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CONTRADICTION ANALYSIS OF CONSTRUCTION INNOVATION: INTEGRATED LABOR COST MANAGEMENT SYSTEM

Irfana Parveen[1], Asha Jose[2]

[1]M.Tech (Structural Engineering and Construction Management) Civil Engineering Student, Dept of Civil Engineering
[2]Assistant Prof, Dept. of Civil Engineering
[1,2] Indira Gandhi Institute of Science and Technology, Kothamangalam, Ernakulam Dist – Kerala 686691

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 labor productivity. The main outcome from the literature is that there is no standard definition of productivity. It covers the construction labor productivity definitions, aspects, factors affecting it. The productivity of labor 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 labor productivity in and around particular location. So survey is carried out through questionnaire and distribute to respondents who work at various projects in wide area and the questionnaires are rated by project managers, experienced engineers and also with labors 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 labor productivity.*

Key words: labor productivity, construction

1. INTRODUCTION

Construction industry is world's most largest and challenging industry. Human resource has a strategic role in increasing productivity in construction industry. With the effective and optimum use of human resources can help in productivity growth. The construction projects are mostly labor based with basic use of hand tools and equipment's in which labor cost consists of about 30% to 50% of total project cost. Indian construction industry is one of fastest growing sector globally. The construction sector gives second largest employment after agriculture. India shares about 8% of total GDP and also provides employment to around 35 million peoples directly or indirectly. In construction industry one of the biggest problems faced is of unskilled labor which implies in productivity loss and impacts on cost overrun and schedule daily. Labor productivity is one of important factor which affects physical progress of construction project. To perform effective job, construction labor should be familiar with materials, tools and machineries that they use.

The cost of employing construction workers on different construction projects varies widely: labor costs on large construction projects typically account for approximately 40% of direct capital cost. Regardless of this significant percentage of labor cost, the construction industry is generally characterized by poor productivity of construction labor. However, "human resource of an organization represents the most variable, uncontrollable, and important element of production" .This is an indication that employees in an organization merit a higher level of concern, most essentially in relation to labor-intensive sectors like the construction industry. Construction management is meant to be strategically used to improve the efficiency of construction employees and enhance overall construction performance during building production processes.

Management of workforce is extensively defined as a logical approach to the management of an organisation's expensive asset who individually and as a group work together towards achieving the set goals of an organisation. Significantly, construction workers are essential to the construction sector, just as construction activities are significant to the economies of nations. Considering the contribution of the construction sector to job creation, the construction industry, offers employment to a significant percentage of a nation's working population, with a large percentage of unskilled and menial workers. Therefore, the construction sector is more labor-reliant than the manufacturing industry. Construction sector still lags behind in the area of workers' efficiency, when compared with the manufacturing industry. The fragmented structure, itinerary nature, and challenging working environments of construction employees are arguably contributing factors to the comparative inefficiencies of the construction workforce. Nonetheless, considering the relevance of employees to organizational development, there is a need to devise an effective management system that can afford utilization of the construction industry's human assets to improve performance on construction projects. Therefore, construction workers' performance improvement, as an essential tool for improving construction project

performance, requires industrial and academic interventions. Construction workforce efficiency and productivity has become an essential focus and a frequently researched area to improve construction project performance.

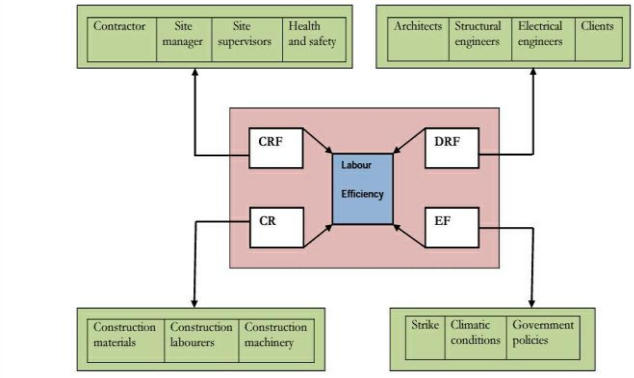

Fig -1: Conceptual framework

Where, CRF: Construction-related factors
DRF: Design-related factors
CR: Construction resources
EF: External factors

1.1 CONSTRUCTION WORKFORCE EFFICIENCY

Construction workforce efficiency and construction productivity are inseparable in the construction environment. The efficiency of construction workers as being comprised of the ratio of actual performance of an employee to the theoretical maximum or expected performance. Similarly, construction labor productivity can be defined as construction input divided by construction output or vice versa, as explained later in this section. Therefore, there is a significant relationship between construction workers' efficiency and productivity. As such, the higher the efficiency of the construction workforce, the higher the productivity of an employee obtained.

In the construction industry in particular, construction productivity implies labor productivity. Although a significant amount of research has been undertaken on construction labor productivity, there is no consensus on general productivity standards in the construction environment. The absence of construction industry overall benchmarking of labor productivity could be a result of the complexity, diversity and fragmentation inherent to the construction industry.

Research has revealed undue cost overruns, time overruns and loss of productivity as a predominant occurrence in delivery of most construction projects. Construction labor constitutes a significant percentage of construction cost, and the quantity of labor hours in performing a task in construction is susceptible to labor influence by management through motivation, incentives, performance assessment, and recognition. These measures are rarely adopted. Thus, improving the efficiency and productivity of workforce in the construction industry becomes challenging, thereby resulting in an increased construction cost and extended duration of projects.

The project-based nature of construction works and co-ordination of people from different locations to effectively work together in the same trade, and under a strictly-controlled budget, are noted as major challenges in the construction sector. As a result, the construction industry's project-based nature contributes to the growth of self-employment in the construction industry and reduces the investment and commitment to training by construction contractors. Nonetheless, the construction workforce requires adequate training, both for individual development and to enhance the collective commitment of the workforce to achieve a high quality of production and, ultimately, to achieve organizational set goals. The construction industry is one of the most complex and dynamic industrial environments. These attributes within the sector create a negative impression on people who are able to deliver a good job, make construction work undesirable and thereby increase the challenge of the acquisition of skilled workers in the construction sector. Previous studies reveal that there exists less effort geared towards proper utilization of the construction workforce by construction firms, and this in turn adversely impacts the quality of construction work during production processes.

The client's desire for project execution at the lowest cost, while demanding the achievement of project objectives is a notable reason for the prevalence of challenges to productivity in the construction sector. Therefore, contractors tend to reduce the duration, or avoid altogether, training for the construction workforce and engage workers with lower levels of skill to execute construction operations. Construction workers have a significant level of control on construction materials and machinery. Therefore, the efforts of construction practitioners to effectively manage construction materials and machinery resources and to prevent construction wastage significantly depend on the effective and efficient utilization of construction human capital.

1.2 BACK GROUND OF LABOR PRODUCTIVITY

Productivity can be defined in many ways. In construction, productivity is usually taken to mean labor productivity, that is, units of work placed or produced per man-hour. The inverse of labor 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: labor, 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 labor productivity. It can be defined in one of the following ways.

Labor Productivity = (Output / Labor Cost) (1.1)

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 labor 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.

