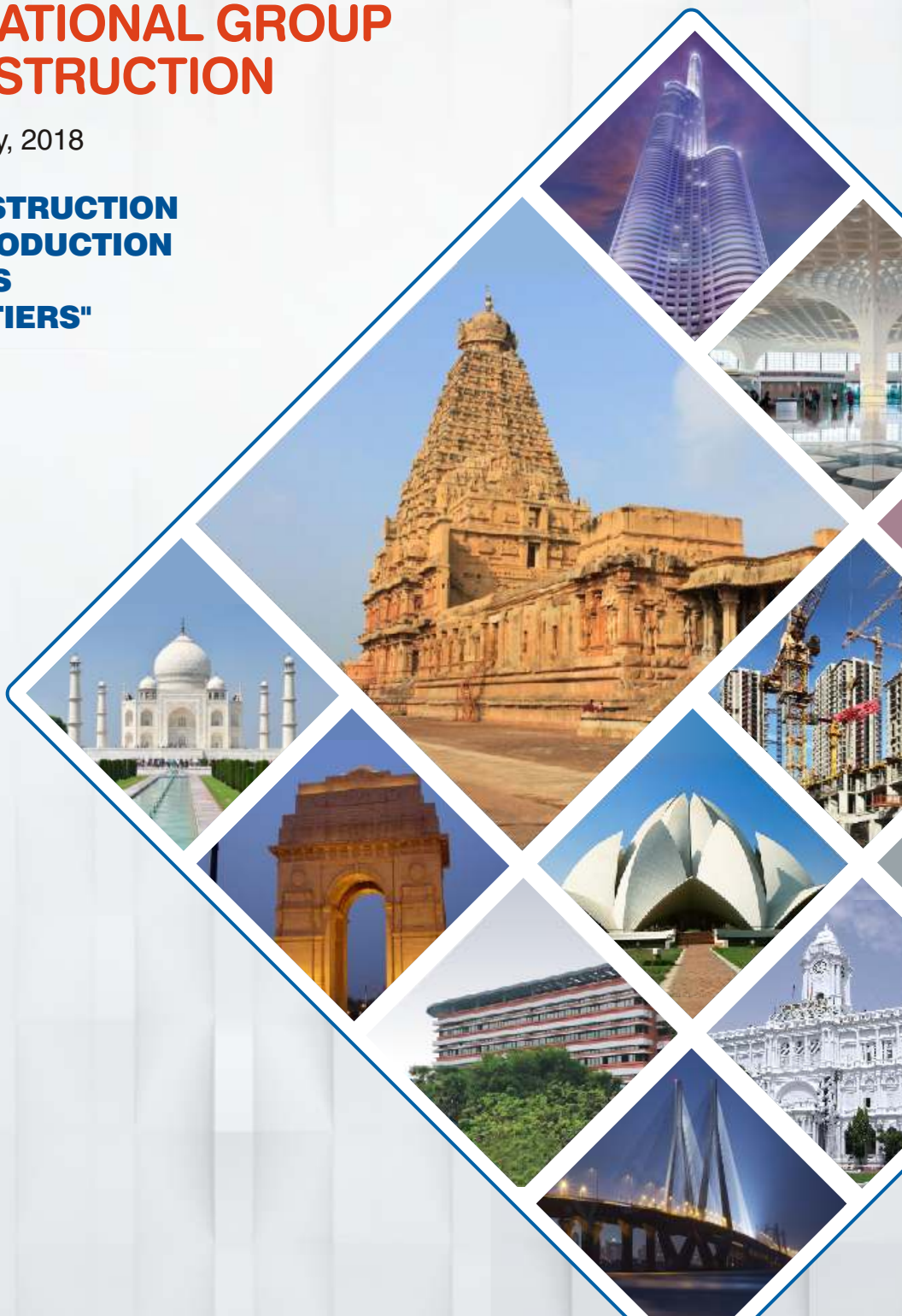
IGLC CHENNAI 2018
International Group for Lean Construction

SOUVENIR AND COMPILATION OF POSTERS

26th ANNUAL CONFERENCE OF THE INTERNATIONAL GROUP FOR LEAN CONSTRUCTION

Chennai, India, 16th to 22nd July, 2018

"EVOLVING LEAN CONSTRUCTION TOWARDS MATURE PRODUCTION MANAGEMENT ACROSS CULTURES AND FRONTIERS"



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- To develop and disseminate Lean practices in India
- Promote co-operation between academic and research institutions and industry in the field of Lean Construction Management.
- To serve as a storehouse of knowledge of Lean practices in India and facilitate their applications for construction projects.

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"EVOLVING LEAN CONSTRUCTION TOWARDS MATURE PRODUCTION MANAGEMENT ACROSS CULTURES AND FRONTIERS"

Souvenir and Compilation of Posters

The 26th Annual Conference of the International Group for Lean Construction

July 16th to 22nd 2018
Chennai, India

Conference Chairs : Prof. N.Raghavan
Prof. Koshy Varghese

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A Note from the Organisers

The Annual Conference of the International group for Lean Construction (IGLC) is an important activity of IGLC and the 26th Annual Conference is being held in India for the first time, in the city of Chennai, as IGLC 2018. Lean Construction is a nascent practice in India but the concept of Lean is slowly, but steadily, taking roots in this country. An organisation called Institute for Lean Construction Excellence (ILCE) formed by Construction Industry organisations along with IIT Madras as the Knowledge Partner has been spearheading the spread of Lean Construction in India. India has a booming infrastructure construction market and Lean practices could be of great help to have better control on the project management of these projects. Two Indian Lean Construction Conferences, ILCC 2015 and ILCC 2017, have been recently conducted as National Conferences, with some international participation also. Pursuant to a fervent desire in the Indian Lean community to get international association, a bid was made for the Annual Conference of IGLC to be conducted in India and was granted, leading to the genesis of IGLC 2018.

It has been a fond hope of the Indian Lean community that this international conference will give a great fillip to the Lean movement in India and these hopes have not been belied: Some 25 contributions, the largest number of papers from a single country this year, out of a total of 132 papers, have been from India. 30 Posters out of a total of 45 are also being presented from India. These significant numbers do auger well for the future of Lean Construction in India.

The Workshop Day anchored by Dr. Tariq Abdelhamid and Dr Paz Arroyo is also featuring a couple of Lean project management practitioners, Puneet Narang and Yash Singh, to share the Indian experience. The Industry Day has four Panel discussions comparing international practices and Indian practices in Lean construction. A Summer School for Doctoral research scholars is also being organised for two days after the main Conference. Here again many Indian scholars are attending apart from international scholars. As has been the practice in previous conferences, a galaxy of international Lean specialists have agreed to be on the panel of Faculty Advisers for the School.

The IGLC 2018 organisers have been working for the last few years to bring IGLC to India and to generate a good bit of enthusiasm in the local Indian community

and these have indeed come about quite well. With the ice so broken, hopefully the Indian Lean community will be a significant participant in future IGLC events!

As part of the organizing efforts, the Conference Proceedings running to about 1400 pages in two volumes and the A3 Compilation covering 132 papers have been compiled and printed. The present publication covers the Conference Souvenir and Compilation of 45 Posters. The Organisers have made a sincere attempt to put together a Conference which would be of multifarious interests to the IGLC community, apart from being merely another technical event, and they hope that the community will also feel the same way after it attends the event! The overall schedule featured elsewhere in this document shows the various interesting leisure activities, Receptions and Dinners planned during the Conference.

The Organisers extend a very warm Welcome to the international Lean community to take part in the technical deliberations in the week-long event here and also enjoy the leisure time in the other interesting activities planned.

With best wishes to all the Delegates for an enjoyable stay at IGLC 2018

Prof. N.Raghavan
Prof. Koshy Varghese
Indian Institute of Technology Madras, India
IGLC 2018 Organising Chairs
with IGLC 2018 Organising Team

IGLC 2018 SCHEDULE

IGLC 2018 SCHEDULE

	Day 1 - 16th July	Day 2 - 17th July	Day 3 - 18th July			Day 4 - 19th July			Day 5 - 20th July		
Event	**Workshop day**	**Industry day**	**Conference**								
Venue	**Gold Coast + Peninsula**	**Gold Coast + Peninsula**	**Gold Coast**	**Peninsula**	**Nautica**	**Gold Coast**	**Peninsula**	**Nautica**	**Gold Coast**	**Peninsula**	**Nautica**
6:00-7:00			Introduction to Yoga (Sea side lawn)								
8:15-9:00	Registration/ Networking... Tea										
09:00 - 13:00	Session	Industry day session	Inaugral + P1			P2			P3		
	Tea Break (10:30-10:50)	Tea Break (10:30-10:50)									
	Session	Industry day session	Tea Break (11:15- 11:45)			Tea Break (11:00 - 11:30)			Tea Break (11:00 - 11:30)		
			1A	1B	1C	4A	4B	4C	7A	7B	7C
13:00-14:00	Lunch										
14:00-17:30	Session	Industry day session	2A	2B	2C	5A	5B	5C	IGLC Business session		
			Tea Break (15:30-16:00)			Tea Break (15:30-16:00)			Tea Break (16:00-16:30)		
	Tea Break (16:30-16:50)	Tea Break (16:30-16:50)	3A	3B	3C	6A	6B	6C	Moving to IIT campus for summer school		
	Session	Industry day session									
17:30-18:00			Experiential activities								
18:00-18:30		Networking									
18:30-19:00	High Tea	Reception+ unconference discussion									
19:00-19:30			Indoor entertainment- Bharatanatyam			Conference Dinner & Participative Entertainment					
19:30-20:00		Industry Day Dinner									
20:00-21:30			Reception & Music								
21:30-23:00		Recreation									

