motivation of the workers

1.3.2 Competence of Site Management

The various measures that may be taken to improve the physical work capacity or to motivate the workers will not be effective if site management is substandard. It is essential for the workers to have confidence in their supervisors. If the workers observe that site management is poor, unfair or corrupt, their morale, motivation and consequent productivity will be reduced. Examples of management shortcomings which reduce efficiency and productivity in this way include

- Delayed, unclear or inadequate instructions
- Delays in delivery of materials, tools or equipment
- Provision of poor tools and equipment
- Unbalanced work gangs
- Use of wrong methods
- Bad advance planning or allocation of work tasks

1.3.3 Motivation of Workers

Workers are motivated in their work by a variety of methods, all of which may be present in varying degrees. They include Fear Discipline Job Satisfaction Financial Incentives

Fear: This includes fear of the supervisor and fear of loosing a job and being out of work and destitute, especially in a country where no form of social security exists. This is a negative and unsatisfactory form of incentive.

Factor	Explanation	Comments and suggestions for improving the capacity
Age	Peak capacity for physical work is generally reached between the age of 20-35	In older persons, especially in skilled jobs, experience and efficiency compensate for lower work capacity.
Nutrition	Capacity is related to calorie protein content of food	Establish project canteens to provide balanced meals. Arrange talks on nutrition.
Temperature & Humidity	Affect the rate at which heat can be dissipated from the human body by radiation, convention and evaporation of sweat, heat and humidity increase dangers of heat stroke and reduce work capacity	Start work at first light and avoid working during the heat of the day.
Health	Resistance to disease is affected by diet. Good hygiene and sanitation is essential to avoid occurrence of debilitating intestinal parasites.	Enforce strict site hygiene. Arrange talks on hygiene and sanitation.

Discipline: This is exemplified by punctuality, lack of absenteeism, good standards of workmanship and the observance of site cleanliness and hygiene. When discipline is lacking, site morale is generally low and productivity is unsatisfactory.

Ways of achieving site discipline include:

- Site rules drawn up and explained to all workers by either supervisors
- Supervisors; by personal example, setting a high standard in self-discipline Workers encouraged to feel that they are working with, rather than under, the supervisor (but at the same time the supervisor should leave no doubt in their minds that he is the leader)
- Retribution should be a matter of inevitability rather than severity. No breach of discipline should go unchecked
- Developing self-discipline through pride in achievement. Good work should always be praised
- Taking a personal interest in the worker, discussing problems fairly, never showing favoritism
- Disciplinary action should be taken as soon after an infringement as possible

Job Satisfaction: Apart from work providing the means of satisfying the workers basic needs as to food, clothing and shelter, job satisfaction is obtained when the higher psychological needs of the worker, e.g. self-respect and personal dignity, are met. Individuals have a need to belong and for their usefulness to be apparent. Job satisfaction is obtained through a sense of achievement as to quality, output or other contributions, particularly if that achievement as to quality, output or other contributions, particularly if that achievement is recognized and acknowledged. Pride in craft and skill and a sense of responsibility are to be encouraged and rewarded with opportunities for advancement and promotion. Negative aspects which detract from job satisfaction and morale, and which consequently affect productivity, are to be avoided. These are generally aspects which imply that the worker is held in low esteem by management and include:

- Poor working conditions and terms of employment
- Poor or subservient relations with supervisors

Financial Incentives: Incentive schemes of this nature are widely used in industrialized countries, but are often a source of contention and dispute between management and workforce. The schemes enable workers to earn bonuses over and above the normal rate of pay for achieving a rate of output at or above a predetermined standard. It is not always easy to work out what this standard performance should be, so that the output targets set by management of which the bonus earnings depend are often inaccurate.

1.4 VARIOUS FACTORS AFFECTING LABOUR PRODUCTIVITY

Identification and evaluation of factors affecting labour construction productivity have become a critical issue facing project managers for a long time in order to increase productivity in construction. Understanding critical factors affecting productivity of both positive and negative can be used to prepare a strategy to reduce inefficiencies and to improve the effectiveness of project performance.

Knowledge and understanding of the various factors affecting construction labour productivity is needed to determine the focus of the necessary steps in an effort to reduce project cost overrun and project completion delay, thereby increasing productivity and overall project performance.

