

# Study and Analysis for Labour Productivity Factor for Construction Activities in Commercial Projects: A Survey

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**ABSTRACT:** The construction industry has an essential part in the developed and developing countries. Construction industry is totally dependent on labour, so increasing labour productivity by using scientific methods is the need of today's highly growing world. Productivity is usually well-defined as the ratio of outputs to inputs. Labour productivity is one of the greatest significant factors that affect the physical growth of every construction plan. To achieve their jobs efficiently, construction labours must be aware with their duties and with the resources, tools, and machinery they use. Inefficient administration of construction labours can outcome in low production. Therefore, it is significant for contractors and construction chiefs to be aware with the methods leading to evaluation of efficiency of the construction labours in different crafts. To accomplish the revenue estimated from any construction project in general, it is significant to have a good controlling hand on the productivity factors that subsidize in the combined production composition, like labour, equipment, cash-flow, etc. This paper presents the study of parameters to develop the labour efficiency.

**KEYWORDS:** Cost, productivity, labour, construction

## I. INTRODUCTION

Every project has its individual beauty of finance and to grow up or to preserve the commercial aspects of the projects it very essential to concentrate performance of resources involved in the project. Productivity can be defined in many ways. In construction, productivity usually means labour productivity i.e. units of work positioned or manufactured per man-hour. The inverse of labour productivity, man-hours per unit (unit rate), is also usually used a.k.a. "Cost per Unit (CPU)". Productivity is usually well-defined as the ratio of outputs to inputs. Construction projects are typically labour based with basic hand tools and equipment and labour costs comprise 30 % to 50 % of whole project cost. Productivity in finances refers to measures of output from production procedures, per unit of input. Productivity might be considered of as a measure of the technical or engineering productivity of production. There are many factors that influence the productivity in construction industry. Labour productivity is one of the greatest significant aspects that disturb the physical growth of any construction project. To accomplish their jobs efficiently, construction labours must be aware with their duties and by the materials, tools, and machinery they usage. Inefficient managing of construction labours can outcome in low output. Therefore, it is significant for contractors and construction executives to be aware with the methods leading to evaluation of output of the construction labors in different crafts. To accomplish the revenue expected from every construction project in general, it is significant to have a good controlling hand on the productivity factors that contribute in the integrated production arrangement, like labour, equipment, cash-flow, etc. The construction industry has an significant role in the developed and developing countries. In the India, construction industry is growing very strongly and has gained many significant achievements.

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The extension of construction activities has produced a lot of jobs for skilled, semi-skilled, and unskilled labour, but beside with this, India's labour productivity remains low against other Southeast Asian countries. A prosperous construction project is one that achieves the intended objectives in relations of cost, time, quality and safety. This is possible only when the planned stages of productivity can be attained. However, productivity, or absence of it, is maybe one of the main problems confronting the construction industry, the construction firm and the construction project. Looking at the significance of the construction industry, the environment of construction projects and the available economic resources, more emphasis should be given to improving productivity. Productivity enables an organization to be modest, accomplish set goals, meet stakeholder value propositions and preserve strategic and economic health. At the industry level, productivity allows the sector to maintain satisfied clientele, attract investment, remain viable and contribute to the economic growth and good fortune of the nation.

Understanding critical aspects affecting the variation of labour productivity is very important to develop the efficiency of construction project in relations of reducing total cost and time, and it could increase the competitive advantages of the construction company and also make the company visible globally. The problem analysis is presented in second section. The productivity in construction is introduced in section three. The aspects affecting labour productivity fluctuation in the construction is presented in forth section. The evolution of shuttering activity is presented in fifth section. The sixth section gives data collection and analysis. Finally seventh section concludes the paper.

## II. LITERATURE REVIEW

A new study by Abdulaziz M. Jarkas in Global Construction perspective and Oxford Economics has predicted India will stand as the world's 3rd largest construction market by 2025. The country will have to gear up to add 11.5 million homes a year to become a US\$ 1 Trillion a year market by then. A significant number of international real estate companies have entered India as they see good investment opportunities emerging. More significantly, the Indian government has allowed 100% FDI in realty projects through the instinctive route. Accounting for 11% of India's GDP the construction industry employments over 32 million individuals and the urgent need for country's infrastructure development is contributing to rise in demand for construction workers. But the industry's problem today is not availability of manpower, but the availability of quality labour.