A, B,C are parallel sessions
P- Plenary sessions

IGLC 2018 SESSION PLANNING FOR CONFERENCE PAPERS

Session wise Schedule with Track Names

** Paper IDs in brackets*

	Time	Venue		
		Gold Coast	Peninsula	Nautica
Day 1				
Inaugral Session	8:30-8:45	**Inaugral**		
Plenary	8:45-10:45	**P1 - Plenary Session 1**		
		PPC 4 (448, 450, 510, 542)		
Tea Break	10:45-11:15			
Parallel 1	11:15-13:05	1A - Production Planning and Control	1B- Contract and Cost Management/Supply Chain Management	1C- People, Culture and Change
		6- **PPC** 6 (218, 414, 491, 420, 494, 526)	6- **CCM 5** (217, 285, 248, 394, 523), SCM 1 (540)	6- **PCC** 6 (270, 282, 416, 441, 486, 490)
Lunch Break	13:05-14:00			
Parallel 2	14:00-15:15	2A - Production Planning and Control	2B- Enabling Lean with IT	2C- People, Culture and Change
		4- **PPC** 4 (433, 452, 505, 517)	4- **ELIT** 4 (224, 427, 520, 536)	4- **PCC** 4 (314, 315, 397, 506)
Tea Break	15:15-15:30			
Parallel 3	15:30-16:30	3A - Production Planning and Control	3B- Enabling Lean with IT	3C- Safety, Quality and Green-Lean
		3- **PPC** 3 (254, 472, 488)	3- **ELIT** 3 (229, 425, 475)	3-**SQG 3** (264, 418, 438)
Day 2				
Plenary	8:45-10:45	**P2 - Plenary Session 2**		
		ELIT 2 (404, 539), **PCC 1** (541), **PDDM 1** (437)		
Tea Break	10:45-11:15			
Parallel 1	11:15-13:05	4A- Enabling Lean with IT	4B- Product Development and Design Management	4C- People, Culture and Change
		6- **ELIT 6** (216, 443, 474, 511, 535, 543)	6- **PDDM 6** (209, 263, 281, 283, 455, 537)	6- **PCC 6** (239, 396, 483, 509, 516, 522)
Lunch Break	13:05-14:00			
Parallel 2	14:00-15:15	5A- Lean Theory	5B- Product Development and Design Management	5C- People, Culture and Change
		4- **LT** 4 (393, 409, 484, 495)	4- **PDDM 4** (482, 489, 493, 513)	4- **PCC** 4 (421, 428, 439, 415)
Tea Break	15:15-15:30			
Parallel 3	15:30-16:30	6A- Lean Theory	6B- Product Development and Design Management	6C-Teaching Lean Construction
		3- **LT** 3 (521, 527, 533)	3- **PDDM** 3 (403, 519, 531)	3- **TLC** 3 (429, 447, 463)
Day 3				
Plenary	8:45-10:45	**P3 - Plenary Session 3**		
		SQG 1 (274), **LT 1** (208), **PSD 1** (500), **SCM 1** (419)		
Tea Break	10:45-11:15			
Parallel 1	11:15-13:05	7A- Production System Design/Safety, Quality and Green-Lean	7B- Supply Chain Management/People, Culture and Change	7C- Production Planning and Control/Lean Theory
		6- **PSD 3** (238, 249, 477), SQG 3 (247, 515, 532)	5- **SCM 2** (280, 524), **PCC 3** (265, 496, 284)	6- **PPC 4** (398, 406, 497, 528), LT 2 (250, 538)
Lunch Break	13:05-14:00			
	14:00-16:00	**IGLC Buisness session**		
Tea Break	16:00-16:30			

NOTE- *Presentation time per paper for plenary session is 25 mins*
Presentation time per paper for parallel session is 15 mins

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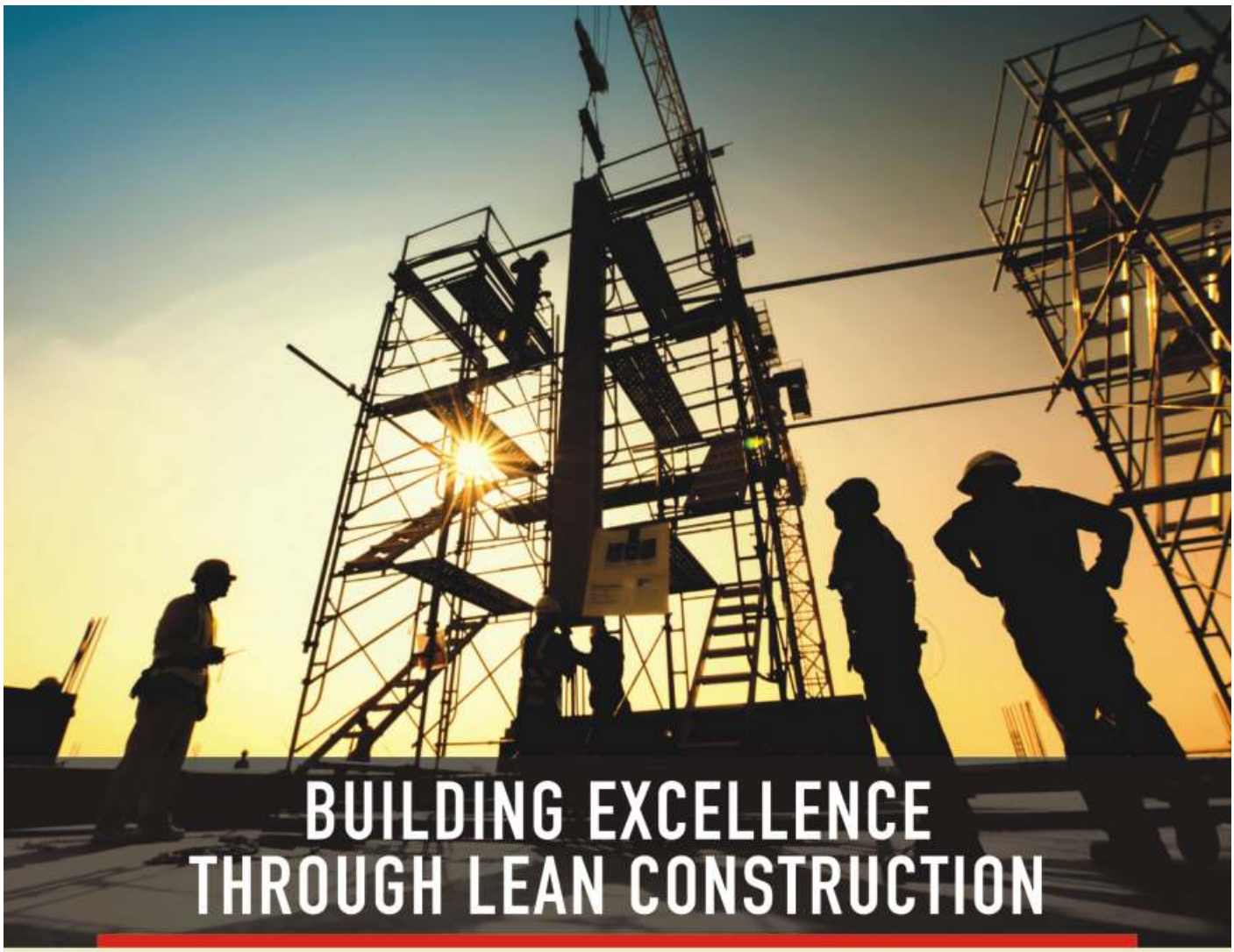

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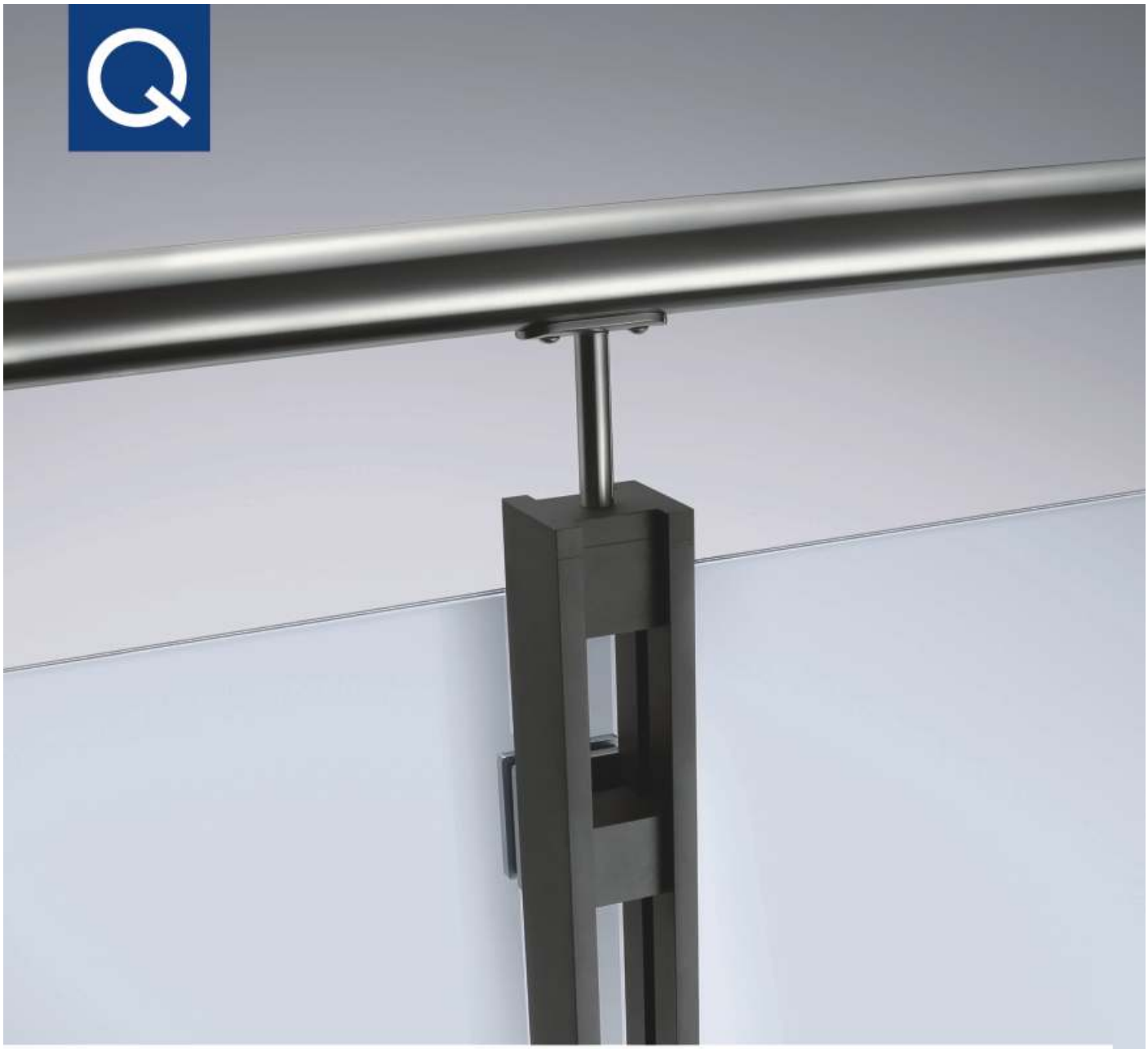

POSTERS

POSTER INDEX

Identification Of Lean Opportunities In A South African Public-sector Projects Cost Management Framework

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IGLC CHENNAI 2018 International Group for Lean Construction
POST207

Central University of Technology, Free State

Abstract

The prevalence of cost overruns in public sector construction projects in South Africa has been observed. This has been attributed to ineffectual approaches to cost management within these projects. The prior study by the authors has made sense of these observations an understanding of existing cost management approaches. Accordingly, this study seeks to identify Lean opportunities from existing cost management practices. Such opportunities will enable identification of effective cost management during project delivery. Adopting a qualitative case study research design, the study relies on data obtained from a purposively selected list of interviewees from a cadre of cases, i.e., recently completed public sector construction projects in South Africa. These interviews will be juxtaposed with evidence from project-related documents. Based on the data, the study will provide a vignette of lean-led cost management frameworks applied to these projects. Encompassing various stages of the project delivery lifecycle, this vignette will enable an identification lean lead cost management on these projects. Subsequently, the vignette will be validated by interviewees. The expectation is that findings from this study will provide a brief picture of cost management frameworks and enable the introduction of probable lean-based solutions to reverse this unbecoming trend.

Introduction

Cost management processes of infrastructure projects are still fragmented in nature.

Need For Study

- Costs are still managed in Isolation
- Collaborative costing needs a structured approach

Objectives

- To produce a vignette of lean led cost management framework
- To illustrate coord

Methods

- A qualitative research design, from a coterie of recently completed cases of the public sector in South Africa.