1.3 PRODUCTIVITY AND LABOR

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 labor has a direct bearing on this being achieved. The factors affecting the performance of labor generally fall into three categories.

i. The human capacity for work

ii. The competence of site management

iii. The motivation of the workers

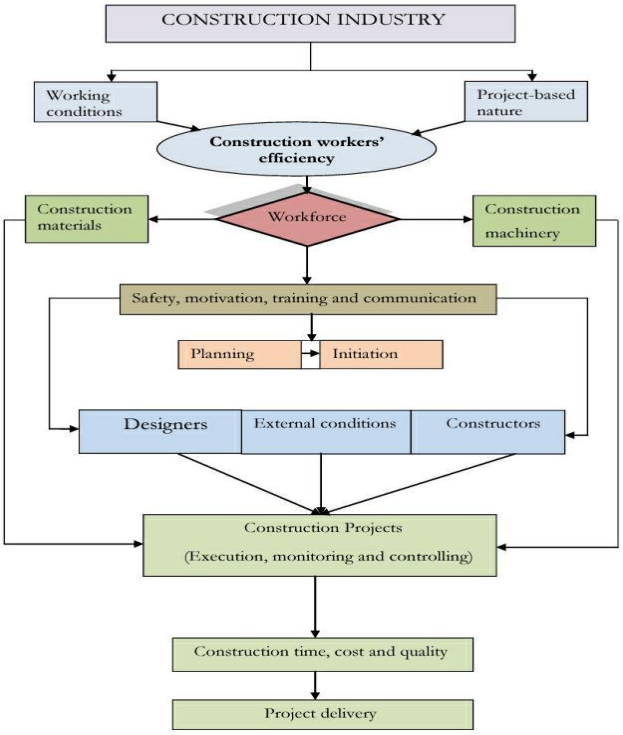

Fig -2: Theoretical framework

1.4 SIGNIFICANCE OF THE STUDY

Considering the contribution of the construction industry to the Gross Domestic Product of India, enhancement of construction workforce efficiency for improved productivity is essential. Human resource of an organization represents the largest investment of an organization. Therefore, inadequate utilization of human assets in the construction industry does not only constitute waste to construction organization, but also to individual clients, governmental organizations, construction workforce and ultimately affects the construction industry's project delivery record. In addition, efficiency is attained through effective utilization of all construction resources to achieve the set organizational objectives. The basic objectives of construction organization are: on time project delivery, project delivery within budgeted cost and delivery at quality expected. These factors constitute the benchmark for construction success and are significantly dependent on the adequate management of the construction workforce. Labor productivity improvement in construction is essential, due to the workers' impact on timely completion of projects and delivery within proposed cost. Hence, since both adequate utilization of construction resources and project performance are subject to the efficiency of construction labor, the improvement of construction workforce performance is essential to ensure efficiency in the building production process.

1.5 OBJECTIVE OF THE STUDY

The objective of this study focuses on views from the construction industry about various factors affecting labor productivity. In this paper analytical study was done to identify construction-related factors affecting construction workers efficiency, to ascertain design-related factors reducing the efficiency of construction labor, to identify the impact of construction resources on construction labor efficiency, to ascertain the external factors affecting the efficiency of human assets in the construction industry, to develop a framework for improving the efficiency of the Indian construction workforce.

1.6 SCOPE OF THE STUDY

- Future studies should explore other influencing factors affecting construction productivity at all stages of the procurement process.
- Contracting companies have to conduct productivity study at the activity/operation level such as studying factors affecting labor productivity and labor productivity measurement in order to find out problem areas and propose ways to improve labor productivity.
- The productivity and materials waste data can be used to prepare estimates for future projects.

2. RESEARCH METHODOLOGY

In order to facilitate the study, after the Literature Review and the focus interviews, a plan was formulated for collecting field information and creating an evaluation process and numerical values. It was necessary to provide straightforward communication to respondents to ensure a clear understanding of all the applicable definitions, procedures, and guidelines that were used in collecting data.

2.1 METHODOLOGY FOR QUESTANNAIRE SURVEY

2.1.1 General

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 labor productivity.

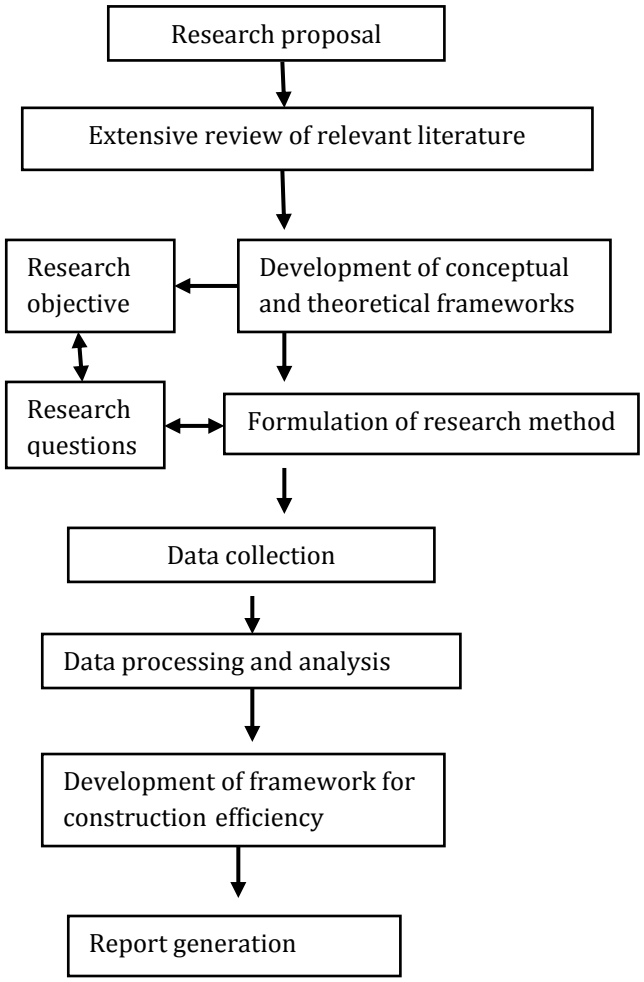

Fig -3: Flowchart for methodology

2.1.2 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 Madurai 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.

2.1.3 Design of Questionnaire

The questionnaire design practice advanced on a communicating basis. It was categorized into profile of the respondent and various factors affecting labor 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 labor 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.

2.1.4 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.

2.1.5 Terms Used in the Questionnaire

- Work breakdown structure

A work breakdown structure is a key project deliverable that organizes the team's work into manageable sections. The work breakdown structure visually defines the scope into manageable chunks that a project team can understand, as each level of the work breakdown structure provides further definition and detail. A work breakdown structure starts with the project as the top level deliverable and is further decomposed into sub-deliverables in a hierarchical order.

- Critical path method

The critical path method (CPM) is a step-by-step project management technique for process planning that defines critical and non-critical tasks with the goal of preventing time-frame problems and process bottlenecks. Basically it means a sequence of activities with the longest duration. A delay in any of these activities will result in a delay for the whole project. CPM calculates the longest path of planned activities to logical end points or to the end of the project, and the earliest and latest that each activity can start and finish without making the project longer. This process determines which activities are "critical" (i.e., on the longest path) and which have "total float" (i.e., can be delayed without making the project longer).

- Productivity

Productivity refers to the ability to generate outputs from a set of inputs. In general language we talk about the productivity of different land or natural resource deposits or the productivity of hard-working individuals. The aim is to present the evidence on how the construction industry has performed in terms of this definition of productivity in the recent past. Productivity in the industry will be examined in terms of both how productive construction is now as well as how productivity growth has performed over time.

- Relational contracting/ partnering

Relational contracting is based on a contract giving due importance to the relationship of trust, cooperation and commitment between parties. The explicit terms of the contract are just an outline as there are implicit terms and understandings which determine the behavior of the parties.

- Integrated project delivery system

Integrated project delivery (IPD), is a collaborative alliance of people, systems, business structures and practices into a process that harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction. Primary IPD team members include the architect, key technical consultants, general contractor and key subcontractors. Using IPD, project participants can overcome key organizational and contractual problems.

2.2 METHODOLOGY FOR ANALYSING WITH PRIMAVERA

Fig- 4: Logo of primavera

Primavera is used for making project management smooth. It is helpful in civil engineering for creating strategies, controlled the delay of project and determines the optimum use of resources.. Primavera is used to complete the project within specified time and cost. It is the application of skills, tools and techniques to project activities in order to fulfill the demand of the owner. Primavera program is used to scheduling, controlling and estimating all types of projects. P6 EPPM is a completely online interface with the goal that venture group can get to the venture data at anyplace and whenever. P6 EPPM can give arranging, planning, cost and asset administration programming that empowers association to settle on educated choices and enhance their capacity to convey projects and tasks on time and on spending plan.

P6 EPPM likewise helps in
• It is a far reaching venture administration arrangement supplier.
• Used and recognized comprehensively
• It can deal with different tasks in a brought together area
• It gives the choice to incorporate ERP or bookkeeping framework.
• It is an electronic venture administration, giving the venture group access to their activities anyplace and whenever.
• It is a 100% online UI that covers the entire venture administration lifecycle.

