Analysis of factors affecting labour productivity of a construction project

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Abstract - Construction sector is the key sector of the national economy for countries all around the world; it takes up a large portion in nation's total employment and plays an effective role in contributing to a nation's revenue as a whole. There are number of activities involved in the construction industry & human resource has an effective role for increasing productivity of any organization which makes it superior in the industrial competition. Labour Productivity is most important factor that affects overall performance in construction industry. There are number of factors that directly affect the productivity of labour, and it is important for any organization to study and identify those factors and take an appropriate action for improving the labour productivity. Improved productivity ultimately reduces or decreases the unit cost of project and gives overall best performance of project. Thus the effective use and proper management regarding labour is very important in construction operations without which those activities may not be possible. One of the biggest problems faced by construction industry is the lack of skilled labour which leads to productivity loss, cost overruns, and failure to keep up with schedule.

Keywords: Labour Productivity, LOPE Method.

1. INRODUCTION

1.1 General

Every year, owner operators, engineering, procurement, and construction (EPC) companies, and contractors are hit with billions of Rupees in construction claims as a result of inefficiency factors impacting labour. Construction activities should be planned in such a way that it considers and track labour factors in the original work scope to accurately reflect all the conditions that were used to estimate and fund the project, as well as to minimize the impact on productivity, which will directly affect the construction costs. It should also include changes in work scope that look at labour impacts as part of the sequence and planning of any work.

Productivity is the ratio of output to all or some of the resources used to produce that output. Output can be homogenous or heterogeneous. Resources comprise: labour, capital, energy, raw materials, etc.

Productivity = Output / Labour cost

Labour Productivity = Output /Work hour

Labour Productivity = (Labour cost / work hour) /Output

There is no standard definition of productivity and some contractors also use the inverse.

This study is divided into two parts. In the first part we discuss the major factors affecting labour productivity & in the second part we study its detailed analysis.

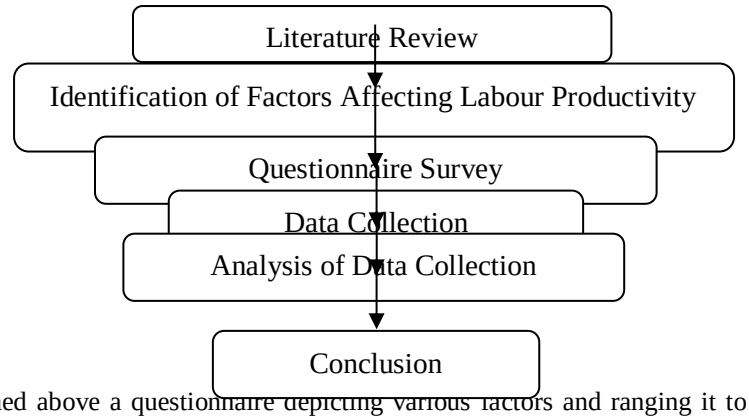
1.2 OBJECTIVES

To identify, evaluate the severity impact of the factors affecting in Labour productivity.

To achieve optimum Labour productivity in construction site.

To suggest a suitable Labour productivity plan to achieve the planned productivity for each activity.

2. METHODOLOGY



2.1 Questionnaire Survey

Based on the factors mentioned above a questionnaire depicting various factors and ranging it to a linear scale of 1 to 5 is developed.

Where,
1= Least Impact.
2= Medium Impact.
3= Average Impact.
4=Heavy impact.
5=Most Impact.
Has been developed to be circulated amongst various construction site engineers via internet to respond to those factors& recording their feedback.
The link for filling questionnaire is:
https://docs.google.com/forms/d/e/1FAIpQLSdYWkaIrwtso4QIrhqAbsVFoLlJl6LpZxCIlsGbYNMqdDGMpQ/viewform
In addition to this an investigation is ongoing on construction activities of a residential building in finding labour productivity achieved at each stage and comparing it to a baseline productivity defined in IS.

