

Improving Construction Efficiency And Productivity Of Industry Using SPSS

T.Subramani¹, S.R.Rajiv²

¹Professor & Dean, Department of Civil Engineering, VMKV Engg. College, Vinayaka Missions University, Salem, Tamil Nadu, India

²PG Student of Construction Engineering and Management, Department of Civil Engineering, VMKV Engg. College, Vinayaka Missions University, Salem, Tamil Nadu, India

ABSTRACT

The most challenging issue in Construction industry is to improving the production efficiency. India is a growing economy. It is estimated to be the third largest economy by 2050. Infrastructure growth is a stepping stone of a stable and productive society, it presents unique challenges but also brings opportunities for private and public sectors in the field of construction. Development will lead to massive construction and there will be a positive growth in industries related to construction. Reports also suggest that the upward trend has been witnessed by these sectors. This study reports the results of a questionnaire survey of project managers, site engineers, supervisors and craftsmen, in India, to identify the factors influencing construction labour productivity.

The top five factors identified as having a significant impact on productivity:

- (1) Timely availability of materials at the worksite,*
- (2) delayed material delivery by the supplier,*
- (3) Strikes called by political parties*
- (4) Frequent revisions of drawings/design, resulting in additional work/rework and*
- (5) Timely availability of drawings at the worksite.*

The findings provide a better understanding of the factors influencing productivity in the Indian context and will aid construction practitioners in making effective plans for productivity improvement by using management software SPSS.

Keywords: Construction, Efficiency, Productivity, Industry, SPSS

1.INTRODUCTION

1.1 Objectives

The objective of this study is to explore the use of simulation in quantifying work change impacts. It also analyzes and quantifies a case study in depth. The lessons learned from the case study showcase the procedure and potential of the methodology. The output of the project is valuable for practitioners who wish to employ simulation in quantifying impacts due to work changes.

1.2 Purposes

The overall purpose of this study is to explore and define the opportunities for using simulation in quantifying impacts of work changes. Quantifying and communicating such impacts are inevitable tasks in construction project management. State-of-art techniques should be introduced to the construction industry to improve those existing. This study offers specific benefits that simulation can bring in quantifying impacts due to changes.

1.3 What Is Disruption

Disruption is loss of productivity, disturbance, hindrance or interruption to a Contractor's normal working methods, resulting in lower efficiency. In the construction context, disrupted work is work that is carried out less efficiently than it would have been, had it not been for the cause of the disruption. If caused by the Employer, it may give rise to a right to compensation either under the contract or as a breach of contract. Construction contracts have two major types of costs associated with them: fixed and variable.

Fixed costs are those costs that the contractor procures on a fixed-price subcontract or purchase order. Fixed costs are inherently lower in risk, because the contractor has fixed them through a contract. Risks do exist, such as the financial failure or default of either a vendor or subcontractor or the installation of defective or faulty work by a subcontractor or vendor, but the risks are much less than the risks in variable-cost items.

Variable costs are items such as the contractor's labour, equipment, and site overhead. Extensive literature has been published about delay claims, which principally are claims related to the extended duration of the job and the resulting extended site overhead costs. However, the major variable risk component on a construction project is labour, not extended site overhead. Equipment, on certain types of construction such as utility, heavy, and highway construction, can be a significant cost; however, equipment costs tend to be proportional to labour costs. It is uncommon to have significant increases in equipment costs without significant increases in labour costs. On many construction projects, the largest single area of cost overrun is in labour costs. This is not surprising given that labour is frequently the largest variable cost for a contractor. Claims involving lost productivity are frequently referred to as disruption claims.

1.4 Demands And Infrastructure Development

Infrastructure is the main priority of Indian Government currently. The development of infrastructure today is the main tool to achieving GDP growth targets. The sector needs huge finances and massive funding. But there is usually a major variation in the commission's target and funds that are actually deployed. Nearly all of the infrastructure sectors present excellent opportunities for construction, with roads and highways, ports and airports, railways and power standing out as bright spots, with huge sums of investment planned. India's economy is big and getting bigger. Liberal and supportive Government policies coupled with deliberate strategies to promote infrastructure spells great opportunities for engineering and construction (E&C) companies in India. Along with construction, allied industries like cement, steel etc also will notice a rise in demand. Construction sector is likely to boom in the 12th five year plan.

1.5 Present Scenario In Indian Construction

The sector is currently surrounded by issues such as delays in getting approvals, lack of new awards being made, lack of alternatives to fund new projects, all would lead to slow-down in the execution According to the Planning Commission, GDP growth is held back by 1.5-2% each year owing to the bottlenecks in infra expansion. After recording a spectacular growth of over 12%, more than the country's GDP in the past half-decade, the Indian construction sector all of a sudden lost stream in last fiscal largely due to global financial turmoil.

