Surge Gears in Labour Productivity in Building Construction Activities

Abstract

The outturn in the Architecture Engineering and Construction (AEC) industry per artisan varies in nature, volume, location, and type of work executed. The productivity and cost-efficacy in structure projects depend upon the lean and smart set of labor, to finish structural projects in time and are limited to building estimates with the present ever-rising cost of labour hours and materials. The building industry relies on the productivity of laborers; therefore, the productivity of construction labor is important. Most areas of the construction industry have faced chronic problems like improper management, disapproving working conditions, and noncompliance with quality. Proper planning of cutting-edge strategies enhances the productivity of construction laborers. The AEC projects have protracted glitches like pitiable managerial strategies, lethargic work environments, meager risk, and quality control management. That invites an overrun in schedule time, cost, resources, and at last country's economy. Research topics on the productivity of construction labor are highly diversified, however, and there is a lack of systematic analysis of issues related to the productivity of construction labor. The present study includes the identification of factors affecting labour productivity in building construction projects then ranking those factors using analytical tools like RII and AHP as labour components in build activities consumes about 60- 70% of construction investment and finally their comparison. Research and implementation differences addressed and future strategies for research proposal made. The outcome of this research may deliver a forum to raise the value of the latest developments and productivity research patterns for both researchers and industrial practitioners.

Keywords: Analytical Hierarchy Process, Consistency Index, Construction sector, Labour productivity, Questionnaire, Variance,

1. Introduction

Productivity is the strategic basics of progress and efficacy of the project economy. A country's prospective can augment its living values and depends almost entirely on its ability to increase its output per worker, i.e. to surge productivity and services for a given number of working hours, Krugman P., (1997)[1]. Workforce efficiency is one of the greatest significance in any construction project for their physical growth. Productivity is the artifact of many factors: i.e. inspiration, ability, preparation, work environment, other resources, time management, and even chances, Dan Carver Spatial Science, (2019)[2]. Labor productivity stands for the work output per hour that surges the country's economic strength. It controls the amount of real GDP (gross domestic product) created per labor hour. Growth in labor productivity hinges on; saving and investment in physical, technology, innovativeness, and financial strength, Chappelow J. (2019) [3]. A prosperous construction project relies on cost, time, and quality although, these three principal performance assessment factors in the built sector, are the Iron Triangle, identified as a Project Management Triangle, Sibiya M., et al. (2015)[4]. Investment in an economy is equal to the savings level because it is necessary to finance investment from saving. Low savings can result in lower investment rates and lower labor productivity and real wage growth rates, Downes A. (1990) [5]. Knowing critical aspects influencing labor productivity variance is very important to develop construction project efficiency in relationships to reduce total cost and time. It could enhance the construction company's competitive advantages.

2. Objective and Goal of the Search

The objective and goal of the search are to investigate the numerous factors prompting labour productivity. The analysis of the lacuna behind the labour productivity, calculating the Relative Important of those factors, and ranking of the critical factors have been attempted by the Analytical

Hierarchy Process (AHC). Finally, recommendations are under proposal through appropriate measures that can be taken to improve labor productivity in construction sector activities.

3. Problem Definition

Upgrading labor efficiency keeps a key and incessant concern of those who are accountable for cost controller of constructed activities, Hendrickson C. (1998) [6]. Extending construction accomplishments has created a lot of jobs for skilled, semi-skilled, and unskilled labour in addition to that, India's labour productivity remains low compared to other Southeast Asian countries, Helble M. et al. (2019)[7]. During the significant failure of productivity, it depletes potentially profit margin, corporate's stalwart and living standards of the stakeholders and the investor, Kenton W. (2019) [8]. To accomplish their jobs efficiently, construction labours must be aware of their duties, the materials, tools, and machinery they use to perform their jobs hands down in tools and machinery usage, Kutscher R. (1994)[9].