- The document analysis data were supplemented with 15 semi-structured interviews data collected from project actors in the selected cases.
- .Interviews were recorded and transcribed using thematic analysis.
- Interviewees were requested to discuss their processes of designing and cost management in the pre-contract stage through to appointment of the contractor

Table No. 1 and 2

PROJECT INFORMATION	Project 1
Department	Department of Health
Project Name	Extension to Boitumelo Hospital
Town	Kroonstad
Date of site handover	28 July 2011
Actual start date	21 November 2011
Completion date	November 2014
Actual completion date	April 2015
Contract Amount	R138 263 009.29
Final Amount	R170 339 718.37
Overrun amount	R32 076 709.05

PROJECT INFORMATION	Project 2
Department	Department of Education
Project Name	New Primary School
Town	Bothaville
Date of site handover	02 October 2013
Actual start date	02 October 2013
Completion date	29 May 2015
Actual completion date	29 May 2015
Contract Amount	R28 152 536.86
Final Amount	R32 758 734.81
Overrun amount	R4 606 197.95

Results

- Lean opportunities identified from the coterie of projects is projects of schools were they utilized Design-Build method. One project performed well in terms of time and cost, and the other performed completely bad on the same parameters.

- Other two projects has the similar results with one performing well and the other bad when compared to the same parameters of cost and time. However, the difference is the two hospital projects employed design-bid-build system. Figure 2 below is a foundation framework utilized to convince respondents on how lean has performed on similar projects and how has obtained significant improvements in project performance.

Figure No. 2

Discussions

Last planner system proved to be what the respondent felt was adequate to overcome the delay in projects, however, cost had conflicting responses. respondents agreed that TVD can make significant contribution to improvement of cost to projects, although they felt on mega projects, rather than smaller ones. Respondents felt TVD needed time and on rushed projects not preferred.

Conclusions

- The study intended to bring across a culture of lean and commence with a framework of cost management in South African construction Industry. It was necessary to start from the mindset of the practitioners before completely convincing them of looking at innovation. Sometimes practitioners admire such innovations but reluctant to implement them, so mindset change is a must first.

- A combination of lean tools such as last planner system, TVD, CBA, are concepts that are welcomed by the respondents, and lean-led case studies proved useful to build a case for lean to be implemented in South Africa..

- Collaboration is a must for lean to be successful, and at this point in time the industry is till trying to grapple with the acceptance of BIM to proffer a solution to collaborate on construction projects in South Africa. Perhaps tools like BIM could also be looked at in order stimulate the industry on the principle of really collaborating rather than talking about collaboration with out necessarily conducting such a task.

Acknowledgement

The author(s) wishes to acknowledge the National Research Foundation – Thuthuka Funding Instrument – 112148 that has made this study possible.

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1. 21st IGLC proceedings, Alarcon et al 2013.
2. Computing in Civil Engineering, Park et al 2007.
3. 25th IGLC proceedings, Namadi et al 2017.
4. Creative construction conference, Orihuela et al 2015.

A LEAN E-GOVERNANCE APPROACH TO MITIGATE CORRUPTION WITHIN OFFICIAL PROCESSES IN THE CONSTRUCTION INDUSTRY

IGLC CHENNAI 2018 International Group for Lean Construction

POST210

Alaa Daramsis, Karim Faour, Lynn Richa Abdel Ahad, Ghadeer Salami and Farook Hamzeh,

American University of Beirut

Abstract

One of the factors that subject the schedule to delays is the official processes performed at the public sectors. Lebanon is a country where official processes run at suboptimal levels and delay the day-to-day activities of citizens and their projects. The concept of applying lean methods to mitigate this corruption is promising; as this is the first study in Lebanon to address this issue by employing a lean perspective. The aim of this paper is to analyze, assess, and formulate frameworks of official processes based on interviews conducted with professionals in the field who have experienced unexplained delays in their construction documents. In addition, this study develops a tailored e-governance strategy that would effectively lead to a lean revamp in the public sector in terms of service quality, transparency, and reliability. Moreover, it serves as the theoretical foundation for the transformative shift in the official processes in the Lebanon.

Introduction

Lean cities are those who apply lean principles to maximize citizens' value-added services and eliminate waste from their processes (Quintana, 2017).

Need For Study

• Corruption in Lebanon is costing the state an estimated $800 million a year (TICPI, 2016).

• 49 percent of Lebanese people offer bribes to speed up transactions (Awada, 2014)

Construction documents are consequently being delayed with higher costs

Objectives

• E-governance via digitizing governmental system provides a tool that enables the control over the process and allows the integration of lean principles: remove waste, achieve transparency, raise problems to the surface

Methods

•Exploratory research about corruption within official processes in Lebanon

•Short interviews to determine the current process steps and the impact of document delays on the construction projects

• Interviews with construction engineers and a document tracker that has been working in the field for more than 30 years

Table No. 1: Survey of Governmental Inefficiency Effects

	Process affected by governmental procedures	Types of waste	Root Cause of problem
1	Request to connect to municipal pipe network for water in a new construction site	Time, money (employee keeps on delaying the service until contractor offers a bribe)	No proper supervision, government employees have the power to delay work and get bribes
2	Negative iterations in the approval process of project design	Time, design resources, rework	Unclear guidelines (wicked), intentions of engineers to trigger designers to pay them to stop drawing refusals
3	Municipal permits required for bank loans	Time, money	The municipality was tight on budget, exploited its authority by delaying the process till contractor pays them money
4	Getting permits for construction	Time, money (If one employs a person from the inside, it would take half the time)	Inefficient process, with lots of inventory, variability, and bureaucracy
5	Permit to modify an existing facility	Time (the document requires one week but extended to a month)	No supervision or transparency, the employee manipulated his job for personal issues with the engineer

Results

•LEAN IT STRATEGY: This foundation is in the form of an Enterprise Resource Planning (ERP) System that breaks down barriers in terms of information silos and enables the swift and real-time transfer of information between different governmental entities involved. Lebanese ministries always have interdisciplinary work among them that requires them to connect with each other in an efficient manner, so an ERP system would be essential to maintain a proper flow of information among them.

•PHASES OF LEAN IT

Figure No. 2: Phase I

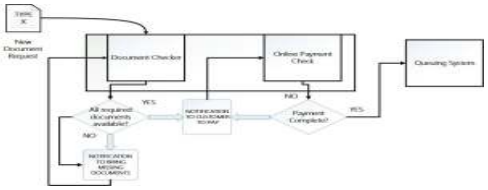
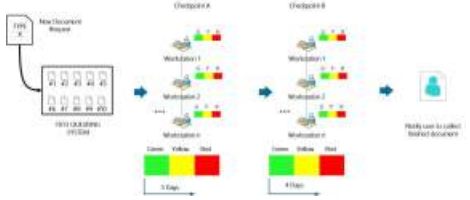


Figure No. 3: Phase II



Discussions

It is very important to take into consideration the design for a lean behavioral strategy that will institutionalize a cultural change. A global approach must be taken that aims to positively shift the mindset of public employees, making them potential agents of change in terms of the quality and reliability of the government services they perform

Conclusions

In conclusion, it is fair to say that change will not come easily when it comes to changing the culture and mentality of Lebanese government employees, but it is only in adopting and staying committed to long-term lean strategies that will give us the opportunity to mitigate the amount of corruption in official processes. These strategies will start by removing inefficiencies of current procedures to end with improved processes that would keep improving with time. By that, we would elevate the standards and transparency within the Lebanese Construction Industry in a way that would motivate other industries to adopt such a lean mentality, and in return, advance at both a personal level as well as a country-wide level through promoting a sense of reliability and authenticity of work.

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LEAN FORMWORK

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IGLC CHENNAI 2018 International Group for Lean Construction

POST211

Abstract

Formwork materials and worker payments are one of the main expenditures in reinforced-concrete structures. Formwork engineering is thus one main factor impacting project success. In current practice, formwork construction including non-value-adding activities results rework and inventory waste. The aim of the paper is to adopt the lean manufacturing ideas to reduce unnecessary waste in the formwork engineering. A lean formwork construction model is developed to achieve this goal. In the lean formwork construction model, an on-site quality control culture is established by using Andon. Using the Andon system, form workers could receive support right away when problem occurs. Moreover, using Andon, operations in formwork engineering are pulled using the Kanban system to lower mold inventory level and create a continuous formwork construction flow. To validate the feasibility of the lean formwork model, a real case is tested. Experimental data demonstrate the developed method could banish unnecessary worker-hours in the formwork's operational flow and enhance formwork's value.

Introduction

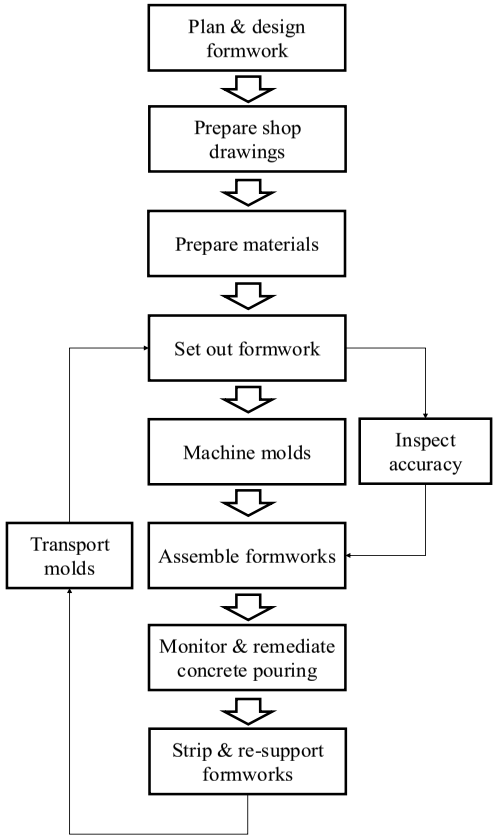
Formwork operations depend heavily on teamwork. However, ageing workers may deteriorate productivity. This worker structural problem directly impact project delivery, quality, and cost. Various studies have proven that lean construction could provide the construction industry with an alternative management philosophy

Objective

The purpose of this research is to applying the lean manufacturing to eliminate waste in formwork engineering.

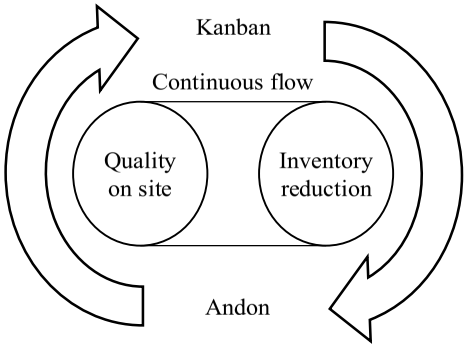
Formwork Operation Process

Formwork operational process includes the following 10 steps, namely: 1) planning and designing, 2) shop drawing preparation, 3) material preparation, 4) mold machining, 5) setting out, 6) formwork assembly, 7) inspection, 8) monitoring and remedy of concrete pouring, 9) stripping, and 10) re-supporting of formwork.



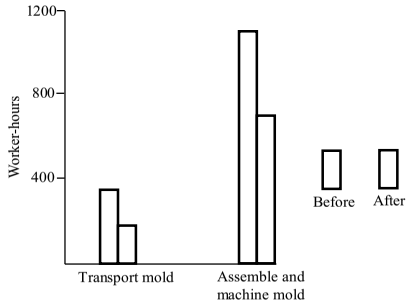
Lean Formwork

Currently the general contractor, formwork subcontractor, and third party of the project work individually. Such team work culture without an integral plan results waste of waiting between subcontractors due to poor coordination. Analyzed results show that the current formwork construction flow contains waste of motion. Main reason is that the formwork foreman does not plan the construction site layout ahead. Therefore, the waste of motions such as walk, search, and wait occur while assembling, machining, and transporting molds. Furthermore, the construction instruction is orally expressed by the formwork foreman. Formwork workers may receive incomplete production information. Moreover, the formwork team generally lacks of on-site quality control concept. Assistance cannot be obtained when workers have doubts in the construction process. These reasons may generate waste of making defective products.



