# IDENTIFICATION & EVALUATION OF CRITICAL CONSTRUCTION PRODUCTIVITY FACTORS

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## ABSTRACT

*In developing countries construction industry is a prominent sector in improving the country's economy. It is a diverse sector which contains engineer, architects, contractors etc. Thus it is crucial to make the construction sector more effective and efficient. This paper focus on several predominant factors which enables to maximize the output at given resources include money, cost and technology. The research is based on the construction productivity in India which aims at providing the latest data which helps in improving the management of the construction processes .The manual investigation is based on the questionnaire which were distributed among the concerned experts and were asked to assess and rank the factors on five point Likert scale .The data obtained from the experts was quantitatively analyzed by Relative Importance Index (RII) method and Microsoft Excel software. The study recognized four important factors as administration of labors, qualified and dedicated employees, manufacturing methods and economical factors, among which administration of labors was identified as the most critical factor. These critical factors can be improved by modern technology, superior management and adequate capital.*

***Keywords – construction productivity, construction technology, labor, productivity improvement, socio economic problems.***

## I. INTRODUCTION

"PRODUCTIVITY" is basically the ratio of the input work to the output work. Company's success and development depend upon the most important key component i.e. productivity. Construction companies may gain advantage over their competitors by improving upon productivity to build projects at lower costs, so the standard of the project is affected variably by the productivity.

Productivity is an important factor in the construction industry, which have a great impact on the economy. Better planning is most impertinent i.e. if contractors do not order material to arrive at a date when it needed, then the worker will be pressurized and will have to wait for material. This study is carried out a different way to find how to increase productivity. In order to increase the productivity different measures serve for different purposes. Safety is the most important component considered on site. A construction company should analyze each phase of its process to determine the factors improving productivity. The construction company can set aim of using equipment efficiently and planning for management.

## II. LITERATURE REVIEW

In the past this type of case study and research shows there are different factors which affect the productivity, but still there are numbers of anonymous factors further need to be studied even in developing countries. Experts and researchers have made several contributions for improving construction productivity all over the world.

(MistrySoham and Bhatt Rajiv,2013)A survey was carried out in Gujarat region on civil contractors, all 51 responses were analyzed by Analytic Hierarchy Process(AHP) and Relative Important Index(RII) through which five most critical factors were identified i.e. delay in payments, skill of labour , shortage of material, motivation of labour and clarity of technical specification. Critical factors according to AHP technique were rain, temperature, high wind, motivation of labour and physical fatigue.(Mohamed S. Abdel-Wahab et al. 2007) A survey of the existing literature relating to skills and productivity suggests common factors namely: logistics and late material delivery, workforce skills, labour training and Education attainment. It is concluded ultimately, that the existing evidence linking skills and productivity is inconsistent without providing training to skills development. (Serdar Durdyev et al. 2013) Qualitative data collected through references formed the basis for questionnaire surveys conducted among the experts and these references revealed 28 labour productivity constraining factors, however after the reliability test was conducted questionnaire based on corrected scale merely consisted 24 of the factors. (Ibrahim Mahamid et al. 2013) conducted a study to identify the main factors affecting labor productivity in Palestinian(Saudi Arabia) building construction projects. He concluded that the top five factors variably affecting labor productivity in construction are: retread, lack of co-operation and communication between construction parties, financial status of the owner, lack of labor experience and lack in materials. (Soekiman et al. 2011) The groups of factors that give high effect are: supervision, material, execution plan and design. Moreover, for large companies including above these factors equipment factors have also high effect and in small and medium companies, consultant factors also need special attention. All past researches tried to show that health and safety factors has not been a concern of small/medium companies and has some effect, while large companies are better, although not as major concern and has average effect. (Nabil Ailabouni1 and Kassim Gidado,2009) This research aims at developing regression models for predicting changes in productivity, when the underlying factors affecting productivity are varied. These factors were broadly categorized as general work environment, organizational work policies, group dynamics and interpersonal relationships and personal competence of the employees as applicable to the construction industry in the United Arab Emirates (UAE). The most significant factors amongst these were determined through surveys using the Severity Index and Chi Square computations for significance. (H. Randolph Thomas,1 Member, ASCE, and Iacovos Yiakoumis2, 1987) The factor model states that there are many factors which cause disturbances to better performance. If these factors can be analyzed from actual productivity data, one is left with an ideal productivity curve, which can be used to predict future performance. Methods for collecting and combining data from various projects are presented and illustrated using actual productivity data from three commercial construction projects. The factor model is display by considering the effect of temperature and relative humidity on productivity. The results of the weather model are compared to similar relationships reported by other researchers and the factor and weather model appear to be valid. The relationship developed by the researchers is consistent with those reported in the literature. (Gerald P. Klanaca and Eric L. NelsonbA, 2004) A loss of

