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Improving Construction Work Flow by Implementing Last Planner System on Construction Site

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Abstract: As part of an improving planning assessment procedure at the construction site, a questionnaire survey has been undertaken among all employees. Questionnaire surveys were administered to the project participants to evaluate the Last Planner System implementation process. The case study was carried out in Reserve Bank Officer's Quarters, Ameerpet, Hyderabad located in Southern region of India. It entailed the construction of one prototype residential building and one community centre building. The project is located at Reserve Bank of India's permanent site which is located 6 km from the Reserve Bank of India's Hyderabad office (Saifabad). The contract value of the project is approximately INR 12.5 Crores with estimated project duration of 18 months (24th July, 2014-23rd January, 2016). The project location is having direct access to the main road and is located in the core hub of the city. The questionnaire was divided into four sections (Section A-D). The first section (i.e., Section A) focused on getting an overview of the outcome of the implementation. Whereas the second section (i.e., Section B) focused primarily on the barriers of the implementation process. The third section (i.e., Section C) gave attention to the critical success factors of the implementation process. Furthermore, the last section (i.e., Section D) dwelt on the benefits perceived on implementing Last Planner System on the case project. The respondents for the questionnaire comprised of the contractor's team, the employer's and the suppliers. A percentage breakdown of the respondents is shown in Table 1 and the details of the questionnaires and their corresponding responses are discussed below. Out of the 25 employees involved in the survey 24 (96%) provided responses accordingly. Out of the respondent, 13 (54.17%), 4 (16.67%),4 (16.67%) and 3 (12.50%) are respectively contractor's team, client's team, sub-contractor's team and the supplier's team.

Key words: Continous improvement system, design science, lean construction, last planner system, weekly work plan, percent planned complete, make work ready planning

INTRODUCTION

Questionnaires surveys were utilized at the tail end of the implementation. The questionnaire was to provide a feedback on the implementation process. The questionnaire was divided into four sections. The first two sections were to establish the profile of the respondents and that of his organization. Subsequently, the next section reviewed the benefits recorded in the implementation of LPS while the last section dwelt with the critical success factors of the implementation. The questions for the case studies focused on the barriers, benefits and critical success factors of the implementation. However, the questionnaires for the current case study focused on the performance of the project in relation to the current construction practices of the project.

MATERIALS AND METHODS

Questionnaire design and analysis: Properly designing and formatting questionnaires plays a huge role in

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achieving a high response rate (Salem *et al*., 2006). The questions were both closed and open-ended and formatted using a 5 point likert scale for each attribute of question.The first section focused on the overview of the implementation, with four different questions being asked on; the effectiveness of the LPS implementation; the fulfillment of results obtained; the usefulness of the Weekly Work Plans (WWP) and the Percentages of Plans Completed (PPC); the degree of difficulty experienced while implementing the LPS. The second section on the other hand, centered on the barriers faced during the implementation process. Six possible barriers derived from the literature search and the other research processes were identified. The respondents were asked to determine the frequency of occurrences of these barriers. Similarly, the third section dwelt on the critical success factors of LPS. Different factors were identified from literature reviews and respondents were asked to determine their frequency of occurrence. Conversely, the fourth section focused on the perceived benefits of implementing LPS. The researcher also identified from literature reviews 10 possible benefits of implementing LPS within the case studies and respondents were asked to determine their frequency of occurrence.

RESULTS AND DISCUSSION

Data analysis: Data analysis is the process of bringing meaning and interpretation to mass data collected. Amaratunga *et al*. (2002) identified that data analysis, forms a major part of any research. It consists of examining, categorising and tabulating data obtained. In this research, a structured literature review was first conducted and it served as the foundation for the research. The empirical data gathered was both qualitative and quantitative in nature and they were used to establish he link between the literature reviews. Questions were asked using questionnaires and interviews. For the questionnaires, a Likert scale was used to access the views of the participants. Sacks and Goldin (2007) indicated that Likert scales fall within the ordinal level of measurement which means that the responses are categorized and ranked into the following categories; never, rare, seldom, frequent and very frequent. The categorization and ranking enables priorities to be allocated (Ballard and Howell, 2004).