Conclusions

• Improving formwork quality depends on continuously learning and improvement attitude. The Andon culture and Kanban system can then be used to eliminate the non-adding-value waste. However, when transforming lean into formwork construction process, foremen and superintendents also should take the resistance of change into consideration. Lean education is necessary when implementing the lean formwork construction model. Since managerial philosophy between the lean formwork construction model and the current practice is different, workers may resist changing.



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THE ROLE OF SLACK IN STANDARDIZED WORK IN CONSTRUCTION: AN EXPLORATORY STUDY

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IGLC CHENNAI 2018 International Group for Lean Construction
POST213

NORIE

Abstract

Standardized work (SW) is a type of action-oriented procedure that sets a basis for continuous improvement in the Toyota Production System. However, the usefulness and applicability of this practice to construction is still unclear. Furthermore, while some studies have addressed the key elements of SW, the role played by the concept of slack as a fundamental element of operations design is rarely discussed in an explicit way. This is a drawback since slack resources allow for the system to cope with variability from different sources.
Considering the context of the construction industry, the aim of this study is to carry out an exploratory investigation of the role played by slack in SW.

Introduction

This paper explores the role played by slack in SW when applied in construction, and it is based on the assumption that slack is relevant for SW because it can be used to absorb variability from different sources.

Need For Study

•SW requires a certain basic stability of production processes, which is difficult to be achieved in construction projects
•In lean literature, the concept of slack has been explicitly addressed only in terms of time, capacity and inventory of materials

Objectives

•To highlight the role of slack as a basic element of SW in construction
•To identify which slack strategies play a key role to coping with variability arising from the preconstruction of a construction task .

Background

What is Slack?

•A mechanism for reducing interdependencies and minimizing the possibility of one process affecting another (Safayeni and Purdy, 1991);
•If not by design or opportunistic intentional use, any resource can contribute to slack in a certain context, since it provides protection against variability sources (Saurin and Werle 2017).

Relationship between slack resources and the basic elements of SW

Table No. 1

Basic Elements	Slack resources	LP approach	Variablity
Takt and Cycle Time	Time	Cycle time for a process should be calculated as 80% of Takt time to ensure that any difference in setup or performance of workers or machines can be absorbed (Rother and Harris,2002).	Internal variability
Takt Time	Capacity	Toyota assembly lines operate in two eight-hour work shifts with a four-hour interval between them. This interval allows for Toyota to increase capacity whenever the production quotas for a shift are not met in normal working time. (Hopp and Spearman, 2004).	Internal variability
Work-in-Process	Safety stocks	The stock of a completed part that is planned for protection from disruption in the flow of the product (Martin and Bell, 2011).	Upstream variability

Other subtler instances of slack resources in Lean Production (Saurin, 2017)

•The use of multifunctional and cross-trained workers;
•The concept of "help chain";
•Cognitive slack like the consideration of several alternatives for solving complex problems or the "set based design" strategy for development;

Strategies for deployment slack in construction

Table No. 2

Strategy	Definition	Examples of application
Redundancy	It is divided into four sub-categories: (i) standby redundancy, which is redundant resources not immediately involved in the task at hand; (ii) active redundancy, which means redundant resources that is involved in the task at hand; (iii) duplication of functions; and (iv) redundant procedures or redundant inspections across process stages.	1. Redundant equipment/tools 2.Creating formal or even informal leadership redundancy to distributed authority when necessary
Work in Progress	Refers to stocks of raw materials, partially finished products and finished products.	1.Several simultaneous work zones 2.Stock of materials
Margins of maneuver	It is characterized by autonomous or coordinated strategies that create margins through reorganization of resources.	1. Multifunctional workers 2.Layouts that allows for different trades share or change space for inventories and flow of workers when necessary 3.Capacity and time buffer
Cognitive diversity	Refers to divergence in analytical perspectives among members of an organization	1.Short-term meetings involving different team leaders to identify and solve problems of previous week 2. Cross-training
Control slack	Refers to individual degrees of freedom in organizational activity, with some range of individual action unconstrained by formal coordination or command.	1.Supervisors allow for experienced subordinates to improvise when the action adopted is consistent with the overall goals of the process

Methods

•The approach of this paper is theoretical, and the analysis is mostly based on a matrix that checks strategies for the deployment of slack resources against sources of variability in construction.

Table No. 3

	Variability of preconditions for a constructiontask							
Strategies	Construction Design	Components and materials	Workers	Equipment/ Tools	Space	Connecting Works	External condition	Work Infrastructure
Redundancy	X	x	X	X	X			X
Work in progress		x				X		
Margins of maneuver	X	x	X	X	X	X	X	X
Cognitive diversity	X		X					
Control slack		x		X	X	X		X

Conclusions

•Results indicate that SW, in construction, should account for a broader range of slack resources than manufacturing.
•The matrix indicates that, although the strategy of using WIP may be the most known, it needs to be jointly applied with other strategies to support SW in construction.
•This matrix also makes it possible to identify that two slack strategies (i.e margin of maneuver and redundancy) play a key role to coping with variability arising from the preconditions of a construction task. Thus, these two strategies of slack should probably be explicitly incorporated into the list of basic elements of SW in construction.

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POST234

FACTORS AFFECTING IMPLEMENTATION OF LEAN CONSTRUCTION

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Abstract

Research has shown advantages an organization can obtain by implementing lean methodology. However, when implementing new philosophies like Lean Construction, there are always some challenges to overcome. The authors of this paper have worked with implementation of lean principles in a Norwegian contractor company. The contractor is split into several sister companies or divisions. Some of the divisions have succeeded in implementing lean, while others have not succeeded well. The authors will evaluate what factors that have affected the implementation. The research methodology used is case study. Research from the case study will address how to overcome challenges related to the implementation process in similar cases.

Introduction

There will always be challenges to overcome when implementing lean principles and tools.
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Need For Study

• Increased interests for implementation of lean principles and tools.
•Challenges are met when implementation of lean
•Contractor companies are divided in different divisions, and sometimes sister companies.
•What factors affect implementation in the different sister companies, and how could we overcome the challenges?

Objectives

• identify factors affecting the implementation of lean in a construction contractor holding company, and its underlying sister companies.

Methods

The case contractor company is the case we are doing research on. It consists of a holding company with 12 widely geographically spread sister companies (each a "division"). The divisions are acquired over a period of 40 years. The divisions are responsible for their day-to-day operations.

The case organization is currently in the middle of an implementation process with lean and lean is already well anchored in the company's strategy.

The case study is based on a literature review, as well as interviews, observations, a questionnaire, document studies and informal conversations with people involved in the process, both internally and externally.

To get knowledge about the implementation process in the holding company, the first step was in-depth interviews with 3 key stakeholders in the holding company and with the external consultant, an expert on lean implementation involved in the implementation process. To get knowledge about the situation in the sister companies and in the projects, a questionnaire together with in-depth interviews with key personnel in some of the sister companies was performed.

The questionnaire was sent to seven sister companies that already had started implementing lean. 151 persons were asked to answer the questionnaire, where 123 answered the questionnaire.

Results

•Holding Company findings

•The aim of the organization is that by 2019 lean construction should be the way they do things.

•Due to absence of any desperate need to change, the organization has the possibility to progress in a healthy manner.

•The organization faced lack of internal competence on lean construction. Therefore, a consultant company was hired. The consultant company developed a roadmap for the implementation.

•The roadmap is like a guiding tool to finally transform the organization into a self-driven one, searching for continuous improvements.

•Sister Company findings

•It is highly important to get manager's and key-personnel's attention.

•The consulting firm maps out on which process they should start their improvement work with help of a process-mapping tool.

•Large differences between the divisions, much based on willingness to change.

•Two of the divisions with most successful implementation processes thus far both have had a feeling of urgency for change and an internal driving force behind implementation.

•Project Level findings

•90 % of the employees know why Lean Construction is implemented, 15 % of the employees did not have enough information about Lean, 20 % did not have enough information about the implementation process

•The companies where projects became more productive after implementing Lean are the same companies that most often use Lean Construction elements in their organization and projects

Conclusions

Through literature search, interviews with the holding company, the questionnaire and interviews with five of the sister companies, important factors for successful implementation were identified. For successful implementation of Lean Construction in a holding company with its sister companies, the following factors are important;

• implementation starts with the holding company with top management support through the sister company and its management and down to the projects
• information and communication around the implementation and the lean principles, from the holding company, through the sister companies down to the project level is important
• showing success from early adopters in the implementation is an advantage
• if use of external facilitator, support with resources both from the holding company and the sister company is necessary, building internal competence to use when the consultant company is no longer there
• marking of victories and recognition of successes along the way, both at holding company level, sister company level and at the project level is important
• establishing a forum for exchange of experiences between the holding company, the sister companies and the projects will give good support on all levels.

Towards Identifying Making-Do as Lead Waste in Refurbishment Projects

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IGLC CHENNAI 2018 International Group for Lean Construction
POST236

Abstract

The aim of this research has been to identify Making-Do in refurbishment projects and the reasons behind it. A case study research approach has been used to collect data by actively participating in weekly Last Planner System meetings, observing work in progress on-site on three projects and conducting work sampling studies on six trades. The research showed that Making-Do is highly likely to be both the prevailing and lead waste form in all of the three cases, and that insufficient management of production was the main cause. This was found by firstly identifying an overlap between known impacts of Making-Do from literature and the most occurring negative impacts observed in the cases. Secondly, finding that talking generally contained the biggest potential for being reduced and that this potential had an apparent correlation with Making-Do.

Introduction

Refurbishment projects have shown declining productivity in the last two decades. At the same time, refurbishment activity is increasing rapidly worldwide to achieve a more sustainable built environment. Thus, understanding reasons for the low productivity is a key aspect to reach environmental as well as economical sustainability

Need For Study

•To reach the national and international goals of reducing CO2 emissions we need to reduce the embedded energy in the execution phase.

Objectives

•Understanding reasons for low productivity in refurbishment projects.

• Ad to current knowledge on waste identification.

Methods

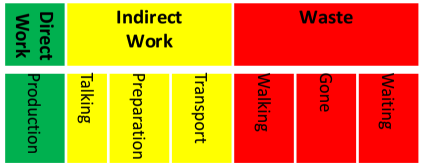
Three social housing refurbishment projects were followed for 12, 8 and 8 weeks respectively.