productivity represent loss of efficiency which arises when productivity is influenced by events for which the contractor is not responsible and is allow to additional compensation. Loss productivity claims are one of many types of claims asserted on construction projects. Contractors assert claims for loss of productivity when the anticipated means, methods, techniques, scheduling or work sequence are altered by events or circumstances outside the contractor's control, and the contractor is entitled to relief for the loss. **(**Mojtaba Afsharian et al. 2013**)** At the firm level productivity growth reveals that resources have been used efficiently and this situation causes decrease in the costs. A firm, therefore, can reduce the prices of its products while maintaining or increasing profit margins. At the national level, productivity is one of the main determinant of economic growth and progress. Productivity growth provides to decrease in rate of inflation and it also develops the competitiveness of domestic firms. (JiukunDai et al. 2009) All critical factors in a descending order of their negative impact on construction productivity as measured by the converted factor score were represented by the following: construction equipment, materials, tools and consumables, engineering drawing management, direction and coordination, project management, training, craft worker qualification, superintendent competency, and foreman competency. Although there were differences observed in the latent factors between trades and between supervisors and craft workers. (Khaled Mahmoud El-Gohary, M.Eng.; and RemonFayek Aziz, Ph.D,2014) Construction industry sectors have been experiencing chronic problems such as poor management, inferior working conditions and insufficient quality. To improve construction labor productivity, one must identify and recognize the influence of the primary factors affecting productivity. This study reveals the importance of management factors on construction labor productivity over the other two categories, labor/human and industry. Despite the importance of management factors, they are almost unpredictable, especially during the bidding phase. (Enno Koehn, M. ASCE and Gerald Brown,1986) Labor productivity is of most and prime interest to the any construction project of any nation. In response to this concern, this paper investigates labor productivity factors for 47 countries throughout the world the data obtained from a survey of international contractors and available literature show that productivity factors can vary quite widely for different country. It is a measure of the spread of the data and a method to appraise the overall experience of different contractors working in the specific countries involved.

## III. METHODOLOGY

Study comprised of manual research conducted in 3 phases:

1) Preparation of the structured questionnaire and distribution among the experts.

2) Collection of data and overall identification of the critical factors by RII method and short listing the factors which have an adverse effect on the construction industry.

3) Collection and analysis of critical factors based on RII from four different category of experts.

The questionnaire factors were collected from various journal papers and internet. Eight main factors were recognized which were further subdivided into total 68 factors. 172 questionnaires were circulated among the 4

categorized experts all over India and 126 questionnaire were received in response, out of which 41 responses were from engineers, 34 from contractors, 29 from architects and 22 from clients.

Analysis of all the factors was done by Relative importance index (RII) method. The equation for the RII is given by;

$$RII = \frac{\sum(Wi*Fi)}{S*N}$$

Where,

Wi = Weightage of the given factors,

Fi = Frequency of occurance of given factor,

S = Number of divisions on the weightage scale (5 point Likert Scale),

N = Number of Responses.

The pie chart no.1 given below gives the detail about the sub division of the questionnaire distributed among the experts. Table no.1 gives the detail about the questionnaire distributed. The frequency given in the table has a weightage ranking from 5 to 1 where, 5 has the maximum weightage and 1 has the minimum weightage. The weightage decreases from 5 to 1 according to the importance of the factor.