2.2 Relative Importance Index

To analyze these factors Relative Importance Index (RII) was used. RII method helps to determine the relative importance of the various factors affecting on labour productivity.

$$RII = \frac{\sum W}{A * N}$$

Where,
W is the weight assigned to each factor by the respondents which range from 1 to 5.
1 = Least Impact
2 = Medium Impact
3 = Average Impacts
4 = High Impacts
5 = Most Impacts.
N is the total number of responses collected for the ordinal scale.
From the responses collected from engineers through questionnaire survey following results were obtained. By analyzing these factors by Relative Importance Index, Ranks were assigned to it based on the level of its impacts.

Table 1: Relative Importance Index of the factors affecting labour productivity

Sr.no	Factors	RII	Rank
1	Lack of communication between site personnel.	0.883333333	1
2	Poor planning & scheduling of activities.	0.816666667	2
3	Delay in decision making.	0.816666667	2
4	Delay in payment.	0.783333333	4
5	Poor Quality of tools & machinery used.	0.75	5
6	Strikes & riots.	0.733333333	6
7	Lack of top management support	0.716666667	7
8	Poor Material & Vendor Management.	0.716666667	7
9	Government policies & laws.	0.683333333	9
10	Lack of proper resource allocation	0.666666667	10
11	Lack in providing incentives.	0.666666667	10
12	Shortage of temporary facilities on site.	0.65	12
13	Unfavorable weather conditions.	0.633333333	13
14	Material Storage area	0.633333333	13
15	Shortage of protective equipment on site.	0.616666667	15
16	Inaccessible or difficult location.	0.6	16
17	Frequent labour turnover.	0.583333333	17

3. CASE STUDY

Project Name: J.K Developers.
Contractor: Ruhaan Skyscrapers (India) Pvt. Ltd
Location: Kiwale, Pune
The study is undertaken at project J.K Developers where 18 floor residential building construction is going on. As the main project is related to shuttering, reinforcement & concrete our main focus is to calculate the productivity of main activities like shuttering, reinforcement & concrete respectively.
This study focusses on the activities from third floor. Following is the detailed schedule of activities obtained from site: Table 3 shows as planned & actual productivity for major items like shuttering, reinforcement & concrete.

Table 2: Details of as planned activities & executed activities.

Sr.no	Duration		Shuttering (sq.m)		Steel (tonne)		Concrete (cu.m)		Delay
			Planned (P)	*Executed (E)*	*Planned (P)*	*Executed (E)*	*Planned (P)*	*Executed (E)*	*(Days)*
1	06-Jan-19	31-Jan-19	710	600	25	18	181	54	17
2	01-Feb-19	26-Feb-19	710	550	23	17	181	40	16
3	02-Mar-19	24-Mar-19	710	650	23	18	181	54	8

The loss in productivity for each item i.e. shuttering, reinforcement & concrete will be calculated separately.

Table 3: Loss in Quantity for major activities.

Sr.no	Duration		Shuttering (sq.m)	Steel (tonne)	Concrete (cu.m)
1	06-Jan-19	31-Jan-19	110	7	127
2	01-Feb-19	26-Feb-19	160	6	141
3	02-Mar-19	24-Mar-19	60	5	127

4. RESULTS & ANALYSIS

Usually productivity of each activity is calculated unit/day but the normal working hours on site is 8 hours therefore the productivity is to be altered for 8 hours of time. Following table shows productivity worked out for 8 hours. For calculating the planned & executed productivity for shuttering, reinforcement & concrete Lope method is adopted using following equation.

$$Planned\ Productivity\ (unit/day) = \frac{Quantity}{Duration} \dots\dots\dots\dots\dots (eqn\ 1)$$

Table 4: Planned productivity for major activities.

Sr.no	Duration		Shuttering (sq.m) for 8 hrs	Steel (tonne) for 8 hrs	Concrete (cu.m) for 8 hrs
			Planned	*Planned*	*Planned*
1	06-Jan-19	31-Jan-19	85.20	3.00	21.72
2	01-Feb-19	26-Feb-19	85.20	2.76	21.72
3	02-Mar-19	24-Mar-19	96.82	3.14	24.68

Similar calculations are made for determining actual productivity of shuttering, reinforcement & concrete.

$$Actual\ Productivity\ (unit/day) = \frac{Quantity}{Duration} \dots\dots\dots\dots\dots (eqn\ 2)$$

Table 5: Actual productivity for major activities.

