International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 05 | May -2017 www.irjet.net p-ISSN: 2395-0072

Investigation and Minimization of Construction Wastage Using Lean Technology in Construction

Ms. Anjali Y. Bodkhe[1], Prof. Ashish P. Waghamare[2],Prof.Shreedhar D. Patil[3]

[1]Post Graduation Student Civil Engineering Department, Savitribai Phule Pune University
[2,3] Assistant Professor Civil Engineering Department, Savitribai Phule Pune University
Dr. D Y Patil School of Engineering and Technology, Lohegaon
Pune, Maharashtra 412105, India

Abstract - - The adoption of lean construction principles within construction industries has led to notable improvement has improved time-to-market, reduced production cost, improved quality of the work. Construction site waste contributes to the large quantities of construction waste that are generated by the construction industry every year. Increased economic growth and urbanization in developing countries has led to extensive construction activities that generate large amounts of wastes. This work aimed at identifying the main sources and causes of materials waste on construction sites arising from storage and handling of high waste generating building materials and employing the Lean Construction approach to reduce such waste and to identify the barriers for adopting the lean concept. Minimizing material wastage would not only improve project performance and enhance value for individual customers, but also have a positive impact on the national economy. This work will be further intended to verify and re-evaluated the status of existing productivity and performances on construction activities and processes for local construction industries. This is meant to have a clearer picture on how "lean" in local construction industry performed currently under the compilation of new measurement parameters particularly on waste and cycle time pertaining to the concepts and principles of Lean Construction. This study mainly focuses on implementation of the tool like Relative Importance Index has been done for finding the cause and the effect of the various wastages at the construction industry. By way of choosing some major construction activities and careful observation of them for the extraction of the causes of the wastage generation has been done in this report.

Key Words: Construction Project, Lean, Wastage, Relative Importance Index, Barriers

1. INTRODUCTION

Lean construction is the term used to define the application of lean thinking principles to the construction environment.
What is lean construction?
Lean construction is a "way to design production systems to minimize waste of materials, time, and effort in order to generate the maximum possible amount of value".
Designing a production system to achieve the stated ends is only possible through the collaboration of all project participants (Owner, A/E, contractors, Facility Managers, End-user) at early stages of the project. This goes beyond the contractual arrangement of design/build or constructability reviews where contractors, and sometime facility managers, merely react to designs instead of informing and influencing the design.
Lean construction recognizes that desired ends affect the means to achieve these ends, and that available means will affect realized ends. Essentially, lean construction aims to embody the benefits of the Master Builder concept.
Lean construction supplements traditional construction management approaches with (1) two critical and necessary dimensions for successful capital project delivery by requiring the deliberate consideration of material and information flow and value generation in a production system; and (2) different project and production management (planning-execution-control) paradigms.
Getting work to flow reliably and predictably on a construction site requires the impeccable alignment of the entire supply chain responsible for constructed facilities such that value is maximized and waste is minimized. With such a broad scope, it is fair to say that tools found in Lean Manufacturing and Lean Production, as practiced by Toyota and others, have been adapted to be used in the fulfilment of Lean construction principles. TQM, SPC, six-sigma, have all found their way into lean construction. Similarly, tools and methods found in other areas, such as in social science and business, are used where they are applicable. The tools and methods in construction management, such as CPM and work breakdown structure, etc., are also utilized in lean construction implementations. The three unique tools and methods that were specifically conceived for lean construction are the Last Planner System, Target Value Design, and the Lean Project Delivery System.
Adopting lean thinking results in a highly flexible, profitable company but the process to achieve it requires radical change and takes a number of years.

Some Fundamental Principles Of Lean Are:

- Define value from the customer's perspective
- Understand the value stream of all steps in the process used to create the end product
- Reduce waste
- Ensure a smooth flow of value added activities
- Prefabricate and modularize building systems
- Utilize collaborative pull scheduling to provide each internal and external customer what they want, when they request it
- Seek perfection by committing to continual improvement in all areas of the process

There Are Principles To Guide The Change Work:

- Identifying value from the point of view of the customer.
- Understanding the value streams by which value is delivered.
- Achieving flow within work processes as waste is removed.
- Achieving pull so that nothing is made/delivered until it is needed.
- Perfection recognizing that improvement needs to be constantly sought.