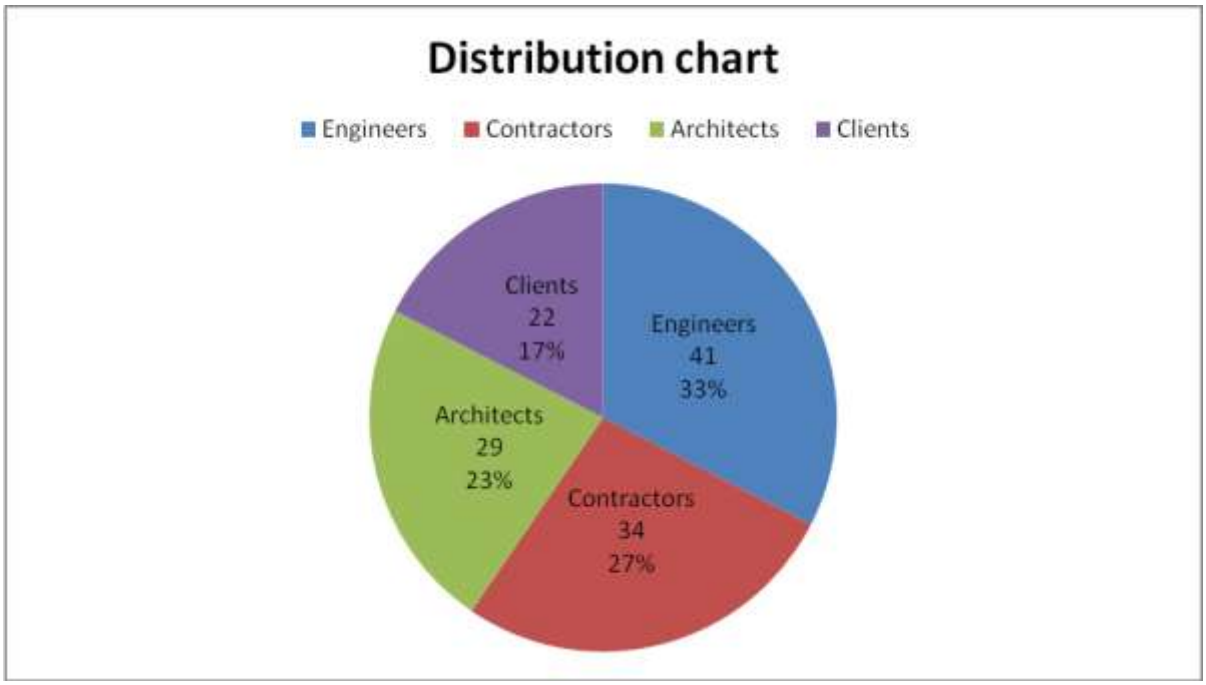


**Fig. 1: Distribution of questionnaire among the experts.**

**Table 1: Overall RII of the factors**

| | | | FREQUENCY OF OCCURANCE | | | | | RII |
|---|---|---|---|---|---|---|---|---|
| SR.NO | FACTORS | PRODUCTIVITY FACTORS | 5 | 4 | 3 | 2 | 1 | |
| 1 | A1 | 1) Safety | 78 | 45 | 3 | 0 | 0 | 0.919 |
| 2 | A2 | 2) Timeliness | 22 | 88 | 15 | 1 | 0 | 0.807 |
| 3 | A3 | 3) Quality | 24 | 34 | 52 | 10 | 6 | 0.695 |
| 4 | A4 | 4) Productivity | 94 | 22 | 8 | 2 | 0 | 0.930 |
| | | **Labour productivity** | | | | | | |
| 5 | B1 | 1) Administration of labour | 103 | 20 | 3 | 0 | 0 | 0.958 |
| 6 | B2 | 2) Technical clarity | 56 | 67 | 3 | 0 | 0 | 0.884 |
| 7 | B3 | 3) Capability of labour | 76 | 41 | 6 | 2 | 1 | 0.900 |
| 8 | B4 | 4) Payment delay | 57 | 45 | 7 | 16 | 1 | 0.823 |
| 9 | B5 | 5) Weather situation | 41 | 64 | 14 | 6 | 1 | 0.819 |
| 10 | B6 | 6) Safety issues | 75 | 46 | 4 | 1 | 0 | 0.909 |
| 11 | B7 | 7) Impractical schedule | 47 | 61 | 7 | 8 | 2 | 0.822 |
| 12 | B8 | 8) Shortage of skilled labour | 48 | 56 | 16 | 6 | 0 | 0.831 |
| 13 | B9 | 9) Communication issues | 60 | 42 | 21 | 1 | 2 | 0.849 |
| | | **Equipments factor** | | | | | | |
| 14 | C1 | 1) Greater use of mechanized equipments | 60 | 63 | 3 | 0 | 0 | 0.890 |
| 15 | C2 | 2) Maintainance and repairs | 84 | 29 | 11 | 2 | 0 | 0.909 |
| 16 | C3 | 3) Ineffectiveness of equipments | 57 | 24 | 33 | 10 | 2 | 0.796 |
| 17 | C4 | 4) Size and capacity | 51 | 54 | 16 | 5 | 0 | 0.839 |
| 18 | C5 | 5) Efficiency | 91 | 26 | 8 | 1 | 0 | 0.926 |
| 19 | C6 | 6) Versatility | 22 | 56 | 43 | 3 | 0 | 0.744 |
| 20 | C7 | 7) Investment cost and depreciation | 51 | 40 | 31 | 4 | 0 | 0.819 |
| 21 | C8 | 8) Keeping records of repair | 40 | 38 | 43 | 5 | 0 | 0.779 |
| 22 | C9 | 9) Performance of equipment | 85 | 35 | 6 | 0 | 0 | 0.925 |
| 23 | C10 | 10) Utilization of available equipment | 82 | 24 | 20 | 0 | 0 | 0.898 |
| | | **Socio-economic factor** | | | | | | |
| 24 | D1 | 1) Economical factors | 39 | 79 | 5 | 4 | 0 | 0.847 |
| 25 | D2 | 2) Delay in arrival of materials | 54 | 36 | 25 | 11 | 0 | 0.811 |
| 26 | D3 | 3) Over crowded work area | 48 | 27 | 38 | 9 | 4 | 0.768 |
| 27 | D4 | 4) Shortage of transportation means | 47 | 38 | 30 | 9 | 2 | 0.788 |
| 28 | D5 | 5) Lack of economic motivation system | 57 | 34 | 24 | 7 | 4 | 0.811 |
| 29 | D6 | 6) Quality of raw material | 89 | 18 | 18 | 1 | 0 | 0.909 |
| 30 | D7 | 7) Laws by government | 72 | 38 | 16 | 0 | 0 | 0.888 |
| 31 | D8 | 8) Acquition of land | 79 | 33 | 14 | 0 | 0 | 0.903 |
| 32 | D9 | 9) Material scarcity | 42 | 49 | 25 | 10 | 0 | 0.795 |
| | | **Human resource factor** | | | | | | |
| 33 | E1 | 1) Qualified and dedicated employees | 100 | 24 | 1 | 1 | 0 | 0.953 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 34 | E2 | 2) Relation between administration and employee | 67 | 56 | 1 | 0 | 2 | 0.895 |
| 35 | E3 | 3) Management factors | 83 | 36 | 7 | 0 | 0 | 0.920 |