Project consumes several resources in its lifetime to achieve the desired goal. The resources have time dependent, direct or indirect costs related to them. For large Construction projects with huge budget; it becomes very difficult for the project team to handle the tasks so, it becomes very necessary to provide a tool in the hand of project team that helps keep a track of activities in the project. Primavera Project Planner P6, a product from Oracle is a very powerful tool present in the hands of project team. The software helps in planning, scheduling and controlling of projects very efficiently. Contractors in India are reluctant to use project planning and scheduling techniques, which are being used world over and already proved as benchmark for in time completion of projects. The study includes with discussion/introduction on Primavera P6 a project planning and scheduling tool available. The quality of schedule generated from the software often lacks detail and the purpose of the software in adding value to the project is generally not met by the users in India. In addition to provide insight on various project tasks, their inter relationship, dependencies to predict total project duration during planning phase. The schedule should be comprehensive enough to let the user understand in detail the purpose of various activities in the schedule. In today's world construction industry is one of the most widely used and rapidly booming industry of our nation and across the world. Hence there is requirement of certain tools and techniques for the improvement of national economic upliftment, and their environment planning to manage with the level of improvement in town and urban areas and the time required to overcome this goal can shortened. There is necessity for effective Project Management.

- Controlling and Monitoring

Monitoring and control can be done for the timely completion of a construction project. It can helps to project management for doing the work as per decided. It gives proper check on project which ultimately remove the queries. With the help of controlling and monitor we can check our daily progress. Now a days many construction management software such as Primavera P6 can be used for controlling and management.

- Delays

There are several definitions for delay. In the construction management simplest definition is given by Mubarak (2005) as "a condition or an event that result in finishing the project later han stipulated in the contract." In another study, to make something happen in later than expected time. Types of Delays:
• Critical or noncritical
• Excusable or non-excusable.
• Compensable or non-compensable
• Concurrent or non-concurrent

2.2.2 METHODOLOGY

• Personal interviews with working people at site.
• Collection of data and their analysis.
• Project can be made on the Primavera according to collected data from site.

Steps Involved in Scheduling

2.2.2.1 Creating EPS

To create an ideal schedule for any project, first step is to collect data available for the project. The following steps can be followed in Primavera P6 software. Create the complete structure of the company with its branches, which is executing the project using primavera P6. This is known as Enterprise project structure (EPS).

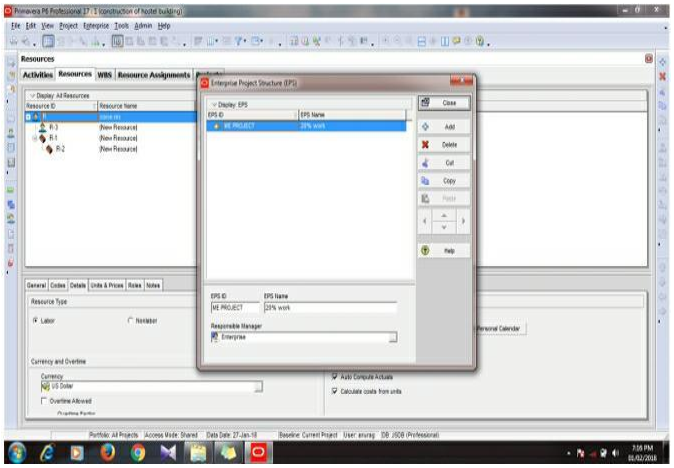

Fig- 5: EPS

2.2.2.2 Creating new project

The project constitutes a plan for creating a product or service contains a set of different activities and associated information. The project is governed under respective divisions in EPS. That can be given planned start and finish dates. Global, resource or project calendar is assigned by the project.

2.2.2.3 Work breakdown structure

WBS elements have defined and organize the project elements. It helps to clearly identify the deliverables, report and summarize project schedule and estimated cost data at different levels of detail. WBS is a hierarchy of any project work that must be accomplished to complete a construction project. Each project has its own project WBS hierarchy structure with top level WBS element being equal to that of each EPS node of the project. Each WBS element contains more detailed in WBS levels, activities, or both resources constrains.

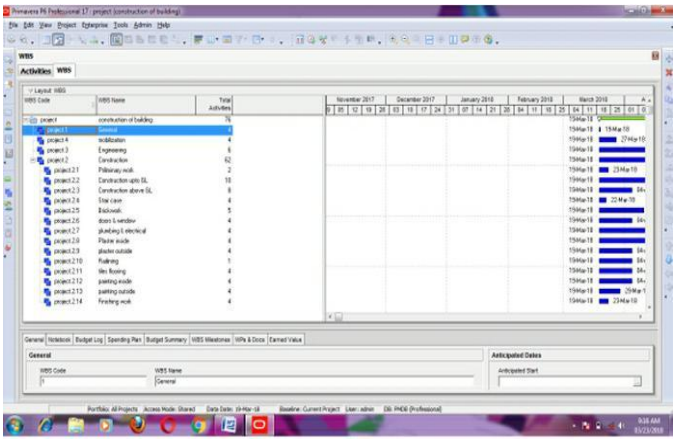

Fig- 6: WBS

2.2.2.4. Defining activity

The smallest subdivision of a project activities are the fundamental and key work elements of a project and form the top to lowest level of a WBS. The characteristics Activity like ID, activity name, start and finish dates, activity calendar, activity codes, activity type, constraints, expenses, predecessor and successor relationships, resources, roles etc .

2.2.2.5. Relationship between activities

By assigning succeeding, preceding activities with significant relationship to the overall project activities, form a network, scheduling the activities should be connected to each other.

- Finish to start (FS) relationship
- Start to start (SS) relationship
- Finish to finish (FS) relationship
- Start to finish (SF) relationship'

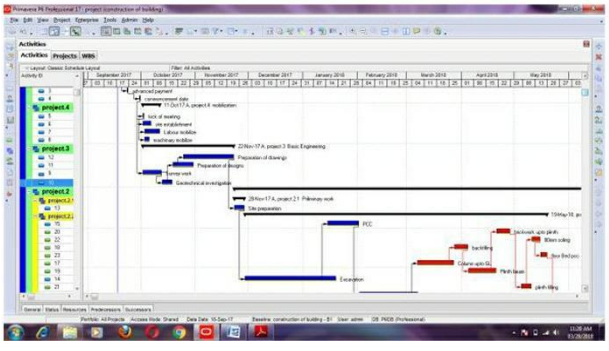

Fig- 7: Relationship Gantt chart

2.2.2.6. Creating a calendar

The calendar can create and assign it to each activity. These calendars define the available work hours in each calendar days. Also specify national holidays, organizations, and project- specific work/non a workdays and resource vocation days.

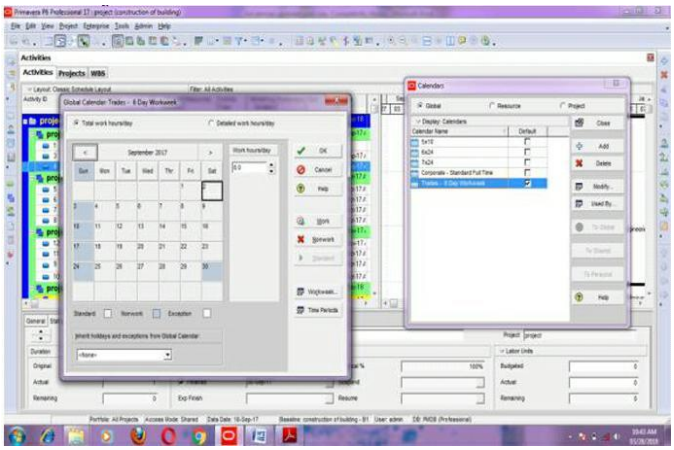

Fig- 8: Calendar

2.2.2.7. Activity Duration

When planning the work, the project duration is entered in the original duration field. The actual duration can only be entered for the project activities, which are completed.

2.2.2.8. Activity Dates

The following types of project activity dates available in the primavera; actual start, planned start, actual finish, planned finish.