Despite the prospects witnessed, the construction sector is mired in problems. It undergoes from capability constraints, absence of finance, mechanization, trained manpower at the workers' level and performance at managerial levels are way below international standards. The recruitment of construction workers is through a long chain of middlemen (contractors and subcontractors) or roadside recruitment (street corners/Nakas), where workers wait each morning to be picked by contractors and many of these small and medium level contractors have no capacity to upgrade. More than often, workers in the construction sector, the second biggest after agriculture, are generally pickled as second-class citizens with no means to protect their dignity. Construction alone accounts for nearly 65% of the over-all investment in infrastructure [2].

The sections in the Construction commerce cover, residential, public, commercial and industrial buildings, highways, bridges, tunnels, Roads, sewers, etc. Besides the general, lower construction skills, other specialized skill sets such as carpentry, plumbing, electrical work and painting are very much essential for the industry. As per G. Carmona and J. L. Molina Over 94% of India's labour strength that includes construction workers is employed in the unorganized sector, exposed to exploitation, job and wage insecurity with no legal protection. To further enhance to their woes, there is no appropriate addressing of quality, skills, education, and employability for higher wages, safety, environment and social aspects of these workers.

In addition, the long term market instability and uncertainty has negatively impacted the opportunities and prevented expansion, training and development facilities. Utmost of them are not registered with the Labour Commission and therefore do not have any legal entitlement, with no provisions like social security and remunerations in terms of labour

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welfare, pension and insurance schemes, financial aids or loans for children education and medical needs or even misfortune and death claims[4].

Construction requires extensive manual labour. Human performance and productivity are reliant on one another. Therefore, the most frequently used measure of productivity is the constant measurement of construction work done per work hour. A study by Hendrickson (1998) talked the time consumption of the average construction worker. Only 40 % of a workers time is considered to be productive, with 55 % unproductive time, and 5 % personal time.

## III. PROBLEM ANALYSIS

Previous studies have been aimed to develop effective methods to increase productivity in construction industry. With the demand for labour and growth in labour rates, there is a essential to have looked into entire construction activity and its impression on the final project cost. It is necessary to advance the effectiveness of the production by means of raising the labour efficiency of the construction industry for the contribution to the progress of life, the progress of the national economy and the improvement of the global competitiveness. This paper defines the significance of labour efficiency.

With the demand for labour and rise in labour rates, there is a requirement to have looked into entire construction activity and its impression on the final project cost. The progressive economy has taken benefit in relations of mechanizing the construction operation by adding more content of prefab works, precast sections, introducing modular design concepts and adopting industries method of construction. In order to endure in such an industry, decision makers and project managers need to be able to ensure that their projects are being completed as productively as possible. In order for this to take place a new tool requirements to be developed to ensure maximum productivity from the beginning to the end of each project. The main objective of this research work is study of parameters to develop the labor efficiency and to design an action plan to increase production for construction activity.

## IV. PRODUCTIVITY IN CONSTRUCTION

Improved productivity in the construction industry can be viewed from two perspectives, the consumer and the contractor. From the consumer's perception, improved productivity lowers costs, reduces construction schedules, offers more value for the money, and achieves better returns on investments. From the contractor's perception, improved productivity leads to a more satisfied customer, while also providing a competitive advantage, and in return leading to faster turnover and increased profits. The definition for productivity with regards to construction is the measurement of the output of construction goods and services per unit of labour as explained below:

Labour Productivity = Output/ Labour Cost or ---- (1)

Labour Productivity = Output/Work Hours ---- (2)

In case the input is a combination of various factors, productivity is termed as

Total Factor Productivity is measured as

Total Factor Productivity = Total Output/ Labour + Material + Equipment + Energy + Capital ---- (3)

Various agencies may modify the definition of productivity as per their requirements by deleting some factors and or adding other factors.