| 36 | E4 | 4) Enthusiasm | 48 | 62 | 17 | 3 | 1 | 0.866 |
| 37 | E5 | 5) Encouragement for good performance | 36 | 75 | 11 | 4 | 0 | 0.826 |
| 38 | E6 | 6) Giving compliments for good jobs | 52 | 63 | 10 | 1 | 0 | 0.863 |
| 39 | E7 | 7) Management and coordination factors | 93 | 32 | 0 | 1 | 0 | 0.944 |
| 40 | E8 | 8) Project preparation | 74 | 49 | 2 | 0 | 1 | 0.909 |
| 41 | E9 | 9) Healthy work atmosphere | 47 | 68 | 11 | 0 | 0 | 0.857 |
| 42 | E10 | 10) Working time factors | 36 | 79 | 9 | 1 | 1 | 0.834 |
| 43 | E11 | 11) Several shifts | 20 | 75 | 22 | 9 | 0 | 0.768 |
| 44 | E12 | 12) Lack of struggle | 8 | 81 | 24 | 13 | 0 | 0.733 |
| 45 | E13 | 13) Absence of supervisor | 48 | 48 | 15 | 12 | 2 | 0.798 |
| | | **Technological factors** | | | | | | |
| 46 | F1 | 1) Manufacturing methods | 100 | 23 | 1 | 1 | 1 | 0.949 |
| 47 | F2 | 2) Drawings and conditions | 61 | 57 | 7 | 0 | 1 | 0.880 |
| 48 | F3 | 3) Modularization and prefabrication | 36 | 80 | 9 | 1 | 0 | 0.839 |
| 49 | F4 | 4) Cost assessment | 81 | 38 | 6 | 1 | 0 | 0.915 |
| 50 | F5 | 5) Software and hardware technology | 75 | 39 | 10 | 2 | 0 | 0.896 |
| | | **Conflicts in construction** | | | | | | |
| 51 | G1 | 1) Poor human resource administration | 43 | 46 | 18 | 17 | 2 | 0.776 |
| 52 | G2 | 2) Labour strike | 22 | 61 | 11 | 26 | 6 | 0.706 |
| 53 | G3 | 3) Mismatch in capacities in customers and architects | 9 | 64 | 16 | 33 | 4 | 0.665 |
| 54 | G4 | 4) Tendancy to hold responsible others | 14 | 62 | 18 | 25 | 7 | 0.680 |
| 55 | G5 | 5) Arguement among the team members | 16 | 60 | 24 | 23 | 3 | 0.700 |
| 56 | G6 | 6) Confusion among the labours | 20 | 60 | 24 | 19 | 3 | 0.719 |
| | | **Construction mistakes,faults and concepts** | | | | | | |
| 57 | H1 | 1) Advance site layout | 78 | 39 | 4 | 5 | 0 | 0.901 |
| 58 | H2 | 2) Nature of project | 65 | 50 | 8 | 3 | 0 | 0.880 |
| 59 | H3 | 3) Misuse of time schedule | 24 | 72 | 10 | 20 | 0 | 0.758 |
| | | **Natural factors** | | | | | | |
| 60 | I1 | 1) Bad weather | 18 | 65 | 14 | 26 | 3 | 0.709 |
| 61 | I2 | 2) Change in weather | 8 | 76 | 23 | 14 | 5 | 0.707 |
| 62 | I3 | 3) Temperature differences | 21 | 62 | 22 | 19 | 2 | 0.728 |
| 63 | I4 | 4) Rain | 27 | 56 | 22 | 17 | 4 | 0.734 |
| 64 | I5 | 5) High winds | 10 | 65 | 19 | 25 | 7 | 0.673 |
| 65 | I6 | 6) Earthquakes | 16 | 44 | 23 | 25 | 18 | 0.623 |
| 66 | I7 | 7) Landslides | 14 | 53 | 14 | 30 | 15 | 0.633 |
| 67 | I8 | 8) Floods | 16 | 51 | 18 | 32 | 9 | 0.652 |
| 68 | I9 | 9) Drought | 12 | 50 | 24 | 33 | 7 | 0.642 |

The factors were overall analyzed and even analysed individually according to engineer, client, architect and contractor perspective respectively. Thus according to this method the top 4 factors identified were administration of labors, performance of equipment, manufacturing methods and qualified and dedicated employees. The following table no.2 shows the factors identified by the perspective of individual expert.