4. Literature Review

The benchmarks of the labour efficiency is an imperative delineator in the project's performance, Manoliadis O. (2011) [10]. In addition to optimization of labour, material, and machinery stressed waste management and labour productive management, Koskela L. (1992) [11]. The optimized lean labour management enhances productivity, lowers waste management, and increases a smooth work atmosphere, Mishra S.P. (2020) [12]. The building industry relies on its workers because of the high labour oriented construction industry, by maximizing the skill of the workforce, it is possible to expand productivity, Ghate P. R. et al. (2016) [13]. A questionnaire survey, has shown that the main factors influencing labour output/unit production are planning, management, and other labour level issues such as motivation, greediness for benefits, and lack of internal communication between supervisors and staff, Nasiru Z. M. (2015)[14].

5. Research Methodology

This paper includes research procedures, research population, pilot survey, questionnaire design, data collection, analysis, and conclusion. It also describes the data collection and analysis approach

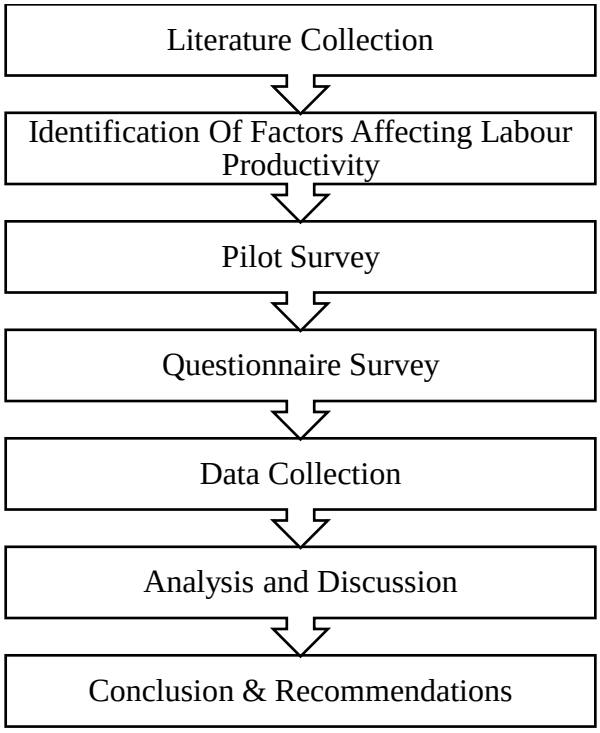

Figure.1 Methodology Adopted for the Study

2.1 Relative Importance Index (RII)

The data collected from the survey will be under analysis using the technique of the index of relative importance (RII). The RII is a statistical method in which the relative weight of each variable among total variables is determined more accurately. The higher the RII, the greater the productivity-influencing factor, Hatkar K B. (2016) [15].

RII estimates for each productivity sub-factor, using the succeeding equation (1).

$$RII = \sum(W) \Big/ (A * N) \quad \text{..... (I)}$$

Where W is the weight given to each factor and ranges from (i) to (v), and A is the highest weight ranging from 1, 2, 3….5. The weights 1, 2, 3, 4, and 5 for not important, somewhat important,

moderately important, very important, and extremely important respectively, N is the total number of responses collected.

2.2 Analytic Hierarchy Process (AHP)

Analytic Hierarchy Process (AHP) is one of the multi-criteria decision-making approaches considered original. It is particularly suitable for complex decisions involving the comparison of hard to calculate elements of the decision. AHP helps in the numerical form to quantify the weight of the assessed criteria, Song B. (2016) [16]. The AHP approach consists of three basic steps: first, the problem must be broken down and organized into a sub-problem hierarchy; second, the data collection and evaluation with pairwise comparisons of the attributes have been on execution; and finally, the priority weights of factors or items are determined in each stage. For assigning weight relative importance scale is used (Table. 1).