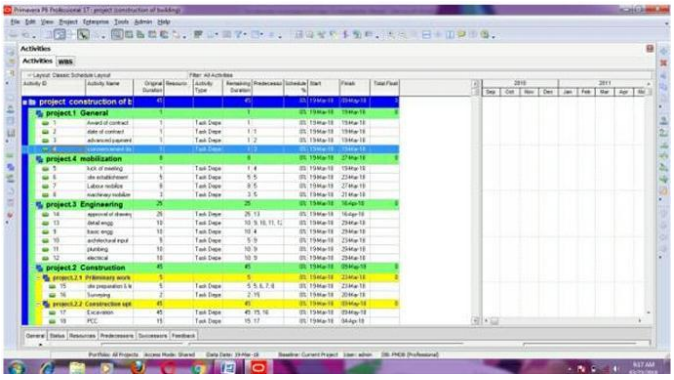

Fig- 9: Activity duration and dates

2.2.2.9. Creating baseline

A complete copy of the original schedule is a simple baseline plan which provides a target against which a project's performance is tracked. Choose project. Maintain baseline. Then add and save a copy of current project as a new baseline B1. Then choose project baseline as B1 and assign primary baseline as B1. Daily updates to be made. Firstly Start date and end date choose the activity to be updated. Then in the activity details window, select status tab. Then tick mark started if the activity has been started and select the date. Tick mark finished if the activity has been finished and select the finish date.

3. RESULTS AND DISCUSSION

3.1 SPSS (Statistical Package for the Social Sciences)

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, Descriptive, 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.

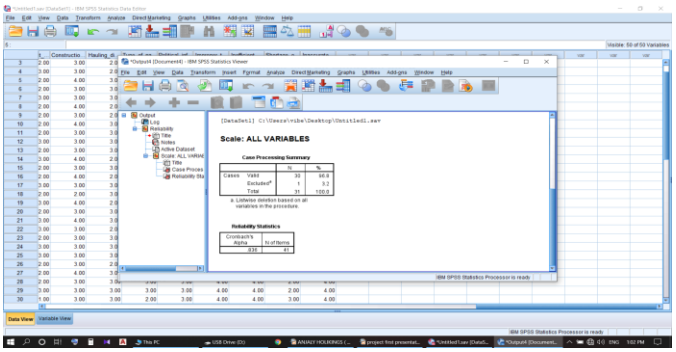

Fig- 10: Data analyzing by SPSS

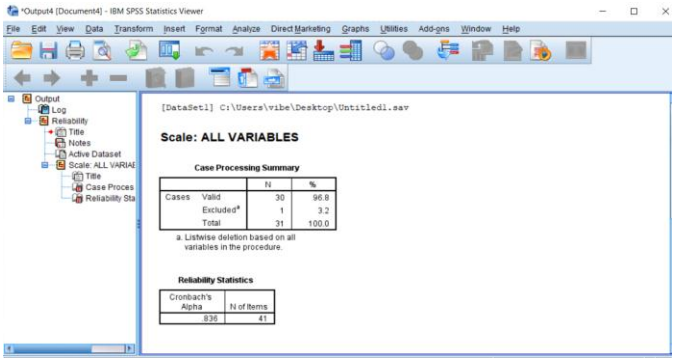

Fig- 11: Case processing by SPSS

3.2 RELATIVE IMPORTANT INDEX (RII)

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

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

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.

3.3.1 Size of Organization (Employees)

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

3.3.2 Number of Projects per Year

The average number of construction projects undertaken per year was 3. Only building construction projects were considered for the study.

3.3.3 Type of Construction Projects

The type of construction organizations that responded is shown in Table 1. Only building construction project were considered.

Table -1: Types of organizations that responded

Construction organizations	Respondents
Residential	6
Commercial	6
Industrial	5
Government	1
Engineering	2
Architecture	5
Owner	3

3.3.4 Job Title

Respondents' job titles are shown in Table 2. Various professional in building construction projects were contacted to gather the information from web-survey.

Table -2: Job title of respondents

Job Title of the Respondents	Number of Respondents
Project Manager	4
Project Engineer	11
Architecture	5
Others (APM, APE, Scheduler, and Estimator)	10

3.4 RANKING OF FACTORS

Hierarchal assessment of factors was carried out to determine ranking of the factors based on level of significance. It was assessed based on Relative important index (RII) value and calculated for each group of respondent's i.e. contractor, consultant and owners and also the overall respondents as presented. It shows that top 10 most significant factors of overall respondents.

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.

3.4.1 Manpower Factors Affecting Labor Productivity

A lack of labor experience was ranked first in the manpower group, with an RII value of 488.7, and twelfth among all 40 factors affecting labor productivity (Table 8).

Lack of labor experience has a great influence on productivity. This result is acceptable because experience improves both the intellectual and physical abilities of laborers which, consequently, increases labor productivity.

Labor disloyalty had a great effect on labor productivity and ranked in the 7th position for the manpower group, with an importance index of 373.75, and 39th among all 40 factors in terms of negatively affecting labor productivity.

Table -3: Manpower factors

Factors	RII	Rank
Lack of experience	488.75	1
Absenteeism	477.25	2
Alcoholism	425.50	3
Misunderstanding among laborers	419.75	4
Age	408.25	5
Lack of competition among the laborers	379.50	6
Disloyalty	373.75	7
Personal problems	368.00	8

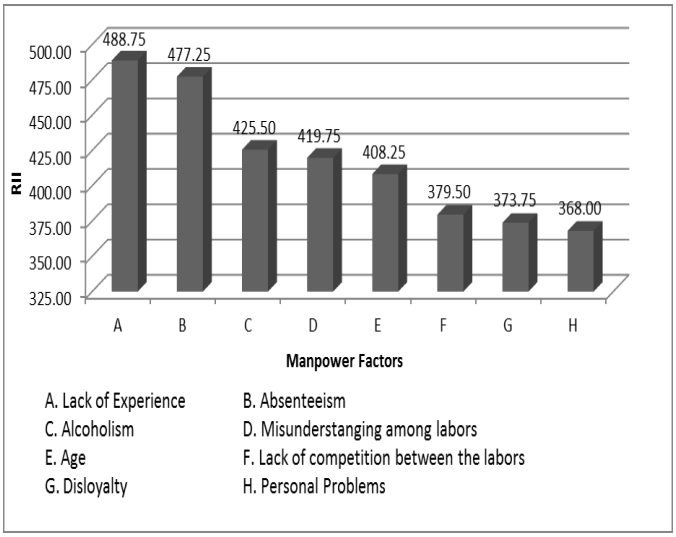

Chart -1: Manpower Factors

Misunderstanding among laborers was ranked 4th in the manpower group, with an RII of 419.75, and 32nd among all 40 factors that affected labor productivity (Table 8). This result is acceptable because misunderstanding among laborers can creates disagreement among them and about the responsibilities for each laborer, which leads to a lot of mistakes in work and, consequently, affects labor productivity. A lack of competition among laborers ranked 6th, with an RII of 379.50, and ranked 38th among all 40 factors for negatively affecting labor productivity (Table 8).

Labors' age was ranked 5th in the manpower group, with an RII of 408.25, and 34th among all 40 factors that affected labor productivity (Table 8). This result is justified because speed required to perform particular task and strength decline over time affecting labor productivity.

Labor absenteeism was ranked 2nd in the manpower group, with an RII of 477.25, and in 18th among all 40 factors that affect labor productivity (Table 8). This result is justified give the transient nature of the local workforce and the ease with which construction contractors could hire additional laborers to cover absenteeism.

Personal problems were ranked 8th in the manpower group, with an RII of 368.00, and 40th among all 40 factors that affect labor productivity (Table 8). This result might be justified because personal problems cause mental disturbance for laborers, and thus can affect labor safety more than labor productivity. Alcoholism ranked 3rd in the manpower group, with an RII of 425.50, and 30th among all 40 factors that affect labor productivity (Table 8). Consuming alcohol at the construction site may lead to various negative effects on other laborers who are working. Alcohol consumption may lead to rework, misplacing the job work, and accidents, thus completely or

partially stopping the construction work and affecting labor productivity.

3.4.2 External Factors Affecting Labor Productivity

Supervision delays were ranked 1st in the external group, with an RII of 488, and 13th among all 40 factors that negatively affect labor productivity (Table 8).

Inspection delays from the authorities were ranked 6th in the external group, with an RII of 448.50, and 22nd among all 40 factors that affect labor productivity (Table 8). Past study proves that inspection delays are an important process; for example, because contractors cannot cast concrete before inspection of formwork and steel work, the inspection delay contributes to delays in work activities. It completely stops the task that require the presence of supervisors, such as casting concrete and backfilling. Additionally, it delays the inspection of completed work which, in turn, leads to a delay in the commencement of new work.