Case facts

Case 1: 297 apartments, basement to 2
Case 2: 291 apartments, basement to 2
Case 3: 601 apartments, basement to 3

The methods applied: 1) interviews and observations and 2) work-sampling (WS)

Figure No. 1 – Categories in WS-study



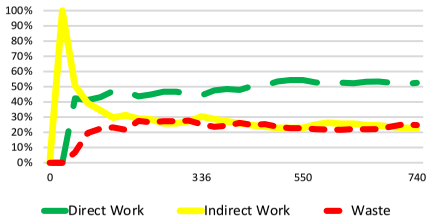
Statistical analysis and stabilization curves

Results from the WS-study of the six trades have been statistically analysed according to Terp et al. (1987) to establish the certainty of the 95.5% confidence interval. The following formula was used:

$$2 \cdot \delta = \pm 2\sqrt{(p(100-p))/n}$$

With: p (relative frequency), n (number of observations) and $\pm 2 \cdot \delta$ (δ, one standard deviation)

Figure No. 2 – Stabilization Curves



Results

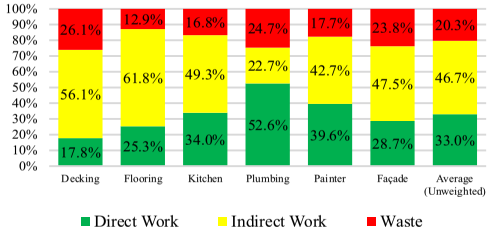
The results from this case study consist of interviews and observations including PPC measurements and a WS-study of six different trades

Results from interviews and observations

1-Insufficient planning leads to talking
2-High frequency in Making-Do events
3-PPC: case1: 54%, case2: 46% & case3: 60%

Results from work sampling study

Figure No. 3



Discussions

Causality in refurbishment projects

WS-study, Interviews and observation
↓
Identify potential
↓
Insufficient Control and Planning
↓
Starting of activities missing at least one flow
↓
Making-Do events occurs
↓
Unnecessary talking among trades
↓
Talking contains the apparent largest optimization potential
↓
Making-Do is highly likely to be the prevailing and lead waste in refurbishment projects.

Conclusions

The conclusion presents an theoretical optimization prognoses based on feedback from each trade observed in WS-study and PPC levels from literature. Feedback from trades were obtained by asking each trade to asses how much time each category required if PPC were stabilized on 100% and site logistics enhanced. To identify a realistic achievable PPC level 10 studies were analyzed finding that a PPC level on 75% is realistic if lean tools as LPS are used. The numbers are plotted in figure 4 with production (Direct-Work) on the x-axis and PPC on the y-axis

Figure No. 4

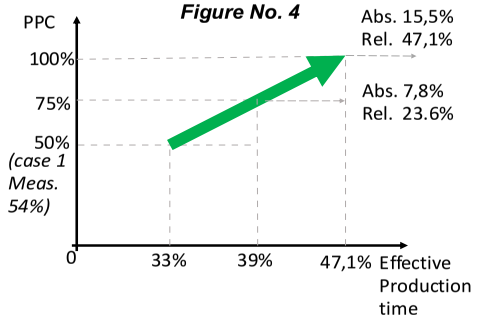


Figure No. 5 – avg. case optimization potential in each category for 6 trades

Cat	Talk.	Prep.	Trans.	Walk.	Gone	Wait.
Abs.	7,4%	0,0%	2,9%	1,4%	3,4%	0,3%
Rel.	52,4%	0,0%	31,6%	19,4%	19,4%	10,0%

Future research

1-Correlation Between Productivity, PPC and Lean Implementation.
2-Baseline of Productivity
3-Optimization Potential

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SyncLean: An Application for Improved Lean Construction Practice

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POST242

Abstract

Visual management (VM) is instrumental in implementing lean construction philosophy and principles. The lack of communication and sharing of information among construction professionals in construction projects hinders workflow. This poster introduces a mobile application, Synclean, inspired by the virtual Obeya room of Toyota Production Systems (TPS) to ease the transfer of information between site personnel. SyncLean's features will ensure the application is relevant to the very last planner on construction sites and will support collaborative value-adding, waste-minimizing work. The application prototype mobile interface was tested by users and the impact of this application will be later tested by surveying site personnel of various positions for the application's impact.

Introduction

The availability and reliability of mobile phones provide an already existing platform for implementing the mobile application, "SyncLean", proposed in this paper, that will utilize Information Technology and Lean philosophy in the favor of the construction industry. SyncLean will employ visual management tools to help improve construction site workflow, quality and safety by incorporating the latter into a mobile application.

Need For SyncLean

•Delays in most if not all construction projects.

•Accessible application that holds Lean features to improve site performance.

Objectives

•Improve construction site work flow.

•Reduce waste and idle time.

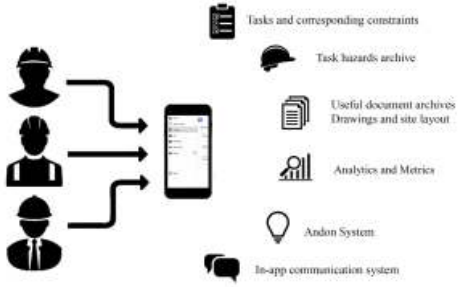
Methods

•The research process will consist of assessing the need for such an application through the review of literature, developing the application interphase and testing of the application features and effectiveness on a small student community and some accessible site personnel.

Features

•This application will provide (1) the description, constraints, progress of tasks, hazards associated to these tasks and the option to add emergent tasks, (2) a weekly or biweekly look-ahead schedule that can be updated from upstream and downstream, (3) access to useful documents like site plans, drawings and methods of statement, (5) a communication system consisting of messages and tap-to-talk, (6) an Andon system for any problems that pop up and (7) other useful analytical features.

Figure No. 1

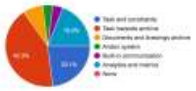


Results

•The application was tested by a small student community at the American University of Beirut and the results turned to be mostly positive. Users praised several aspects, mainly the task hazards tab, the Andon/notification system, and the analytical features that automatically generate metrics. The users also reported the ease of use of SyncLean, and the simple design that ensures a fast learning/adaptation process.

Figure No. 2

Figure No. 3



Discussion

•As for the application itself, Alarcon et al. (2013) state that managing information is critical for organizational performance, and that information networks are vital for value generation (Alarcon et al., 2013). SyncLean, being the center of construction site information sharing will make way for value generation through accessibility to the Last Planner. Not only will the mobile application provide easy accessibility, but also shorter communication time between the site personnel and decision-making entities through its communication features and virtual Andon system. Hamzeh et. al (2012) state that an agile response to unexpected problems is ensured through shortening the previously mentioned communication time. By achieving a more reliable workflow on site, through SyncLean, schedule performance will be significantly affected.

Conclusions

To conclude, the theoretical analysis for the need of SyncLean is but a step in the course of fully implementing this application in a construction project. Much work is yet to be done however, in terms of fully developing this application and testing it on real ongoing projects. Next steps would be to release a final build of the application that would then be implemented into a construction site for study. Full implementation would serve as a case study that would uncover the weaknesses of SyncLean and show through quantitative analysis whether it would benefit a project.

Interphase

Figure No. 4

Figure No. 4

References

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POST252

VALUE-ADDING ACTIVITIES LEVEL IN BRAZILIAN INFRAESTRUCTURE CONSTRUCTION COMPANIES - 9 CASES STUDY

Bernardo Martim Beck da Silva Etges

Abstract

This work presents an approach to answer the question of what is the level of value-adding activities that infrastructure projects usually operates. Considering the Lean Construction concepts, waste definitions and Value Stream Mapping, added to an Operational Excellence perspective, it brings the result of nine infrastructure projects conducted by a consultancy company in seven Brazilian Construction Companies.

Introduction

Given the premise of understanding the operational level of value-adding activities as a basis or kaizen implementations and productivity improvement, construction groups, focused on infrastructure in the public and private sector in Brazil are investing in improvement processes and implementation of operational excellence programs. To understand the level of value-adding activities on site, the process diagnostic step is conducted integrated three main concepts:

- Waste identification,
- Value Stream Mapping (VSM)
- Gemba routines and observations of the shop floor.

Objectives

•To illustrate the value-adding status in infrastructure projects in the public and private sector.

•To demonstrate the use of production analysis tools that allow us to understand the zero line for the implementation of productivity kaizens the analyzed works.

Methods

The data collection comprises two phases of the Workshops: (a) Analysis/Diagnosis and (b) Kaizen Workshop.

Analysis/Diagnosis:

In this phase is mapped the VSM for the main activity and the Gemba and waste analysis is conduced: the 7 wastes defined by Ohno are used as references. In order to identify wastes and their impacts, the following tools are used:

(a) Gemba-Walk, which consists of observing and finding evidence of the aforementioned wastes;

(b) Multi Moment Analysis (MMA), a count of people who add value or for some of the types of the seven wastes, an analysis of several consecutive intervals of time;

Kaizen Workshop:

7-phase Workshop, where in the third step the project team go deeper in the VSM analyses and after the process has been mapped and the value stream has been clarified, the Workshop team engages on field-work in order to identify and quantify failures and wastes. The team is split up to cover some formats of analysis that include: Identifying the seven wastes; a spaghetti diagram; a MMA for periods of at least 30 minutes of observation.

Results

The results were analysed in three criteria's: (a) type of construction operation under execution during the observation; (b) level of value-adding activity in each project; and (c) level of value-adding activity in each type of operation observed.

The consultants developed over 1090 observations in a total period of 72 observation hours and more than 890 manhour considering the total of frontline workers on-site in each observation. Considering the critical path identified in the VSM the main operations observed that Steel assembly, frames and concrete represent the highest amount of observation time (representing 67% of the total time).

The level of value-adding activities is shown in Figure 1.

Figure No. 1

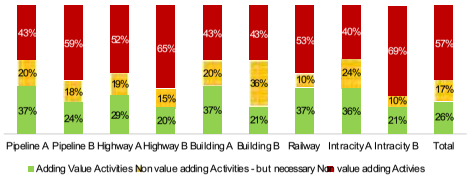
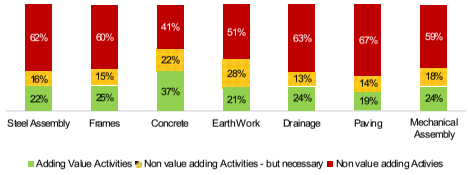


Figure 2 illustrates the analysis of the value stream critical operations.

Figure No. 2



- Paving and earth work had the lower level of value-adding activities,
- Concrete operations are the highest level of value-adding activities since it is normally an activity that must be quick, organized and requires a predeterminate number of frontline workers

Discussions and Conclusions

- The results show that 57% the construction activities observed did not add value (69% and 65% on Intracity B and Highway B respectively). Being able to understand this level of waste, promote critical change actions is a fundamental stage in the performance improvement process, cost savings and a leaner construction management.
- The perception, identification and presentation of the level of wastes and non-value-adding activities to the Construction Companies managers brought a new managing attitude toward planning, control and understand their on-site activities.

•By implementing the described methodology even companies with high technical level and management team with extensive experience in infrastructure works, are unaware of a high level of non-value-adding activities. It is also clear to conclude that as more organized, prepared, planned, and controlled the activity is, better level of value-adding may be found.

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MAPPING OF BIM PROCESS FOR TEACHING LEAN

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IGLC CHENNAI 2018 International Group for Lean Construction
POST258

NICMAR

Abstract

The principles and practices of Value Stream Mapping (VSM) and Building Information Modelling (BIM) benefit construction process, however, there are limited studies that elucidate their synergies and demonstrate the value for teaching lean in construction management programs. To this end, the process of conversion of 2-dimensional (2D) design drawings to a 3D building information model of a construction project was foremost captured through VSM technique in an experimental study consisting of 4 student teams. The action learning methodology helped to reinforce the VSM technique in teaching lean and allowed the students to present appropriate opportunities for improvement.

Introduction

The benefit of Lean practices in the construction industry, has currently promoted teaching Lean in the curriculum of construction management programs world-wide.

Need for the Study

VSM visually maps a process and identifies areas for possible improvement. However, it is directly applicable on assembly line operations in a manufacturing industry, an environment which the civil engineering students may not be familiar with, and therefore require experiential learning. Further, construction management students, find it difficult to grasp the abstract concepts of 'waste', 'value', 'process', 'conversion' and 'flow' of activities that are analogous to Lean manufacturing (Nofera et al.,2015; Pellicer & Ponz-Tienda, 2014; Hirota & Formsa, 1998).