In carrying out this research, the Ranking Indices of Importance (RII) was used. RII is commonly used to measure the extent to which the occurrence of an outcome exists. The following formula was used to calculate RII.

$$RII = \frac{\overset{v}{x}}{K}$$

Where:

$$\overset{v}{x} = \text{mean} = \frac{Sfx}{Sfy}$$

Where:

k = Maximum point on likert scale (k = 5)
x = Points on the Likert scale (1, 2, 3, 4)
f = Frequency of respondents choice

For the interpretation of the RII values, RII is ranked from the highest to the lowest. If RII < 0.60 item has low rating 0.60 <RII < 0.8 item has high rating RII = 0.8 item has very high rating. Other statistical analysis were also employed using simple Microsoft excel and word to present a visual representation of the patterns and trends of the data, especially for the PPC presentations and the reasons for incomplete assignment calculations.

Post implementation process: The respondents for the questionnaire comprised of the contractor's team, the employer's and the suppliers. A percentage breakdown of the respondents is shown in Table 1 and the details of the questionnaires and their corresponding responses are discussed below. Out of the 25 employees involved in the survey 24 (96%) provided responses accordingly. Out of the respondent, 13 (54.17%), 4 (16.67%), 4 (16.67%) and 3 (12.50%) are respectively contractor's team, client's team, sub-contractor's team and the supplier's team (Table 2-6).

The question asked that whether Last Planner System is effective within the project or not, was examined by the 24 respondents under the Five Point Likert Scale. The percentage of those accepting the effectiveness of Last Planner System within the project is 76%, against 24% that neither agreed nor disagreed. Furthermore, it was identified that 56% of the respondents agreed to the statement that as compared to their previous projects, the results were quiet satisfactory this time. In the same way, the question that whether the weekly work plans or PPC's were useful to the implementation was carefully examined, 48% respondents agreed on the usefulness of weekly plans and PPC while the remaining 52% respondents were indifferent or disagreed. Additionally, from the survey results, 64% of the respondents felt that the process of implementing Last Planner System was difficult. However, the remaining 36% felt it was easy to carry out the implementation of Last Planner System. In summary of the section A and judging from the proportion of responses

Table 1: Respondents of the questionnaire for the case study

Parameters	Frequency	Percentage
Contractor's team	13	54.17
Client's team	4	16.67
Subcontractor's team	4	16.67
Supplier's team	3	12.50
Respondents total	24	100.0

Table 2: Overview of the implementation (Section A) case study

	Weighting frequency (f)										
Reasons	1	2	3	4	5	Σf	$\bar{x}$	RII	Rank	Rating	Rating (%)
LPS was very effective within this project.	0	1	5	12	7	25	4.00	0.80	1	Very high	76.00
The results obtained from the implementation were satisfactory as compared to the previous projects	5	6	0		6	25	3.16	0.63	3	High	56.00
The weekly work plans and PPC were very useful	5	3	5	12	0	25	2.96	0.59	4	Low	48.00
Difficulty to carry out the implementation	4	0	5	9	7	25	3.60	0.72	2	High	64.00

Table 3: Barriers during the implementation (Section B) case study

	Weighting frequency (f)										
Barries	1	2	3	4	5	Σf	$\bar{x}$	RII	Rank	Rating	Rating (%)
Poor Supervision and quality control	5	5	3	10	2	25	2.96	0.59	3	Low	48.00
Fluctuations and variations	6	7	2	10	0	25	2.64	0.53	6	Low	40.00
Employer's involvement	0	8	8	7	2	25	3.12	0.62	2	Low	36.00
Resistance to change	7	5	2	7	4	25	2.84	0.57	4	Low	44.00
Cultural issues	4	4	2	15	0	25	3.12	0.62	1	High	60.00
Length approval issues by client	9	0	5	11	0	25	2.72	0.54	5	Low	44.00

Table 4: Critical success factors to the Implementation (Section C) case study

	Weighting frequency (f)										
Factors	1	2	3	4	5	Σf	$\bar{x}$	RII	Rank	Rating	Rating (%)
Training and empowering last planners	0	3	2	11	9	25	4.04	0.81	3	Very high	80.00
Involvement of all stake holders (team work)	0	0	8	9	8	25	4.00	0.80	4	High	68.00
Motivating people to make changes	3	4	0	10	8	25	3.64	0.73	6	Very high	72.00
Having the appropriate human capital	0	5	5	9	6	25	3.64	0.73	7	High	60.00
Top management support	0	3	0	15	7	25	4.04	0.81	2	Very high	88.00
Manage resistance to change.	2	1	4	7	11	25	3.96	0.79	5	High	72.00
Close relations with suppliers	0	1	0	13	11	25	4.36	0.87	1	Very high	96.00

