International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 02 | Feb 2019 www.irjet.net p-ISSN: 2395-0072

Recognition of Factor Impacting Labor Productivity for Reinforcement Installation Activity in India

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Abstract: *Construction industry for the majority of the developing nation is labor intensive. The fact that the labor are easily available and at an affordable cost, the constructors and developers bank on them for the various construction activities to be completed. In concurrent, the foremost challenge for the constructor in developing nation like India is the low productivity level of labor amongst the various other constrains. The objective of this investigation study is recognizing and rank the relative important indices of the factors affecting the reinforcement installation activity in India. For achieving this objective, a structured questionnaire was prepared through literature survey and consulting experts from the industry. A total of 23 factors were categorized into four groups: management, technical/ technological/construction method, human/labor and external/on-site job conditions; and group of constructors, builders and consultants participated in this survey. Through the data retrieved and analysis, factors like: skills of the fitter; supervision of foremen; stringent inspection by engineers and supervisors; materials supply on time; overtime provision; safety measures; size of crew; accuracy rates and details in design; method of hauling steel; and height of the work remarked significant impact on productivity. The results retrieved from this investigation study could be utilized by the constructors and other construction practitioners to develop broader perspective on the factors influencing the production rates, and enhance the practises for efficient utilization of human labor.*

Keyword: Labor productivity, factors, reinforcement installation, Relative Importance Index (RII).

1 INTRODUCTION

Construction projects globally cannot be completed on behalf of the human force. This factor is especially most evident in the developing nations as construction labor are the most prominent choice for the constructor and developers to bank on for performing construction task, as the man force are easily available and at an affordable price. Perhaps the work completed in the work hour i.e., productivity of the labor plays a vital role. Also, labor productivity is one of the most frequently researched topics amongst the researchers of the various countries. It is also pointed out in one of the research study conducted by J. Abdulaziz and B. Camille (2012) in Kuwait, that construction labor contribute about 30% to 50% of the overall construction cost of the project, indicating labor play an important role in economic success of the project. Regardless of all the technological advancement, abundance of the construction materials, tools and plants, the construction cost are consistently rising, with overrun in time and further increasing the budget of the project. For this reason, the new government laws for the residential and commercial project are enforced, i.e., the Real Estate Regulatory Authority (RERA); for which the projects registered under this act should be completed within the stipulated time, further enforcing the contractors and developers to handle the projects in more planned and systematic manner. But still the challenges prevail, and one of them being the labor productivity. In this article, the authors debate particularly about the construction labor productivity for reinforcement installation activity.

The objective of this research study is to identify the relative important indices of the factors affecting the productivity for reinforcing installation activity in India; from the perspective of not only the constructors, but also the developers and consultants; because outcomes of such a study could be utilized by the various construction practitioners of locals, nationwide and also by the international industry.

The research article begins with definition of the productivity encountered during the review study and literature review of the previous investigation studies on similar background, further explaining the research methodology for the data analysis, brief explanation of the results retrieved is further explained and at last, marking a conclusion of the research study.

2 LITERATURE REVIEW

The literature survey conducted is split into two segments: (1) definition of labor productivity and (2) review of the studies.

2.1 Definition of productivity

In theory, productivity is well-defined as ratio of unit output per given unit input [1]. In relevance to the

availability of the data and measuring objectives numerous definitions of productivity are encountered [1] and [2]. Also, there is no universal accepted productivity measurement standards for estimating purposes [3]. For a same activity, the measures to quantify productivity shall be different and the subsequent productivity values cannot be directly analogous. Thus, making it imperative for productivity measurement to define the subjective and experience-based assessment through defined collection of data via survey form. Various other definition were encountered, but due to restrain in the length of the paper, the definition used for this study is expressed. In the year 2006, equation for labor productivity for formwork and reinforcement installation and concreting activity was given by A. E. Samer and S. Lokman [5] as,

$$\text{Labor Productivity} = \frac{\text{Crew Size(man)} * \text{Duration for task completion(days)}}{\text{Quantum of work(units)}} \quad \text{..... (Eq. 1)}$$

where, productivity is measured in man x days/ unit for all three activities of reinforcement installation, formwork installation and concrete pouring activity.

