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Awareness of Lean Construction in Construction Industry through Questionnaire Survey in India

Radhika Sharma[1], Archana Tiwari[2]

[1]M. E. student, civil engineering department , Madhav Institute of Technology and Science(MITS), Gwalior
[2]Professure of Civil Engineering department, Madhav Institute of Technology and Science(MITS), Gwalior

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Abstract - *The concept of Lean Construction has been introduced successfully into the Construction Industry to increase efficiency and profit by elimination of non-value adding activities or 'Waste'. Lean Construction is an adaptation of Lean manufacturing principles and is the future of the Construction Industry in developing as well as developed countries. There has been much study and documentation conducted on 'Lean Construction' in USA. Even though people have started practicing Lean in India, there is lack of documented information available about it. Professionals within the Industry could already be minimizing 'Waste' and/or following Lean principles without the knowledge of the term 'Lean Construction. This suggested a need for education, training, and an increased awareness about the Lean Construction in India. It is possible that professionals, within the industry are already minimizing waste and adopting principles without being aware of 'Lean Construction' as a term. This research work is about Lean Construction practices and awareness in Madhya Pradesh.*

In the present work author conducted study in two parts. In the first part a questionnaire is prepared to assess the knowledge and awareness of construction professionals in Gwalior and nearby areas about lean construction practices

Key Words: **lean Construction, Industry, Questionnaire, Awareness**

1.INTRODUCTION (*Lean Construction)*

Lean Construction was introduced in 1993 in USA by the International Group of Lean Construction (IGLC). The goal of the IGLC is to significantly enhance both the product and the architectural, engineering, and construction (AEC) process in order to better satisfy client requests (IGLC, 2010) [1] Lean Construction is a relatively new Construction Management philosophy in developing countries like India. Lean Construction has evolved from Lean manufacturing principles. There has been a lot of interest in Lean Construction in developing countries, along with its numerous tools including the Last Planner System, Just in Time, Total Quality Management, and Continuous Improvement. has received a lot of attention in developing nations.

1.1 BASIC CONCEPT OF LEAN

Womack and Jones (1996) [2] identified following five key principles for the basis of design of any lean construction system.

- **Value**: There is a need to clarify the customer's needs in order to clarify activities or products that signify value.
- **Value Stream:** By mapping the whole value stream, establishing cooperation between the participants, and identifying and eliminating waste, the construction process can be improved.
- **Flow**: Business flow includes project information (pacifications, contracts, plans, etc.). Job site flow involves the activities and the way they must be done. Supply flow: refers to the materials used in a project.
- **Pull:** The efforts of all participants stabilize pulls during the construction process.
- **Perfection**: Work instructions, procedures and quality controls are established.

1.2 CONTINUOUS IMPROVEMENT

A Lean approach with Continuous Improvement provides a framework to continuously examine work processes and seek better performances. Various tools are available, and the cross-functional teams often bring new perspectives to the table.

Lean thinking can provide continuously improving Value for the customer by:

- Improving the quality of work processes
- Reducing errors or defects in work processes
- Reducing waste and costs
- Improving flow of the process
- Simplifying complex processes
- Reducing lead time
- Improving employee morale

1.3 COLLABORATIVE WORKING

- "Collaborate"— "the action of working with someone else to produce or create something."
- Collaboration starts with sharing information and knowledge across the team to work together to develop the best project plan within the applicable budget, schedule, and quality constraints.
- True collaboration requires the face to face, hand to hand working together in a collaborative space that makes all ideas visible, allows all voices to be heard and develops several options to problem solving that allow for choices among competing ideas for all aspects of the project.
- Collaboration inevitably leads to innovation. It also has another; equally important benefit allows trust to develop.

Project as a Production System –

ERA-1 PRODUCTIVITY 1900-1990	**ERA-2 PRIDICTIVITELY 1950**	**ERA-3 PROFIBILITY 2000-**
Scientific Management	Project Management	Project and Production System
How to Get More Out Of Workers	How to Predict Project Outcomes Through Measurement and Compliance.	How to Deliver Business Objectives Minimal Use of Resources

- Key strategies of Ford's system of Mass Production and Frank wool lard's Flow Production followed by TPS (Toyota Production System) include
- maintaining a flow of production from the beginning to the end of the process or
- the value stream by reducing variability and effectively controlling the amount of work-in process.