1.6 Road Sectors

Roads would still be the most endearing asset from the perspective of private sector investment in the years to come, as only 2.1m kms (50%) has been upgraded till now. The immediate opportunity on plate is around 9000kms which will throw open investment opportunities of nearly US\$20bn. Very recently the governments of India have geared up to meet the target of building 20 km of highways a day. We are currently doing around 12 km a day. By next year, we will have work in progress on over 25, 000 km of highways. NHAI has completed 99.99 per cent of India's much-awaited infrastructure project - the Golden Quadrilateral (GQ) highway network- connecting Delhi, Mumbai, Kolkata and Chennai. A recent study has stated 18,637 km of expressways need be built by the end of the 13th Five-Year Plan period, i.e. 2022. Infrastructure development (for expressway projects alone), on such a massive scale would require about Rs US\$ 77.54 billion

1.7 Airport Sectors

The key focus here was on lack of a common governing act or an agreement on pricing. India is the 9th largest Aviation market in the world at present and is expected to be in the top five by 2020. The overall projected investment opportunity is pegged at US\$150bn and the target is to handle about 280m pax by 2020. Following has been proposed. Two new international Airports at Bhubaneswar and Imphal. 50 new low cost small airports will be taken up by Airports Authority of India. 8 Greenfield Airports are to be awarded this year in PPP mode: Navi Mumbai, Juhu (Mumbai), Goa, Kannur, Pune (Rajguru Nagar Chakan), Sriperumbudur, Bellary and Raigarh. Airport operations and maintenance through PPP contracts will be introduced in AAI airports. Airports being considered are Chennai, Kolkata, Lucknow, Guwahati, Jaipur and Ahmedabad.

2.METHODOLOGY

Methodology adopted in this study shown in Figure.1



Figure.1 Methodology

3.ABOUT SOFTWARE

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. The original SPSS manual has been described as one of "sociology's most influential books" for allowing ordinary researchers to do their own statistical analysis.^[4] 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.

Statistics included in the base software:

- Descriptive statistics: Cross tabulation, Frequencies, Descriptive, Explore, Descriptive Ratio Statistics
- Bivariate 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), Discriminate.

The many features of SPSS Statistics are accessible via pull-down menus or can be programmed with a proprietary 4GL command syntax language. Command syntax programming has the benefits of reproducibility, simplifying repetitive tasks, and handling complex data manipulations and analyses. Additionally, some complex applications can only be programmed in syntax and are not accessible through the menu structure. The pull-down menu interface also generates command syntax: this can be displayed in the output, although the default settings have to be changed to make the syntax visible to the user. They can also be pasted into a syntax file using the "paste" button present in each menu. Programs can be run interactively or unattended, using the supplied Production Job Facility.

Additionally a "macro" language can be used to write command language subroutines. A Python programmability extension can access the information in the data dictionary and data and dynamically build command syntax programs. The Python programmability extension, introduced in SPSS 14, replaced the less functional SAX Basic "scripts" for most purposes, although Sax Basic remains available. In addition, the Python extension allows SPSS to run any of the statistics in the free software package R. From version 14 onwards, SPSS can be driven externally by a Python or a VB.NET program using supplied "plug-ins". (From Version 20 onwards, these two scripting facilities, as well as many scripts, are included on the installation media and are normally installed by default.)

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.

3.1 Data Collection And Analysis

General various data's have been collected for designing the questionnaire. A translated questionnaire in Tamil language has been prepared, for the labors for convenient purpose.

3.1.1 Questionnaire Design

The design of questionnaire was done based on the analysis made in various literatures reviews. The design of questionnaire was done based on the factors to be considered irrespective to labours.

Table.1 Statistical Data of Questionnaires Sent and Received

Details of Questionnaires	No.	Percentage of Total (%)
Total Questionnaires Sent	75	100
Total Questionnaires Received	64	85
Invalid Data	3	2.25
Used for Study	61	81.2