Eq. (1) is utilized for determination of the labor productivity for this research study, as the data retrieved from the site contains the details briefed in the formula and meets the objective of the study of determination of the production rates of labor.

2.2 Review

In the early nineties there was a boost in construction works all over the world which lead the labor from different countries to travel in search of job. As such, with increment in the construction activities in Singapore, there was a concern for low labour productivity level. Correspondingly, a study was investigated in late 1992 with the top civil-engineering companies and the constructors [6]. E. Lim and A. Jahidul (1995) identified 17 factors and with the aid of relative important index factors like: difficulty in enrolment of supervisor, trouble in recruitment of labour and significant proportion of labour turnover were identified affecting productivity level [6]. With the similarly approach, Z. Mahmood et al. (1996) for the Iran construction industry identified factors like: material shortage, equipment failure, meteorological and site conditions, drawing deficiencies/ change orders, and lack of proper tools and equipment affecting labour productivity [7]. Later in (1997), P. Kaming et al. studied factors affecting craftsmen's in Indonesia and concluded lack of materials, rework, absenteeism of operatives and lack of suitable tools are amongst most influential [8]. A. Makulsawatudom et al. (2004) investigated 23 parameters influencing productivity of labor of Thailand construction industry and concluded lack of materials, inadequate drawings, incompetent supervisors, lack of tools and plants, absenteeism, lack of communication, instruction time, poor site layout, delay in inspection and rework were the most crucial factors [9]. M. Abdul Kadir et al. (2005), examined effects of 50 factors on productivity for Malaysian projects of residential buildings and scrutinized: material shortage at site; non-payment to suppliers causing the stoppage of material delivery to site; change order by consultants; late issuance of construction drawing by consultants and incapability of site management as the most influential parameters [10]. H. M. Alinaitwe et al. (2007) investigated factors affecting craftsmen ship in Uganda and identified: incompetent supervisors, lack of skills, rework, lack of tools and equipment's and poor construction methods as being the utmost substantial parameters [11]. A couple of years later, J. Dai et al. (2009) measured crafts worker perspective over 83 factors throughout United States which comprised 1,996 craft workers survey. Factors like tools and consumable, materials, management of the engineering drawing and construction equipment were identified as to have greater impact from craftsmen workers perspective [12]. Three years later, A. A. Attar et al. (2012) listed out factors affecting labor productivity rates district of Sangli, Kolhapur and Pune of Maharashtra [13]. The authors identified lack of material, delay in arrival of materials, unclear instruction to labourer, labour strikes, financial difficulties of the owner, high absenteeism of labours, no supervision method, supervisors absenteeism, lack of equipment and design changes, there is no definite schedule, poor management, unproductive time (internal delay, extra break, waiting & relaxation), lack of skill, supervision delay, lack of tools & equipment, poor instructions, poor quality of labour, supervision factor, material factor, execution plan factor, health & safety factors, labour shortages, working time factor, accidents, organization factors, improper training, bad weather , use of alcohol & drug as the influential parameters. N. Thabani and G. B. Wellington (2016) investigated factors affecting labor productivity in Zimbabwe [14]. A total of 22 parameters were determined and surveyed in concurrent with the different construction firms. From the investigation it was revealed that factors like: late and/ or non-payment of wages and salaries, suitability and/or adequacy of capital, non-payment to suppliers, availability of experienced labour as well as education and training are the most significant factors impinging productivity in Zimbabwe. D. Serdar et al. (2017) investigated factors causing project delays in Cambodia and the results showed that lack of materials on site, unrealistic project scheduling, delay in material delivery, shortage of skilled labour, complexity of project, labour absenteeism, delay in payment for completed work, poor site management, delay by subcontractor, accidents due to poor site safety as the most crucial factors [15]. D. Saurav et al. (2018) surveyed 18 factors

affecting the productivity of labor in India. A total of 112 responses were investigated with aid of RII and concluded planning and scheduling, availability of material, and storage area for materials as the most significant factors contributing to the labor productivity [16].