Variations in the drawings were ranked 2nd in the external group, with an RII of 488.75, and 14th among all 40 factors that affect labor productivity (Table 8). Incomplete drawings were ranked 3rd in the external group, with an RII of 483.00, and 16th among all 40 factors that affect labor productivity (Table 8). Design changes were ranked 5th in the external group, with an RII of 465, and 21st among all 40 factors that affect labor productivity (Table 8). A complex design in drawings ranked 8th in the external group, with an RII of 437.00, and 27th among all 40 factors that affect labor productivity (Table 8). Payment delays were ranked 7th in the external group, with an RII of 442.75, and 24th among all 40 factors that affect labor productivity (Table 8). Payment delays in the construction industry are adversarial and disastrous. Late payment affects a company's cash flow and may ultimately lead to a business's failure. Timeliness of payment is important to avoid the risk of the late-payment problem. A study by Zou et al. 2007 pointed out that project-funding problems have been identified as cost-related risks, time-related risks, and quality-related risks which can significantly influence the delivery of a construction project. The risk of delayed payment from the owner impacts the duration and cost of the project. These risks causes the project's cost to increase abnormally and, subsequently, delay the project's progress.

Rework ranked 4th in the external group, with an RII of 471.50, and 19th among all 40 factors that affect labor productivity (Table 8). Past study confirmed that rework is one of the major factors in the construction industry to affect labor productivity in building construction. The study also listed rework as one of the critical factors effecting productivity and stated that rework is due to incompetent craftsmen and supervisors.

Implementing government laws was ranked 9th in the external group, with an RII of 419.79, and 31st among all 40 factors that affect labor productivity (Table 8). For most projects, government authorities refer to specific versions and construction standards of their design. Sometimes, government authorities, who have documented standards for design and construction, may decide to revise those standards after the job has been awarded, based on a previous version, thus affecting the overall labor productivity of the building construction.

Training sessions were ranked 10th in the external group, with an RII of 414.00, and 33th among all 40 factors that affect labor productivity (Table 8). Past studies stated that persons entering the construction industry directly from high school usually start as inexperienced in construction industry or as laborers. They can learn from their job quickly by working closely with experienced people. Whereas, skilled laborers, such as carpenters, bricklayers, plumbers, and other construction trade specialists, most often get their formal instruction by attending a local technical school or through an employer-provided training program.

Table -4: External factors

Factors	RII	Rank
Supervision delays	488.75	1
Variations in the drawings	488.75	2
Incomplete drawings	483.00	3
Rework	471.50	4
Design changes	465.75	5
Inspection delays from the authorities	448.50	6
Payment delays	442.75	7
Complex designs in the provided drawings	437.00	8
Implementation of government laws	419.75	9
Training sessions	414.00	10

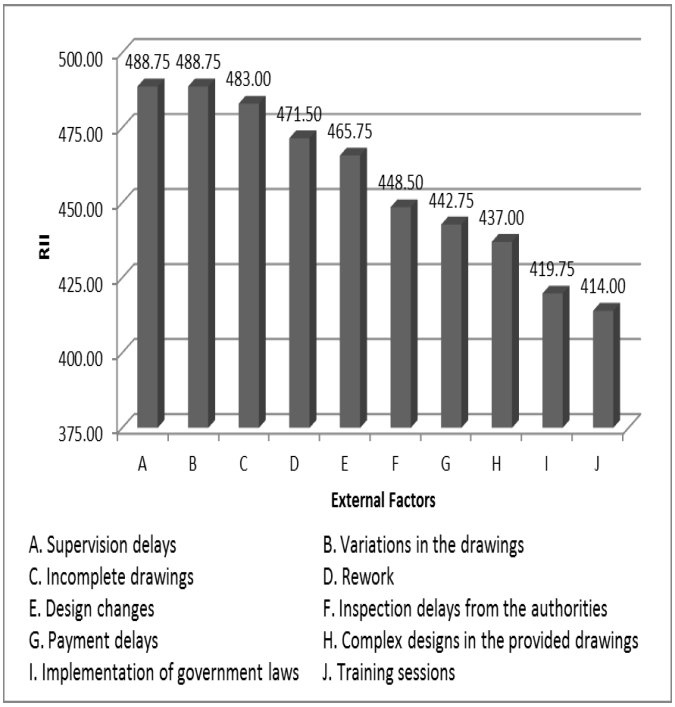

Chart -2: External Factors

3.4.3 Communication Factors Affecting Labor Productivity

Change order from the Design Engineer ranked 1st in the communication group with an RII of 465.75, and 20th among all 40 factors affecting labor productivity (Table 8).

A change order from the OW ranked 2nd in the communication group, with an RII of 442.75, and 23th among all 40 factors affecting labor productivity (Table 8). Disputes with the OW were ranked 5th in the communication group, with an RII of 391.00, and 37th among all 40 factors affecting labor productivity (Table 8). Misunderstanding among the OW, CO, and DE ranked 3rd in the communication group, with an RII of 431.25, and 29th among 40 factors affecting labor productivity (Table 8).

Disputes with the DE were ranked 4th in communication factors, with an RII of 396.75, and 35th among all 40 factors affect labor productivity (Table 8). This result can be justified because DE shortages are changes that result from defective or confusing aspects of construction designs and specifications which cannot be discovered until the contractor begins performing task sketched on drawing sheets. Design deficits are frequently the result of poor quality control in the design process, and they are manageable. The owner is also responsible for the contractor's costs due to designer errors, such as unreasonable delays in reviewing shop drawings, failure to provide drawings or design information in a timely fashion, failure in timely inspections, and other delays due to the designer's contract-administration problems.

Table -5: Communication factors

Factors	RII	Rank
Change orders from the designers (DE)	465.75	1
Change orders from the owners (OW)	442.75	2
Misunderstanding among OW, Contractors (CO), and DE	431.25	3
Disputes with the DE	396.75	4
Disputes with the OW	396.75	5

3.4.4. Resource Factors Affecting Labor Productivity

A lack of required construction material was ranked first in the resource group, with an RII of 558.00, and was first among all 40 factors affecting labor productivity (Table 8)

Inadequate construction material was ranked 11th in the resource group, with an RII of 437.00, and 28th among all 40 factors affecting labor productivity (Table 8). An increase in the price of material was ranked 7th in the resource group, with an RII of 396.00, and 36th among all 40 factors affecting labor productivity (Table 8).

Since material resource contribute 40-60% of the total project cost, it is supposed to be one of the most important factors which required good knowledge to improve labor productivity in construction. Past study shows, required consideration is not given to material resource management and its effects on labor productivity. It is impossible to complete any particular task without availability of required materials. A material shortage is ranked first position among factors affecting labor productivity. A lack of material refers to the inaccessibility of certain materials or the excessive time expended to obtain them. It is estimated that poor material management caused an 18% work-hour overrun. This study found a total of 35.6 man hours of unproductive time attributed to material unavailability, which amounts to 9.5% of the total wasted time.

A lack of required construction tools/equipment was ranked second in the resource group, with an RII of 540.00, and fourth among all 40 factors affecting labor productivity (Table 8). This result can be justified as major equipment on the site, including cranes, passenger/cargo lift, trailer concrete pump, truck mixer, and safety scaffolding. The entire construction process depends heavily on this equipment. For example, cranes are needed to move and position formwork, and to hoist and place

reinforcement; the truck mixer and concrete pump are indispensable to transport and place concrete. Any interruption in the use of the equipment leads to serious material-handling problems as well as a slowdown or a stoppage of operations. Therefore, the availability of equipment is regarded as important for construction progress.

The material storage location was ranked sixth in the resource group, with an RII of 504.00, and ninth among all 40 factors affecting labor productivity (Table 8). Previous study stated that the size and the organization of the materials' storage location has a significant impact on masonry productivity. This result is justified because laborers need more time to bring required materials from unsuitable storage locations, negatively affecting productivity.

Insufficient lighting was ranked third in the resource group, with an RII of 510.00, and basic requirements for obtaining fair labor productivity with any construction work. Failure to have adequate lighting may lead to different consequences, such as misplacing a particular job, or even serious accidents and the death of laborers at construction sites, thus negatively affecting labor productivity.