1.4 LEAN CULTURE

- Our team-mates values, attitudes, beliefs, orientations, and underlying assumptions compose the culture of our workplace.
- This culture is defined as the social domain that expresses continuities and discontinuities of shared meaning over time.
- In essence, it is the "stuff" we pass on to others for them to learn from and follow
- Having a shared culture makes it easier for processes to be sustainable in the long run without much moment-to-moment guidance.
- This was the case with Toyota when their renowned 'Toyota Way' emerged from their unique culture of inspired and empowered people, good communications, and continuous improvement."
- It is essential to create and manage teams in order to foster a project team culture that promotes full collaboration.
- This should be a culture with shared behaviours, attitudes, values, and rules that contribute significantly to the success of the project. Such a culture must go beyond merely encouraging.
- positive thinking; it must also offer space, tools, and procedures for its growth and flourishing.
- An effective project team culture must include qualities such as trustworthiness, open-mindedness, global consciousness, collaboration, innovation, and more.

1.5 CORE CONCEPT OF LEAN IDENTIFY WASTE & ELIMINATE IT

MURA (Inconsistency/ Unevenness) - Unevenness in the production system relating to labour.

MURI (Unreasonableness / Impossible / Overdoing) – Overburden of labour and Machine

MUDA Activities that do not add any value to the customer (the 8 wastes)

There are 8 types of waste in Muda:

1. **Transportation** -Locating materials to far from the point of installation
2. **Inventory** -Stockpiling too much material well before it is needed and in the way of other trades
3. **Motion** - Double and triple handling of material when planning could have reduced it to on move
4. **Excess Processing** - Finishing a foundation wall when it will be backfilled or covered
5. **Defects -** Items of work that are deficient and do not meet requirements which require rework

6. **Over-production-** Producing more pipe spools than required

7. **Waiting -**Wait for materials, tools, instructions, work-area etc.

8. **Not Utilizing Human Resources -** Assigning tasks to people who cannot do it, Not-assigning to people who can do it

Lean identified eight forms of waste that can be summarized by the mnemonic "TIME DOWN".

Types of MUDA

Beyond the 8 forms of Muda, is generalized into-

Type 1 Muda (NVAN – Non-Value Added but Necessary)

- Actions that are non-value added, but are deemed necessary for the process. This type of waste cannot be eliminated immediately.

Type 2 Muda (NVA – Nov-Value Added)

- Actions that are non-value added, and are also not necessary for the process. These are the first target of elimination.

MURA and MURI are the root causes of MUDA

1.6 KEY LEAN TOOLS

Key Lean tools	Lean Principle	Types of waste	Implementation time
Productivity Measurement System (not a formal lean tool)	Assisting in measuring and monitoring productivity	Indicates there is waste	Existing system
Work Sampling (WS)	Identify waste through observation	NVAN, NVA (more detailed categories if required	Low
Value Stream Mapping (VSM)	Flow of production; visualization; waste identification	Inventory, Transportation, Defect, Waiting	Medium
5S	Waste identification and elimination organize and standardize the work value	Motion, delays	Medium
Collaborative Planning System (CPS)/Last Planner System (LPS)	Workflow reliability; pull; collaboration, cooperation	Addresses waste reduction at a micro level	High
Big Room Approach	Cross functional collaboration; Coordination pulls	Addresses waste reduction at a micro level	High

2. LITERATURE REVIEW

Application of Lean thinking, principles, and tools to the lifecycle of capital construction projects is known as 'Lean Construction'. The term 'Lean Construction' is intended to cover the application of Lean thinking, principles, and tools to the entire process of a project from the concept through decommissioning. However, the initial reaction to the term within the industry caused opposition and exclusion. Lean Construction was misinterpreted as applying only to the 'construction' phase of a project. Therefore, constituencies like owners and architects did not think that the methodology also applied to them – this is changing. (Sayer & Anderson, 2012) [3]

Several authors have studied the application of Lean philosophy to the Construction Industry. Salem et al. (2005) [4] conducted a field study with the help of direct observations, interviews, questionnaires, and documentary analysis to evaluate the effectiveness of some Lean Construction techniques, including the last planner, we have implemented visualization techniques, regular team meetings, initial trial analyses, the 5s methodology and a safe system to ensure high quality standards. The study focused on the first phase of a four-floor university garage project located in the USA. The structure was cast-in-place reinforced concrete. It was found that there is need for behavioral changes and training for effective use of Lean Tools The majority of the Lean Construction tools chosen for the project are either suggested with minimal adjustments or are ready to use.