Several researchers have attempted to classify the construction labor productivity factors based on groups in order that it could be recognized globally, however, the construction practises are not the same and consensus amongst the researchers of such classification of groups is not been reached [2].

J. Abdulaziz and B. Camille (2012) surveyed factors affecting labor productivity in Kuwait and acknowledged 45 factors and grouped into four categories: management, technological, human/labor and external [2]. Factors like: clarity of technical specification, amount of variation/modification in order during execution, coordination level among design discipline, lack of labour supervision, proportion of work subcontracted, design complexity level, lack of incentive scheme, lack of construction manager leadership, stringent inspection by engineer and delay in responding to requests for information were identified as the most influential affecting productivity. In the same year, G. Parviz and R. H. Mohammad (2012) investigated factors for Iranian construction industry [17]. The authors categorized the 31 factors into seven groups and the analysis represented: materials/tools, construction technology and method, planning, supervision system, reworks, weather, and jobsite condition in the descending order of their ranking as the influential groups affecting productivity. M. Ibrahim (2013) surveyed contractors view point on factors affecting productivity in West Bank Palestine [18]. The author identified 31 factors and grouped into four categories of labor, managerial, materials and equipment, environmental, and financial, and established factors like: rework, lack of cooperation and communication between construction parties, financial status of the owner, lack of labor experience, and lack in materials to have significant impact on productivity. M. E.-G. Khaled and F. A. Remon (2013) investigated factor influencing labor productivity in the Egyptian construction industry [19]. The authors grouped 30 factors into three groups namely: human/labor, industrial and management. Factors like: labor experience and skills, incentive programs, availability of the material and ease of handling, leadership and competency of construction management, and competency of labor supervision were identified to have the most significant impact on productivity. For the Iranian construction industry H. Gholamreza and E. Eslamdoost (2015) [1], identified 45 factors having greater impact on labour productivity for South Pars Gas Field and categorized them into four groups namely: external, management, human and technical were identified in the Iran construction industry. From their finding the most influential factors were: weather, management, enthusiasm and enticements, tools, planning and materials. G. N. Shamil (2016) presented a state of the art in the productivity research and to represent factors that can harm productivity on-site [20]. A total of 46 factors were identified and grouped under five categories namely: pre-construction activities; activities during construction; managerial and leadership issues; motivational factors; and organizational factors. The results evaluated revealed that labor productivity are largely affected by the pre-construction activities namely: ineffective project planning, delays caused design error and variations, communication systems adopted, design and buildability related issues inclusive of specifications and procurement method adopted.

From the literature survey conducted it is evident that the factors affecting construction labor productivity could either be simply listed or could also be categorized according to the groups so that the structured questionnaire are easily understood for the respondents. The authors suggest following four primary groups: management, technical/ technological/ construction method human/labor and external factor & on-site conditions for this study.

3 RESEARCH METHODOLOGY

The data pertaining to this this study were collected by a structured, closed-ended questionnaire survey. In regards to the literature survey conducted of the previous investigations and valuable inputs provided from the industry professionals and practitioners, 23 factors were identified as to being affecting the labor production rates for reinforcing installation activity in India.

For the further investigation of this study it was necessary to validate the results obtained, i.e., to ensure the questions do measure the required objective of this study. A pilot study was conducted on a small group of 5 respondents from the industry. The aim of this test was to ensure that the questions pertaining the survey was testified, the choices and range are defensible and determining how efficiently the respondents could complete the questionnaire.

The feedback from the respondents were positive, and with few comments and recommendations in regards to the context simplifications. Subsequently, the authors reframed the questions to avoid the misinterpretation of information and understanding for the future use by the respondents.

The targeted population of the construction firm included the firms registered under Real Estate Regulatory Authority (RERA). The contractors, builder and

developers were confirmed having registered RERA number to be a part of the investigation. Consequently, a total number of 100 construction firms were confined for this investigation.