Objectives

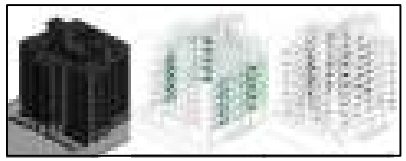
- To demonstrate, VSM technique can minimize waste in the production of 3D BIM from 2D design drawings
- To enhance team building capacity of students.

Methods

- VSM is process oriented, thus an action-based learning methodology was adopted (Stringer, 1999).
- A synthetic experiment was conducted with post graduate students having background in civil, mechanical and electrical engineering for a period of 1 week. 4 student teams with 5 students each were involved in producing 3D BIM in Revit® Architecture and MEP of a construction project with 5 main tasks: foundation, structural framing, architecture and interiors, plumbing and electrical.
- VSM steps followed include: a) determining the appropriate process, b) creating the current state map, c) determining the appropriate metric for improvement, d) creating the future state map, and e) determining improvement methods and initiate action plans (Tapping et al., 2002).
- Lean metrics - Takt time, cycle time, process time, lead time, defective rate and total value added time. Value parameters - improved process efficiency and quality.

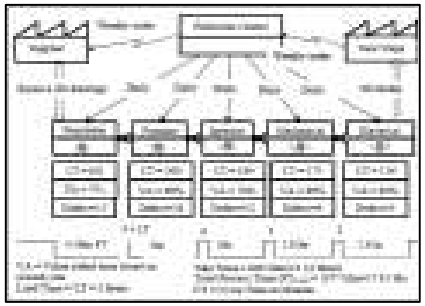
Figure 1: Initial Team Times to build 3D

Figure 2: 3D BIM – Architecture, Mechanical, Electrical



Results and Discussions

Figure 3: VSM – Current State Map



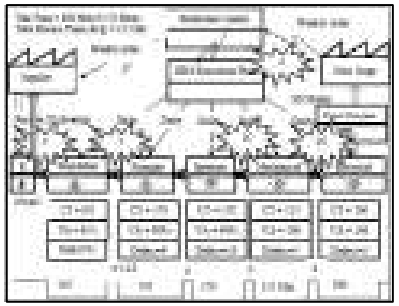
Kaizen Efforts and Team Reflections:

- Lack of sufficient information in the drawing – led to waiting time
- Review activity – non-value added but necessary activity
- Errors, structural clashes such as column in ramp (figure 4), beam-column structural clash, plumbing lines and masonry clash, all these led to rework, wasted time
- Lack of constructability check during handover leading to rework
- Redundant information exchange due to lack of coordination
- Entire process observed as push based instead of a pull system
- Standardization on level of detail – reason for over production
- BIM model heavily front loaded – rework difficult and time consuming
- Rework due to non-value added tasks such as coordinate system
- Lack of version control – inexperience

Figure 4: Errors/Defects in Model

Results and Discussions

Figure 5: VSM – Future State Map



Recommendations for future state VSM:

- Synchronize the output with Takt time
- Standardize work procedures to avoid rework such as level of details and types of handrail, staircase etc.
- Restructure work where needed to improve flow, avoid waiting for information by: a) introduction of a coordinator at the beginning and end of sequence to review input/output, b) incorporate BIM plan (pull)
- Quality control efforts through self-checks/checklists reduced the defects
- Average cycle time reduced to 12.5 hrs.

Conclusions

- This experiment reinforced the value of VSM technique in identifying and minimizing waste in BIM process through experiential learning.
- In specific, it increased commitment, transparency and coordination amongst the actors apart from enhancing team building skills.

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POST309

What is lean construction: another look — 2018

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What is Lean Construction - 1999

WHAT IS LEAN CONSTRUCTION - 1999

Gregory A. Howell[1]

ABSTRACT

The origins of lean production are reviewed and a claim made that it is a new form of production management, that is neither mass nor craft. Then the applicability of lean production in construction is considered and nature of lean construction discussed in comparison with current practice.

KEY WORDS

Lean construction, lean production, production management

chair that Americans would christen "The Chair"—the perfect chair. Yet, he continued to design chairs because, as he once observed, "nothing is so good that it cannot be made better." Wegner may well have been the world's most prolific furniture designer. He designed more than 1,200 pieces of furniture, about 500 of his designs went into production, and he

Hans J Wegner, Danish furniture designer

Findings

Some in our community have a preferred definition of lean construction

There is no shared or agreed definition

It may be more helpful to think about the purpose of lean construction

There is no agreement about whether or not there should be a definition

Background

Can we do research without one?

Many have complained about the lack of an agreed definition

This study reports a simple survey to collect 'definitions in use' within our Community.

It includes in incomplete review of definitions used in the formal & *informal* lean construction literature.

Definition

"An exact statement or description of the nature, scope, or meaning of something"

An *operational definition* provides unambiguous measurement criteria

there is no agreement that there should be a definition

Criteria

for a definition

differentiate — and so exclude those who practice traditionally

be operational

be concise — *as simple as possible and no simpler*

reduce communication problems

make it easier to teach, instruct

make research easier

make it easier to define overall goals of the concept

Method

I asked our community for their favourite answer to ***"What is lean construction?"*** via:

- a LinkedIn article
- posting 2 'discussions' on LinkedIn
- an email to the IGLC yahoo group

42 'definitions' from 39 authors
+ 26 definitions via Google
+ others collected over the years

Limitations

not a systematic review of the literature.

not the whole of our community

no sense how representative those who responded are

... and there is a problem:

there is no robust explanation for lean
– Lauri Koskela

"Lean ... is an American tradition built by consultants & writers attempting to say sexy things that come out of ... what Ohno & colleagues did at Toyota. Their observations were idiosyncratic, fragmented, without ANY attention to the heart of the matter which has to do with cultural traditions and language. [Lean] failed ... the big 3 automotive companies, has produced ... important practices in manufacturing in the West, & is busy failing in construction in the West. – Chauncey Bell

my conclusion

This fails to meet Greg Howell's criterion (it doesn't differentiate);

it is not operational.

It does speak to purpose.

lean is *a collection of practical theories, principles, axioms, techniques (tools) & ways of thinking that together & severally* ***help individuals and teams improve the processes and systems within which they work***..

summary

would a definition help or hinder?

Can we do research without one?

There is no agreement about whether we should have a definition

Lean construction is continually evolving

Nothing is so good it cannot be made better. Hans J Wegner

On the absence of a definition

"Lean does not have an agreed definition, it has numerous, ..., this is the subject of discussions between academics, & professionals. Not having a ... definition has not stopped Lean from being ... applied in motor manufacturing. O'Neil 2016

"The ... problem in introducing Lean Construction in Japan is [the] *definition is not clear.* Inokuma 2017

Some *definitions-in-use*

- *"A new way of managing projects based on two theories, The Value-Flow-Operations* [TFV] *theory that puts schedule & logistics before budget & work, and chaos theory that introduces pull logistics through Last Planner.* *Sven Bertelsen, email*
- *"A management principle that stimulates continuous learning and improvement and supports cooperation.* *Sven Bertelsen, email*
- "lean = the design of slack. *John Rooke, email*
- *"principally the management of learning and commitment* *John Rooke, email*
- *"the elimination of waste, particularly waste of time.* *John Rooke's favourite, email*
- *"A collaborative, proactive, transparent, and involving environment, focusing on an optimal production flow for the end product, systematically & visually using combined work and plan processes, cross-functionally keeping the bigger picture in mind.* *Hans Thomas Holm, Linkedin*
- *"a way of thinking to create more value for the customer with fewer resources; focus on flow, continuous improvement and value for the customer.* *Anon, email*
- *"exactly what the customer wants, ... when they want it, with nothing in store.* *Kristen Parish, email*
- *"synchronised harmony* *Christine Pasquire, email*
- *"An application to construction of a management* ***philosophy*** *defined by the* ***ideal*** *it pursues, the* ***principles*** *followed in pursuit of the ideal, & the* ***methods*** *used to implement the principles.* *Ballard 2012* (& others)
- *"Lean Construction is systems thinking, respecting people, pursuing continuous improvement, & so much more.* Tommelein 2018

For more definitions and full references go to the paper.

LAMINATED TIMBER versus on-site cast CONCRETE: a comparative study

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POST313

Introduction

Veidekke AS, one of the largest contractors in Scandinavia, has a strategy to acquire knowledge on and gain a competitive advantage by building environmentally friendly buildings. Veidekke was using both Cross Laminated Timber (CLT) and on-site cast concrete to construct two apartment buildings at the same building site in Trondheim, Norway, in a comparable setting. The contractor used the Lean method Collaborative Planning (CP), a Last Planner adaption, during design and construction. They also used Takt Planning for the construction planning. This provided a unique opportunity to research both on Lean construction and buildings in CLT.

CLT-building Concrete building

What is CLT?

CLT elements are prefabricated with high precision in modern factory settings. Several advantages are associated with such prefabrication of CLT (Smith et al. 2017). Less material waste on the building site, element accuracy due to prefabrication, reduced on-site construction time and usage of lower quality timber in structural elements are among them. CLT consist of multi-layered panels made of construction timber (Buck et al. 2015). The layers are arranged with the fibers perpendicular to the neighboring layer and glued together.

Need For Study

- The fifth assessment report of the Intergovernmental Panel on Climate Change confirms with 95% certainty that global warming is caused by anthropogenic greenhouse gas emissions. It is estimated that 18% of the global CO_2 emissions are directly or indirectly generated by the building sector and is projected to increase by 50-150% by mid-century.
- Builder experience with mass timber in general and CLT in particular is limited and not widely known.

Objectives

The objective of this study was to investigate how Lean measures like Last Planner and Takt influence the construction process when new and green materials like CLT are introduced. To answer this objective, the following three research questions were formulated:

1. What are the differences between construction in cross laminated timber (CLT) and on-site cast concrete?
2. What pros and cons are associated with the use of CLT?
3. How can contractors improve construction with CLT?

Methods

An initial literature review was conducted on the topic "mass timber". The aim was to map the state of the art from a project management point of view in relation to construction in mass timber.

This study used a case study approach, collecting data from three sources:

- Three direct observations were conducted in design meetings. A role as a participating, but passive, observer was used
- Five respondents from the main contractor and seven respondents from the sub-contractors, were interviewed.
- A document study was conducted based on the available and relevant documents in the online project hotel of the main contractor.

Results and Discussions

During this case study some significant differences were identified. Three categories of differences between construction in CLT and on-site cast concrete were identified by the respondents in this study, listed in the table below:

Due to mass timber:	Due to new material, not mass timber explicitly:	Occurring in any type of project:
Enlarged concrete beams in the basement	Level of uncertainty in concept development and detailed design	Cooperation issues
Development of acoustic solutions	Development of new construction details	Builder choices
Development of fire solutions	Early involvement of sub-contractors and consultants using CP	Decreased value creation for the main contractor
Dimensions of CLT-elements	Implementation of the design process	
Improved HSE during production	Shortened construction time	

The most important findings:

- Acoustic, fire and structural challenges related to the use of CLT caused extra work during concept development and detailed design. The architect and the main contractor were the most influenced parties.
- The CLT-elements represent an advantageous construction method. Reduced construction time and the accuracy of the elements due to prefabrication are the most significant benefits.
- Reduced material waste at the building site, improved HSE and reduced CO_2 emissions are among the sustainability benefits for contractors.
- The main drawbacks with CLT in this case is the loss of work that can be carried out with in-house capacity and an increased design cost.
- Early involvement through CP may have lowered the perception of risk concerning the building in CLT and have been a key factor to provide a stabile framework in the design and production planning process.

