LEAN WASTE ASSESSMENT AND BLUE PRINT FOR ELIMINATION OF WASTE THROUGH LEAN DIGITAL METHOD

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Abstract - *Waste has been considered a major problem in the construction industry for its financial and environmental impacts. There are a lot of wastes from managerial point of view in construction processes, which were left unnoticed. One of the major change efforts for the construction industry is lean construction. This thesis analyzes the managerial perspective of lean waste assessment in Indian construction industry from the lean Digital construction perspective. Prior to the analysis in question, requisite information about change in the construction industry, lean thinking and lean construction will be presented. A questionnaire, based on a lean construction model is prepared and distributed to construction firms, is used to survey the practices and gather the data for the analysis. Various statistical analysis methods are performed on the gathered data to make inferences. According to these analyses, the eight types of construction waste and mostly preferred waste elimination method are listed out in ascending order and the lean construction characteristics of the construction companies will be discussed and the recommendations for improving the lean conformance of the construction companies will be presented. Thus the final conclusion is to determine the primary key drivers of the construction industry leads to enormous waste and most suitable waste elimination method to reduce the managerial waste.*

Key Words: *Lean Digital Construction, Managerial waste, Waste elimination method*

1. INTRODUCTION

The Indian construction industry forms an integral part of the economy and a conduit for a substantial part of its development investment, is poised for growth on account of industrialization, urbanization, economic development and people's rising expectations for improved quality of living. There are mainly three segments in the construction industry like real estate construction which includes residential and commercial construction; infrastructure building which includes roads, railways, power etc; and industrial construction that consists of oil and gas refineries, pipelines, textiles etc. Construction, without a doubt, has also been affected by improvements in terms of the development of advanced engineering materials, the utilization of mechanical power, the application of information and telecommunication technologies and the quality and the productivity conciseness to a degree. The effects on construction are basically over the technological utilization, application and the adaptation of the primarily manufacturing related phenomena. However, the adaptation and the penetration of the organizational and the managerial foundations that lead to some real quality improvements, cost reduction and flexibility are questionable. Indeed, the construction industry seems to contain seriously wasteful practices and struggles to satisfy the parties involved. It is also such an important and fundamental industry that its shortcomings create huge detrimental effects.

Lean Thinking is a concept coined by Womack et al (1990) that is based on the Toyota Production System (T. P. S.). It was ultimately developed in a manufacturing environment, more specifically in the automotive industry. The main pioneers and promoters of lean thinking, Toyota's chief engineer Taichii Ohno and the C. E. O. Eiji Toyoda was dedicated to eliminate both hidden and obvious waste. Womack and Jones moved from the automotive industry to look at manufacturing in general and established the five principles for Lean Production; this theoretical foundation is called Lean Thinking by them. Lean construction is defined as "A holistic facility design and delivery philosophy with an overarching aim of maximizing value to all stakeholders through systematic, synergistic, and continuous improvements in the contractual arrangements, the product design, the construction process design and methods selection, the supply chain, and the workflow reliability of site operations".

2. Literature review

The practical stream started with Howell and Ballard's (1995) observations that typically only half of the tasks in a weekly plan get realized as planned on site. In a series of experimental work, a new approach to production control, called the Last Planner System, was developed (Ballard 2000). Whilst Last Planner covers production control and improvement, methods for production system design have also been developed (Ballard et al. 2001). Furthermore, various new practices for different aspects of design and construction management have been developed (Bertelsen and Koskela 2002, Bertelsen et al 2002, Christ offersen 2003).