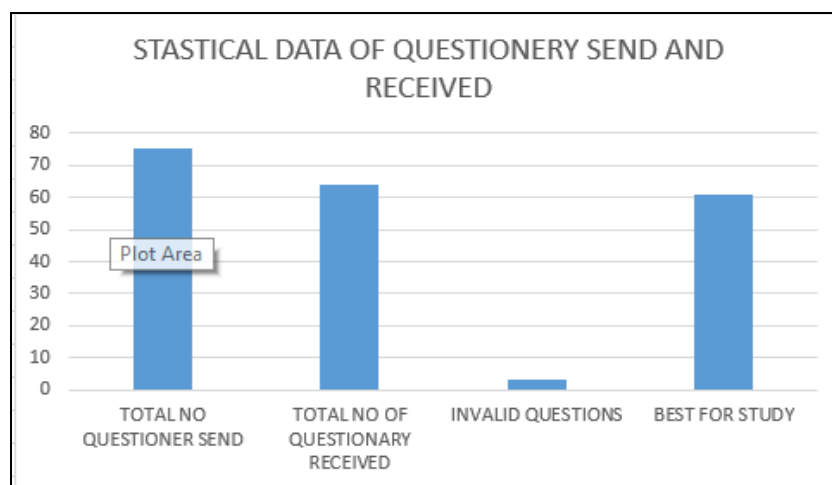


Figure. 2 Statistical Data of Questionnaires Sent and Received

3.1.2 Questionnaire Survey

The prepared Questionnaire on human resource management in Construction industry is distributed to 75 labors and their response have been extracted Responses from all three levels (large scale, medium scale and small scale) of companies are equally distributed. The answered questionnaires were collected and the answers were ranked in order to obtain statistical data from the theoretical options. Ranking should be based on scale type. As five point scale was adopted, rank 1 represents the strongly disagree factor and rank 5 represents the strongly agree. In our case neutral point is suggested as rank 3. The neutral point represents neither positive nor negative condition, the frequency of respondents, that is, for every factor respondent's view may vary. The variation in views can be obtained through the answers from questionnaire survey.(Table1. And Figure.2)

3.2 Data Analysis Using SPSS

SPSS Statistics is a software package used for statistical analysis. Long produced by SPSS Inc., it was acquired by IBM in 2009. The current versions (2015) are officially named IBM SPSS Statistics. Companion products in the same family are used for survey authoring and deployment (IBM SPSS Data Collection), data mining (IBM SPSS Modeler), text analytics, and collaboration and deployment (batch and automated scoring services).The software name

originally stood for Statistical Package for the Social Sciences (SPSS), reflecting the original market, although the software is now popular in other fields as well, including the health sciences and marketing.

3.2.1 Size of Organization (Employees)

The average number of employees in an organization was 30. Only building construction projects were considered for the study.

3.2.2 Number of Projects per Year

The average number of construction projects undertaken per year was 2.3. Only building construction projects were considered for the study.

3.2.3 Type of Construction Projects

The type of construction organizations that responded is shown in Table.3 and Figure.3. Only building construction project were considered.

Table. 3 Types of Organizations that Responded

Construction Organizations	Respondents
Residential	31
Commercial	5
Industrial	11
Government	6
Architecture	8