Conclusions

- When it comes to how contractors can improve construction with CLT, Lean tools such as Last Planner and Takt proved advantageous in the studied pilot project.
- With higher uncertainty arises the need for increased planning for the unforeseen. Tools like Last Planner and Takt provided the stability needed for tackling the uncertainty that entailed the introduction of a new and green material as CLT.
- Early involvement through CP may have lowered the sub-contractor's perception of risk concerning the building in CLT.
- To get a good flow through the design process, the main contractor depended on reliable consultants and sub-contractors. CP and Takt can be used to secure this reliability, and these tools may have influenced the outcome more than the respondents have realized so far.

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Evaluating Why Quantity Surveyors Conflict With Collaborative Project Delivery System

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POST391

Introduction

The UK construction industry has evolved a 'survivalist shape' set by certain commercial activities in reaction to the environment in which it operates (Farmer, 2016). This is evident as the industry and its clients usually have non-aligned interest reinforced by the wasteful procurement protocols that have become part of the institution of the construction industry 'the way it does business' (Sarhan et al, 2014). Accordingly, this is pointing to lack of strategic framework in place to galvanised the transformation required in the industry. The current study contributes to the existing knowledge by providing empirical data on QSs commercial activities that operates outside the production system.

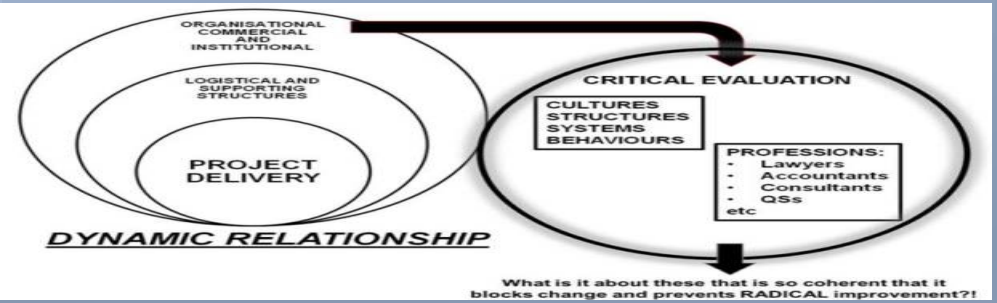

Figure 1. A roadmap guide for the study showing dynamics around construction model and the institutionalised structures surrounding it.

Purpose

In an attempt to explain why the conventional model is somewhat 'dualised' into production and contractual system, this study looks at one aspect, the commercial roles of QSs outside the production stream. In particular, the study aims to evaluate why QSs functions in either the traditional or advanced system conflict with collaborative practice. The study draws upon theory of production (TFV) and the concept of five big ideas in lean, as they seems to provide insights on how production systems can be optimised to overcome the conflicts & adversarial relationships surrounding the business model in construction. The underlying premise is that if we understand how commercial roles & functions are established in lean system, then the adoption and practicality of collaborative practice would be more wide spread in the UK construction industry.

Methodology

The research adopts a case study approach (Yin, 2009) to provide an in-depth and real-life instances. Eighteen semi-structured interviews were conducted with industry expects in order to:

- Investigate collaborative practice from a multidisciplinary setting and understand how commercial teams are maintained.
- To also understand the commercial challenges affecting CP in projects and programmes.

Conceptual Framework

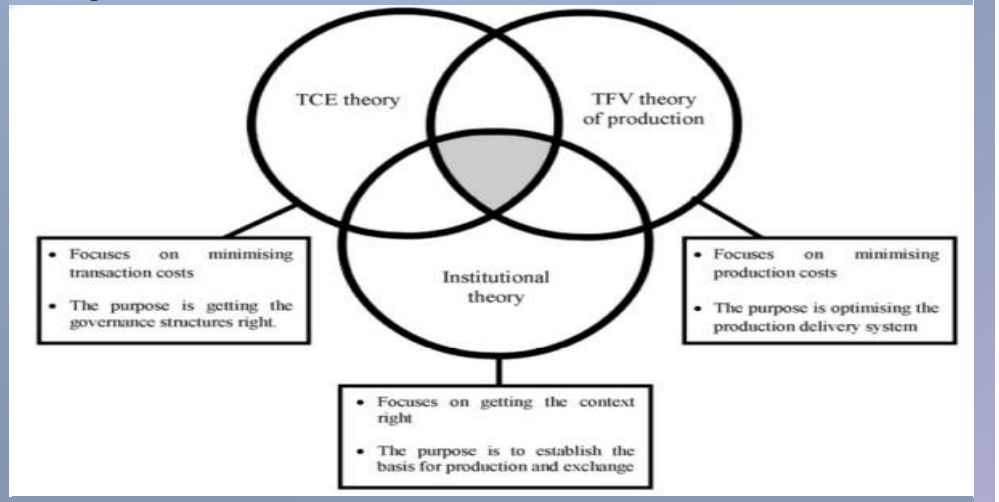

Figure 2. A conceptual framework adopted as a guiding lens for the study.

Working Hypothesis

From the production perspective, figure 3 further illustrates how the construction model is separated which gave rise to safeguarding practice that continue to deter collaborative agenda.

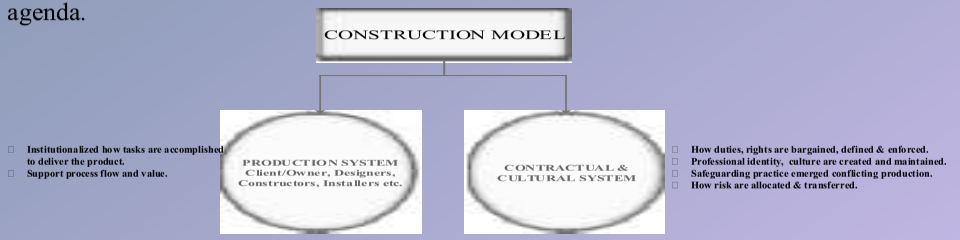

Figure3. Construction model showing the separation between production and contractual system [modified from Gottlieb & Kim Haugbølle, (2013)]

Findings

- The study sheds light on how the construction model is separated, and how commercial teams, QSs are formulated outside the production system.
- The research identified other commercial factors that continue to stifle collaborative practice drawn from major infrastructural sectors in the UK industry.
- The study recommend on establishing commercial teams/QSs and their associated roles into a relational contract arrangement in order to promote collaborative practice in the UK construction industry.

TEACHING CHOOSING BY ADVANTAGES: LEARNINGS & CHALLENGES

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Abstract

Choosing by Advantages (CBA) is a promising lean tool for fostering collaboration, value generation, cost optimization and reduction of waste in the design phase of construction project. This paper describes the experience with teaching of this tool to the students of masters programme in Construction Engineering and Management in an Indian university. As part of the exercise of Choosing by Advantages, the students were asked to select design problems for a construction project. The students group comprised of engineers and architects, which facilitated the role play of real life industry stakeholders - contractor, designer and client. A participant observation of the role play was conducted to understand their learning from this CBA exercise. The analysis indicated that the students learned about necessity of collaboration, design complexity and systematic decision making. Although, the concepts can be articulated in much better manner after overcoming the cognitive barriers and perceptions about prevailing construction industry environment.

Introduction

Among the different tools for lean design management, the Choosing by Advantage (CBA) method hold great potential owing to imbibing or rather forcing collaborative process in design process and raising the fundamental question if technical decisions bring value to the client.

Need For Study

- Impart knowledge on lean philosophy to the budding construction managers
- Increasing awareness on collaborative effort among stakeholders, value creation for the client and waste removal

Objectives

- To discuss the learnings and challenges in teaching CBA

Methods

- The instructors involved in this CBA exercise played multiple roles. Firstly, they played the role of "teacher" with the primary objective of teaching the application of CBA in the design process at hand.
- Further, they played the role of "facilitator" for role play exercise wherein collaboration and communication was facilitated. From the perspective of participant observation research method, the instructors also played an important role of "observer".
- Based on this typology suggested by Baker (2006), the role play by the instructor seems to equate to "Moderate or Peripheral Membership" wherein the researcher wants to "maintain a balance between being an insider and an outsider, between participation and observations" (Baker 2006).

Figure No. 1

Project	Design Problem	Design Options
Four laning of Mehsana Himatnagar Highway	- Choice of recycled material in sub base layer - Choice of street lights - Choice of crash barrier	- Reclaimed asphalt, steel slag, glass, plastic - Solar powered LED lamps, Sodium Vapour Lamps, Mercury Vapour Lamps -W-Beam Metallic, Concrete, Cable
Vadodara Exhibition and Convention Centre	-Choice of material for partition walls -Choice of sewer drains -Choice of pavement for parking	-Brick, precast hollow core, gypsum board -Hume, HDPE, DI -Hot mix asphalt, precast paver blocks, concrete
Desalination plant for industrial water supply in Kutch region	-Choice of energy source for the desalination plant -Choice of pump technology -Choice of material used for pump manufacturing	-Non-renewable, photovoltaic, wind Membrane -Reverse osmosis, ultra filtration, nano filtration -Stainless steel, carbon steel, cast iron and copper nickel alloy
Redevelopment of Motera(Stadium	-Selection of stadium roof material -Choice of parking alternatives	-PVC, PTFE (Teflon coated fibre glass) -Surface, Conventional multilevel, automated multilevel

Figure No. 2

Learnings

- Advantages of collaboration between designer, contractor and client in the design process became evident with the role play played by the students
- The journey from protecting or sticking to factors identified by each student representing a specific role, to arriving at final list helped the students to appreciate the collaborative nature of design process
- Students understood that identification of factors, advantages and criteria is just half journey and it is important to communicate their relevance to other key stakeholders and arrive at conclusion
- Flow of communication among different disciplines during the design process is cornerstone for reducing wastes in design and engineering process. In this context, the learning of students, gave them first-hand experience with not only how effective communication but also ingraining of diverse perspectives helps in arriving at design solution
- Students understood following aspects of value definition: 1) value can not defined by the single stakeholder associated with the project rather it is an collaborative process and 2) the process is not sequential in nature with phased involvement of different functional areas but iterative process with questioning of your traditional notions and practices.

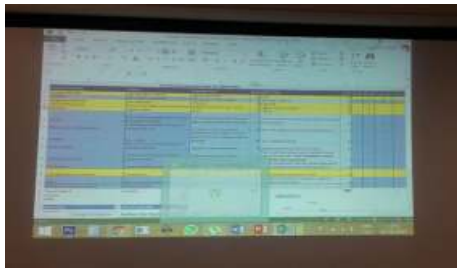
Challenges

Students have faced hurdles in seeking reliable cost information for few design alternatives owing to reasons like proprietary and confidential nature of cost

Conclusions

- Students got enhanced understanding of collaboration and communication flow required between key stakeholders – client, contractor and designer during design process of construction project.
- Students realized that the CBA offers structured approach for value maximization at design stage without diluting the very much required collaboration and communication among stakeholders.
- Paper provides guidance on conducting CBA exercise in a classroom environment

Figure No. 3



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POST476

Mastering complexity in Takt planning and Takt control – Using the three level Model to increase efficiency and performance in Construction Projects

Dlouhy J., Binninger M.., Oprach S. and Haghsheno S.