These Principles Can Be Applied At A Number Of Levels:

- By an individual design company who recognizes its clients to be both the owner of the buildings and those downstream in the design and construction process.
- By an individual component supplier who delivers value through their component products eg. bricks, concrete etc.
- By a PFI organizations that provide value to different clients through the provision and operation of a building product e.g. a hospital or a prison.
- By a group of companies who provide value to various clients through the provision of a building product e.g. city office space.
-

The Benefits Of Adopting Lean Thinking Are:

- Making good profit margins whilst contributing to improving the social infrastructure by protecting the environment and respecting the people who work for you.
- Creating a construction industry for the future that attracts young people who view it as a vibrant, satisfying, healthy environment in which to employ their talents.

2. OBJECTIVE OF STUDY

- To review the Lean construction technique.
- To study in detail Lean construction and its benefits.
- To identification of barriers to successful implementation of lean construction.
- To investigate construction wastage.
- To reduce construction wastage using Lean Construction technique.

3-METHODOLOGY

- Methodology adopted for this study is shown in flow chart:

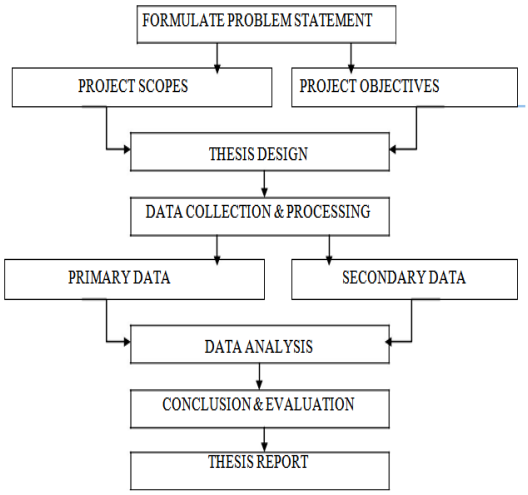

Fig-1: flow Chart

First Phase - Formulation Problem Statement
Second Phase - Project Design
Third Phase - Data Collection & Processing
Fourth Phase - Data Analysis
Fifth Phase - Conclusion & Evaluation
Sixth Phase - Project thesis Report

To apply lean technology in the construction sector, in this project a questionnaire was used as a tool or material to find out the main factor which causes maximum wastages of different materials. Method adopted is simple and classified into following steps Study of literature review and conversation with senior engineers from various sites for the preparation of questionnaire. After preparation of questionnaire, this tool were distributed to various sites to collect the information related with wastages of materials After collection of all the questionnaire, it's analysis was carried out with the help of Relative Importance Index method to find out the ranking of various factors And lastly giving remedial measures for those factors which causes more than 70% wastages.

4. BARRIERS TO ADOPATION OF LEAN CONSTRUCTION CONCEPTS

The barriers to implementation of Lean Construction identified from literature and confirmed by construction site practitioners that the five strongest barriers to implementation of LC in construction site are "fragmented nature of the industry", "extensive use of subcontractors", "lack of long term relationship with suppliers", "delays in decision making" and "waste accepted as inevitable", in that order. The weakest barriers include "inefficient use of quality standards", "lack of supply chain integration" and "poor project definition" among others.

Classified barriers into six components.

Component 1: Lack of proper planning and control

Component 2: Lack of teamwork

Component 3: Poor project management

Component 4: Lack of technical capabilities

Component 5: Lack of professional motivation

Component 6: Poor communication between parties

Component 1: Lack of proper planning and control

This component identified delays in materials delivery, inefficient use of quality standards, long implementation period, waste accepted as inevitable, inconsistency in government policies, high dependency of design specifications on in-situ components and materials, extensive use of subcontractors, lack of long term commitment to change and innovation, lack of long term relationship with suppliers, delays in decision making and materials scarcity as major barriers to the implementation of lean construction. Despite the significant economic contribution made by the construction sector in various countries, it faces numerous problems relating to improper planning and control.

Component 2: Lack of teamwork

This component identified the fragmented nature of the industry, lack of interest from clients, poorly defined individual responsibilities and less involvement of contractors and specialists in design process. Teamwork can be defined "cooperative effort by the members of a group or team to achieve a common goal"

Component 3: Poor project management

This component identified poor project definition, lack of equipment, lack of agreed implementation methodology and unsuitable organizational structures as barriers to implementation of LC.

Component 4: Lack of technical capabilities

This component identified lack of buildable designs, incomplete designs and lack of standardization as the major barriers to the implementation of lean construction. These barriers are considered technical because they have a direct impact on the success of application of lean construction principles and tools such as reliability, simplicity, flexibility and benchmarking might offer more cost-effective solutions.