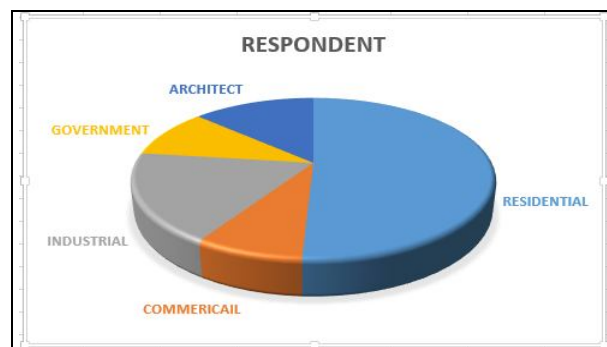


Figure.3 Types of Organizations that Responded

3.2.4 Typical Size of Projects

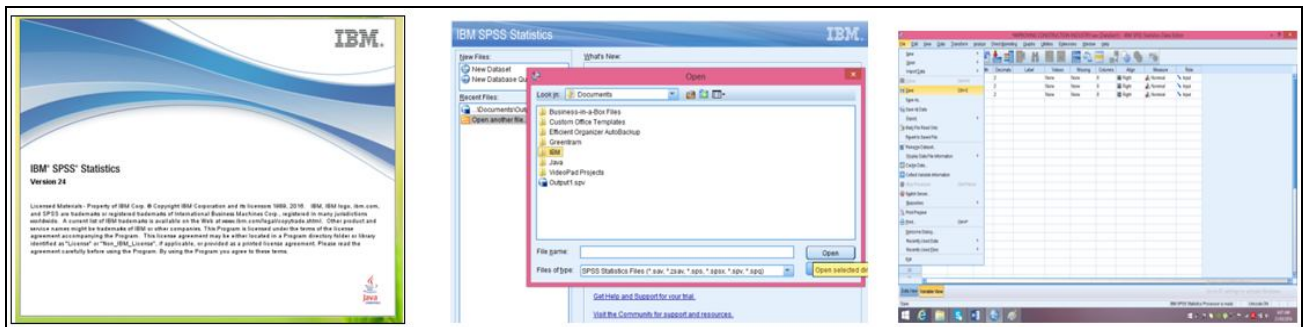


Figure. 3 SPSS Index Page

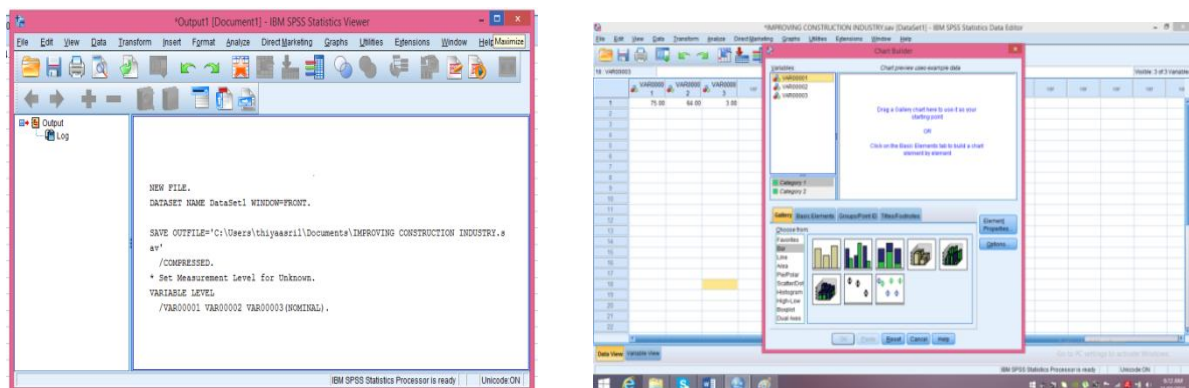


Figure. 4 SPSS Working Windows

Only building construction projects were considered for the study. 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. The size of the projects in Indian rupees undertaken by the respondents' companies is studied. Only building construction projects were considered for the study. 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. Figure.3 and Figure.4 shows the SPSS Index Page and SPSS Working Windows.

4. WORK CHANGES IN THE CONSTRUCTION INDUSTRY

4.1 Work Changes

The dynamic and complex nature of construction projects requires contractual tools to accommodate the need for dynamic changes to the project. The changes may be due to design omissions, unforeseen events or preference. A simple definition of work changes is alterations to the original scope of work given in the contract documents. In this sense, changes involve alterations to the sequence of work, to the design, to the quantity of work, to the specifications, or changed conditions of the project. Work changes are inevitable in the construction industry. Changes are important in terms of their functions and their impacts on construction projects. On the one hand, they are useful to accommodate any unforeseen circumstances, omissions in designs, or changed conditions. For example, a design omission may be observed on site and corrected. Changes give flexibility to both owner and contractor to meet their goals. On the other hand, they have various negative impacts on performance and, as a consequence, on the success of the project. Changes have direct impacts on the cost and schedule of the project (Cost and Schedule Task 1990). They can increase project cost and extend project duration. In addition, work changes are the primary cause of construction disputes and claims. Increased costs and extended project duration cause the involved parties to argue over who is responsible for the problem. However, this process is not straightforward and generally causes disputes and claims.

4.2 Why And How Do Work Changes Occur?

Construction projects are never performed as they were planned. This is a result of the construction industry and is not extraordinary when one considers the ingredients . of a construction project. These ingredients include various participants and agents, physical conditions, a contract and resources. The participants are owner, contractor, and third parties. Resources include labor, equipment, capital and time. Mostly these ingredients bear uncertainties from the beginning of the project until the end. It is not always possible to foresee design omissions until construction, or to predict whether the owner will change his mind regarding a work item. No one can guarantee physical conditions such as those in the subsurface. The quantities in the contract are just estimates and they can increase or decrease. Estimates just form a baseline regarding the quantities. Resources, being scarce, require a fine-tuned scheduling. However, there will always be problems or delays for either third party or owner-furnished equipment or materials. The uncertainties can be listed further. Contract packages limit these uncertainties to an extent by establishing a baseline and setting forth the rules to manage the uncertainties in case they arise. Contractors rely on the contractual documents as a baseline and plan their operations and resource flows, and establish their schedule and budget. Nevertheless, these uncertainties will cause changes and as-planned operations will not take place as they were planned

4.3 Impacts On Project

Changes in any planned activity will cause a disturbance and will require the rearrangement or review of the existing plan under the recent developments. Given the complex, multi-party and multi-resource nature of the construction industry, it is not difficult to perceive the impacts of changes on projects. Impacts of a change are defined as the **net** effects of the change on the project performance. Numerous studies have been done to identify the impacts of changes, relationships between change and its impacts, and true consequences of changes in terms of cost and time (Cost/Schedule Controls Task Force 1990; Hester et al.1991; Thomas and Napolitan1994; Project Change Management Team 1995; Ibbs and Allen 1995).