Based on the study, Factors affecting construction labour productivity have been identified and are grouped into 15 categories according to their characteristics, namely

- Design factors
- Execution plan factors
- Material factors
- Equipment factors
- Labour factors
- Health and safety factors
- Supervision factors
- Working time factors
- Project factors
- Quality factors
- Financial factors
- Leadership and coordination factors
- Organization factors Owner/consultant factors
- External factors

1.4.1 The top ten factors that affect the small and medium company

- Lack of material
- Labour strikes
- Delay in arrival of materials
- Financial difficulties of the owner
- Unclear instruction to labourer and high absentees of labours
- Bad weather (e.g. rain, heat, etc.)
- Non discipline labour and use of alcohol and drugs

- No supervision method, design changes, repairs and repetition of work, and bad resources management
- Bad supervisors absenteeism and far away from location of material storage
- Bad leadership

1.5 Misunderstandings about Labour Productivity

A study from (Adrian 1990) states the following general misconceptions about labor productivity.Key factor for low productivity in construction industry is labour.Because the construction industry is controlled by the weather, productivity cannot be improved.The construction industry always has an unfavourable relationship

1.6 Facts about Labour Productivity

Following are a few facts about the construction productivity studied by Adrian(1990).Tuesday is studied as most productive day of the week.10 a.m. is studied as most productive time of the day.The least productive time frame for labour is right before the finishing time.A labourer is capable of lifting approximately 94 pounds on his own .If the labourer is engaged in performing the same task repeatedly, there is a chance of low productivity after 60-70 minutes of performing the same work .Friday has been proven to be the least productive day of the week

2.METHODOLOGY

Survey research is defined as collection of different data by asking people questions. The data collection process used in this research had the option of two basic methods: questionnaires and personal interviews. A questionnaire was preferred as the best effective and suitable data-collection technique for the study. It was concluded that the questionnaire was described as a self-administered tool with web-design questions, an appropriate response. A questionnaire in a web-survey format comparatively requires less duration and saves cost for the researcher while permits respondents to response the questionnaire at their personal ease. However, for this approach the reply rate is usually lower as compared to face-to-face interviews. Data was collected from literature reviews from books, journals, articles, seminar conferences, and websites which emphasize building construction's labour productivity.

2.1. SURVEY PLANNING

For the research study, email technology was used to send the survey questionnaire. Collecting general information on various factors affecting labor productivity in building construction all over coimbatore was the basic aim of the survey. The purpose and approach used in the survey was fully explained to the respondents. Guidelines were provided to the respondents to ensure that the procedure was followed properly to reduce errors. During the survey period, some oversights were provided to help ensure the process was going smoothly and consistently. The data were stored in order to maintain confidentiality, and the output was received from the Group Discussion Center (GDC) in the form of electronic mail, which included raw data sheets, summary sheets, and computer databases. Results included the overall statistics as well as individual statistics.

2.2. DESIGN OF QUESTIONNAIRE

The questionnaire design practice advanced on a communicating basis. It was categorized into profile of the respondent and various factors affecting labour productivity in building construction. Questions in the respondent profile were created to collect information such as job position, experience of the work, locations of the current and/or previous works and contact information. It was studied, these questions in the survey were of great important to the research by analyzing productivity loss concerns from a variety of different profiles from different regions. It was practical to anticipate that a location can have an impact on the loss of productivity due to various field disturbances, especially geographical and climatic conditions.

The set of questions, was targeting the factors affecting labour productivity in the different groups. It included factors affecting labor productivity. Respondents simply furnished of factors affecting productivity for given typical condition. Hence, each respondent had a choice to select only one option for each factor. The responses were to be based on the understanding, knowledge and experience of the respondents and not related to any definite project. This simple and straight method was selected to establish a means of developing a list of factors affecting labor productivity in building construction.

2.3. PILOT SURVEY AND QUESTIONNAIRE REVISION

To improve the questionnaire section, a pilot study was accompanied. This section contained identification of different causes, collection, and conclusions of data. The application of this section benefited in better formation of the

web-survey development , were sent by e-mail to laborers, contractors, architectures, owners, project managers, and project engineers of various building construction organizations. It was expected to complete and submit the response within 2 weeks. By the end of 2nd week, 25 responses collected from the pilot survey, 5 of those were incomplete and were removed from the set, leaving a total of 20 respondents in the database. Information obtained and the recommendations provided in from pilot survey are discussed below.

- Questionnaire should always start with the general information of the organization
- Some factors are not related to construction. They should be removed or modified.
- To get more suitable and consistence meaning some factors should be rearranged.
- Some factors should be revised with additional information.
- Factors repeated with similar meaning should be removed.
- Some factors should be changed to give clearer importance and understanding.

Better and accurate questionnaire related to the topic was achieved from the pilot study. The perfections related to the organization of the questionnaire and the response time. In terms of organization, the web survey was created using a light appearance and pleasant-looking font colors. It also included a percentage bar for the completed survey and had an option to navigate to any question at any given time. All the information entered via the web had an auto-save option and the respondents had the luxury to return to the survey within the allotted duration Respondents were informed about the confidentiality of the responses. The list of questions used for the web survey can be found .