Component 5: Lack of professional motivation

This component identified poor professional wages materials and poor workmanship and corruption as the major barriers to implementation of LC. Corruption which includes bribery, extortion and fraud may damage the implementation of LC by resulting in the cutting of corners, overpricing of projects, using of inferior Lean construction principles. materials and poor workmanship .

Component 6: Poor communication between parties

This component identified lack of communication and difficulty in understanding lean concepts as the major barriers to implementation of LC. Since LC evolved from the manufacturing industry, it is vital that the parties involved in the construction industry have a full knowledge of the lean manufacturing concept before its implementation. In the process of implementing lean principles, poor communication between respective parties will lead to disruption and ineffective delivery and co-ordination process.

INTRODUCTION TO RELATIVE IMPORTANCE INDEX
Relative Importance Index

Relative Importance Index method helps to determine the Relative importance of the each factors affecting to occupational health risk. Then five-point scale consist of,

1 – Never
2 – Very rare
3 - Seldom
4 - Frequent
5 - Very Frequent

Data is obtained from experts, processed it & Converted it to relative importance indices (RII) for each Factor as follows:
Relative Importance Index,

$$R.I.I. = \frac{5n5+4n4+3n3+2n2+1n1}{5(n5+n4+n3+n2+n1)}$$

Where,
1, 2, 3, 4, 5, etc. are rating scale,
n1, n2, n3, n4, n5, etc. are no. of respondents.

5. DATA COLLECTION

For data collection, this is research relies on primary data, which was obtained using questionnaires having both closed and Open- ended (un-coded) questions; containing varied questions on material wastage and management. It was directed at the respondents relevant to the study including engineers, architects, quantity surveyors, builders and contractors to identify the various sources of waste encountered on construction sites and how these wastes can be minimized and managed. The data obtained were in construction analysed using tables and statistical indices.
The scope of this research is limited to firms in every question is evaluated by giving marks in the range of 1-5.With the help of Relative Importance Index, these questions to be analysed and ranking prepare.

6. DATA ANALYSIS

Table no.1: RII having more than 70% Risky Factor

Sr. No.	Description	Score					Total	RII
		Never	Very Rare	Seldom	Frequent	Very Frequent		
1	At the end of concrete, cleaning of pump.	0	0	1	14	30	209	0.9289
2	Use of cut piece as per required size.	0	0	2	21	22	200	0.8889
3	Stacking out cut piece bar diameter wise.	0	1	2	28	14	190	0.844
4	Reuse of waste mortar for filling of gaps or other small works.	0	2	4	24	15	187	0.8311
5	Use of cut piece bar.	0	0	4	31	10	186	0.8267
6	For cutting of CLC block proper equipment are not used.	0	0	8	26	11	183	0.8133
7	In hopper.	0	0	11	28	6	175	0.7778
8	Shifting of bricks.	0	0	14	22	9	175	0.7778
9	Locking system of steel bundle to avoid theft.	0	1	7	34	3	174	0.7733
10	Stacking of steel bundle.	0	1	15	25	4	167	0.7422
11	From worker at the time of placing of concrete.	0	0	16	28	1	165	0.7333
12	Quantity of mortar mix as per no. of mason working and capacity of mason.	0	2	18	19	6	164	0.7289
13	Study of drawing and calculation of cutting length of bar as per WBS.	0	0	20	24	1	161	0.7156
14	Pump line chockup.	0	1	24	16	4	158	0.7022

7. CONCLUSIONS

In this thesis, we had analyzed the general perceptions of construction industry and how the lean construction tools can be used to improve the implementation of these activities particularly in managing construction wastes. As mentioned in this thesis, we developed a process improvement tool using lean construction and we had executed it in two sites. We received an overwhelming response from the construction team and they found it very effective tool that can be implemented in the site.

The following are the advantages that we found by using our tools.

1. Lean technology reduces all forms of non-value added activities and improves its performance.
2. Lean technology helps to waste elimination method which provides a significant competitive advantage for the participants.
3. This study yields a methodology for waste detection and improvement of construction process.
4. This will help to saving in the project cost as saving in the materials.
5. Each member of the construction supply chain will be aware of its influence on the overall project

6. Materials and components can be selected to meet the best needs of supply chain discipline
7. It focus on delivering the value desired by the owner, which primarily leads to the principle „Customer is the King"
8. It is a continual improvement/pursuit of perfection involving everyone in the system
9. Inefficiency and waste in the use of labour and materials will be eliminated .