The main obstacle for Lean Construction is that the project manager or the contractor may question the use of the Lean principles at an early stage of implementation of Lean at any new project site. This is since the benefits of Lean implementation are seen in long term. The long-term benefit of Lean is that the project is constructed under or at least within the estimated budget and within the scheduled time as Lean emphasizes on 'minimizing the 'Waste'.

Song, L. & Liang, D. (2011) [5]After conducting an analysis of the contractor's case study it became evident that apart, from reevaluating construction methods and approaches there was a requirement, for innovative tools to effectively incorporate Lean principles. Their study observed 'Waste' in both project-level contractor coordination and operation-level construction performance. Tools for 3-D visualization and building simulation were used to apply "Waste"

elimination methods at the operational level. One of the main reasons leading to 20 wastages at the construction site was the lack of communication and coordination. Song and Liang developed a vertically integrated scheduling system that features an interface with critical path method (CPM) based schedules, a location-based look-ahead scheduling algorithm, and a graphic weekly planning method to improve it.

In a vein Dr. Siddique in his work (date not provided) explored the current condition of the cement industry, in India well as how fly ash and construction "Waste" are being utilized in construction activities. The study also discussed potential advances in use of materials such as high-volume fly ash (HVFA) which is the byproduct produced during the combustion of coal, ready mix concrete the use of RMC (Ready Mix Concrete) and self-compacting concrete (SCC), in construction activities expected to take place in India over the decade (2008 2018). Their impact, on the Concrete Construction Industry. Additionally, it provided information about the developments that have taken place in India related to the utilization of fly ash, cement production and construction 'Waste' as well as potential in the decade the Concrete Construction Industry is expected to make progress by incorporating supplementary cementing materials, RMC (Ready Mix Concrete) and SCC (Self Compacting Concrete), on a large scale.

Bhattacharjee, B. (2010) [6] concluded that there was a need for being concerned about sustainability of concrete in India and minimizing the wastage of precious natural resources by making their efficient and judicious use. Concrete construction, in India has been able to achieve advancements through the utilization of large-scale mechanization along, with the widespread implementation of ready-mix concrete (RMC) techniques and prefabrication methods whenever feasible. Furthermore, the study concluded that use of six concrete components namely, coarse aggregate, fine aggregate, water, ordinary Portland cement (OPC) with mineral admixture/blended cement and plasticizer for production of Using engineered concrete of non-engineered or semi engineered concrete has the potential to make the concrete industry, in India more sustainable.

3. METHODOLOGY

For this research information was collected confidentially using a survey questionnaire. For this purpose, more than 70 professionals working in firms related to Construction Industry from India were identified and subsequently requested to complete the 12 questionnaires. These professionals included architects, structural engineers, project managers, and various consultants associated with the Construction Industry.

The questionnaire was created using the google form. The invitation to take the survey was distributed via emails. From this, 49 professionals duly filled the survey and were respondents for this study.

4. DATA COLLECTION

The information collected through the survey. Response to each question from the respondents is shown in graphical form and is explained further.

Table 1. Respondents and their experiences

Sr. no.	Answer	Response	%
1	Architect	5	13.5%
2	Construction Manager/Project Management	5	13.5%
3	Contractor / Sub-Contractor	10	27%
4	Designer/ Engineer	15	40.5%
5	General Manager	2	5.4%
	Total	37	100%

Table 1., it was discovered that majority of the respondents in this study had varied roles in their respective company, i.e., Architects, 5 individuals (13.5% respondents). Respondents representing Construction Manager/Project Management were the third largest group corresponding to 5 individuals or 13.5%. There were 10 respondents (27%) who were Contractor / Sub-Contractor while the 15 individuals (40%) were designer and engineer and rest 2 individual were General Manager.

Table 2. Respondent's Level of Experience (In Years);

#	Answer	Response	%
1	Fresher's	9	23.7%
2	0 to 5 years	20	52.6%
3	5 to 10 years	7	18.4%
4	More than 10 years	2	5.3%
	Total	38	100%

that as many as 9 (23.7%) respondents were fresher's and 20 (52.4%) Respondents with experience between 0 to 5 years. 7 respondents (18.4%) had work experience between 5 to 10 years while remaining 2 respondents (5.3%) had more than 10 years of experience in the industry.