4.3.1 Direct Impacts

Direct impacts are impacts of changes that appear in immediate activities of the changed work. These impacts can be easily linked to the change in most cases. Nevertheless, closer analysis and supervision of the impacted activities are required to identify these impacts. Moreover, the true consequences such as quantification of the impacts solely due to changes are not easy and require additional data keeping and analysis.

Productivity degradation: Production will be lowered due to interruptions. The

magnitude of the impact is a function of the required degree of concentration for the changed work, type of the required resources, total number of interruptions, elapsed time since the last interruption, expectation of interruption, source of the interruption and, finally, whether workers agree with the change.

- Delays: Additional and different types of material may be required. This may take some time.
- Equipment and labor in tearing out completed work: Removal of the completed work may require additional equipment and labor.
- Materials wasted in rework: Changes may necessitate removing some contractor furnished material. This may result in waste of materials.
- Nonproductive periods during redirection of work: Reorganization of the crew may take some periods of nonproductive times.
- Recovery scheduling: Overtime and multiple shifts may be required to meet deadlines in the project. Each of these items will be a burden to the project in terms of additional cost and time. Further, these impacts will also cause secondary impacts on the other activities.

4.3.2 Indirect Impacts

Indirect impacts known as consequential or ripple effects, are those resulting from the direct impacts and are experienced by the other activities either concurrently or later in the project. The identification and proof of these type of impacts are more difficult since this time a logical link to the impact of the change should be established. However, they are equally important and should be included in an analysis.

- Productivity degradation in succeeding sequential activities: There is a tendency that the lowered productivity will adversely affect the succeeding activity.
- Productivity degradation of adjacent concurrent activity: Interruption in one activity will have impacts on the adjacent activities. The affected crews will reflect their idleness to the surrounding work area.
- Increased overhead costs: First, additional supervision will be needed. Also, a delay in completion time will increase overhead costs.
- Extended project time: A critical activity may be affected and the project duration may be extended. In case the owner fails to recognize the extension, constructive acceleration will occur. The contractor should claim the incurred costs.
- Crash scheduling cost: In order to meet project completion time, schedule compression may be required. This necessitates overtime and multiple shifts, which are not so efficient.
- Changes to Subcontracts: Any change will be reflected in the work performed by subcontractors. When this happens, they will request price and schedule adjustment.
- Time-value of capital employed: Changes may require purchasing some additional material. This money would be used somewhere else or earn interest.
- Change of work to a different working period: Sometimes, delays caused by changes may push the working time to another working period. This working period may not be convenient in terms of weather conditions and cause disturbance e.g., a concrete pour that moves into the winter.

4.3.3 Disputes Due To Changes

The other important impact of changes is their potential to cause disputes among the parties involved, and sometimes these may result in litigation. As explained in the previous section, changes do have serious impacts on the project performance. It is not easy to prove changes and impacts, and to relate them to the responsible party. This is the origin of most disputes. The potential of changes to cause dispute can be seen from the list given in Table 3-4. This table is arranged based on responses to a survey of state transportation agencies and contractors.

5. QUANTIFY TIME IMPACTS IN CONSTRUCTION

5.1 Time Impacts

Time impact is one of the major consequences of work changes as covered in the previous chapter. In claims, time impacts are often called delays. Delays are extensions of time for a project or an activity due to an unexpected event (Bramble and Callahan 1987). These delays may be in the form of a late start or late finish either for a project or for an activity. For example, a change in owner-specified material may cause delay in procurement of that material, and this may well change start and finish times of all related activities. These types of delay are common in the construction industry. All these individual delays cause major consequences in the projects. Time is essential in construction contracts. That is, contractors and owners agree and commit on time-based performances. As such, delays are important to the parties involved. The effects of delays also increase this importance. Bramble and Callahan (1987) list the effects of delays as follows:

- Prevention of possible early completion,
- Acceleration,
- Loss of production and efficiency,
- Rescheduling and resequencing,
- Claims,
- Increased time-related costs, and
- Abandonment and termination of contract.
- All of these effects threaten the success of a project. Therefore, comprehensive

analyses of delays are required to mitigate and quantify impacts. These analyses involve contractual and quantitative investigation. Our discussion will focus on quantification methods.

5.2 Quantify Delay Impacts

Schedule analyses are successfully applied both to recognize delays and to quantify the net impacts of delays on a project. Bar Charts and Critical Path Methods are the basic tools that are used in the analyses.

5.2.1 Bar Charts

Bar charts are time-scaled drawn charts to show duration, start and finish times of project activities. Bar charts are one of the first tools in work scheduling. Bar charts are visually effective in communicating a schedule. However, this effectiveness diminishes, as projects become complex. This might not have been a problem in the past, but today bar charts can only be used to depict the summarized schedule of a project or a fragment from a schedule.