The theoretical stream started with Koskela's (1992) analysis of the application of the new production philosophy to construction. The question is about the interpretation of generic principles of operations / production management. Others (dos Santos 1999) have examined the validity of these principles in the production situation of construction. In (Koskela 2000) the discussion on the principles was deepened and theoretical explanation for the principles was presented, based on current theories in operations management. While this work addressed primarily the theory of production, research on the theory of management was also embarked on, especially in the context of project management (Howell & Koskela 2000, Koskela & Howell 2002) and for explaining the underlying principles of the Last Planner system. Furthermore, the issues of complex adaptive systems have been addressed (Bertelsen 2002, 2003 a and b). Growing interest towards exploring the theories of inherent social and psychological functions in production and its management, such as cognition, communication, learning, decision-making, etc. can be perceived (Macomber and Howell 2003).

3. OBJECTIVES

1) To Study the various types of wastes in construction industry from managerial perspective i.e. (Material Waste & Time Waste)
2) Understanding the barriers in the construction industry related to Cost, Quality & Time.
3) Preparation of Questionnaire related to lean waste assessment based on above two objectives and distribution of the Questionnaire in many construction companies to gather the information related to waste management system.
4) To determine the most suitable lean waste assessment method based on questionnaire.
5) Analysis of the Questionnaire is carried out by means of SPSS software to determine the primary drivers which lead to generation of enormous managerial waste.

4. PROJECT METHODOLOGY

Lean construction aims to maximize the customer's satisfaction through concurrent design of both the constructed facilities and the construction process that delivers these facilities, and through the consequent control of each stage in the construction process. In addition, by focusing on the workflow, lean construction is able to unplug the clogs in the project stream. Thus, construction processes like planning, engineering, designing, constructing, producing and delivering of materials are all better coordinated to deliver maximum value for the project owner. The methodology adopted for lean waste assessment from construction firm is explained as follows:

Factors for Selection of the Population under Study:

The population considered for this study stretches over a vast number. The construction industry by large comprising both the infrastructure and real estate industry is contemplated. Since Lean concepts are still in the premature stage in the Indian construction industry, the population selected for study includes firms which have and don't have lean management methodology in place. With reference to the fact that lean concept is by itself unaccustomed, Lean Digital concept is far from reality.

The factors considered for the selection of population are as follows:

1. Operational expanse of the firm (within country, abroad or both)

This factor will throw a light on the construction practices that are being adopted across the various parts of the country and also the globe giving us a wider perspective for analysis.

2. Nature of clients served (Public, private or both)

The firms essentially mould themselves in terms of processes, practices and policies depending on the nature of the clients that they serve. It ranges widely from the elaborate methodologies of the public sector to the more quality driven practices of the private sector. The management methodologies undergo metamorphosis to adapt to the changes.

3. Years of operation in the industry

Any firm's management methodologies revel around the various projects that have been accomplished over the years. However, we cannot really ascertain that the longer their existence in the industry, the better is the end product. It is subject to various other factors. But this study is centered on the management practices. Eventually, the approach to a project will depend on the experiences attained in various projects down the years. Hence this factor is also quite critical in this analysis.

4. Areas of expertise in the industry

The project management approach to every project is unique at some level or the other. The more complicated the projects are the more complex the management becomes. Thereby, the areas of expertise like residential and commercial buildings, industrial facilities, tunnel works, power plants etc have to be identified for the wholesome analysis of the subject.

5. Scale of the firm

The scale of the firm is a pivotal factor to be considered in any construction firm. The scale of the firm determines the hierarchical arrangement and hence the flow of authority.

4.2 Types of Waste Elimination Method:

Following are the types of waste elimination method used in various construction companies;

1. Material Kanban Cards
2. Quality Management
3. Concurrent Engineering
4. Last Planner System
5. Daily Huddle Meetings
6. Value Stream Mapping

4.3 Methodology for Analysis:

The analysis aims to;

➢ Rank the eight managerial wastes based on the significance of their occurrence in the industry,

➢ Establish a correlation between the various managerial attributes that contribute to these wastes,

➢ Rank the most feasible lean waste elimination method that can be adopted by the construction firms.