Thomas [6] stated "Because disruptions adversely affect labor productivity, the best productivity occurs when there are few or no disruptions. This best productivity is called the baseline productivity." The baseline productivity is calculated by applying the following steps to the daily productivity values:

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- Determine the number of workdays that comprise 10% of the over-all workdays.
- Round this number to the next utmost odd number; this number should not be less than 5. This number, n, defines the size of (number of days in) the baseline subset..
- The contents of the baseline subset are the n workdays that have the highest daily production or output.
- For these days, note the daily productivity.
- The baseline productivity is the median of the daily productivity values in the baseline subset.’’

## V. FACTORS AFFECTING LABOR PRODUCTIVITY

Productivity is the outcome of several interrelated factors. Discussed below are various factors affecting labor productivity and are reviewed from past studies.

**Time:** During construction projects, there are many tasks which causes a loss of productivity. Past study shows productivity decreases with working overtime. The most regularly stated reasons are fatigue; improved absenteeism; reduced morale; reduced supervision effectiveness; poor workmanship, resultant in higher rework; increased accidents Working overtime initially outcome in increased output, but ongoing overtime may lead to bigger costs and reduced productivity (Hinze, 1999). Time used by a construction laborer on useful activities averages about 30% of the over-all time available. An employee in the field only works efficiently for 3.5 hours of his 8-hour shift and spends 20% of his time on direct value-adding doings

**Schedule Compression:** When there are early delays in a project, compressions of the whole time frame for a later activity are repeatedly the way to reimburse disruptions and to complete the allocated task on schedule.

From a professional scheduling perspective, schedule compression may be promising without accelerating separate work doings by using float in the project’s overall schedule. However, on many projects, schedules are not fully resource loaded. As significance, a correctly updated schedule reflecting the intervals may show the project finishing on time without limitation separable activities.

Schedule compression may result to strength extra labors for the anticipated task by the contractor because of shortening the whole duration, allowing the contractor to complete the total remaining work. Schedule compression, when linked with ultimately, often outcomes in major productivity losses due to shortages of material tools or equipment to support the extra labor’s, resulting in difficult for planning and coordinating the task, and unavailability of experienced labors (National Electrical Contractors Association, 1983).

**Type of Project:** To accomplish substantial productivity, each member of a crew requires adequate space to perform task without being affected with/by the other crew members. When more labors are allocated to achieve particular task, in a fixed quantity of space, it is possible that interfering may occur, thus declining productivity. Additionally, when multiple trades are allocated to work in the identical area, the probability of interference rises and production may be reduced.

Interference amongst the numerous crews and laborers is due to mismanagement on construction sites. For example, a steel-fixture crew has to wait before fixing the reinforcement rods if the carpenter’s framework is incomplete. The kinds of doings and construction methods also impact labor productivity

**Safety:** Accidents have high impacts on labor productivity.

Various accident types occur at the site, such as an accident triggering death and resulting in a total work stoppage for a sum of days. An accident that causes an wounded person to be hospitalized outcomes in a work reduction of the crew for which the injured employee worked. Minor accidents resulting from nails and steel wires can halt work and, thus,

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reduction productivity. Even insufficient lighting shows reduced productivity because sufficient lighting is essential to work efficiently and because insufficient lighting has negative effects.

Quality: Inefficiency of equipment and poor quality of the raw material are factors which cause low productivity. The productivity rate of incompetent equipment is low.

Old equipment is subject to a great number of failures, and it takes a long time for the laborers to complete the work, thus reducing productivity. Poor-quality material used for work is the added feature because poor materials usually lead to unsatisfactory work and can be rejected by supervisors, thus reducing the productivity.

Managerial Factors: Managers' skill and attitudes have a vital manner on productivity.

In many organizations, productivity is low even though the latest technology and trained manpower are made available. Low productivity is because of ineffectual and indifferent management. Experienced and committed managers can obtain surprising results from regular people. Employees' job enactment rest on their ability and readiness to work. Management is the compound to make both.