In order for procuring the statistical representation of the sample population, the formula depicted in (Eq. 2) was used [21] and [2]

$$n = \frac{m}{1+(\frac{m-1}{N})} \quad \text{..... (Eq. 2)}$$

where n, m, and N are the sample size of the limited, unlimited, and available population, respectively. m is evaluated by (Eq. 3)

$$m = \frac{z^2 * p * (1-p)}{\varepsilon^2} \quad \text{..... (Eq. 3)}$$

where z is the statistical value for confidence level used, i.e., 2.575, 1.96, and 1.645, for 99%, 95%, and 90% confidence levels, respectively; p= the value of the population proportion that is being estimated; and ε is the sampling error of the point estimate.

Because the value of p is unknown, S. Terry [22] suggested a conservative value of 0.5 to be used such that a sample population that is at least as large as required is obtained. Using 90% confidence level, i.e., 10% significance level, the unlimited sample population (m) is approximated as follows:

$$m = \frac{(1.645)^2 * 0.5 * (1-0.5)}{(0.1)^2} \approx 70$$

Accordingly, for the total number of construction firms i.e., N, of 100, the representative sample size of the population required is determined as follows:

$$n = \frac{70}{1+(\frac{70-1}{100})} \approx 42$$

Correspondingly, to acquire the desired sample size population a total of 100 firms were approached to be the part of the survey, through communication via direct contacts, phone calls, e-mails etc. As a result of which 62 responses were returned out of which 6 were incompletely filled and were rejected. A total of 56 completed questionnaire were collected from the survey, which exceeded the sample size requirements. The respondents were managers, senior site in-charge and senior supervisors having experience in the similar nature of work. The questionnaire consisted general data of the respondents, followed by the structural member under consideration and further with the factors identified.

The 23 factors surveyed were classified into five categories:(1) management, (2) technical/ technological / construction method, (3) human/ labor, (4) external and on-site condition. The questionnaire survey comprised on simple ranking scale to mark the level of effectiveness in ascending order from 1 (not effective) to 5 (very strongly effective). The scaling represents the effect of each factor on the labor productivity from the respondent's perception and practice followed on the respective site. The data retrieved were analysed using Relative Importance Index (RII) and is calculated as shown in (Eq. 4) [2]as

Relative Importance Index %

$$= \frac{5(n5)+4(n4)+3(n3)+2(n2)+1(n1)}{5(n1+n2+n3+n4+n5)} \text{ X } 100 \quad \text{.....(Eq. 4)}$$

where n1, n2, n3, n4 and n5 are the number of respondents who selected not effective, less effective, moderately effective, strongly effective and very strongly effective respectively [2].

Ranks for each of the factors were explored based on their relative importance index. Further the ranks of the groups were evaluated by considering the average value of the importance indices for all factors within; indicating a greater impact of the group on productivity.

4 RESULTS AND DISCUSSION

The data retrieved from site are evaluated to analyse the impact of 23 factors on the productivity of labor for reinforcement installation activity in India. The results of relative importance of the factors impacting according to the group, overall considering all the factors and group importance are further discussed. A comparison of this study with the previous investigation is also presented.

4.1 Management category

The importance index along with their ranks for the management category is represented in Table 1.

The most influential parameter affecting productivity is lack of supervision by the foremen with RII of 85% and also it ranked second amongst all the factors taken into consideration. Supervision of foremen inculcates the important aspect, as the task work of reinforcement cutting and bending is allocated by the foremen; it is important to ensure the work as per instructions and design are performed by the fitter. Also, the foremen ensure that the correct reinforcement is placed for the respective structural member before it is being checked by the supervisors and engineers. Thus, supervision of foremen can help in avoiding such circumstances on-site which can affect productivity.