Sr.no	Duration		Shuttering (sq.m) for 8 hrs	Steel (tonne) for 8 hrs	Concrete (cu.m) for 8 hrs
			Actual	*Actual*	*Actual*
1	06-Jan-19	31-Jan-19	72.00	2.16	6.48
2	01-Feb-19	26-Feb-19	66.00	2.04	4.80
3	02-Mar-19	24-Mar-19	88.64	2.45	7.36

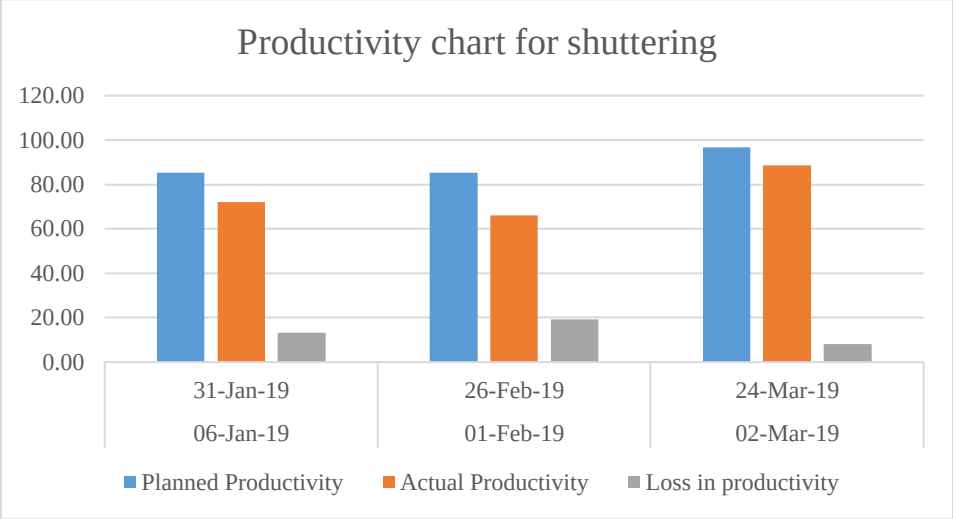
The loss occurred in productivity is calculated from following equation

$$Productivity\ Loss = Planned\ Productivity - Actual\ productivity \dots\dots\dots\dots\dots (eqn\ 3)$$

Table 6: Loss in productivity for shuttering.

Sr.no	Duration		Loss in quantity	Shuttering (sq.m)		Loss in productivity	Delay (days)
				Planned Productivity	*Actual Productivity*		
1	06-Jan-19	31-Jan-19	110	85.20	72.00	13.20	1.29

2	01-Feb-19	26-Feb-19	160	85.20	66.00	19.20	1.88
3	02-Mar-19	24-Mar-19	60	96.81	88.64	8.17	0.62

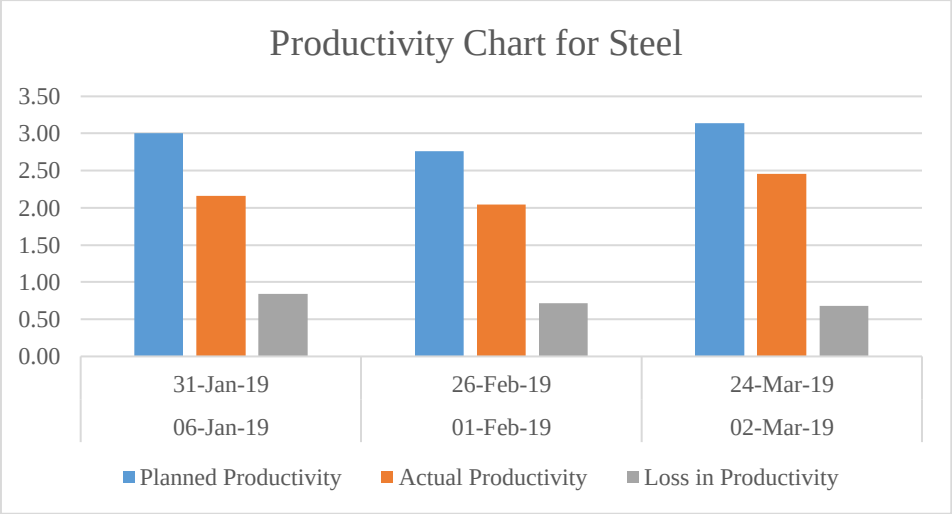


Graph 1: Graphical representation of productivity for shuttering item.