- The first step is to calculate the weight. Weight needs to be calculated by adding the factors and later, all the factors are independently divided by the total of all individual factors. Finally, the average of all factors is under consideration.

a) The 2nd step is to Calculation of The consistency index is calculated in the 2nd step, using the formula (ii),

$$CI = {}^{(\lambda_{max} - n)}\Big/_{(n-1)} \quad \ldots\ldots \text{(ii)}$$

Where 'λmax' = the maximum Eigenvalue and 'n' is the number of factors.

b) The 3rd step involves the calculation of "the consistency ratio" by using formula (iii).

$$CR = {}^{CI}/_{RI} \quad \ldots\ldots\ldots\ldots \text{(iii)}$$

- Where RI is the average random index.
- Accept the consistency ratio; when the consistency ratio is identical or < 0.1 or 10%, or otherwise, is inconsistent and so not acceptable. Then the matrix needs recalculation or reformation, Hossain M. F. et al. (2014)[17].

Table 1 Scales of the relative importance

Scale	Weightage on Importance	Description
1	Not important	Two elements compared possess equal importance
3	Moderately important	That element; is slightly more important than the other
4	Very important	Considered that element is more important than the other
5	Extremely important	An element is considerably more important than the other element
2	The mid-value of the above scale	The degree of importance is considered on the above scales

2.3 Pilot Study

This stage aimed to minimize the inevitable problems of turning the questionnaire design into reality. A small-scale survey was piloted to ensure the readability, accuracy, and comprehensiveness of the questionnaire to the participants. The present research shall enable us to ensure the validity of the questionnaire. In a pilot study conducted to validate the questionnaire, we sent the questionnaire to some professionals with more than 10 years of construction experience, and based on the reliability check of their answers, it represents that the responses have high reliability and it is interpreting that the scale is internal consistency (Table. 2).

Table 2 Questionnaire Reliability

Item/Questionnaire	26
The sum of the item variances	23.71882
The variance of the total score	110.6259
Cronbach's Alpha	0.817018>0.75(High reliability)

2.4 Questionnaire Design

The first-hand analysis of the data considered for this investigation was gathered through various literature reviews followed by the use by various authors on a questionnaire survey. The focused gris are contractors, subcontractors, material suppliers, and labours. The questionnaire set of different questions concentrates on the factors affecting the labour output and efficiency among various categories of the workforce. The comprising factors that influenced work output and overall productivity of the project. Respondents simply provided variables that would influence efficiency for a given typical situation. Questions were created according to get the profile of the respondents to gather materials called data like present job place, work knowledge, their current or previous work locations, and contact addresses. These questions circulated during the survey were analyzed. The productivity loss that concerned a variety of respondents of different profile, sections was of great importance to the exploration. A formal questionnaire survey was the main tool for collecting data from construction firms. This method of collecting data has proven extremely effective in delivering large amounts of data at a relatively low cost. The Likert scale is used to rank the importance of each factor. This ranges from 1 to 5 (ranges categorized as 1 as not important, 2 as somewhat important, 3 as moderately important, 4 as very important, and 5 as extremely important.

2.5 Data Collection

Data (information) gathering is the method in which facts/figures are collected from all accessible sources to catch answers to the projected research issues. The data collection methodologies compartmentalized into two groups: primary data gathering and secondary data assortment methods. The processes of a questionnaire filled out by workers and site management employees collected the information. A questionnaire was made up of various elements influencing labour productivity and conveyed to over 42 members out of which 142 surveys were conducted. Using two techniques, which are the Relative Importance Index and the Analytic Hierarchy Process

(AHP), we analyzed the data after getting it. Below are the factors used in the survey questionnaire (Table. 3).

2.5.1 Factors that affect productivity

Many factors in building construction activities affect labour productivity. About 26 factors were identified that mostly affect labour productivity for construction accomplishments. Labour efficiency and productivity are the zones of identification and evaluation that affect construction labour output. They have become long-term critical issues encountered by project managers in building construction projects to increase productivity in the construction sector.