5.2.1.1 Limitations Of Bar Chart

Bar charts have serious limitations. A detailed list of bar charts disadvantages:

1. Size limits a bar chart in what it can graphically present
2. Bar charts do not show the interrelationships or interdependencies of one bar to another
3. Bar charts do not show available float or contingency time, nor can they show the delay impact of one bar on another
4. Bar charts are not capable of accurately distributing or controlling manpower and project costs.

5.3 CRITICAL PATH METHOD

The Critical Path Method (CPM) is originally a planning, scheduling and controlling tool in project management. CPM defined as "A graphic representation of the planned sequence of activities that shows the interrelationships and interdependencies of the elements composing a project." Despite the fact that CPM was intended as a planning tool, later another feature of CPM was exposed: it can be well applied to prove delay claims. This results primarily from CPM's capability to depict the picture of the project and changes. Now it is possible "[t]o deal with previously illusive question of concurrent.

6.FACTORS AFFECTING LABOUR PRODUCTIVITY

Labour productivity is a function of various controllable and uncontrollable factors. Listed these factors under six groups comprising:

- (1) Schedule acceleration;
- (2) Change in work;
- (3) Management characteristics;
- (4) Project characteristics;
- (5) Labour and morale; and
- (6) Project location/external conditions.

6.1 Project Change

Whilst a number of the factors impacting on labour productivity on a project are readily identifiable, the consequences of change are often underestimated and therefore specifically referenced here. Change is normally defined as any event that results in a modification of the original scope, execution time, cost, and/or quality of work⁸. There are generally five types of changes, namely:

- Change in scope;
- Differing site conditions;
- Delays;
- Suspensions; and
- Acceleration.

The costs of performing changed work consist of both:

- (1) Those costs directly related to the accomplishment of the changed work; and
- (2) Those costs arising from the interaction between the changed work and unchanged work⁹. Notwithstanding that most forms of contract recognise and provide for the valuation of work relative to the circumstances under which it is being executed, this second aspect is often significantly underestimated or undervalued by both Contractors or Employers and their Representatives

6.2 Disruptions And Cumulative Impacts

In Coastal Dry Dock & Repair Corp., disruption is noted as the “cost effect upon, or the increased cost of performing, the unchanged work due to a change in contract”¹⁶. In some studies¹⁷, disruptions are defined as the occurrence of events that are acknowledged to negatively impact on labour productivity. More broadly, the AACE; Recommended Practice standard¹⁸ defines “disruptions as an action or event which hinders a party from proceeding with the work or some portion of the work as planned or as scheduled.” As noted previously, disruptions can be caused by change. These changes can reduce labour productivity and extend the project duration¹⁹. Disruptions caused by change can be both foreseeable and unforeseeable. The foreseeable or local disruptions can occur at the same time and either the same place or within the same resource as the changed work, whereas unforeseeable or cumulative disruptions can also occur at a time or place.

The words “cumulative disruption” and “cumulative impact” can be used interchangeably. Cumulative impact has been described as being “...the unforeseeable disruption of productivity resulting from the ‘synergistic’ effect of an undifferentiated group of changes. Cumulative impact is referred to as the ‘ripple effect’ of changes on unchanged work that causes a decrease in productivity and is not analysed in terms of spatial or temporal relationships”. Jones argued that when the Board states that cumulative impact cannot be analysed in terms of spatial or temporal relationships, it means that cumulative impact costs cannot be secured within individual contract changes. Pricing of the direct impact due to local disruptions and cumulative impacts due to cumulative disruptions is different. The direct impact costs are prepared on a forward pricing basis. The cumulative impact costs, on the other hand, are more often priced on a backward pricing basis as a contractor cannot foresee or readily quantify the impact.

6.3 Methods Of Quantifying Lost Productivity

The construction industry has developed and employed a number of methodologies for estimating lost labour productivity. Based on the appropriate data input, these methods can be classified into three major groups; namely:

- (1) Project practice based;
- (2) Industry based; and
- (3) Cost based methods.

6.4 Baseline Productivity Analysis

This approach was proposed in order to avoid some of the limitations and impractical assumptions of a current measured mile analysis. Similar to the measured mile method, baseline analysis relies on the contractor’s actual performance of the project being analyzed. A central point of this analysis is to establish the baseline productivity. It represents the best and most consistent productivity the contractor was able to achieve on the project. Analyzing a project database revealed that the baseline productivity mainly depends on the complexity of the design and the work methods used

6.5 Earned Value Analysis

Productivity measurement is sometimes difficult when there is insufficient information concerning the physical units of work installed on the project. In these situations, a simplistic form of the earned value analysis method can be utilised to calculate estimated labour hours. The contractor’s estimate or alternatively the monetary value of payment applications, contract amounts or unit prices can be used to determine labour hours, when they were expended and, possibly, on what activities. Physical units of work completed multiplied by budget unit rates can be used to determine earned hours. The earned hours are then compared to the actual hours expended for the period of the impact and the difference between the two may be used to calculate the productivity loss experienced. Earned value measurement of contemporaneous project documentation, such as percentages complete from schedule updates or payment applications can assist with calculating labour productivity. Additionally, the claimant may calculate the actual revenue per hour of labour versus the planned revenue per hour, as an alternative. Earned value analysis may also be utilized to calculate estimated labour hours.