Poor access within a construction site was ranked eighth in the resource group, with an RII of 492.00, and eleventh among all 40 factors affecting labor productivity (Table 8). Study from (Sanders and Thomas 1991) proves one of the common reasons for low productivity is poor access within the construction site. Poor access reduces the free movement of labor and, consequently, reduces labor productivity. Interference between crews and laborers is caused by mismanagement on construction sites, with steel fixers suffering more of the mismanagement, possibly because they are more dependent on other trades. For example, if the carpenters have not completed the formwork, steel fixers have to wait before fixing the reinforcement rods.

Differing site conditions from the plan was ranked fifth in the resource group, with an RII of 504.00, and eighth among the 40 factors affecting labor productivity (Table 8), Poor site condition ranked was ranked fourth in the resource group, with an RII of 510.00, and sixth among the 40 factors affecting labor productivity (Table 8). A differing site or unpredicted condition occurs when underlying site conditions for a construction project are uncovered after the contract between the contractor and the owner has been executed and were not previously expected or included in the design documents. Differing site conditions are worth making note of only if the contractor experiences an increased cost and/or delay. Common examples of differing site conditions occur when a contractor performs earth excavation and uncovers objects or soil types that were previously unforeseen, requiring extraordinary measures to accommodate. These extraordinary measures can easily cost the contractor extra money and/or time above that for which was originally contracted.

Violation of safety laws was ranked 9th in the resource group, with an RII of 480.00, and 15th among the 40 factors affect labor productivity (Table 8). Construction is one of the most unsafe industries. The major causes of accidents are related to the unique nature of the industry, human behavior, difficult work-site conditions, and poor safety management, which result in hazardous work methods, equipment, and procedures. Preventing occupational injuries and illness should be a primary concern among both employees and employers. In the construction industry, the working environment is constantly changing sites that exist for a relatively short time as well as activities and inherent risks that change daily. Within a short time of a hazard being identified and dealt with, typically, the workplace has changed, bringing new hazards.

Quality of the required work was ranked 10th in the resource group, with an RII of 480.00, and 17th among the 40 factors affecting labor productivity (Table 8). In many cases, the quality of the product is not present and results in rework. The time required to construct particular task using poor quality material is greater than the time required to build with better quality materials. Additionally, wasting poor-quality materials is high, particularly at the time of handling. In addition, using materials of poor quality generally leads to poor-quality work which can be rejected by the supervisor.

Table -6: Resource factors

Factors	RII	Rank
Lack of required construction material	558.00	1
Lack of required construction tools/equipment	540.00	2
Insufficient lighting	510.00	3
Poor site condition	510.00	4
Differing site condition from plan	504.00	5
Material storage location	504.00	6
Poor access within construction site	492.00	7
Violation of safety laws	486.00	8
Quality of required work	480.00	9

Inadequate transportation facilities for workers	438.00	10
Inadequate construction material	437.00	11
Increase in the price of material	396.00	12

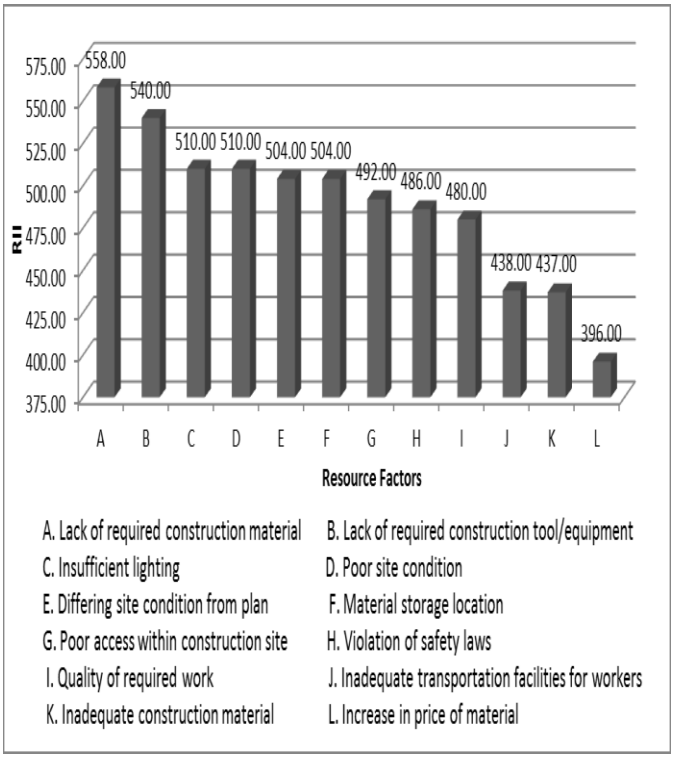

Chart -3: Resource Factors

3.4.5 Miscellaneous Factors Affecting Labor Productivity

A shortage of water and/or power supply was ranked 1st in the miscellaneous group, with an RII of 1st 552.00, and 2nd among all 40 factors that affect labor productivity (Table 8). Accidents during construction were ranked second in the miscellaneous group, with an RII of 546.00, and third among all 40 factors that affect labor productivity (Table 8).

Weather conditions were ranked third in the miscellaneous group, with an RII of 510.00, and seventh among the 40 factors that affect labor productivity (Table 8). A majority of the construction-related activities are performed in an open atmosphere and can be seriously affected by unexpected, extreme weather. Past studies prove that temperature and humidity have an adverse effect on productivity. Performing the construction task under extreme weather conditions (below -10o F and above 110o F) is generally difficult.

Working overtime was ranked fourth in the miscellaneous group, with an RII of 504.00, and tenth among the 40 factors that affect labor productivity (Table 8). Working overtime can be a negative factor causing various problems such as increase in absenteeism and reduced in safety. Number of hours worked beyond 40 hours per week is termed as overtime. It is generally introduced to achieve acceleration of the assigned task. It is generally used to make up for delays in projects. The extra work under overtime is usually paid time and half of the regular wages.

The project objective not being well defined ranked 5th in the miscellaneous group, with an RII of 442.75, and 25th among the 40 factors that affect labor productivity (Table 8). Poor planning, inadequate estimates, lack of training, lack of productivity standards, and poor project management are the factors involved with the project objective not being well defined.

Table -7: Miscellaneous factors

Factors	RII	Rank
Shortage of water and/or power supply	552.00	1
Accidents during construction	546.00	2
Weather conditions	510.00	3
Working overtime	504.00	4
Project objective is not well defined	442.75	5

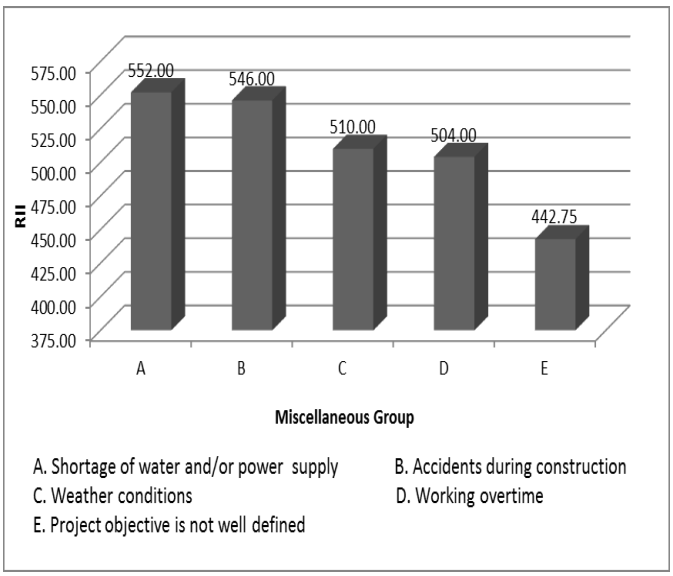

Chart -4: Miscellaneous Factors

3.4.6 Overall Factors Affecting Labor Productivity According to RII Value

The result in Table 8 and Chart 5 shows overall ranking of 40 factors that negatively affect labor productivity, identified in this study.