Table- 1: Relative Importance Index and Ranks of Management Category Productivity Factors

Factors	Relative Importance Index (%)	Rank
Supervision of foreman	85.00	1

Materials supplies on time	83.57	2
Overtime provision	82.86	3
Quantity of steel erection for particular work	75.00	4

The second parameter is the material supplies on time, which mark second place in the management category with RII of 83.57% and ranked fourth while considering the overall factors. It is evident that if the materials aren't arriving on time or before the scheduled dates the work can come to stop. Thus, it is obligatory for the responsible firms to ensure the materials arrive before the schedule dates. Materials not arriving on time and lack of materials on-site affect the productivity is also represented in investigation studies of [7]- [10]; [13]; [15]; [16] and [19].

The next factor ranking third in the category with RII of 82.86% and overall fifth ranking inclusive of all factors is overtime provision. This parameter was included in the investigation survey based on discussion with experts from the industry. This factor significantly implies on the productivity because workers at site prefer to complete the task allocated to them for the day within the specified hours of work or even complete work before time. So even if the size of the crew is not enough to perform particular task, and if the overtime is provided the workers tends to complete it during the day hours. Further, quantity of steel erection for particular work is ranked lowest in the management category with RII of 75% and ranked thirteenth amongst all the factors. This factor also marks the realistic and unrealistic nature of planning for the completion of particular task work impacting both positive and negative influence on the productivity.

4.2Technical/Technological/Construction method category

The factors in this class of category is ten, and due to the limitations of this paper not all of the factors will be discussed briefly. The importance index along with their ranks for technical/technological/construction method category is represented in Table 2.

The foremost significant factor impacting in this class of category is the stringent inspection by the supervisors and the engineers with RII value of 84.29% and overall ranking amongst all the factors as third. Inspection is carried out by the contractor engineers and also the consultant engineers ensuring the work is as per the scheduled design. Stringent inspection by the engineers not allowing the marginal tolerance in work causes the rework and changes to be made for the same structural member leading to reduce in the productivity level. The effect of this factor on productivity is also enlightened by [2] for Kuwait construction industry. The second parameter amongst the category is maintaining the accuracy rates and detailing in the design with RII of 80.36% and overall ranking of eight. This factor run in parallel with the stringent inspection, because, if the details in the design and tolerance level are maintained for the reinforcing work the inspection wouldn't get much affected.

Table- 2: Relative Importance Index and Ranks of Technical/Technological/Construction method Category Productivity Factors

Factors	Relative Importance Index (%)	Rank
Stringent inspection by engineers & supervisors	84.29	1
Accuracy rates and design details	80.36	2
Method of hauling steel	79.29	3
Reassignment of work due to change in order	77.14	4
Change in specifications	76.79	5
Method of steel bending	71.43	6
Design difficulty	69.64	7
Degree of difficulty of work	65.71	8
Degree of repetition of steel work	64.64	9
Steel bending machine breakdown	60.36	10

The next factor is method of hauling steel with ranking of third among the category with RII of 79.29% and overall ranking amongst factor of ninth. Many construction sites in India still prefer hauling of steel manually as compare to using equipment to do the same. Thus, man force is involved reaching out the steel to the required location for its installation.

The fourth factor ranking amongst the category is the reassignment of work due change in order with RII of 77.14% and overall ranking of eleven among all the factors. Also, change in the specification ranks fifth in the category with RII of 76.79% and overall ranking of twelve. These factors run in parallel, because if the specifications of the structural member are changed correspondingly, the work is reassigned and the necessary changes are to be incurred. Also, if the reinforcement installation for particular structural member is not possible, the necessary changes are recommended by the structural engineers which is inclusive of the design difficulty factor ranked seventh amongst the group with RII of 69.64% and overall ranking of sixteen. Change in order and rework have marked to affect productivity in investigation studies of [2]; [7]; [10] and [13], while change in specifications and design complexity is enlightened in [20] and [2] respectively.

Method of bending steel ranked sixth amongst the category with RII of 71.43% and overall ranked fourteenth among all factor. The bending of reinforcement is practised was both traditional method

and with the use of steel bending machine. The productivity of labor would obviously be more with the machine. The degree of difficulty of the work marked eight among the group with RII of 65.71% and overall rank of nineteenth. This factor relates to nature of the work i.e., w.r.t. to the structural member. The reinforcing task work for retaining wall would be difficult in comparison to column or slab. While, the degree of repetition of work ranked ninth among group with RII of 64.64% with overall rank of twenty overall; and steel machine break down tenth in group with RII of 60.36% and ranked last amongst all the factors.