Table 5: Benefits of the implementation (Section D) case study

	Weighting frequency (f)										
Benifits	1	2	3	4	5	Σf	$\bar{x}$	RII	Rank	Rating	Rating (%)
Solve Problems on time.	2	0	7	9	7	25	3.76	0.75	3	High	64.00
Reducing the incidence of bad news and to get what bad news there is early	0	0	7	9	9	25	4.08	0.82	2	Very high	72.00
Developing supervisory skills and reducing the load on management	2	5	6	7	5	25	3.32	0.66	7	Low	48.00
Creating a more predictable and reliable production program	0	0	7	8	10	25	4.12	0.82	2	Very high	72.00
Delivering projects more safely, faster and at reduced costs	5	5	4	5	6	25	3.08	0.62	8	Low	44.00
Stabilize projects and support other lean actions	0	1	5	8	11	25	4.16	0.83	1	Very high	76.00
Improving construction logistics on projects	0	8	0	8	9	25	3.72	0.74	4	High	68.00
Improving predictions of labour required	3	0	8	9	5	25	3.52	0.70	5	High	56.00
Reduces the risk of catastrophic loss	4	1	6	7	7	25	3.48	0.70	5	High	56.00
Completes projects on schedule	0	3	9	13	0	25	3.40	0.68	6	High	52.00

Table 6: Benefits of last planner system (Section E) case study

	Weighting frequency (f)										
Reasons	1	2	3	4	5	Σf	$\bar{x}$	RII	Rank	Rating	Rating (%)
Increased work flow reliability	0	1	1	13	10	25	4.28	0.86	1	Very high	92.00
Improved supply chain integration	5	0	4	10	6	25	3.48	0.70	10	High	64.00
Reduced production time	0	1	3	9	12	25	4.28	0.86	2	Very high	84.00

Table 6: Continue

	Weighting frequency (f)										
Reasons	1	2	3	4	5	Σf	$\bar{x}$	RII	Rank	Rating	Rating (%)
Improved communication.	0	0	8	13	4	25	3.84	0.77	6	High	68.00
Improvement in quality of work	2	0	8	6	9	25	3.84	0.77	7	High	60.00
Improved collaboration	0	3	9	13	0	25	3.40	0.68	11	High	52.00
Greater customer satisfaction	1	1	9	10	4	25	3.60	0.72	8	High	56.00
Improved safety	0	0	6	15	4	25	3.92	0.78	4	Very high	76.00
Commitment	1	1	9	11	3	25	3.56	0.71	9	High	56.00
Improved project delivery time	0	0	5	13	7	25	4.08	0.82	3	Very high	80.00
Less stress	1	0	6	12	6	25	3.88	0.77	5	Very high	72.00

obtained from each question, we can conclude that a large proportion of the respondents agreed to the effectiveness of the Last Planner System and the results obtained from the implementations were satisfactory. Similarly, a large proportion of respondents also attested to the usefulness of WWP and PPC. However, a significant proportion agreed that it was difficult to implement Last Planner System on this project.

Summary: This chapter presents in substantial detail the process of implementing "last planner system" in the construction of reserve bank officer's quarters in Ameerpet, Hyderabad. The chapter described the phases of Last Planner System implementation; these phases comprised of Pre-implementation, Implementation and Post-implementation phases. The chapter also highlights the Barriers, Critical success factors and the perceived benefits recorded from the responses of the survey questionnaire completed by the project participants. From the PPC data recorded in this chapter, it was also revealed that material unavailability, pre-requisite work, labour supply, submittals, poor weather, rework, equipment breakdown and incomplete design information were all constraints faced within the project. However, implementing last planner system by the contractor was able to identify these constraints on time and it minimised the effect on the project.

CONCLUSION

It was observed that contractor produced substantial results in terms of time cost and quality performances. The contractor completed the construction project two months before than the actual completion date allocated to the project, even though the project kicked off three months late. The contractor had a better allocation of resources, an organized flow and access of materials and this reduced interference amongst working teams by making all the team members aware of what to do and when to do each assignment. Although the project suffered from shortage of materials, the problem of material shortage was overcome by engaging in short term and look ahead planning together with regularly doing a constraint analysis to envisage possible constraints to the project before they occur. Thus, implementation of Last Planner System helped the project team to receive information regularly of the project success and failures during weekly meetings.

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