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Lean Construction Practices in Public Projects of Pakistan

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Abstract:
Background*: Lean construction is an effective process being used in construction industry to overcome the problems of non-value adding activities and associated generation of physical and non-physical wastes. Lean construction is a philosophy which consists of several methods and techniques serving as strong tool for improving construction productivity. Lean construction has 11 well established principles which ensure the successful application of lean concept in construction. In Pakistani construction industry, lean construction is a new concept.*
Materials and Methods*: To assess the level of effectiveness and implementation(adoption) of various lean principles in construction projects of Pakistan, a comprehensive survey and data analysis was made through a developed questionnaire survey. Thirty-two completed questionnaire forms were received from different client organizations, consultant and contractors. Based on the responses collected through questionnaire survey, assessment was done based on statistical analysis. Analysis of data involved reliability test and mean value test for determining level of implementation of lean principles and theireffectiveness level.*
Results*: The analysis results indicated that three principles namely focus control on complete process, simplify by minimizing the number of steps, parts and linkagesand increase transparency are the most adopted lean principles by the construction industry of province of Sindh, while reduce variability, increase process transparency and balance flow improvement with conversion improvement are the most effective principles of leanwhich will increase profitability, minimize inventory, &enhance the performance of the construction sector by reducing the waste production in the project activities and processes.*
Conclusion:*The findings of this study will be very helpful for the practitioners involved in construction industry to know various lean principles and to enhance for implementation in construction projects.*
Key Word*:Construction Industry, Lean, Lean Principles, Pakistan, Sindh.*

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I. Introduction

The construction industry is a growing sector on global level[1]. Fundamental part of economy of many parts of the world depends upon this industry. The 70 % growth of this industry was forecasted by the 'Construction 2025' industrial strategy report published by UK Government in between 2013 and 2025. Several threats as environmental pollution, waste production and energy consumption are however associated with this industry[2]. Besides this, managerial issues, escalations, time and cost overruns are always being intimidations to this trade. Lean Construction can be one of the emerging solutions to this menace in context of Pakistan.

Implementation of lean principles and techniques at the site for management of construction and other utilities is defined as lean construction[3]. In the area of improving project performance of the construction works, lean construction has remained popular topic amongst researchers. Lean construction is basically a philosophical approach which helps in enhancing value of the works through continuous improvement[4]. Lean application in construction helps in achieving completion of project within or even before scheduled time[5]. A study revealed that by application of lean concepts, 25% of the construction times was reduced [6] while it also contributed in reduction of 5 to 12% of the project cost. Though traditional approach to construction managementfocuses on sustainability, quality, cost and time but lean construction technique expands this to minimization of environmental degradation, social, contextual and cultural consideration, minimal resource depletion and way to build a health built environment[7,8,9]. Successful implementation of lean construction results in improving project performance[10]. Due to scarcity of literature regarding lean applications in Pakistan construction industry, this study aims to assess the current status of lean construction management so that necessary path way can be built to enhance the application of lean construction in Pakistan. However, the scope of the data collection was limited to the construction projects carried out in province ofSindh only. This study focused on identifying the

level of adoption of lean principles and level of effectiveness of those principles in the construction industry of Pakistan.

The aspiration of lean thinking is the purging of waste called as Muda in Japanese. Lean focuses on maximizing the customer value by reducing waste. Lean application can be ensured by adoption of basic principles[4] which include:

1. Reduce the share of non-value-adding activities.
2. Increase output value through systematic consideration of customer requirements.
3. Reduce variability.
4. Reduce cycle times.
5. Simplify by minimizing the number of steps, parts and linkages.
6. Increase output flexibility.
7. Increase process transparency.
8. Focus control on the complete process.
9. Build continuous improvement into the process.
10. Balance flow improvement with conversion improvement.
11. Benchmark.

II. Data Collection and Results

The Questionnaire survey was carried out through by interview, post(e-mail) and by hand to different groups of respondents i.e. client, consultant, contractor that were from Public and Private Sectors. A total of 100 questionnaires were distributed randomly in many construction companies during the semester break. The response rate was moderate and 32 completed questionnaire sets were received. Demographic information of the respondents is presented in table 1.

Table no 1: Type of Organization.

Respondent Organization	Response Frequency	Percent (%)
Client	5	15.6
Consultant	5	15.6
Contractor	22	68.8
Respondents work experience		
0-5 years	15	46.9
6-10 years	3	9.4
11-15 years	9	28.1
16-20 years	3	9.4
20-25 years	1	3.1
>25 years	1	3.1
Respondents Qualification		
Diploma	2	6.2
Bachelor's	24	75
Master's	6	18.8
PhD	0	0

Table 1 above depicts that the respondents involved in data collection for this project represented all three major stakeholders i.e. contractor, client and consultant. However, majority of respondents belonged to contractor organizations. All the respondents had experience of handling construction projects for several years and most of the personnel have engineering degree. Data was tested for reliability check using Cronbach's Alpha (α) with SPSS software. Alphavalue was obtained as 0.845 which is considered as satisfactory. Hence, it can be summarized that consistency level of data is high and data can be used for further analysis. Responses for the principles of lean were collected using measurement scale as shown in table 2.