Table 3 Responses in percentage-wise

Questions	Responses (No)	Not important (%)	Some what Important (%)	Moderately Important (%)	Very important (%)	Extremely Important (%)	Total
Q1. Availability of Expert Skilled labour	142	2.38	9.52	23.81	45.24	19.05	100
Q2. Availability of expert technical staff	142	0.00	4.76	11.90	64.29	19.05	100
Q3. Labour and supervision absenteeism	142	0.00	2.38	16.67	59.52	21.43	100
Q4. Staff & Management Coordination	142	0.00	0.00	2.38	38.10	59.52	100
Q5. Salary amount (level) of the labour	142	0.00	9.52	23.81	54.76	11.90	100
Q6. Ability to provide great care (incl. health insurance) to workers	142	0.00	4.76	19.05	40.48	35.71	100
Q7. Poor communication between foreign workers (different languages)	142	4.76	16.67	23.81	35.71	19.05	100
Q8. Employer pledge to labourers rights (vacation, air ticket, etc.)	142	4.76	19.05	19.05	33.33	23.81	100
Q9. Convenient worker's housing and acceptable living standards	142	0.00	11.90	23.81	47.62	16.67	100
Q10. Labour and staff loyalty to the company	142	0.00	2.38	14.29	52.38	30.95	100
Q11. Availability of motivation program	142	0.00	7.14	19.05	42.86	30.95	100
Q12. Labour age	142	2.38	7.14	35.71	26.19	28.57	100
Q13. Late arrival, early finish, and/ or unscheduled break for work	142	9.52	4.76	26.19	33.33	26.19	100
Q14. Labour personal problems	142	14.29	35.71	30.95	14.29	4.76	100

Q15. Labour strikes	142	7.14	16.67	21.43	35.71	19.05	100
Q16. Labour physical fatigue	142	2.38	2.38	16.67	50.00	28.57	100
Q17. Lack of training offered to labour	142	0.00	9.52	4.76	64.29	21.43	100
Q18. Due to Insufficient lightening	142	0.00	2.38	11.90	50.00	35.71	100
Q19. Working at height	142	0.00	7.14	16.67	35.71	40.48	100
Q20. Working in extreme weather	142	0.00	4.76	19.05	50.00	26.19	100
Q21. Complex Design in Provided drawing	142	0.00	9.52	28.57	38.10	23.81	100
Q22. Poor Site Condition	142	9.52	0.00	21.43	30.95	38.10	100
Q23. Poor Site Management	142	7.14	0.00	0.00	42.86	50.00	100
Q24. Overcrowding	142	9.52	7.14	26.19	40.48	16.67	100
Q25. Old and insufficient Equipment/ material	142	7.14	7.14	21.43	45.24	19.05	100
Q26. Improper work planning	142	9.52	0.00	7.14	47.62	35.71	100