**Table 2: Individual RII of the productivity factors by experts**

| | {1-41} ENGINEER | | | | | | {42-76} CONTRACTORS | | | | | | {77-105} ARCHITECTS | | | | | | {106-126} CLIENTS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FTRS | 5 | 4 | 3 | 2 | 1 | RII | 5 | 4 | 3 | 2 | 1 | RII | 5 | 4 | 3 | 2 | 1 | RII | 5 | 4 | 3 | 2 | 1 | RII |
| A1 | 27 | 12 | 2 | 0 | 0 | 0.921 | 22 | 11 | 1 | 0 | 0 | 0.897 | 20 | 9 | 0 | 0 | 0 | 0.937 | 7 | 14 | 0 | 0 | 0 | 0.866 |
| A2 | 9 | 29 | 2 | 1 | 0 | 0.824 | 9 | 18 | 7 | 0 | 0 | 0.788 | 0 | 23 | 6 | 0 | 0 | 0.758 | 4 | 17 | 0 | 0 | 0 | 0.838 |
| A3 | 10 | 11 | 17 | 1 | 2 | 0.726 | 10 | 5 | 12 | 5 | 2 | 0.674 | 0 | 5 | 18 | 4 | 2 | 0.579 | 4 | 13 | 4 | 0 | 0 | 0.8 |
| A4 | 34 | 6 | 0 | 1 | 0 | 0.956 | 23 | 6 | 4 | 1 | 0 | 0.874 | 17 | 8 | 4 | 0 | 0 | 0.889 | 19 | 2 | 0 | 0 | 0 | 0.98 |
| B1 | 35 | 6 | 0 | 0 | 0 | 0.97 | 22 | 10 | 2 | 0 | 0 | 0.891 | 25 | 3 | 1 | 0 | 0 | 0.965 | 20 | 1 | 0 | 0 | 0 | 0.99 |
| B2 | 25 | 16 | 0 | 0 | 0 | 0.921 | 12 | 19 | 3 | 0 | 0 | 0.828 | 12 | 17 | 0 | 0 | 0 | 0.882 | 6 | 15 | 0 | 0 | 0 | 0.857 |
| B3 | 24 | 14 | 1 | 1 | 1 | 0.887 | 15 | 14 | 4 | 1 | 0 | 0.828 | 17 | 11 | 1 | 0 | 0 | 0.91 | 18 | 1 | 2 | 0 | 0 | 0.952 |
| B4 | 16 | 15 | 3 | 7 | 0 | 0.795 | 6 | 21 | 3 | 3 | 1 | 0.742 | 14 | 8 | 1 | 6 | 0 | 0.806 | 16 | 1 | 4 | 0 | 0 | 0.914 |
| B5 | 14 | 23 | 1 | 3 | 0 | 0.834 | 3 | 25 | 5 | 1 | 0 | 0.754 | 5 | 13 | 8 | 2 | 1 | 0.731 | 19 | 2 | 0 | 0 | 0 | 0.98 |
| B6 | 26 | 13 | 2 | 0 | 0 | 0.917 | 23 | 8 | 2 | 1 | 0 | 0.885 | 22 | 7 | 0 | 0 | 0 | 0.951 | 4 | 17 | 0 | 0 | 0 | 0.838 |
| B7 | 14 | 17 | 3 | 6 | 1 | 0.78 | 11 | 20 | 2 | 1 | 0 | 0.817 | 6 | 18 | 2 | 2 | 1 | 0.779 | 15 | 6 | 0 | 0 | 0 | 0.942 |
| B8 | 11 | 14 | 11 | 15 | 0 | 0.848 | 6 | 25 | 2 | 1 | 0 | 0.788 | 14 | 12 | 3 | 0 | 0 | 0.875 | 16 | 5 | 0 | 0 | 0 | 0.952 |
| B9 | 24 | 13 | 3 | 0 | 1 | 0.887 | 5 | 15 | 13 | 1 | 0 | 0.72 | 11 | 12 | 5 | 0 | 0 | 0.813 | 17 | 4 | 0 | 0 | 0 | 0.961 |
| C1 | 19 | 20 | 2 | 0 | 0 | 0.882 | 21 | 13 | 0 | 0 | 0 | 0.897 | 18 | 10 | 1 | 0 | 0 | 0.917 | 2 | 19 | 0 | 0 | 0 | 0.819 |
| C2 | 26 | 8 | 5 | 2 | 0 | 0.882 | 22 | 10 | 2 | 0 | 0 | 0.891 | 17 | 8 | 4 | 0 | 0 | 0.889 | 18 | 3 | 0 | 0 | 0 | 0.971 |
| C3 | 17 | 5 | 12 | 6 | 1 | 0.751 | 8 | 6 | 17 | 3 | 0 | 0.691 | 10 | 13 | 4 | 1 | 1 | 0.806 | 21 | 0 | 0 | 0 | 0 | 1 |
| C4 | 19 | 15 | 6 | 1 | 0 | 0.853 | 5 | 22 | 3 | 4 | 0 | 0.742 | 5 | 17 | 7 | 0 | 0 | 0.786 | 21 | 0 | 0 | 0 | 0 | 1 |
| C5 | 34 | 4 | 2 | 1 | 0 | 0.946 | 14 | 15 | 5 | 0 | 0 | 0.828 | 22 | 6 | 1 | 0 | 0 | 0.944 | 18 | 1 | 2 | 0 | 0 | 0.952 |
| C6 | 6 | 21 | 13 | 1 | 0 | 0.756 | 5 | 18 | 9 | 2 | 0 | 0.731 | 7 | 13 | 9 | 0 | 0 | 0.786 | 4 | 3 | 14 | 0 | 0 | 0.704 |
| C7 | 14 | 19 | 7 | 1 | 0 | 0.824 | 7 | 8 | 18 | 1 | 0 | 0.702 | 11 | 11 | 5 | 2 | 0 | 0.813 | 18 | 2 | 1 | 0 | 0 | 0.961 |
| C8 | 15 | 15 | 9 | 2 | 0 | 0.809 | 6 | 12 | 14 | 2 | 0 | 0.708 | 16 | 7 | 5 | 1 | 0 | 0.862 | 3 | 4 | 14 | 0 | 0 | 0.695 |