Table no 2: Measurement Scale.

Description for Level of Adoption	Description for Level Effectiveness	Scale
Never	Not Effective	1
Sometimes	Less Effective	2
Moderately	Moderately Effective	3
Usually	Very Effective	4
Always	Extremely Effective	5

Collected data was analyzed for ranking purpose with statistical software package SPSSand the results are presented in table 3 below.

Table no 3: Ranking of Lean Principles.

S#	Lean Principles Level of Adoption	Frequency (Percent)						Mean Value	Rank
		1	2	3	4	5	Total		
Level of Adoption of Lean Principles									
1	Focus control on the complete process	0	3(8.8)	6(17.6)	14(41.2)	9(26.5)	32(100)	3.91	1
2	Simplify by minimizing the number of steps, parts and linkages	0	0	0(29.4)	16 (47.1)	6(17.6)	32 (100)	3.87	2
3	Increase process transparency	0	1(2.9)	11(32.4)	12 (37.5)	8 (25)	32 (100)	3.84	3
4	Build continuous improvement into the process	0	2(5.9)	10(29.4)	12(35.3)	8(23.5)	32(100)	3.81	4
5	Increase output flexibility	0	3(8.8)	8(23.5)	13(38.2)	8(23.5)	32(100)	3.81	5
6	Benchmark.	0	2(5.9)	9(26.5)	15(44.1)	6(17.6)	32(100)	3.78	6
7	Balance flow improvement with conversion improvement	0	1(2.9)	11(32.4)	14(41.2)	6(17.6)	32(100)	3.75	7
8	Reduce variability	0	4(11.8)	9 (26.5)	13(38.2)	6(17.6)	32 (100)	3.66	8
9	Reduce cycle times	0	3(8.8)	12(35.3)	11(32.4)	6 (17.6)	32 (100)	3.63	9
10	Increase output value through systematic consideration of customer requirements	0	5(14.7)	7(20.6)	16 (47.1)	4 (11.8)	32 (100)	3.59	10
11	Reduce the share of non-value-adding activities	0	1(2.9)	16 (47.1)	12 (35.3)	3 (3.8)	32 (100)	3.53	11
Level of Effectiveness of Lean Principles									
1	Reduce variability	0	1(2.9)	10 (29.4)	13(38.2)	8(23.5)	32 (100)	3.88	1
2	Increase process transparency	0	1(2.9)	8(23.5)	18 (52.9)	5 (14.7)	32 (100)	3.84	2
3	Balance flow improvement with conversion improvement	0	1(2.9)	11(32.4)	13(38.2)	7(20.6)	32(100)	3.81	3
4	Reduce cycle times	0	2(5.9)	9(26.5)	15(44.1)	6(17.6)	32 (100)	3.78	4
5	Focus control on the complete process	1(2.9)	1(2.9)	10(29.4)	14(41.2)	6(17.6)	32(100)	3.72	5
6	Increase output flexibility.	(2.9)	2(5.9)	8(23.5)	16(47.1)	5(14.7)	32(100)	3.69	6
7	Simplify by minimizing the number of steps, parts and linkages.	0	2(5.9)	9(26.5)	19 (55.9)	2(5.9)	32 (100)	3.66	7
8	Build continuous improvement into the process	0	3(8.8)	10(29.4)	14(41.2)	5(14.7)	32(100)	3.66	8
9	Increase output value through systematic consideration of customer requirements	0	4(11.8)	8(23.5)	17 (50.0)	3 (8.8)	32 (100)	3.59	9
10	Benchmark.	(2.9)	1(2.9)	15(44.1)	10(29.4)	5(14.7)	32(100)	3.50	10
11	Reduce the share of non-value-adding activities	0	3(8.8)	15 (44.1)	12 (35.3)	2 (5.9)	32 (100)	3.41	11

From table 3 it can beseen that most commonly adopted principle of lean in construction works of Pakistan is "focus control on the complete process" and is placed at 1st rank. Simplify by minimizing the number of steps, parts and linkages is reported as second commonly adopted principle while the respondents reported that at third rank from adoption level in lean principle is increase process transparency. On the other hand, the respondents are of the opinion that reduce variability is most effective principle of the lean. By reducing variability, uncertainty level is controlled, and project performance can be increased. Increase process transparency is considered as 2nd most effective principle of lean while third ranked principle of lean from effective perspective is Balance flow improvement with conversion improvement.

III. Conclusion

This paper studiedthe adoption and effectiveness level of lean principle in construction projects of Sindh province. Analysis of 32 collected samples from construction stakeholder revealed that focus control on the complete process, simplify by minimizing the number of steps, parts and linkages;and increase process transparency are three commonly adopted principles while reduce variability, increase process transparency and balance flow improvement with conversion improvement are the effective principles of lean. Overall construction performance can be improved by bringing effective principles in practice.

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