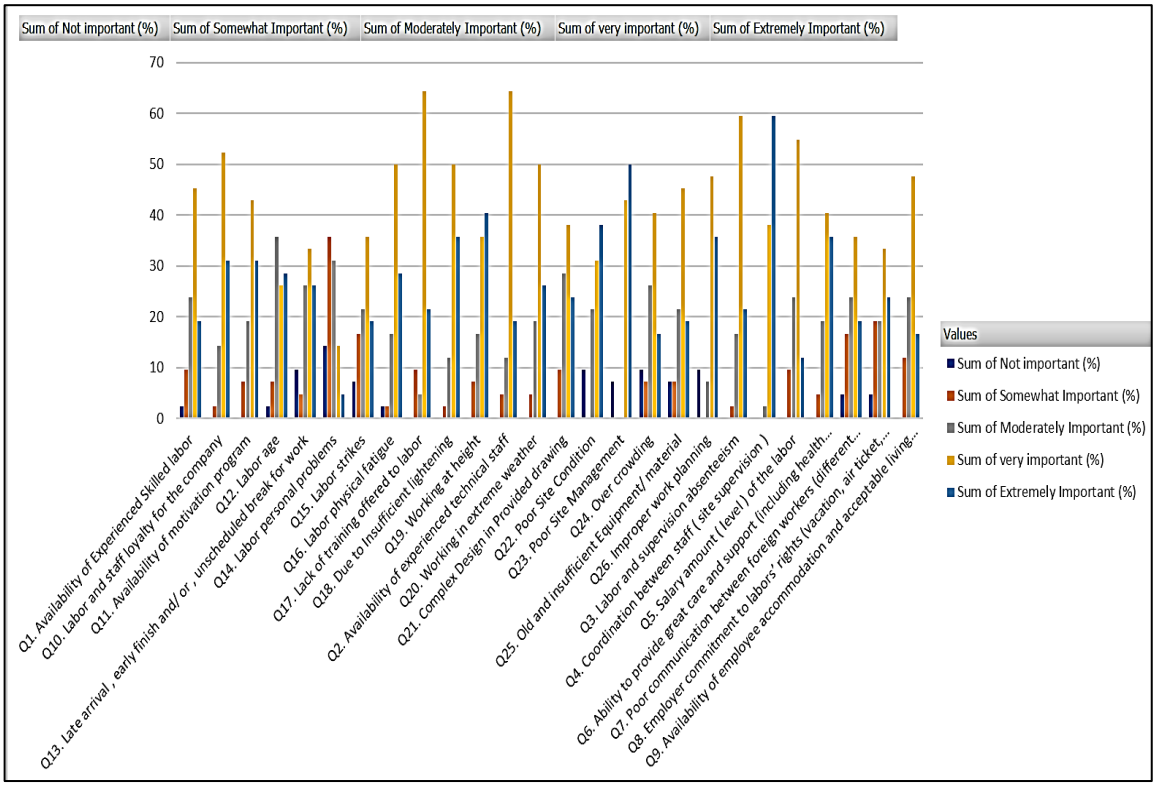

Figure.2 Responses represented in a graphical view

6. Analysis and findings

The present study suggests two different ranking techniques for factors affecting the productivity of labour. These factors are segregated into five main categories as (a) Manpower group (b) Motivation group (c) Environment group (d) Safety group and (e) Equipment. In the first technique, it is possible to calculate the Relative Importance Index (RII) of each factor affecting labour productivity (Table. 4) and use the Analytical Hierarchy Process in the second technique (Table. 5).

The table listed below shows the Relative Importance Index of factors.

Table 4: Ranking of factors using RII.

Criteria/ Sub- Criteria	Minimum	Maximum	RII	Rank
MANPOWER				
Availability of Experienced Skilled labour	1	5	0.73810	17
Availability of experienced technical staff	1	5	0.7952	10
Labour and supervision absenteeism	1	5	0.8000	7
Lack of training and inexperienced workers	1	5	0.7952	10
Complexity in Design	1	5	0.7524	15
Age of the Workforce	1	5	0.7429	16
MOTIVATION				
Coordination between staff	1	5	0.9143	1
Salary amount	1	5	0.7381	17
Care and support (including health insurance) to the workers	1	5	0.8143	6
Poor communication between foreign workers	1	5	0.6952	23
Labour and staff loyalty	1	5	0.8238	4

Availability of motivation program	1	5	0.7952	10
Labour strikes	1	5	0.6857	25
Employer commitment to labours' rights	1	5	0.7048	22
Environment				
Overcrowding	1	5	0.6952	23
Poor Site Condition	1	5	0.7762	14
Working in extreme weather	1	5	0.7952	10
Unscheduled break for work	1	5	0.7238	20
Due to Insufficient lightening	1	5	0.8381	3
Poor Site Management	1	5	0.8571	2
Improper work planning	1	5	0.8000	7
Safety				
Availability of employee accommodation	1	5	0.7381	17
Labour personal problems	1	5	0.5190	26
Labour physical fatigue	1	5	0.8000	7
Working at height	1	5	0.8190	5
Equipment				
Old and insufficient Equipment	1	5	0.7238	20

The table listed below shows the Ranking of factors using AHP.