11.REFERENCES

[1] Associates General Contractors of America, "Partnering"

[2] Ballard, G. and Hill, G., "Shielding Production: Essential Step in Production Control", Journal of Construction Engineering and Management, Jan/Feb, 11-17

[3] Ballard, G., "Lean project delivery system", LCI White Paper-8. Lean Construction Institute, (2000)

[4] Bresnen M. and Marshall N., "Partnering in construction: a critical review of issues, problems and dilemmas", Construction Management and Economics (2000) 18, 229-237

[5] Cardoso, F.F. (1996). Doct. Diss. Paris: École Nat. des Ponts et Chaussées, "Stratégies d'Entreprises et Nouvelles Formes de Rationalisation de la Production dans le Bâtiment au Brésil et en France. (Entrepreneurial Strategies and NewFormes of Production Rationalization in the Brazilian and French Building Sector)"

[6] Cristiano R., Texas A&M University, "An Effective Way to Reduce Residential Construction waste: a Case Study in Texas", Texas (USA)

[7] E\knarin Sriprasert and Nashwan Dawood, "Genetic Algorithms for Multi-Constraint Scheduling: An Application for the Construction Industry", Centre for Construction Innovation Research, University of Teesside (UK)

[8] Francis Paul, "Construction Project Partnering in Texas' Public Universities",Thesis submitted to Texas A&M University, Texas (USA), (2007)

[9] Gihan L. Garas, Associate researcher, Cairo Univ., Ahmed R. Anis Prof., Cairo Univ., Adel El Gammal, Ass. Prof., National Research Centre, Cairo, "Materials Waste in Egyptian Construction Industry", Cairo (Egypt)

[10] Glenn Ballard, Asst. Prof., University of California, Dick Decker, and John Mack, "A case study on implementation of Lean Construction in California Health Centre", California (USA)

[11] Greg Howell, Adjunct Professor, Boise State and Virginia Tech., and GlennBellard, Asst`. Pro. University of California, Berkley, "Implementing Lean Construction: Understanding and Action"

[12] Herman G. Ballard, Ass. Prof., University of California, "The Last Planner System Of Production Control"

[13] Haitao Yu1; Tarry Tweed2; Mohamed Al-Hussein3; And Reza Nasseri4 Development Of Lean Model For House Construction Using Value Stream Mapping Journal Of Construction Engineering And Management © Asce / August 2009

[14] Jay Shankar Goit Minimization Of Wastage Using Lean Technology In Construction International Journal Of Technical Research And Applications Volume 4, Issue 3 (May-June, 2016)

[15] Nimesha Vilasini Thomas R. Neitzert J.R. Gamage Lean Methodology To Reduce Waste In A Construction Environment. 15th Pacific Association Of Quantity Surveyors Congress Conference Paper · 23 – 26 July 2011

[16] O. Salem On _© Lean Construction: From Theory To Implementation."Part Of Journal Of Management In Engineering". (October 1, 2006 Doi: 10.1061/_Asce_0742-597x_2006_22:4_168

[17] O. Akinkurolere And 3s.O. Franklin , Yujia Shan, Wuhan Ubei Province, Investigation Into Waste Management On Construction Sites In South Western Nigeria American Journal Of Applied Sciences 2 (5): 980-984, 2005 © Science Publications, 2005

[18] O.Salem1,J.Solomon2,A.Genaidy3,AndLuegring Site Implementation And Assessment Of Lean Construction Techniques ©Leanconstructionjournal20054 Www.Leanconstructionjournal.Org Vol 2 # 2 October 2005 Issn: 1555-1369

[19] Olajide Olamilokun Investigating Facilitators and Barriers for Adopting Lean www.ijird.com.Vol 4 2015

[20] Construction Principles in the Nigerian Building Consulting Firms

[21] Piotr Nowotarskia, Jerzy Pasawskia, Jakub Matyjaa Procedia Engineering Improving Construction Processes Using Lean Management Methodologies – Cost Case Study 161 (2016) 1037 – 1042 Scie Nce Direct.Com

[22] .Sunil V. Desale1, Sharad V. Deodhar2- Identification And Eliminating Waste In Construction By Using Lean And Six Sigma Principles Application Of Cnc Waste With Recycled Aggregate In Concrete Mix. In International Journal Of Innovative Research In Science, Engineering And Technology .An Iso 3297: 2007 Certified Organization Volume 3, Special Issue 4, March 2014. National Conference On Recent Advances In Civil Engineering (Ncrace-2013) During 15-16 November.

[23] Y Algan Tezel, Ph.D.1; And Yasemin Nielsen2 Lean Construction Conformance Among Construction Contractors In Turkey Journal Of Management In Engineering, Vol. 29, No. 3, July 1, 2013. © Asce.