2.4 METHODOLOGY FLOW CHAT

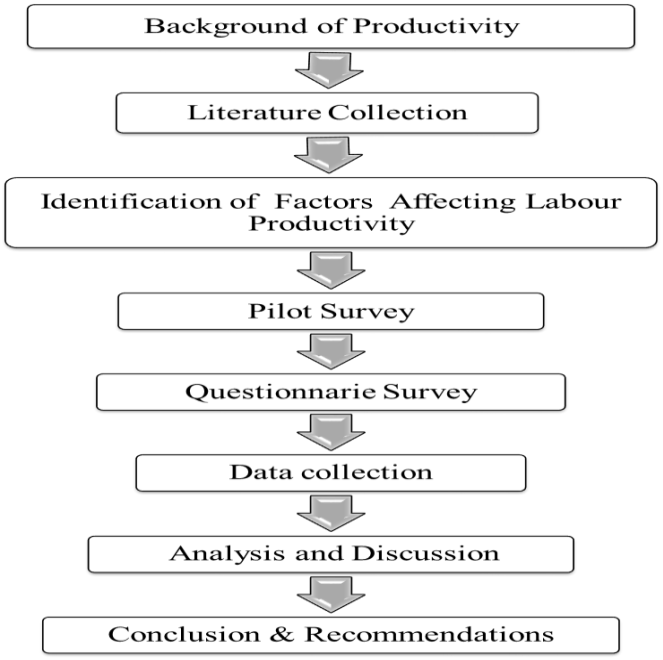

Fig 3.1 Flow Chart for Methodology

3. STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES

3.1 SPSS

Statistics is a software package used for statistical analysis. Long produced by SPSS Inc., it was acquired by IBM in 2009. SPSS is a widely used program for statistical analysis in social science. It is also used by market researchers, health researchers, survey companies, government, education researchers, marketing organizations, data miners, and others. In addition to statistical analysis, data management (case selection, file reshaping, creating derived data) and data documentation (a metadata dictionary was stored in the data file) are features of the base software. In Civil Engineering field Statistical package for the social science (SPSS) software is mainly used for analyzing the questionnaires.

Statistics included in the base software:

- Descriptive statistics: Cross tabulation, Frequencies, Descriptives, Explore, Descriptive Ratio Statistics
- Means, t-test, ANOVA, Correlation (bivariate,partial,distances), Nonparametric tests

- Prediction for numerical outcomes: Linear regression
- Prediction for identifying groups: Factor analysis, cluster analysis (two-step, K-means, hierarchical), Discriminant

SPSS Statistics places constraints on internal file structure, data types, data processing, and matching files, which together considerably simplify programming. SPSS datasets have a two-dimensional table structure, where the rows typically represent cases (such as individuals or households) and the columns represent measurements (such as age, sex, or household income). Only two data types are defined: numeric and text (or "string"). All data processing occurs sequentially case-by-case through the file. Files can be matched one-to-one and one-to-many, but not many-to-many.

Larger datasets such as statistical surveys are more often created in data entry software, or entered during computer-assisted personal interviewing, by scanning and using optical character recognition and optical mark recognition software, or by direct capture from online questionnaires. These datasets are then read into SPSS.

3.2 RELATIVE IMPORTANT INDEX (RII):

The questionnaires are collected and analysed using statistical software package SPSS v 21. The ranking of factors was calculated based on Relative Importance Index

$$RII(\%) = \sum a * \frac{n}{N} * \frac{100}{5}$$

Where:

RII = Relative Important Index
a = constant expression weight
n = frequency of response
N = total number of response

3.3. Data Collected from the Survey

In successfully achieving main objective of the study, one of the most important phase is collection of accurate data. Data collection is a procedure of collecting crucial data records for a certain sample or population of observations (Bohrnstedt and Knoke, 1994). A total of 125 questionnaires were sent to construction professional through e-mail in early November 2014. By the due date, a total of 77 questionnaires were received, resulting in a nearly 66.4% reply rate (Table 4.1). Missing data frequently occur after the respondent chooses not to response a question or when the respondent rejects to answer the question. (Kim, 1993). The most serious concern presented in the responses was some missing data. Some of the unclear response was clarified over the phone. A total of 6 (i.e., 4.8%) invalid data received were deleted from research study. The reason to discard the data was incompleteness and invalid responses.