Table 5 Ranking of factors using AHP

Criteria/Sub-criteria	Minimum	Maximum	AHP Weight	Rank
Manpower				
Availability of Experienced Skilled labour	1	5	0.045606	4
Availability of experienced technical staff	1	5	0.040698	9
Labour and supervision absenteeism	1	5	0.032942	22
Lack of training	1	5	0.034999	20
Complex Design	1	5	0.030853	24
Labour age	1	5	0.046919	2
Motivation				
Coordination between staff	1	5	0.03117	23
Salary amount	1	5	0.047535	1
Care and support (including health insurance) to the workers	1	5	0.041902	7
Poor communication between foreign workers	1	5	0.039001	12
Labour and staff loyalty	1	5	0.037103	16
Availability of motivation program	1	5	0.03683	17
Labour strikes	1	5	0.03569	19
Employer commitment to labour's rights	1	5	0.041183	8
Environment				
Overcrowding	1	5	0.038971	13
Poor Site Condition	1	5	0.034688	21
Working in extreme weather	1	5	0.038926	14
Unscheduled break for work	1	5	0.036063	18
Due to Insufficient lightening	1	5	0.040373	10
Poor Site Management	1	5	0.039419	11

Improper work planning	1	5	0.038855	15
Safety				
Labour personal problems	1	5	0.024938	26
Availability of employee accommodation	1	5	0.030269	25
Labour physical fatigue	1	5	0.046338	3
Working at Height	1	5	0.044557	5
Equipment				
Old and insufficient Equipment	1	5	0.044192	6

4. Recommendation

- About the motivation might have a positive impact on the productivity of labour. The built sector should increase labour satisfaction activities by declaring awards, either financially or societal/ promotional recognition. By implementing motivational measures, the workforce shall boost, and the morale of workers can be augmented.
- The fact that labour is not permanent employees of any company is a misconception. Properly taught or hands-on training of work force shall create belongingness and love to work for a longer period for the same organization.
- Only inadequate lighting indicates decreased efficiency because it requires adequate lighting to work efficiently and insufficient lighting has negative effects. So proper illumination of the activity area is essential during dark or night shift works.
- The construction groups should have more communication and coordination during all phases of the project, to have smarter site management.
- These factors can be included in strategizing labour's policy on boarding a company to increase productivity.

5. Conclusion

Various researches and works are in progress to identify and focus on the factors that is influencing labour output in the building information modelling sector and the built

environment. Labour efficiency/productivity is a thought-provoking task in the construction sector because it harshly upsets the project cost and the goodwill of the farm. It can be stated that many factors affect labour productivity and their effects vary from one industry to another. After studying the parameters affecting labour productivity it is concluded that labour productivity is 4 aspects of the successful completion of construction projects. The theoretical model of this study proposed five independent groups affecting the variation of Labour Productivity in building construction activities namely, Manpower factors, Motivational factors, Environment factors, safety factors, and Equipment factors. In this study, all the possible factors that affect labour productivity in construction are identified, and it was found that twenty-six factors positively affect labour productivity. The ranking of factors is done using the Relative Importance Index method and the Analytic Hierarchy Process method. From the result and analysis, the top factors that affected the labour productivity are given below,

The top ten factors affecting labour productivity by the RII method are as below

1. Coordination between staff
2. Poor Site Management
3. Due to Insufficient lightening
4. Labour and staff loyalty
5. Working at height
6. Care and support to the workers
7. Labour and supervision absenteeism
7. Improper work planning
7. Labour physical fatigue
10. Availability of motivation program
11. Working in extreme weather

The top ten factors affecting labour productivity by the AHP method are as below,

1.Salary amount

2.Labour age

3.Labour physical fatigue

4.Availability of Experienced Skilled labour

5.Working at height

6.Old and insufficient Equipment

7.Care and support (including health insurance) to the workers)

8.Employer commitment to labour's rights

9.Availability of experienced technical staff

10. Insufficient lightening

6. Limitation

- This research focuses solely on labour productivity in building activities without including the total productivity factor and financial productivity.

- Work is related to the Statistical analysis of factors of labour productivity, which is only under a few building construction activities. Future research, therefore, needs to focus on other factors affecting overall building productivity, such as slow innovation adoption, lack of benchmarking, project uniqueness, technology impacts, real wage trends, inadequate building training, etc., Naveed et al 2016[18], Mishra S P., 2017[19], Khan et al, 2020[20], Giannakis et al., 2022[21], Katyare et al., 2022[22],

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