6.6 Basic Tools To Quantify Productivity Related Impacts

Tools are required to quantify productivity impacts. Once an impact is quantified, then it is a matter of picking the right strategy, several of which are discussed above, to prove the damages. Despite the fact that courts recognize productivity loss damages, any unreasonable method employed to quantify damages will prevent recovery.

6.7 Common Shortcomings Of The Existing Tools

The tools employed to quantify productivity-related impacts are not as effective as the tools for time impact analysis. Further, CPM is not so effective in the case of productivity-related impacts because it is not capable of addressing the productivity related issues. This is expected since its methodology is intended for scheduling. As for the currently used tools, their limitations are too serious to be promising in this area: They are not visually effective. This prevents depicting cause-effect relation. The capability to display the relationship between cause and effect is essential in terms of credibility and is also important for convincing the other parties. Further, these tools lack capability to segregate impacts. This is crucial in that it may be necessary to determine each single disruption and relate them to the responsible party. Finally, they do not offer any computational capability, limiting experimentation flexibility. This is important to exercise different scenarios.

7. IMPROVEMENT IN CONSTRUCTION DEVELOPMENT

To achieve higher productivity it is essential that the organization leadership develop and maintain a culture of high productivity in how projects are planned and executed. For construction safety it has been proven that it is essential that company and project leadership be committed to eliminating accidents and achieving a zero-accident environment. In a clearly defined safety culture reinforced with effective proven Best Practices, training, planning and clear accountability many companies have significantly reduced accidents on their projects. The same is true for improving construction labor productivity. When leadership is committed to improving productivity and reinforce that with implement Best Practices for planning and implementing projects then it is possible to achieve improvement.

- The culture which results in improved labor productivity would include:
- Commitment of company resources to
- Implementing Best Practices for quality front-end engineering
- Effective planning of all phases
- Lessons learned and continuous improvement across projects
- Supply Chain management and materials management
- Right tools and equipment
- Effective collaborative team building and communications

To make it possible for all workers on your projects, simply clean up the project and keep it clean. Contractors need to provide adequate facilities for disposing of trash efficiently and to provide appropriate general project cleaning. Another important element is to have clear expectations of workers and enforce the rules. Orderliness includes keeping an appropriate level of materials on-site and keeping them organized and located conveniently. Tools and equipment should also be stored properly and located near the work sites. Workers should be expected to place trash and debris in proper receptacles, keep scrap lumber orderly and free of nails, keeping their work areas clean and return tools and unused materials to the appropriate places. Storage and work areas that will be muddy should be improved using fill, gravel, plywood or planks. Stairs and emergency exits should be kept open at all times. Clean and orderly projects will also promote good safety practices and reduce the risk of accidents and injuries. To improve productivity, you need to know how you are doing so you can confirm that you are improving. Most contractor cost reporting systems report the quantity completed and how much has been spent. These reports are very sufficient for tracking individual cost accounts. Knowing how many cubic yards of concrete have been poured and the labor \$'s spent on that account is useful for identifying issues and taking corrective action. The only problem with quantity reporting is that it is difficult to summarize the results from many cost accounts and look at parts of the project or trends over many accounts.

7.1 Construction Industry Development Council

Construction industry Development Council (CIDC) is the apex body of Construction Industry of India and is promoted jointly by the Planning Commission, Govt. of India and the Construction Industry of India. The paper describes, in brief, the political, social and legal framework. The paper details the economic overview, administrative and regulatory features, enhancement and development of Indian Construction Industry and the globalization of construction services with a perspective of WTO and GATS.

7.1.1 Political, Social & Legal Framework

• Secular Constitution. • Stable Democratic environment since 1947. • Broad consensus on Economic policy across party lines. • Independent multi-tier judicial system. • Judicial systems in sync with international practices. • Preferred language of domestic business & international interactions is English.

7.1.2 Economic Overview

India's economy encompasses traditional village farming, modern agriculture, handicrafts, a wide range of modern industries and a multitude of support services & industries. Production, trade, and investment reforms have provided new opportunities for Indian businesspersons. India has an estimated 350 million middle class consumers. Construction Projects are subject to a host of Central and State laws simultaneously. Administratively and in terms of regulation, Central & State Governments have their own roles to play in Construction.