| C9 | 37 | 4 | 0 | 0 | 0 | 0.98 | 11 | 21 | 2 | 0 | 0 | 0.828 | 17 | 10 | 2 | 0 | 0 | 0.903 | 19 | 0 | 2 | 0 | 0 | 0.961 |
| C10 | 31 | 6 | 4 | 0 | 0 | 0.931 | 15 | 18 | 11 | 0 | 0 | 0.93 | 15 | 9 | 5 | 0 | 0 | 0.868 | 19 | 1 | 1 | 0 | 0 | 0.971 |
| D1 | 9 | 29 | 0 | 3 | 0 | 0.814 | 12 | 18 | 4 | 0 | 0 | 0.822 | 14 | 13 | 1 | 1 | 0 | 0.875 | 3 | 18 | 0 | 0 | 0 | 0.828 |
| D2 | 15 | 9 | 8 | 9 | 0 | 0.746 | 5 | 11 | 17 | 1 | 0 | 0.697 | 14 | 14 | 0 | 1 | 0 | 0.882 | 19 | 2 | 0 | 0 | 0 | 0.98 |
| D3 | 15 | 2 | 17 | 6 | 1 | 0.717 | 4 | 22 | 7 | 1 | 0 | 0.748 | 7 | 3 | 14 | 2 | 3 | 0.662 | 21 | | 0 | 0 | 0 | 1 |
| D4 | 13 | 5 | 15 | 6 | 2 | 0.702 | 6 | 20 | 7 | 1 | 0 | 0.76 | 7 | 12 | 8 | 2 | 0 | 0.765 | 16 | 1 | 4 | 0 | 0 | 0.914 |
| D5 | 15 | 11 | 9 | 3 | 3 | 0.756 | 16 | 12 | 5 | 1 | 0 | 0.828 | 6 | 9 | 10 | 3 | 1 | 0.71 | 19 | 2 | 0 | 0 | 0 | 0.98 |
| D6 | 34 | 5 | 1 | 1 | 0 | 0.951 | 11 | 6 | 17 | 0 | 0 | 0.742 | 22 | 7 | 0 | 0 | 0 | 0.951 | 21 | 0 | 0 | 0 | 0 | 1 |
| D7 | 22 | 12 | 7 | 0 | 0 | 0.873 | 21 | 7 | 6 | 0 | 0 | 0.862 | 24 | 3 | 2 | 0 | 0 | 0.951 | 5 | 16 | 0 | 0 | 0 | 0.847 |
| D8 | 28 | 5 | 8 | 0 | 0 | 0.897 | 8 | 21 | 5 | 0 | 0 | 0.794 | 23 | 6 | 0 | 0 | 0 | 0.958 | 19 | 1 | 1 | 0 | 0 | 0.971 |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D9 | 11 | 12 | 12 | 6 | 0 | 0.736 | 9 | 17 | 7 | 1 | 0 | 0.777 | 15 | 5 | 6 | 3 | 0 | 0.82 | 7 | 14 | 0 | 0 | 0 | 0.866 |
| E1 | 34 | 6 | 1 | 0 | 0 | 0.96 | 25 | 9 | 0 | 0 | 0 | 0.92 | 21 | 7 | 0 | 1 | 0 | 0.931 | 19 | 2 | 0 | 0 | 0 | 0.98 |
| E2 | 27 | 13 | 0 | 0 | 1 | 0.917 | 10 | 23 | 1 | 0 | 0 | 0.828 | 22 | 6 | 0 | 0 | 1 | 0.931 | 8 | 13 | 0 | 0 | 0 | 0.876 |
| E3 | 32 | 8 | 1 | 0 | 0 | 0.951 | 9 | 20 | 5 | 0 | 0 | 0.8 | 24 | 4 | 1 | 0 | 0 | 0.958 | 17 | 4 | 0 | 0 | 0 | 0.961 |
| E4 | 17 | 23 | 0 | 1 | 0 | 0.873 | 14 | 8 | 10 | 2 | 0 | 0.777 | 7 | 14 | 7 | 0 | 1 | 0.779 | 4 | 17 | 0 | 0 | 0 | 0.838 |
| E5 | 13 | 27 | 0 | 1 | 0 | 0.853 | 13 | 9 | 10 | 2 | 0 | 0.771 | 8 | 19 | 1 | 1 | 0 | 0.834 | 2 | 19 | 0 | 0 | 0 | 0.819 |
| E6 | 22 | 18 | 1 | 0 | 0 | 0.902 | 15 | 19 | 2 | 1 | 0 | 0.908 | 13 | 9 | 7 | 0 | 0 | 0.841 | 1 | 20 | 0 | 0 | 0 | 0.809 |
| E7 | 34 | 6 | 0 | 1 | 0 | 0.956 | 24 | 10 | 0 | 0 | 0 | 0.914 | 20 | 9 | 0 | 0 | 0 | 0.937 | 14 | 7 | 0 | 0 | 0 | 0.933 |
| E8 | 26 | 14 | 0 | 0 | 1 | 0.912 | 24 | 9 | 1 | 0 | 0 | 0.908 | 20 | 8 | 1 | 0 | 0 | 0.931 | 3 | 18 | 0 | 0 | 0 | 0.828 |
| E9 | 15 | 21 | 5 | 0 | 0 | 0.848 | 22 | 12 | 0 | 0 | 0 | 0.902 | 8 | 15 | 6 | 0 | 0 | 0.813 | 2 | 19 | 0 | 0 | 0 | 0.819 |
| E10 | 18 | 17 | 5 | 1 | 0 | 0.853 | 2 | 30 | 2 | 0 | 0 | 0.777 | 10 | 16 | 2 | 0 | 1 | 0.834 | 5 | 16 | 0 | 0 | 0 | 0.847 |
| E11 | 4 | 24 | 8 | 5 | 0 | 0.731 | 9 | 18 | 5 | 2 | 0 | 0.777 | 4 | 14 | 9 | 2 | 0 | 0.737 | 3 | 18 | 0 | 0 | 0 | 0.828 |
| E12 | 0 | 25 | 8 | 8 | 0 | 0.683 | 5 | 20 | 7 | 2 | 0 | 0.742 | 0 | 17 | 9 | 3 | 0 | 0.696 | 3 | 18 | 0 | 0 | 0 | 0.828 |