4.4 Limitations of the Study:

Some of the limitations of the study are:

1. The questionnaire was prepared to be filled by only contractors however it was administered to all types of firms.
2. All respondents were chosen among lower, mid or upper level management only. However, most respondents belonged to the mid and lower level management.
3. The questionnaire was more widely applied to Indian firms only.
4. The questionnaire is mainly focused on internal operational aspects of firms, rather than environmental effects.

5. RESULT

The questionnaire was distributed to over 90 construction firms. It was administered to Real estate, infrastructure companies and project management consultants. Out of 90 attempts, 50 responses were collected. From the 50 responses, 30% were primarily Real estate firms while 40% were primarily Infrastructure firms and 20% operate in both sectors and 10% were consultants

Respondents Attributes:

There are 4 questions in the questionnaire to identify respondents' attributes. These questions are about respondents

1. Professions.
2. Levels of education.
3. Positions.
4. Levels of experience.

By profession, 10% respondents were Architect, 74% were Civil Engineer and 16% were Construction Technician. The level of education of the respondents were spread in the ratio 12% respondents were holding Associate degree, 64% respondents were holding a Bachelor's degree and 24% respondents were holding Master degree. As for the position, 36% respondents were from the lower level management while 52% respondents were from the middle level management and 12% respondents belongs to upper level management. As for the level of experience, 60% respondents belonged to the range of 0-5 years' experience, 28% respondents belonged to the range of 5-10 years and 12% were belonged to the range of 10-20 years.

Firms Attributes:

There are 6 questions in the questionnaire to identify firm attributes. These questions are about firms.

1. Areas of operation.
2. Operational times since their foundations.
3. Average numbers of employees.
4. Average annual turnovers.
5. Major clients
6. Geographical operational locations.

1. The areas of operations of the firm has constitutes Project and Design 16%, Building Construction 34%, Industrial facilities 12%, Infrastructure facilities 8%, Highway and Transportation 12%, Airports 8%, Pipelines 6%, Tunnel works 4%.
2. As for operational time since establishment, 24% have been operating beyond 20 years, 36% have been operating between 10-20 years, 32% have been operating between 5-10 years and 8% have been operating fewer 5 years.
   3. The spread of the average number of employees in the Respondent firms has been in the ratio of 26% having employees in the range of 0-100, 22% having 100-500 employees, 36% having 500-1500 employees and 16% having more than 1500 employees.
   4. As for the average annual turnover, 16% firms have INR 10-100 crores, 52% have INR 100-1000 crores and 32% have more than INR 1000 crores.
   5. The respondent firm's major clients have been in the ratio of 24% public organizations, 48% private organizations and 28% both public and private organizations.
   6. The geographical spreads of the respondent firms have been in the ratio of 36% in the country, 60% within the country and abroad and 4% in abroad only.

Result of the Waste Ranking:

Rank	Waste	Frequency
1	Waiting	39
2	Rework	35
3	Inventory	37
4	Transport of materials	36
5	Motion of people	38
6	Over production	34
7	Over processing	35
8	Unutilized human potential	32

Result of Rankings of Waste Elimination Methods:

Rank	Method	Frequency
1	Quality Mgt.	29
2	Last Planner System	31
3	Daily Huddle Meetings	36
4	Material Kanban Cards	33
5	Value Stream Map	30
6	Concurrent Engineering	27

6. CONCLUSION

- Through this study, the various managerial wastes impeding the progress of a construction have been prioritized, thereby facilitating the design of a suitable elimination method.
- The elimination methods suggested in this study are the more prevalent methods in the industry. However, there are numerous lean digital elimination methods which have been surfacing recently.
- However, for the absolute implementation of Lean digital in the construction industry, a radical change in the outlook of the construction industrialists is the only solution.
- It has been deduced that organization culture, quality and safety facets and the handling of drawings are the primary drivers for the generation of these enormous managerial wastes.
- The firms evaluate the projects based on costs and conformance to specifications. However, they overlook the aspect of level of constructability which determines the success or failure of a project.

7. ACKNOWLEDGEMENT

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BIOGRAPHIES

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