Above table shows detailed representation in tabular & graphical form of planned & actual productivity of shuttering activity by using equation 1, 2 & 3 for period from January 2019 to April 2019 of its schedule along with loss in productivity & delay associated with each activity.

Table 7: Loss in productivity for reinforcement.

Sr.no	Duration		Loss in quantity	Steel (tonne)		Loss in productivity	Delay (Days)
				Planned Productivity	*Actual Productivity*		
1	06-Jan-19	31-Jan-19	7	3.00	2.16	0.84	2
2	01-Feb-19	26-Feb-19	6	2.76	2.04	0.72	2
3	02-Mar-19	24-Mar-19	5	3.14	2.45	0.68	2



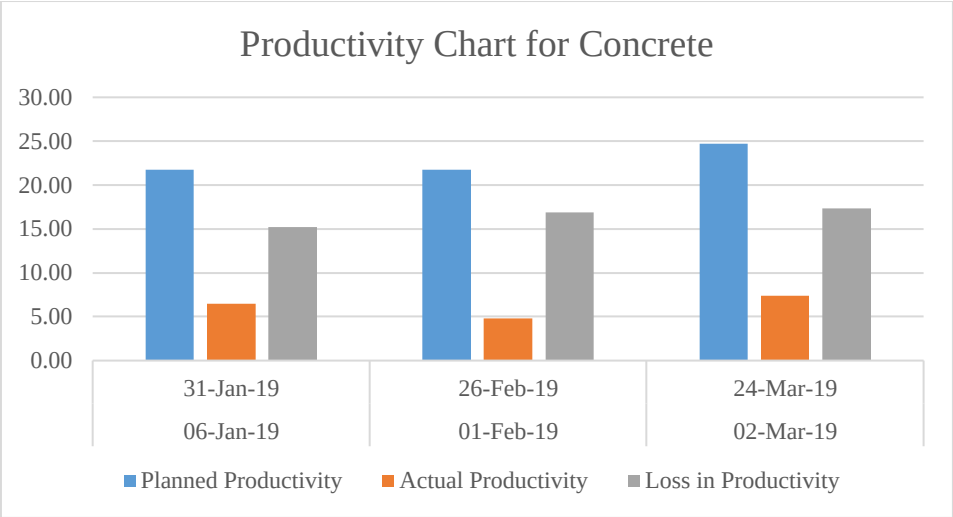
Graph 2: Graphical representation of productivity for reinforcement item.

Above table shows detailed representation in tabular & graphical form of planned & actual productivity of reinforcement by using equation 1, 2 & 3 for period from January 2019 to April 2019 of its schedule along with loss in productivity & delay associated with each activity.

Table 8: Loss in productivity for concrete.

Sr.no	Duration		Loss in quantity	Concrete(cu.m)		Loss in productivity	Delay (Days)
				Planned productivity	*Actual productivity*		
1	06-Jan-19	31-Jan-19	127	21.72	6.48	15.24	6

2	01-Feb-19	26-Feb-19	141	21.72	4.80	16.92	6
3	02-Mar-19	24-Mar-19	127	24.68	7.36	17.32	5



Graph 3: Graphical representation of productivity for Concrete item.

Above table shows detailed representation in tabular & graphical form of planned & actual productivity of concrete by using equation 1, 2 & 3 for period from January 2019 to April 2019 of its schedule along with loss in productivity & delay associated with each activity

6. CONCLUSIONS

The analysis done on the outcome of major activities it gives us new outlook on losses occurred in productivity of each activity, the delay associated with it. The above table shows us the planned productivity required to complete activity with maximum required efficiency & the actual productivity achieved on site. The planned productivity can be achieved by coordinating daily activity properly, assigning each activity with a specified time period, giving incentives so that the desired productivity is achieved & the activity is completed.

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