| E13 | 10 | 13 | 10 | 7 | 1 | 0.717 | 21 | 5 | 4 | 3 | 1 | 0.822 | 12 | 14 | 1 | 2 | 0 | 0.848 | 5 | 16 | 0 | 0 | 0 | 0.847 |
| F1 | 37 | 2 | 0 | 1 | 1 | 0.956 | 23 | 10 | 1 | 0 | 0 | 0.902 | 25 | 4 | 0 | 0 | 0 | 0.972 | 14 | 7 | 0 | 0 | 0 | 0.933 |
| F2 | 27 | 13 | 0 | 0 | 1 | 0.917 | 12 | 20 | 2 | 0 | 0 | 0.834 | 13 | 11 | 5 | 0 | 0 | 0.855 | 8 | 13 | 0 | 0 | 0 | 0.876 |
| F3 | 12 | 28 | 1 | 0 | 0 | 0.853 | 12 | 18 | 4 | 0 | 0 | 0.822 | 6 | 18 | 4 | 1 | 0 | 0.8 | 6 | 15 | 0 | 0 | 0 | 0.857 |
| F4 | 30 | 8 | 3 | 0 | 0 | 0.931 | 13 | 18 | 2 | 1 | 0 | 0.828 | 22 | 6 | 1 | 0 | 0 | 0.944 | 15 | 6 | 0 | 0 | 0 | 0.942 |
| F5 | 25 | 14 | 1 | 1 | 0 | 0.907 | 23 | 9 | 2 | 0 | 0 | 0.897 | 11 | 10 | 7 | 1 | 0 | 0.813 | 16 | 5 | 0 | 0 | 0 | 0.952 |
| G1 | 7 | 12 | 10 | 11 | 1 | 0.663 | 16 | 11 | 6 | 1 | 0 | 0.822 | 12 | 9 | 2 | 5 | 1 | 0.779 | 8 | 13 | 0 | 0 | 0 | 0.876 |
| G2 | 1 | 15 | 4 | 19 | 2 | 0.57 | 7 | 16 | 7 | 3 | 1 | 0.725 | 13 | 9 | 0 | 4 | 3 | 0.772 | 1 | 20 | 0 | 0 | 0 | 0.809 |
| G3 | 1 | 16 | 8 | 13 | 3 | 0.595 | 1 | 12 | 4 | 17 | 0 | 0.565 | 5 | 16 | 4 | 3 | 1 | 0.744 | 2 | 19 | 0 | 0 | 0 | 0.819 |
| G4 | 3 | 16 | 9 | 9 | 4 | 0.624 | 6 | 8 | 7 | 13 | 0 | 0.622 | 3 | 18 | 2 | 3 | 3 | 0.703 | 2 | 19 | 0 | 0 | 0 | 0.819 |
| G5 | 4 | 14 | 5 | 16 | 2 | 0.609 | 6 | 13 | 12 | 3 | 0 | 0.708 | 4 | 13 | 7 | 4 | 1 | 0.703 | 2 | 19 | 0 | 0 | 0 | 0.819 |
| G6 | 4 | 14 | 8 | 13 | 2 | 0.624 | 5 | 15 | 11 | 3 | 0 | 0.708 | 8 | 12 | 5 | 3 | 1 | 0.758 | 3 | 18 | 0 | 0 | 0 | 0.828 |
| H1 | 29 | 7 | 2 | 3 | 0 | 0.902 | 12 | 19 | 2 | 1 | 0 | 0.822 | 19 | 9 | 0 | 1 | 0 | 0.917 | 17 | 4 | 0 | 0 | 0 | 0.961 |
| H2 | 25 | 12 | 2 | 2 | 0 | 0.892 | 8 | 24 | 2 | 0 | 0 | 0.811 | 13 | 11 | 4 | 1 | 0 | 0.848 | 18 | 3 | 0 | 0 | 0 | 0.971 |
| H3 | 4 | 19 | 4 | 14 | 0 | 0.663 | 8 | 22 | 3 | 1 | 0 | 0.794 | 5 | 16 | 3 | 5 | 0 | 0.744 | 7 | 14 | 0 | 0 | 0 | 0.866 |
| I1 | 0 | 21 | 3 | 15 | 2 | 0.609 | 15 | 12 | 4 | 3 | 0 | 0.805 | 1 | 12 | 7 | 8 | 1 | 0.627 | 2 | 19 | 0 | 0 | 0 | 0.819 |
| I2 | 0 | 23 | 11 | 5 | 2 | 0.668 | 5 | 24 | 5 | 0 | 0 | 0.777 | 1 | 9 | 7 | 9 | 3 | 0.572 | 2 | 19 | 0 | 0 | 0 | 0.819 |
| I3 | 6 | 16 | 12 | 6 | 1 | 0.697 | 10 | 21 | 2 | 1 | 0 | 0.811 | 1 | 7 | 8 | 12 | 1 | 0.565 | 4 | 17 | 0 | 0 | 0 | 0.838 |
| I4 | 3 | 18 | 10 | 8 | 2 | 0.658 | 18 | 8 | 5 | 2 | 1 | 0.811 | 6 | 8 | 7 | 7 | 1 | 0.675 | 0 | 21 | 0 | 0 | 0 | 0.8 |
| I5 | 1 | 14 | 7 | 15 | 4 | 0.565 | 8 | 18 | 6 | 1 | 1 | 0.76 | 1 | 11 | 6 | 9 | 2 | 0.6 | 0 | 21 | 0 | 0 | 0 | 0.8 |
| I6 | 4 | 14 | 0 | 15 | 8 | 0.556 | 7 | 3 | 18 | 3 | 3 | 0.628 | 4 | 6 | 5 | 7 | 7 | 0.551 | 1 | 20 | 0 | 0 | 0 | 0.809 |
| I7 | 2 | 13 | 3 | 16 | 7 | 0.536 | 8 | 12 | 6 | 6 | 2 | 0.685 | 3 | 8 | 4 | 8 | 6 | 0.558 | 1 | 19 | 1 | 0 | 0 | 0.8 |
| I8 | 3 | 14 | 2 | 17 | 5 | 0.565 | 8 | 9 | 9 | 7 | 1 | 0.674 | 4 | 8 | 6 | 8 | 3 | 0.613 | 1 | 19 | 1 | 0 | 0 | 0.8 |
| I9 | 1 | 14 | 6 | 15 | 5 | 0.556 | 5 | 9 | 13 | 6 | 1 | 0.645 | 5 | 7 | 4 | 12 | 1 | 0.62 | 1 | 19 | 1 | 0 | 0 | 0.8 |