Advanced technology needs knowledgeable laborers who, in turn, work productively under skillfully qualified executives. It is only concluded sound management that optimal consumption of human and technical resources can be secured.

Manpower Group: Literature appearances that absence of labor experience is the issue which negatively affects labor productivity and demonstrates that, to attain good productivity, labor plays a significant role. Contractors should have adequately expert laborers employed to be productive. If expert labor is unavailable and a contractor is essential to complete precise task with less-skilled labor, it is possible that productivity will be affected. The lack of any crew member may influence the crew's production rate because workers will, typically, be incapable to achieve the same production rate with fewer resources and with different crew members.

Misunderstanding among laborers generates disagreements about responsibilities and the work bounds of every laborer, which leads to a lot of work errors and decreases labor productivity.

Motivation: Motivation is one of the important factors affecting construction labor productivity. Motivation can best be accomplished when labors personal desires are related to those of the company. Factors such as payment intervals, a absence of a financial motivation system, non-provision of proper transportation, and a lack of training sessions are gathered in this topic (DeCenzo and Holoviak, 1990)

Supervision: Generally, projects come across certain design, drawings and description variations during construction. If drawings or disclaimers are with faults and uncertain productivity is expected to reduction since laborers in the field are uncertain about what requirements to be done. As a result, task may be delayed, or have to be completely stopped and postpone it until clear instruction. There is a 30% loss of productivity when work modifications are being achieved (Thomas et al., 1999). Work review by the superintendent is an crucial process to proceed. For example, the contractor cannot cast concrete before an examination of the formwork and steel work, thus disturbing labor productivity (Zakeri et al., 1996). With non-completion of the essential work according to the disclaimers and drawings, administrators may ask for the revise of a precise task. Managers' absenteeism stops the work wholly for deeds that need their presence, such as casting concrete and backfilling, more delaying review of the completed work which, in turn, leads to delays in starting new work.

Material/Tools: Material management is one of the most significant aspects in construction industry. Productivity can be affected if required materials, tools, or construction equipment for the specific are not accessible at the correct location and time. Selection of the appropriate type and size of construction equipment often touches the prerequisite amount of time it is, therefore, crucial for site managers to be aware with the features of the major types of equipment most frequently used in construction. In order to rise job-site productivity, it is useful to select equipment with the

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correct characteristics and a size most suitable for the work conditions at a construction site. Laborers need a minimum number of tools and equipment to work efficiently to complete the assigned task.

Project Management Factors: Improper scheduling of work, shortage of dangerous construction equipment or labor, may result in forfeiture of productivity.

Improper planning of project-initiation measures normally lead to lost labor productivity. Moreover, poor site layout can donate to a damage of productivity. Laborers have to walk or drive a long way to lunch rooms, rest areas, washrooms, entering, and exits, disturbing overall productivity.

Natural Factors: Various natural factors disturbing labor productivity together from previous study are weather conditions of the job-site and geographical conditions.

Others aspects such as fuel, water, and minerals also affect productivity to certain extent. Productivity is found to be highly affected if weather recorded are too be extreme (too cold, heavy rainfall, too hot).

External Factors: Weather conditions are significant factor to consider for completion of any construction project. Adverse winter weather, such as winds and rains, reduces productivity, particularly for external work such as formwork, T-shape work, concrete casting, external plastering, external painting, and external tiling. Adverse weather sometimes stops the work totally.

- Manpower Factors Affecting Labor Productivity:
  - Lack of experience
  - Absenteeism
  - Alcoholism
  - Misunderstanding among labor
  - Age
  - Lack of competition among the labour
  - Disloyalty
  
- External Factors Affecting Labor Productivity
  - Supervision delays
  - Variations in the drawings
  - Incomplete drawings
  - Rework
  - Design changes
  - Inspection delays from the authorities
  - Payment delays
  - Complex designs in the provided drawings
  
- Communication Factors Affecting Labour Productivity:
  - Change orders from the designers (DE)
  - Change orders from the owners (OW)
  - Disputes with the DE
  - Disputes with the OW
  
- Resource Factors Affecting Labor Productivity:
  - Lack of required construction material
  - Lack of required construction tools/equipment
  - Insufficient lighting
  - Poor site condition
  - Differing site condition from plan



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- Material storage location
- Poor access within construction site
- Violation of safety laws
- Quality of required work
- Inadequate transportation facilities for workers
- Inadequate construction material
- Increase in the price of material

## VI. SHUTTERING (FORMWORK)

After studying the above stated factors labor productivity approach is apply on construction site for increasing production to avoid delay and cost. The over-all cost of concrete construction work contains the cost of formwork also. In this study a detail of shuttering work is presented.

