

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 labour, to complete construction projects on time and within budget with the rising cost of labour and material. The building industry relies on the productivity of labours; therefore, the productivity of construction labour is important. Most areas of the construction industry have faced chronic problems such as poor management, poor working conditions, and poor quality. Proper planning of cutting-edge strategies enhances the productivity of construction labours. 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 labour are highly diversified, however, and there is a lack of systematic analysis of issues related to the productivity of construction labour. 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 need addressing and future strategies for research are being proposed. The outcome of this research may provide a forum to appreciate the latest developments and patterns in productivity research for both researchers and industrial practitioners.

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

1. Introduction

Productivity is the key source of growth and competitiveness in the economy. The ability of a country to improve its living standards depends almost entirely on its ability to increase its output per worker, i.e. to produce more goods and services for a given number of working hours, Krugman P., (1997)^[1]. Labour productivity is one of the most significant aspects of any construction project's physical growth. Productivity is the product of a mix of factors: inspiration, ability, preparation, work environment, other resources, time management, and even chances, Dan Carver Spatial Science, (2019)^[2]. Labor productivity calculates the hourly output of a country's economy, and it charts the amount of real gross domestic product (GDP) produced by an hour of labor. Growth in labor productivity hinges on; saving and investment in physical capital, new technology, and human capital, Chappelow J. (2019)^[3]. A prosperous construction project relies on cost, time, and quality although, these three principal performance assessment factors in the construction industry, are also known as the Iron Triangle of Project Management Triangle, Sibiy 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 labour 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 of the study

The objective and goal of the study are to identify the various factors influencing labour productivity and make an analysis, calculate the Relative Important of those factors, rank the critical factors by Analytical Hierarchy Process and finally recommend appropriate measures that

can be taken to improve labour productivity in Building construction activities using Research paper review.

3. Problem Definition

Improvement of labor productivity should be a major and continual concern of those who are responsible for cost control of constructed facilities, Hendrickson C. (1998)^[6]. Extending construction activities has created a lot of jobs for skilled, semi-skilled, and unskilled labour, but in addition to that, India's labour productivity remains low compared to other Southeast Asian countries, Helble M. et al. (2019)^[7]. When productivity fails to grow significantly, it reduces potential gains in incomes, corporate profits, and living standards, 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 benchmarking in the labour productivity is an important delineator in the project 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]. In this paper, the author conducted a questionnaire survey, and the result of the analysis showed that the main factors influencing labour productivity are management and labour level factors such as motivation, benefits, lack of 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

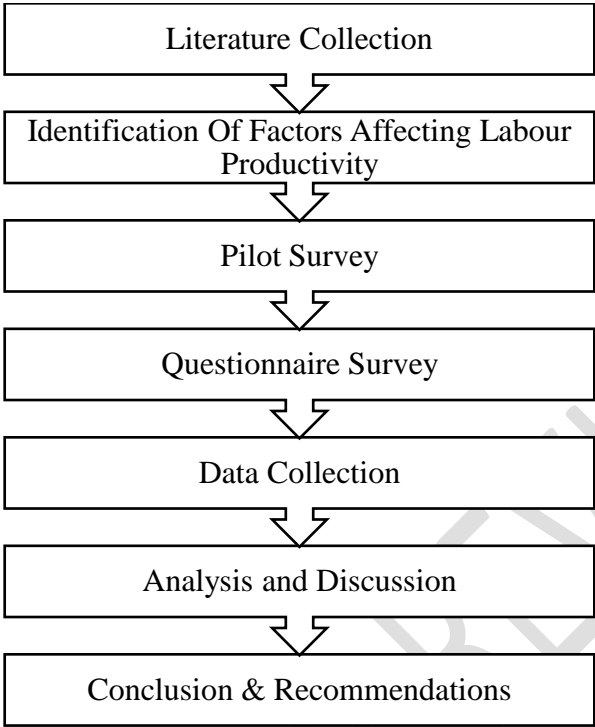


Figure.1 Methodology Adopted for the Study

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). 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 to be estimated for each productivity sub-factor, using the following equation (1).

$$RII = \frac{\sum W}{A * N} \dots\dots\dots(1)$$

Where W = the weight given to each factor and ranges from 1 to 5.

A = is the highest weight

5 = extremely important

4 = Very important

3 = moderately important

2 = somewhat important

1 = Not important.

N is the total number of responses collected.

2.2 Analytic Hierarchy Process (AHP)

Analytic Hierarchy Process (AHP) is one of the original multi-criteria decision-making approaches. 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).

- a) The first step is to calculate the weight
- Firstly, add the factors.
 - All the factors need to derive separately. They are divided by the total of all individual factors.
 - After this, write the average of all factors.
- b) The second step is to calculate the consistency index by using the following formula (2),

$$CI = \frac{(\lambda_{max} - n)}{(n - 1)} \dots\dots(2)$$

Where ‘λmax’ is the maximum Eigenvalue and ‘n’ is the no. of factors.

- c) The third step is to calculate the consistency ratio by using a formula (3).

$$CR = CI/RI \dots\dots\dots(3)$$

- Where RI is the average random index.

- When the Consistency ratio is equal to or less than 0.1 or 10%, then the calculated value of the consistency ratio is acceptable. Otherwise, the calculated value of the consistency ratio is inconsistent or unacceptable. Then the matrix is recalculated or reformed, Hossain M. F. et al. (2014)^[17].