Thus the top overall factors and individual factor according to engineer, client, architect and contractors were identified and then it was cross verified.

## IV. CONCLUSION

In today's world, the construction sector is rated as one of the key sectors. It helps in developing and achieving the goal of society. Study and knowledge of construction productivity are very important since they eliminate the losses to the governing agencies and also influence the economics of the construction industry. Prior knowledge of construction productivity during construction can save money and time. Investments for these projects are very high and because of the complexity in construction, various factors can highly affect overall productivity, thus the project can end up adding even more time and money in order to be completed. This research is intended to identify the causes of probable factors affecting construction productivity in industry.

Now defy the complex nature of construction activities and the presence of several contents of questionnaire of outside the control of management, the models and the underlying implications can help construction personnel to achieve improved productivity rates on sites; i.e. to ensure favourable factors for achieving optimal productivity, keeping costs within budget, completing projects on time and ultimately helping contractors to run their business profitably.

## V. RECOMENDATIONS

1. Administration of labors must be proper- Labors must be be managed properly. At sites safety instructions must be provided to them for their well being.

2. Proper working of equipments- Every equipment must be checked on regular basis and record should be maintained for them.

3. Dedicated employees- It must be ensured that dedicated and knowledgeable employees must be recruited at site.

4. Manufacturing methods- Mordernized equipments must be used as much as possibl to reduce time and cost of construction.

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