7.1.3 Structure And Role Of Construction Administration

Structure and Role of Construction Administration of Central Government & Structure and Role of Construction Administration of Local Government. There is focused central machinery or structure of administration for the Construction Industry. As this sector's activities are involved with every sector of the economy, at the Central Government level, the issues related to Construction are taken up by the Planning Commission. In fact Construction was given the Identity of an Industry only two years ago. Housing & Real Estate, constituting around 10.3% of total Construction, is the only one segment of the Construction Industry which has a Ministry called the "Ministry of Urban Affairs". Equivalent Ministries exist at State level and at Municipal/local levels. Activity at any site is governed by the State or a combination of State and Central administration, depending on the location.

8. CONCLUSION

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 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 75 questionnaires were distributed, and 64 questionnaires (85% 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. Work changes are unavoidable in the construction industry. On the one hand, they introduce flexibility and increase the quality of the final product. On the other hand, work changes have serious impacts. They may increase costs and cause delays. The challenge is to be able to understand the true effects of changes and to be able to control the impact of these changes before they escalate to major problems. Delays are one of the major consequences of work changes. Scheduling techniques are well developed for the analysis of delays and are recognized CPM as an effective tool for time impact analysis. This past experience with CPM pinpoints certain capabilities that other tools should possess for quantifying impacts. These can be listed as follows:

1. Capability to communicate cause-effect relationships visually,
2. Capability to segregate impacts,
3. Capability to incorporate factual data,
4. Capability to exercise different scenarios, and
5. Capability to compute in an effective and structured manner.

Disruptions are also one of the major consequences of work changes and the primary source for productivity-related impacts. Certain methodologies and tools are available for quantifying productivity related impacts. However, currently employed tools fail to support some of the above listed capabilities.

REFERENCES

- [1]. T.Subramani, V.Jayaraman , " Analysis Of Construction Workers Migrate From Industries" , International Journal of Application or Innovation in Engineering & Management (IJAEM) , Volume 4, Issue 5, pp. 274-283 , 2015
- [2]. T.Subramani, M.Sekar , " Preplanning And Scheduling Of Road Construction By Using PPM" , International Journal of Application or Innovation in Engineering & Management (IJAEM) , Volume 4, Issue 5, pp. 234-244 , 2015
- [3]. T.Subramani, K.Chinnadurai , " Construction Management And Scheduling Of Residential Building Using Primavera" International Journal of Application or Innovation in Engineering & Management (IJAEM) , Volume 4, Issue 5, pp. 188-198 , 2015
- [4]. T.Subramani., P.S.Sruthi.,M.Kavitha. , "Causes Of Cost Overrun In Construction", IOSR Journal of Engineering, Volume. 4, Issue. 6 (Version 3), pp 1 - 7, 2014.
- [5]. T.Subramani., A.Sarkunam., J.Jayalakshmi "Planning And Scheduling Of High Rise Building Using Primavera" , International Journal of Engineering Research and Applications, Volume. 4, Issue. 6 (Version 5), pp 134 - 144, 2014.
- [6]. T.Subramani., P.T.Lishitha, M.Kavitha, "Time Overrun And Cost Effectiveness In The Construction Industry", International Journal of Engineering Research and Applications, Volume. 4, Issue. 6 (Version 5), pp 111- 116, 2014.
- [7]. T.Subramani., R.Lordsonmillar., "Safety Management Analysis In Construction Industry", International Journal of Engineering Research and Applications, Volume. 4, Issue. 6 (Version 5), pp 117- 120, 2014.

AUTHORS



Prof. Dr.T.Subramani Working as a Professor and Dean of Civil Engineering in VMKV Engg. College, Vinayaka Missions University, Salem, Tamil Nadu, India. Having more than 25 years of Teaching experience in Various Engineering Colleges. He is a Chartered Civil Engineer and Approved Valuer for many banks. Chairman and Member in Board of Studies of Civil Engineering branch. Question paper setter and Valuer for UG and PG Courses of Civil Engineering in number of Universities. Life Fellow in Institution of Engineers (India) and Institution of Valuers. Life member in number of Technical Societies and Educational bodies.

Guided more than 400 students in UG projects and 220 students in PG projects. He is a reviewer for number of International Journals and published 136 International Journal Publications and presented more than 30 papers in International Conferences.



Er. S.R.Rajiv, Completed his Bachelor of Engineering in the branch of Civil Engineering in VTU. He is working as an Assistant professor in Moodlakatte Institute of Technology, Kundapura, Karnataka and Associate member of Institution of Engineers, Kolkata. Currently he is doing M.E (CEM) in VMKV Engineering College of Vinayaka Missions University, Salem, Tamil Nadu, India.