Table 3. Respondent's awareness about the term 'Lean Construction'

#	Answer	Response	%
1	yes	16	46%
2	no	17	54%
	Total	35	100%

Table 3. indicates that there was a mixed response to the awareness of the term 'Lean Construction'. 54% respondents from India did not know the term 'Lean Construction' while remaining 46% respondents knew the term.

Table 4. Respondents using project management system/technique in construction projects

#	Answer	Response	%
1	yes	33	89.2%
2	No	4	10.8%
	Total	37	100%

Table 4. indicate that 33 (89%) respondents were using project management system/technique in construction projects and remaining 4 (10.8%) did not use this technique.

Table 5. Quantify project time overrun in project

#	Answer	Response	%
1	yes	32	86.5%
2	No	5	13.5%
	Total	37	100%

Table 5. indicate that 33 respondents were using the Quantify project time overrun in project and 5 of them are not using the method.

Table 6. Identify risk factors in projects

#	Answer	Response	%
1	yes	30	83.3%
2	No	6	16.7%
	Total	36	100%

Table 6. indicate that 30 (83%) responders were Identify risk factors in projects and 6 of them are not identify the risk factors.

Table 7. waste reduction in construction

#	Answer	Response	%
1	yes	32	84.3%
2	No	6	15.8%
	Total	38	100%

Table 8. Checking daily Master schedule?

#	Answer	Response	%
1	yes	34	89.5%
2	No	4	10.5%
	Total	38	100%

Table 9. Risk response plan

#	Answer	Response	%
1	yes	33	86.8%
2	No	5	13.2%
	Total	38	100%

Table 10. Modify the master schedule

#	Answer	Response	%
1	yes	30	78.9%
2	No	8	21.2%
	Total	38	100%

The questionnaire included a total of 12 questions. First 4 questions were aimed at clarifying respondents' professional and occupational attributes. Questions 4 to 10 were related to operational characteristics of lean construction. The question was critical as it asked if the respondent was familiar with the term 'Lean Construction'. its use while respondents in India might have been implementing the 'Lean principles' without being aware of the technical term 'Lean Construction'.

The sample data gathered are displayed and documented in detail. This analysis included displaying summary of descriptive statistics and making inferences from the data. In the conclusion section, important findings from the present research were noted and recommendations were made for further research.

5. RESULT AND DISCUSSION

The survey was taken by professionals from Madhya Pradesh. its helping to obtain unbiased results. Information was compiled through response to the survey by individuals with very specific knowledge of present construction practices and relevant professional work experience. The level of education and professional experience of most of the respondents held the Master's Degree and had a vast experience in the field (more than 10 years). Most of the participating firms were owned privately. This background information gathered via survey implied that the results were indicative of the general trends and practices of the

industry in Gwalior or nearby areas and the survey was reliable.

Results gathered from the set of questions related to current managerial practices showed that there were few Lean principles used by them. It was apparent that there was a general awareness about resource utilization, although there was a lack of processes in place indicating proper methods such as Lean. Also, the disadvantages due to inadequate use of Lean methods had not been fully and correctly quantified since the importance of such practice had not yet been realized.

Lastly, the research indicated that there was an increasing response to the use of Lean Construction methods in developed country like in a developing country like India. This suggested a need for education, training and an increased awareness about the Lean Construction methods and concepts in India.

6. CONCLUSIONS

The purpose of this research was to explore and evaluate lean construction awareness in India by analyzing the methods of minimum wastage and implementation of Lean practices in the construction projects. Lean Construction is adaptation of the Lean manufacturing concepts in the Construction Industry. A questionnaire was prepared and distributed to professionals evaluate current construction practices and awareness about 'Lean Construction concepts.

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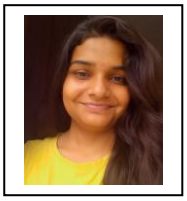

Ms. Radhika Sharma
M.E. (construction technology and management), MITS Gwalior
B. tech (civil engineering) SRGOC Banmore Gwalior

Pro. Archana Tiwari
Professor, of civil engineering department, MITS Gwalior
B.E, M.E (structural engineering) from IIT Roorkee