Table -8: Overall Ranking of Factors Affecting Labor Productivity

Factors	RII	Rank
Lack of required construction material	558.00	1
Shortage of power and/or water supply	552.00	2
Accidents during construction	546.00	3
Lack of required construction tools/equipment	540.00	4
Poor site condition	510.00	5
Insufficient lighting	510.00	6
Weather condition	510.00	7
Differing site conditions from plan	504.00	8
Material storage location	504.00	9
Working overtime	504.00	10
Poor access within construction site	492.00	11
Lack of experience	488.75	12
Supervision delays	488.75	13
Variations in the drawings	488.75	14
Violation of safety laws	486.00	15
Incomplete drawings	483.00	16
Quality of required work	480.00	17
Absenteeism	477.25	18
Rework	471.50	19
Design changes	465.75	20
Change orders from the designer	465.75	21
Inspection delays from the authorities	448.50	22
Payment delays	442.75	23
Change orders from the owner	442.75	24
Project objective not well defined	442.75	25
Inadequate transportation facilities for workers	438.00	26
Complex design in the provided drawings	437.00	27
Inadequate construction material	437.00	28
Misunderstanding among owner, contractor, and designer	431.25	29
Alcoholism	425.50	30
Misunderstanding among laborers	419.75	31
Implementation of government laws	419.75	32
Training sessions	414.00	33
Age	408.25	34
Disputes with designer	396.75	35
Increase in material price	396.00	36
Disputes with the owner	391.00	37
Lack of competition among laborers	379.50	38
Disloyalty	373.75	39
Personal problems	368.00	40

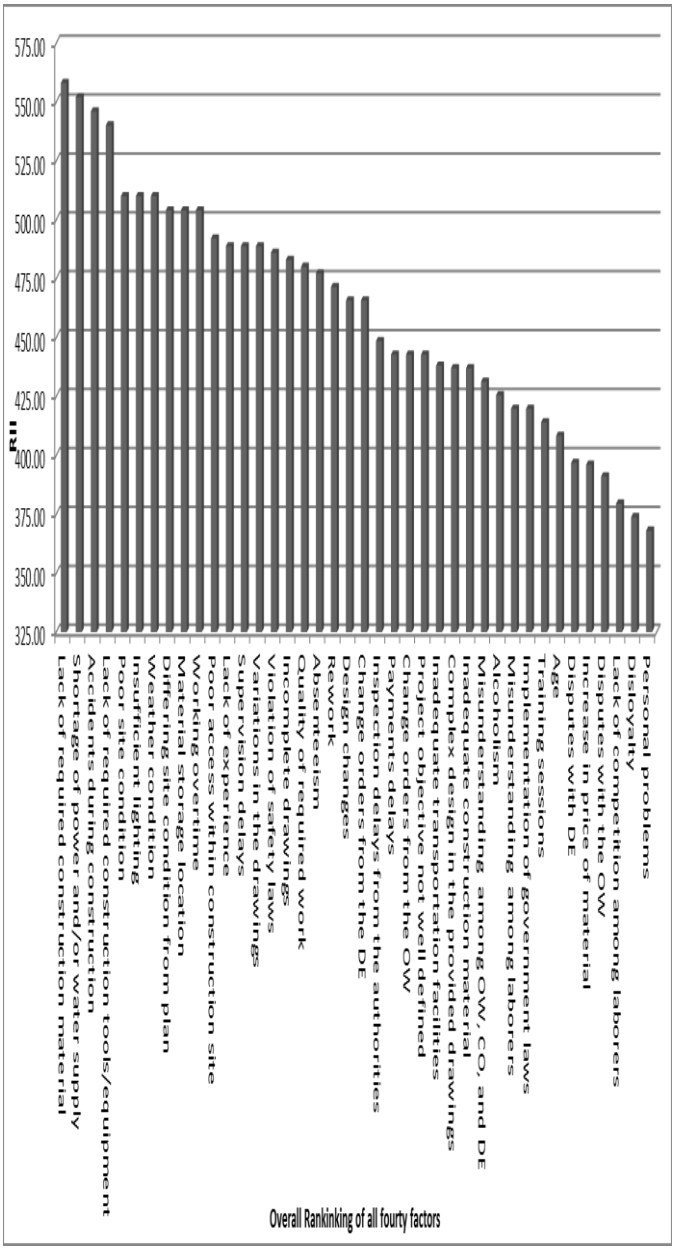

Chart -5: Overall ranking of factors

3.4.7 Group of Factors Affecting Labor Productivity

Group ranking according to the respective factors affecting labor productivity is shown in Table 9 and Chart 6. It was calculated by taking into consideration the average RII value for all the factors that affect labor productivity in construction. Miscellaneous factors was the top group, with an average RII of 510.95, and the manpower group was at the bottom, with average RII value of 417.59.

Table -9: Group Factors

Factors	RII	Rank
Miscellaneous	510.95	1
Resources	487.91	2
External	455.98	3
Communication	425.50	4
Manpower	417.59	5

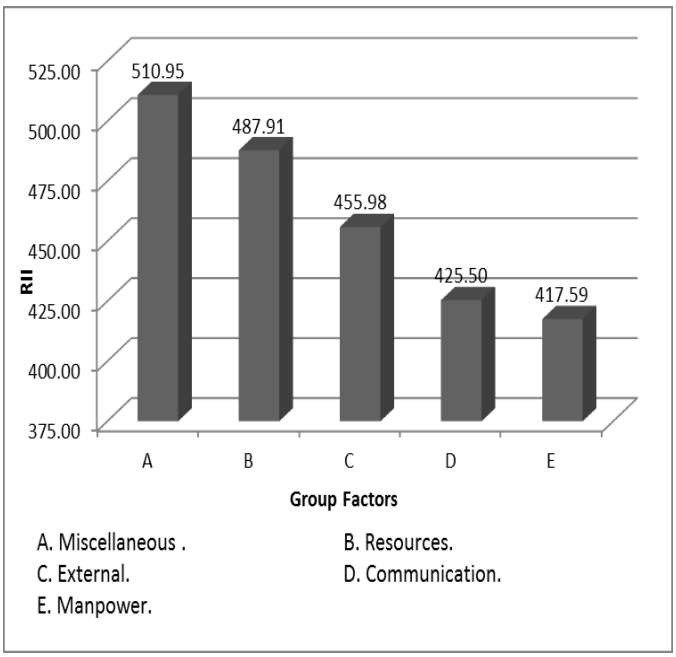

Chart -6: Group factors

3.5 FREQUENCY TABLE

3.5.1 Sanitation and hygiene of the construction site and the temporary –shed

Table -10: Sanitation and hygiene of the construction site and the temporary –shed

Description		Frequency	Percentage	Valid percent	Cumulative percent
Valid	Disagree	1	1.3	1.3	1.3
	Neither agree not	10	13	13	14.3

	disagree				
	Agree	28	36.4	36.4	50.6
	Strongly agree	38	49.4	49.4	100
	Total	77	100	100	

The inference made from response of construction employees and owners 1.3 % are average critical factors affecting the performance of construction project are due to Sanitation and hygiene Of the construction site and the temporary shed, 36.4 % of the respondent says agree ,49.4% of the respondent says strongly agree .

3.5.2 Labor injuries on site

Table -10: Labor injuries on site

Description		Frequency	Percentage	Valid percent	Cumulative percent
Valid	Neither agree not disagree	15	19.5	19.5	19.5
	Agree	27	35.1	35.1	54.5
	Strongly agree	35	45.5	45.5	100
	Total	77	100	100	

The inference made from response of construction employees and owners 19.5 % are average critical factors affecting the performance of construction project are due to Labor injuries on site, 35.1 % of the respondent says agree ,45.5% of the respondent says strongly agree .

3.5.3 Alcoholism and similar problems among workforce

Table -11: Alcoholism and similar problems among workforce

Description		Frequency	Percentage	Valid percent	Cumulative percent
	Disagree	6	7.8	7.8	7.8
	Neither agree not	13	16.9	16.9	24.7
Valid	disagree				
	Agree	20	26	26	50.6
	Strongly agree	38	49.4	49.4	100
	Total	77	100	100	

The inference made from response of construction employees and owners 7.8 % are average critical factors affecting the performance of construction project are due to Alcoholism and similar problems among workforce, 26 % of the respondent says agree ,49.4% of the respondent says strongly agree.

3.5.4 Working overtime

Table -11: Working overtime

Description		Frequency	Percentage	Valid percent	Cumulative percent
Valid	Strongly disagree	1	1.3	1.3	1.3
	Disagree	6	7.8	7.8	9.1
	Neither agree not disagree	11	14.3	14.3	23.4
	Agree	21	27.3	27.3	50.6
	Strongly agree	38	49.4	49.4	100
	Total	77	100	100	

The inference made from response of construction employees and owners 1.3 % are average critical factors affecting the performance of construction project are due to Working overtime, 27.3 % of the respondent says agree ,49.4% of the respondent says strongly agree.