Table 1 Scales of the relative importance

Scale	Definition	Description
1	Not important	Two compared elements have equal importance
3	Moderately important	An element is slightly more important than the other element
4	Very important	An element is more important than the other
5	Extremely important	An element is considerably more important than the other element
2	The middle value of the above scale	The degree of importance is between the above scales

2.3 Pilot Study

The aim of this stage was to minimize the inevitable problems of turning the questionnaire design into reality. A small-scale survey needs to be 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 preliminary analysis of the subject data for this study needs to gather through a literature review followed by the use by various authors of a questionnaire survey aimed at contractors, subcontractors, and labours. The set of questions focused on the factors affecting the efficiency of labour in the various groups. It included factors that influenced productivity at work. Respondents simply provided variables that would influence efficiency for a given typical situation. Questions need to create according to get the respondent profile and to gather information such as job position, work experience, current or previous work locations, and contact information. These questions were studied in the survey by analyzing productivity loss concerns from a variety of different profiles from different regions and were of great importance to the research. 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 used to rank the importance of each factor. This ranges from 1 to 5. We name the ranges as 1 is not important, 2 is somewhat important, 3 is moderately important, 4 is very important and 5 is extremely important.

2.5 Data Collection

Data collection is a method by which information is collected from all available sources to find answers to the research issue. The methods of data collection are divided into two categories: secondary data collection methods, and primary data collection methods. The data was collected via a questionnaire filled out by workers and site management employees. 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 that affect labour productivity. Because of this part, 26 factors were identified that mostly affect labour productivity for construction activities. Identification and evaluation factors affecting labour construction productivity 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

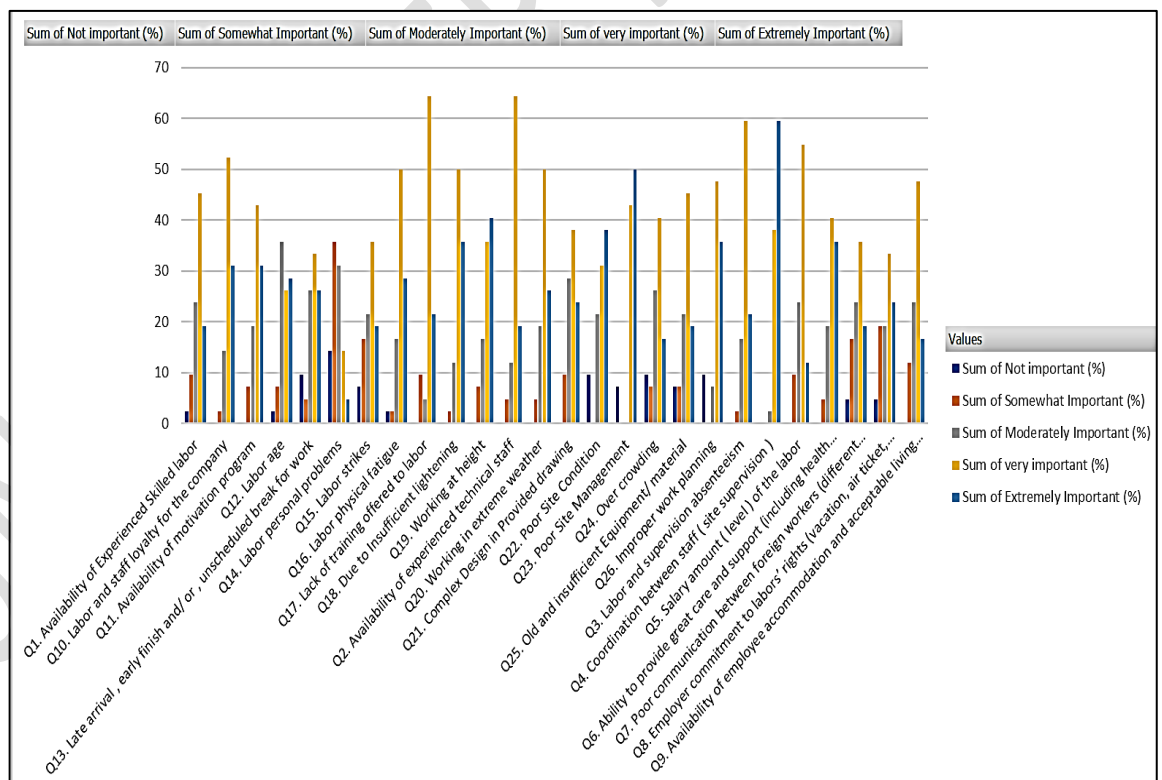


Figure.2 Responses represented in a graphical view

6. Result and Discussion

The present study suggests two different ranking techniques for factors affecting the productivity of labour. These factors categorized 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 Work force	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 right	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
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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 labours' 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 construction company should, therefore, increase labour satisfaction by developing a program of financial reward or recognition and taking motivational measures to boost the morale of workers.
- It can be understood that labour is not permanent employees of any company, but if they receive training, they will be motivated 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 lighting is mostly needed in 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 onboarding a company to increase productivity.

5. Conclusion

Several studies are done on the evaluation of factors influencing labour productivity in construction. Labour productivity is a challenging task in the construction industry because it severely affects the total cost of the project. 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 projects have been identified, and it was found that twenty-six factors positively affect labour productivity. The ranking of factors has been 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.

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