Table3.1 Statistical Data of Questionnaires Sent and Received

	No.	Percentage of Total (%)
Total Questionnaires Sent	125	100
Total Questionnaires Received	83	66.4
Invalid Data	6	4.8
Used for Study	77	61.6

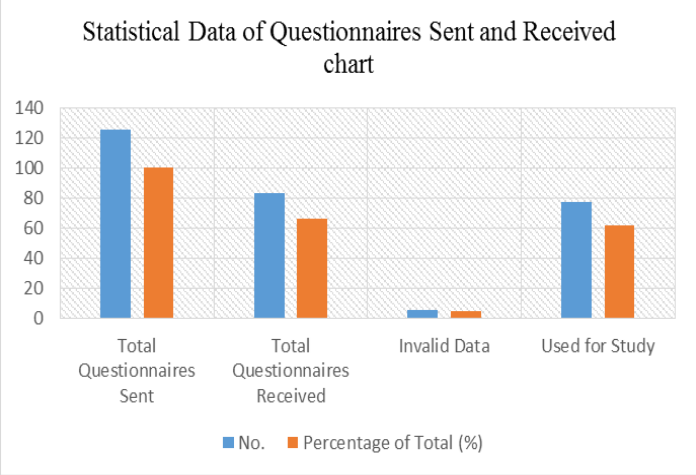

Fig : 3.2. Statistical Data of Questionnaires Sent and Received

3.4. Size of Organization (Employees)

The average number of employees in an organization was 36. Only building construction projects were considered for the study.

3.5. Number of Projects per Year

The average number of construction projects

undertaken per year was 3-5. Only building construction projects were considered for the study.

3.6. Type of Construction Projects

\\\\ The type of construction organizations that responded is shown in Table- 3.2 Only building construction project were considered.

Table 3.2. Types of Organizations that Responded

Construction Organizations	Respondents
Residential	36
Commercial	7
Industrial	17
Government	7
Architecture	10

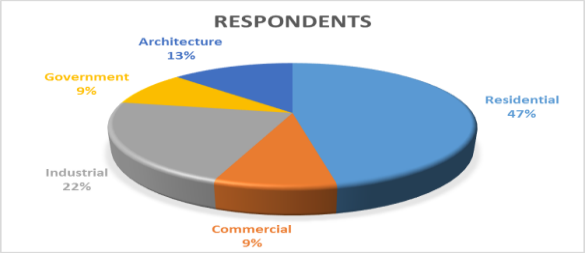

Fig: 3.3. Types of Organizations that Responded

3.7. Typical Size of Projects

The size of the projects in Indian rupees undertaken by the respondents' companies is shown in Table 4.3. Only building construction projects were considered for the study. Table 4.5. Typical Size of Projects,Research was performed considering, 40 factors affecting labor productivity for building construction were identified, and their RII was calculated.

These factors were classified into five groups: manpower factors, external factors, communication factors, resources factors, and miscellaneous factors. Different groups used in the study are discussed in detail.

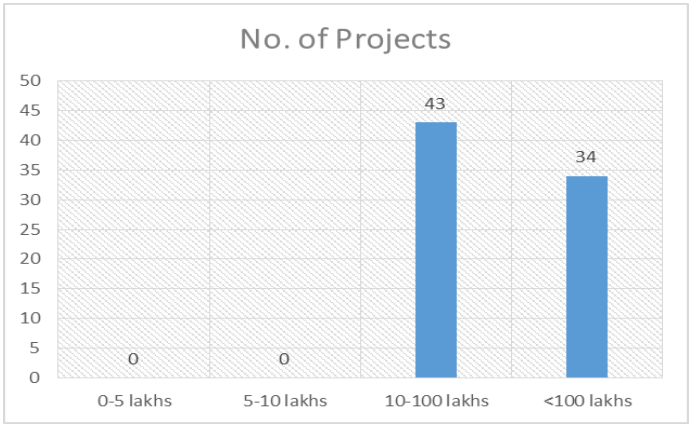

Fig:3.4.Typical Size of Projects

4.CONCLUSION:

The theoretical model of this study proposed fifteen independent groups affecting the variation of Labour Productivity in the construction projects namely Labour factors , Supervision factors , External factors , Owner/consultant factors , Execution plan factors , Designer , Working time factors , Equipment factors , Financial factors , Quality factors , Project factors , Organization factors , Leadership and coordination factors , Health and safety factors. This research is intended to identify the causes of probable factors affecting labour productivity in building construction. This study investigates all possible factors through a structured questionnaire administered all over Coimbatore. The survey results are subjected to analysis, and the ranking of factors is calculated using the Relative Important Index. The basic ideas of the research is to study various factors affecting labor productivity on construction.

The target groups in this study were construction professionals. Total of 125 questionnaires were distributed, and 83 questionnaires (66.4 % response rate) were returned. Because project engineers, project managers have vast experience in construction, their adequate experiences were a proper suggestion to study about the various construction factors affecting labor productivity.

From the result and analysis the top most factors affected the labour productivity are given Sanitation and hygiene Of the construction site and the temporary shed; Labour injuries on site; Alcoholism; Working overtime; Shortage of construction materials; Payment delays; Change orders from the designers; Improper equipment; Poor quality of construction materials; Misunderstanding among laborers.

So we have to recommend some ideas to develop the labour productivity from this research.

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