Construction of formwork includes substantial expenditure in terms of cost of material, cost of labour for fabrication, creation and removal of formwork and time element. In order to successfully carry out its task, formwork must achieve a balance of following requirements:

- Containment: formwork must be accomplished of shaping and supportive the fluid concrete until it cures.
- Strength: formwork must be proficient of safely withstanding lacking distortion or danger the dead weight of the fluid concrete is placed on it, labour weight, equipment weight and any ecological loadings. Leak at that point. Leaks cause honeycombing of the surface.
- Accuracy: formwork must be precisely set out so that the resultant concrete product is in a right place and is of precise shape and dimensions.
- Resistance to leakage: all joints in form work must be either close fitting or enclosed with form tape to create them grout tight. If grout leak happens the concrete Will
- Ease of handling: form panels and items should be designed so that their all-out size does not surpass that which can be simply controlled by hand or mechanical means. In addition all formwork must also be designed and built to include amenities for adjustments, leveling, easing and striking without damage to the form work or concrete.
- Finish and reuse potential: the form face material must be selected to be proficient of constantly imparting the wanted concrete finish (smooth, textured, featured or exposed aggregate etc.) At the similar time it should also achieve the required number of reuse.
- Access for concrete: any formwork arrangement must be deliver access for engaging of the concrete.

The extent of this establishment will be reliant on the ease of carrying out the concrete tasks.

- Economy: all the formwork is very expensive. On normal about 35% of the total cost of any completed concrete unit or component can be attributed to its formwork; of this just over 40% can be engaged for material for formwork and 60% for labour.

The formwork designer must therefore not only consider the supreme number of times that any form can be reused, but also produce a project that will minimize the time occupied for erection and striking.

## VII. DATE COLLECTION AND ANALYSIS

In this research work data is collected from construction site for shuttering work. Data is collected in the standard format in the form of bar chart. Scheduling is done for the period of two years. After monitoring the shuttering activity, it is observed that initially there is delay in the work from scheduled time. For avoiding this delay by using labor productivity theory standard time required is calculated, action plan is designed and applied on site. Figure 2 shows the analysis of shuttering (formwork) for project, in which the column shows achieved target, planned target, and construction standard productivity. To achieve continuous improvement following action plan is followed-

- a. Work methodology statement discussion with team before starting of the activity.

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- b. Planning of tools required for the job and its advance procurement before starting of activity.
- c. Activity planning and study of its criticality after receiving of drawings.
- d. Manpower calculation as per productivity norms stated in Gilbert's theory.
- e. Material rotation planning for effective utilization of available resource.
- f. Use of tower cranes and lifting machineries for handling of machineries.
- g. Providing proper work front.
- h. Subletting job on task work basis.
- i. Time motion analysis helps us for finding out loop holes in the system.
- j. Appreciation for good work and timely completion of given target.
- k. Job based hand skill training plays important role in productivity improvement.

After applying this plan, there is continuous improvement in shuttering work as shown in figure 2.

## VIII. CONCLUSION

After studying the parameters affecting the labor productivity it is conclude that labor productivity is very important aspect for successful completion of construction projects. Labour productivity affects the profitability of the project to a great extent, no project can ignore this issue and reach completion date successfully, and the parameters affecting labor productivity can be controlled by proper study and careful planning. Total project completion time is dependent on formwork scheme and its effective utilization and by doing analysis we can save project budget up to certain extent. Productivity analysis of reinforcement and concreting activity is the future work.

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