3.5.5 Shortage of construction material

Table -12: Shortage of construction material

Description		Frequency	Percentage	Valid percent	Cumulative percent
Valid	Disagree	2	2.6	2.6	2.6
	Neither agree not disagree	13	16.9	16.9	19.5
	Agree	39	50.6	50.6	70.1
	Strongly agree	23	29.9	29.9	100
	Total	77	100	100	

The inference made from response of construction employees and owners 2.6 % are average critical factors affecting the performance of construction project are due to Shortage of construction materials, 50.6 % of the respondent says agree ,29.9% of the respondent says strongly agree.

3.5.6 Payment delays

Table -13: Payment delays

Description		Frequency	Percentage	Valid percent	Cumulative percent
Valid	Strongly disagree	2	2.6	2.6	2.6
	Disagree	7	9.1	9.1	11.7
	Neither agree not disagree	19	24.7	24.7	36.4
	Agree	11	14.3	14.3	50.6
	Strongly agree	38	49.4	49.4	100
	Total	77	100	100	

The inference made from response of construction employees and owners 2.6 % are average critical factors affecting the performance of construction project are due to Payment delays,14.3 % of the respondent says agree ,49.4 % of the respondent says strongly agree.

3.5.7 Change orders from designers

Table -14: Change orders from designers

Description		Frequency	Percentage	Valid percent	Cumulative percent
Valid	Disagree	7	9.1	9.1	9.1
	Neither agree not disagree	22	28.6	28.6	37.7
	Agree	25	32.5	32.5	70.1
	Strongly agree	23	29.9	29.9	100
	Total	77	100	100	

The inference made from response of construction employees and owners 9.1 % are average critical factors affecting the performance of construction project are due to Change orders from the designers, 32.5 % of the respondent says agree ,29.9 % of the respondent says strongly agree.

3.5.8 Improper equipment

Table -15: Improper equipment

Description		Frequency	Percentage	Valid percent	Cumulative percent
Valid	Strongly disagree	1	1.3	1.3	1.3
	Disagree	7	9.1	9.1	10.4
	Neither agree not disagree	19	24.7	24.7	35.1
	Agree	29	37.7	37.7	72.7
	Strongly agree	20	26	26	100
	Total	77	100	100	

The inference made from response of construction employees and owners 1.3 % are average critical factors affecting the performance of construction project are due to Improper equipment, 37.7 % of the respondent says agree, 26.0 % of the respondent says strongly agree.

3.5.9 Poor quality of construction materials

Table -16: Poor quality of construction materials

Description		Frequency	Percentage	Valid percent	Cumulative percent
Valid	Strongly disagree	2	2.6	2.6	2.6
	Disagree	8	10.4	10.4	13
	Neither agree not disagree	17	22.1	22.1	35.1
	Agree	25	32.5	32.5	67.5
	Strongly agree	25	32.5	32.5	100
	Total	77	100	100	

The inference made from response of construction employees and owners 2.6 % are average critical factors affecting the performance of construction project are due to Implementation of government laws, 32.5 % of the respondent says agree ,32.5 % of the respondent says strongly agree.

3.5.10 Misunderstanding among laborers

Table -16: Misunderstanding among laborers

Description		Frequency	Percentage	Valid percent	Cumulative percent
Valid	Disagree	7	9.1	9.1	9.1
	Neither agree not disagree	22	28.6	28.6	37.7
	Agree	26	33.8	33.8	71.4
	Strongly agree	22	28.6	28.6	100
	Total	77	100	100	

The inference made from response of construction employees and owners 9.1 % are average critical factors affecting the performance of construction project are due to Implementation of government laws, 33.8 % of the respondent says agree ,28.6 % of the respondent says strongly agree.

4.1 CONCLUSIONS

The theoretical model of this study proposed fifteen independent groups affecting the variation of Labor Productivity in the construction projects namely Labor 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 labor productivity in building construction. This study investigates all possible factors through a structured questionnaire administered all over Madurai. 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. 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 labor productivity are given Sanitation and hygiene Of the construction site and the temporary shed; Labor 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 labor productivity from this research.

4.2 RECOMMENDATION

Firstly, the Motivation factor has the highest impact on Labor Productivity variation. The low labor satisfaction could have negative impact on labor productivity. So, the construction company should increase labor satisfaction by paying a reasonable salary, developing financial reward or recognition program and improving the living condition on site.

This study focused on constraints to construction on-site productivity; however, there are several aspects to construction productivity. Future studies should explore other influencing factors affecting construction productivity at all stages of the procurement process such as Properly training to the laborers; Advance site layout; Systematic flow of work; On time payment to the workers; Motivation to workers towards project completion; Pre plan to avoid work stop; Properly, clearly & in time supervision; Maintain work discipline; Facilities to the laborers; Advance equipment and material planning; Maximum use of machinery and automation system; Properly and in advance material procurement and management; Clearance of legal documents before starting of work; Systematic planning of funds in advance.

- Use of scheduling techniques

It is necessary to use project scheduling techniques such as computer-aided construction project management in each project to optimize the times of related activities and make sure that works allow continuous task performance so as to reduce the idleness of the labor force to a minimum.

- Use of motivation system

It is important for each contracting companies to adopt motivational or personnel management measures to boost workers' morale. For example, tie compensation to performance; ensure that pay, fringe benefits, safety, and working conditions are all at least adequate; and enlarge the jobs to include challenge, variety, wholeness, and self-regulation.

- Productivity study

Contracting companies have to conduct productivity study at the activity/operation level such as studying factors affecting labor productivity and labor productivity measurement in order to find out problem areas and propose ways to improve labor productivity. Also contracting companies are encouraged to keep historical data of productivity study in finished projects to improve the effectiveness and accuracy of cost estimation of future projects.

- Project procurement system

There is a need to change the traditional system of project procurement to design build system. This new procurement system will enable contractors to participate in design process which minimize change orders during project execution.

- Improving contract condition

It is necessary to improve the contract condition towards adopting more use of management practices. Contract should include statements about time planning and productivity management to be implemented in a regular base through projects life cycle.

- Training in productivity improvement programs

It is necessary to conduct training courses and seminars in the topics that will improve productivity in construction projects. The training effort should be tailored to improve the abilities to use the project scheduling techniques such as Microsoft project and Primavera. Also the training effort should be tailored to improve the methods of studying productivity and ways of productivity improvement in construction sites.

- Trade's schools

There is a need to increase the number of trade's schools which focus on teaching construction trades such as block work, formwork, painting, plastering, plumbing etc to improve the abilities and skills of craftsmen working in construction projects.

- Transferring of technology

More efforts should be spent by contracting companies to get the use of what other developed countries had

achieved through transferring of technology and best use of benchmarking.

4.3 Recommendations for the Clients

- Appropriate funding levels should always be determined at the planning stage of the project so that regular payment should be paid to contractors for work done.
- Clients should not interfere frequently during the execution and keep making major changes to the requirements. This can cause inordinate delays in the project.
- The selected contractor must have sufficient experience, technical capability, financial capability, and sufficient manpower to execute the project.
- Communication and Co-ordination should be proper with the other parties.

4.4 Recommendations for the Consultants

- All working drawings must be clearly drawn indicating all the dimensions and scale so as to avoid ambiguity during construction.
- Avoid the redesign of the project once submitted.
- Accurate site investigation should be done in order to avoid errors in design.
- Establish control system to control and evaluate variation in orders initiated by owner.
- Consultants should prepare and approve drawings on time.

4.5 Recommendations for the Contractors

- Contractors should not take up the job in which they do not have sufficient expertise.
- Development of good system for site management and proper supervision develops project planning and scheduling.
- Initially calculate optimistic duration to execute the project.
- In order to improve contractors' managerial skills there is need for continuous work training programs to update their knowledge and be familiar with project management techniques and processes.
- Contractors should appoint experienced and reputed subcontractors.
- Contractors must plan their work properly and provide the entire schedule to the clients
- Proper work as per specification to avoid rework due to error.
- Contractors must make sure they have a sound financial backing.

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