4.3 Human/Labor category

The importance index along with their ranks for the human/labor category is represented in Table 3.

The foremost significant factor in this category as well as amongst the overall factor is skills of fitter with RII of 87.50%. For performing any task work with labor involved, it is important aspect that the labor possesses the technical knowledge as well as the skills to perform the task. Skilful labor can outperform the task with required accuracy and detailing as compared to the unskilled labor. The skills of the labor marked significant impact on productivity in the investigation studies of [13]; [15] and [19].

Table- 3: Relative Importance Index and Ranks of Human/Labor Category Productivity Factors

Factors	Relative importance Index (%)	Rank
Skills of fitter	87.50	1
Size of crew	80.71	2
Duration for steel cutting and bending	70.00	3
Absenteeism	68.93	4
Time required for stirrups bending	62.86	5

Another factor affecting the productivity is size of the crew with second ranking among the class along with RII of 80.71% and overall ranking amongst factor of seventh. The crew size plays crucial role for the productivity of labor because if the crew size is less the require quantum of work cannot be completed within the speculated time; whereas if the crew size is too big the productivity of labor tends to decrease. Therefore, the optimum size of the crew should be utilized for the tasks work. Size of the crew also established remarkable impact on productivity of labor in the studies of [13] and [14].

The next factor of duration for steel cutting and bending implies to the longitudinal reinforcement, ranking third in the group with RII of 70% and overall ranking of fifteenth. While, time required for stirrups bending ranked least in the group with RII of 62.86% and overall ranking of twenty second.

Absenteeism marked fourth in the group with RII of 68.93% and overall ranking of eighteenth. This factor is included in human/laor category with a perspective that the labor tends to opt for holidays during bad weather conditions, festive seasons, non-payment of wages and even during the season of cultivation. The labor leave for holidays when irrespective of the work incubated in the construction. Therefore, affecting the overall work of the project. Absenteeism affects the productivity of labor is also enlightened in the investigation studies of [8]; [9] and [15].

4.4 External and on-site conditions category

The importance index along with their ranks for the external/on-site conditions category is represented in Table 4.

The leading factor in this class of category is the safety measures adopted on-site with RII of 82.50% and overall ranking of sixth among all factors. Safety measures are particularly more prominently required when the task work is enforced with labor, avoiding in the accidental situation on-site and perhaps delay. Safety measures and accidental causes due to poor safety have also remarked in the investigation studies of [13] and [15] respectively. The height of the work marks second in the group with RII of 78.21% and overall ranking of tenth. Since, the residential projects are having greater number of stories, at the greater heights the necessary safety measures are not adopted it increases the risks of the life of labor. Therefore, this parameter runs parallel with the safety measures adopted at site.

Table - 4: Relative Importance Index and Ranks of External and On-site Conditions Category Productivity Factors

Factors	Relative Importance Index (%)	Rank
Safety measures	82.50	1
Height of work	78.21	2
Weather conditions	69.29	3
Access to work area	64.29	4

The third factor amongst the group is the weather conditions with RII of 69.29% and overall ranking of seventeenth. The climatic conditions vary with rain, winters and summers; these conditions are varied for the different regions. In concurrent to the climatic aspect the work is carried out or not executed for the desired degree of the work. Weather conditions affecting labor productivity is also stated in research work of [1].

The fourth factor is access to the work area marking RII of 64.29% and overall ranking of twenty first. Access to the work area implies to the job-layout of the site; i.e., how easy is for the labor to get access to materials and work place. Access to work site was marked affecting the productivity in research study of [9].

4.5 General ranking of the productivity factors amongst the retrieved survey and group ranking

The overall recognized effects of the productivity factors are summarized in Table 5.

Table - 5: Overall Relative Importance Index and Ranks of the Productivity Factors

Factors	Relative Importance Index (%)	Rank
Skills of fitter	87.50	1
Supervision of foremen	85.00	2
Stringent inspection by engineers & supervisors	84.29	3
Materials supplies on time	83.57	4
Overtime provision	82.86	5
Safety measure	82.50	6
Size of crew	80.71	7
Accuracy rates &details in design	80.36	8
Method of hauling steel	79.29	9
Height of the work	78.21	10
Reassignment of work due to change in order	77.14	11
Change in specifications	76.79	12
Quantity of steel erection for particular work	75.00	13
Method of steel bending	71.43	14
Duration of steel cutting and bending	70.00	15
Design difficulty	69.64	16
Weather condition	69.29	17
Absenteeism	68.93	18
Degree of difficulty of work	65.71	19
Degree of repetition of steel work	64.64	20
Access to work area	64.29	21
Time required for stirrups bending	62.86	22
Steel machine breakdown	60.36	23

As shown in Table 5, the foremost 10 ranked factors marking a significant impact on the labor productivity of reinforcing installation activity in India are: (1) skills of the fitter; (2)supervision of foremen;(3)stringent inspection by engineers and supervisors;(4) materials supplies on time;(5) overtime provision;(6) safety measures;(7) size of crew; (8) accuracy rates and details in design;(9) method of hauling steel; and (10) height of the work. From the findings it is evident that out of 10 most influential factors three each parameter is classified under management and technical/technological/construction method; further two each factor is classified under human/labor and external and on-site conditions; marking the factors are distributed in a very effective manner.

The results of the group category demonstrate managemental factors as the most influential factors amongst the other group with average RII of 81.61%; indicating prominent effect of productivity if not taken care of. The second parameter with average RII of 74% is the human/labor factor; representing the labor marks significant impact on productivity after the managemental factors. Thus, projecting for increased productivity the factors of these groups play substantial role. The third and the fourth category represents the external/on-site conditions and technical/technological/construction method with average RII of 73.57% and 72.96%, respectively. The results indicate a very marginal variations amongst the last three groups.

Table - 6: Overall Average of Relative Importance Index and Ranks of Productivity Categories

Categories	Relative Importance Index (%)	Rank
Management	81.61	1
Human/labor	74.00	2
External and On-site conditions	73.57	3
Technical/Technological/ Construction method	72.96	4

5 CONCLUSIONS

The current investigation study has identified and, computed their relative important indices, deduced ranks of the 23 utmost influential factors impacting the productivity of labor for reinforcement installation activity in India. The factors were further categorized into four groups:(1) management; (2) technical/ technological/ construction method;(3) human/ labor; and (4) external/ on-site conditions.

This study represents that the managemental factors remarks significant impact on the labor productivity, indicating substantial skills and orientation towards the work is required to achieve the optimum production out of labor. Since, the construction practices in India as a developing nation is labor intensive, the second most critical group of factors affecting the productivity is the human/labor category. Because the manual labor carry out the considerable amount of work it is necessary that

the skills of labor are developed, they are motivated and encouraged for the task work completed, looked after their health and safety facets and most importantly educated with the technical aspect of the specifications; so that they are driven and invigorated for inculcating the required production level. Further, the on-site job conditions and external parameters like the weather condition, working conditions and the accessibility to work place and job-site; improvements of this parameters further enhance the productivity of the labor.

Apart from this three class of category, the technical/technological and construction method imparts to drive the productivity. The practice of keeping the drawing updated, maintaining the tolerance level for the described work, following the updates from the structural engineers for design details; boost further to the productivity of the labor.

Finally, the authors remarks that the investigation of this study bridges the gap of knowledge in recognitions of factors impacting the productivity rates of labor for reinforcement installation activity in India, which could be incorporated by the constructors, developers and consultants as guidance to draw focus and acted upon in order to achieve the required level of work with desired level of standard of the work. The authors further recommend to replicate this survey for other construction activities like formwork installation, concrete pouring, masonry work and floor finishing, and the same could be utilized to predict the future performance of labor.

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