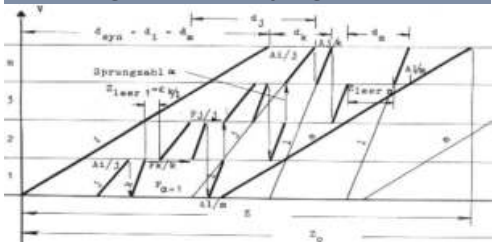
1. Abstract

When scheduling a construction project, resource consumption, efficiency of the trades, external influences and the possible changes within the construction process must be taken into account. Hence, the complexity of the construction schedule and an exact planning is difficult. So often the time buffers are balancing the unexpected events. That's the reason the full potentials of the construction project are often missed. The approach of Takt Planning and Takt Control (TPTC) offers a possibility to dimension buffers and schedule them transparently. This approach is often seen as a rigid and complicated procedure. The planning has to be adapted with a huge effort to changes in the construction process and therefore often does not show the real image of the construction site. The three level model tries to structure the method for all participants.

Introduction

A quick and transparent reaction in order to change the schedule is prevented due to the detailed planning and post calculation. Therefore, a standardization of the product and an always similar process with as little disruptive factors, is often the main condition for Takt. In doing so, rigid requirements are given to the contributors of the construction project, in order to comply with the Takt Plan. These requirements create little acceptance with the contributors and already with minimum disruption in the procedure, for example caused by lacking material, disease or default in the rendering of services, the takt plan fail to comply with the reality on the construction site.

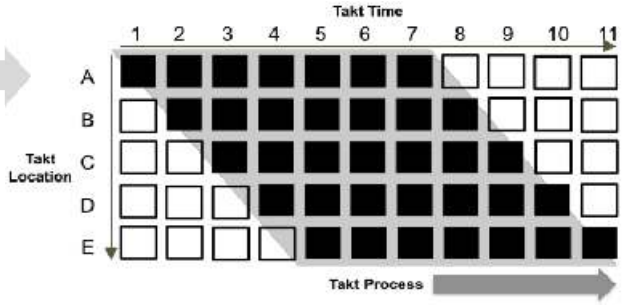
Figure No. 1 Priority Alignment



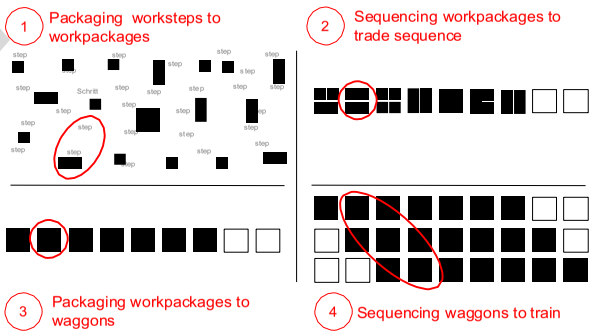
2. Theoretical Foundations

Takt time is the time dimension. For every Takt in a system is it the same or scalable. It creates a generally valid rhythm.
Takt process or Takt content represent the ongoing, which takes place in the Takt. This dimension is often combined with Takt time. (cf. Verband für Arbeitsstudien, 1985, p. 282).
Takt location describes the place, where the Takt process happens. It is not necessarily a physical place.

Takt is not an one-dimensional unit, but it is an interaction of different dimensions. By considering the components of Takt principles in ***Figure No. 2***



The double packaging and double sequencing represents status of research. The multiple packaging allows an itemization of the work steps whilst simultaneous overlapping level of detail. As shown in ***Figure No. 3***



4. Conclusions

Takt planning and Takt Control is seen in a lot of projects as a very complex and rigid procedure: The trades are individually optimized and, in each case, harmonized with the construction site flow by a complex buffer dimensioning. In case of changes of the plan, the updating of the Takt plan causes a lot of working steps. Due to this effect trades as forced to adhere to a rigid Takting. In another case the Takt plan doesn't represent the real image of the construction due to variations. The complexity of Takting is mostly caused by mastering of the three dimensions. These are Takt time, Takt process an Takt location. To be able of simplifying and mastering all of the three dimensions, different abstraction and communication levels are needed.

3. Results

Macro Level

The macro level of the three-level method serves as communication and decision basis for the customer. It contains information with reduced depth of detail, which is needed for strategic decisions referred to the total building process.

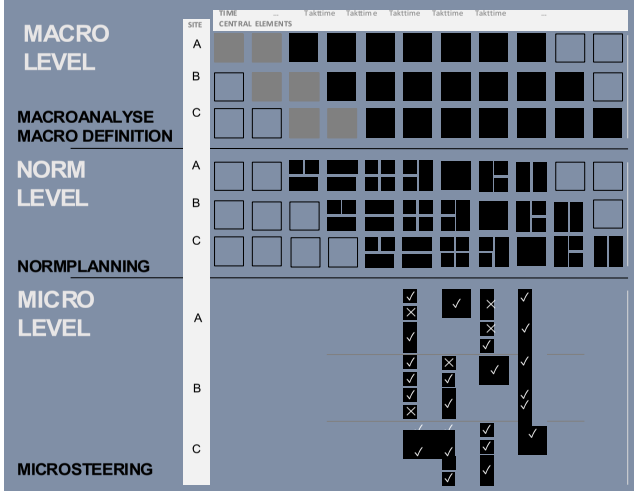
Norm Level

The norm level of the three-level method illustrates the processes of the construction coordination with a middle degree of detail (see figure 5). Information and requirements, out of the macro level, become attuned to the project and the construction progresses are planned and coordinated.

Micro Level

The micro level is the lowest and at the same time the most detailed level of the three-level method. It represents the actual proceeding processes of the value adding level and controls the short-cycled implemented work (see figure 6).

Figure No. 6 the three level model



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POST479

IMPROVING DESIGN COORDINATION WITH LEAN AND BIM, AN INDIAN CASE STUDY

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Abstract

Building Information Modeling (BIM) and Lean construction principles have been used independently as significant methods to construction process improvement. Their combination presents challenges and opportunities in implementation, especially when applied in the field.

This study explores two perspectives, firstly identifying factors and issues in design coordination of construction projects; secondly, applying lean and BIM functions simultaneously to overcome some of the problems in design coordination. BIM and lean functions such as 4D simulation integrated with Look ahead planning, Quantity take off, Clash detection during look-ahead and weekly work planning, to reduce change orders and RFIs for additional value to customer were applied in an integrated fashion. Finally a matrix is drafted based on previous research that shows integration of Lean Principles and BIM functionalities adopted for the case study.

Introduction

The design phase for any project is characterized by high level of uncertainties in resulting outputs in contrast with design requirements. The problems occurs when the requirements and the resulting outputs both are indistinct.

Need For Study

• Inadequate design coordination in terms of design, cost and time. Illogical design, multiple systems conflict, and incorrect design details.

•Repetitive design cycles that results from unanticipated changes, poor management.

Objectives

•To identify design coordination issues and solve these through BIM and lean.

•Matrix drafted showing Lean and BIM interaction.

Methods

•**Quantification - Quantity Take- off from BIM :** Automated quantity take off is more precise as there are less chances of error, hence reducing variability and taking less time with respect to manual calculations. The quantities automatically change if at any time in future design changes. For the purpose of this case study, quantity take-off was taken up for Slab, Blockwork and Column.

•**Clash Detection** : Clash detection helps to track design coordination problems at an early stage. In this case clashes were detected by appending different models in Navisworks and the results were obtained in the form of reports that showed major clashes between plumbing pipes and beams. The cost saving by avoiding core cutting was calculated and solution was by providing sleeves in advance.

•**One month look ahead** : A four week look ahead schedule helped to monitor in advance the challenges that would be faced in the coming month at the time of execution and tried to solve them to save cost and time overruns. The look ahead schedule integrated with BIM tackled two distinct challenges, that of visualization of plan and detailed production planning including resource allocation and commitment management in general.

•**Constructability through 4D Simulation** : Constructability through 4D simulation has a link based on clash free model obtained in and zoning created for one month look-ahead. The schedule was integrated with BIM and a 4D simulation model was generated. The major activities observed for constructability taken for Ground and First floor were Column, Slab, Beam, Blockwork and Staircase. The columns were distributed into different zones for 2300.61 sq.mt of floor area i.e. Zone 1(Red), Zone 2(Yellow), and Zone 3(Green) .

Results

•There were significant time savings compared to manual take off, as time consumed in BIM Quantity take-off was: 10-15 minutes, whereas for manual take-off it was: 2 hours. For the scope of the entire building the time saving was approximately 88%.The variation in quantity and cost for the entire project was identified as: Blockwork (100 & 200 mm) -2,155 sq.m, Rs -28,17,800 (~$ -43,062.84) , Column concrete -175 cu.m , Rs -14,38,850 (~$ -21,983.70) and Slab concrete 350 cu.m , Rs 24,51,750 (~$ 37,511.78) . This process helped at the time of billing by comparing and avoiding any discrepancies, hence reducing variability and improving the production and cost control.

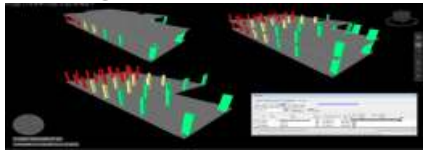
•The clashes detected were mostly regarding MEP.The clash detection helped in a way that it paved the path for not causing an extra cost of Rs 61, 6400 (~$ 9,449.41) for the entire scope, with 500 core cuts and 1 week instead of a day for detecting clashes manually contributing to waste. The total number of real (solvable) clashes detected for the entire scope were 70.The RFI'S related to plumbing works reduced from 10 to 3 for a particular week i.e. almost 70% reduction.

Table No. 1 Clash Detection(a subset)

Real	8	Structure: Blockwork 200 mm	Plumbing: Circular Pipe	BIM coordinator	Structure: Plumbing	Resolved
Real	8	Structure: Column	Plumbing: Circular Pipe	BIM coordinator	Structure: Plumbing	Resolved

•From one month look ahead 4D simulation was achieved and the duration of activities was reduced from 358 days to 230 days with cost saving of Rs 5, 40,000 (~$ 8,278.20) in terms of shuttering material.

Figure No. 1 4D Simulation



Conclusion

•The study highlighted that there are several design coordination issues that affect the efficiency of not only the design but also the construction process. Lean and BIM if implemented simultaneously can help resolve these issues.Based on the case study and solutions devised, matrix was created to demonstrate the interactions that were achieved between Lean and BIM, based on the original study by(Sacks et al. 2010).

Table No. 2 Interaction Matrix

	Lean Principles			
	Reduce Variability	Increase flexibility	Design the production system for flow and value	Verify and Validate
BIM Functionality	A	B	C	D
Visualization of form	1			
Reuse of model data for predictive analyses	1			
Maintenance of information and design model integrity	2			2
Collaboration in design and construction	3			3
Rapid generation and evaluation of multiple construction plan alternatives	1	1		
			4	

Table No. 3 Explanation of matrix cells

Index	Explanation	
	Pre Implementation	Post Implementation
1	Manual clash checking took 1 week for an area of 23791.11 sq.m with still having manual discrepancies.RFI'S related to plumbing were 10 for a particular week.	The incompletely detailed parts were easily observed in automated clash checking reducing efforts to a day simultaneously RFI'S reduction to 3, almost 70% reduction. This improved design quality reducing variations.
2	Manual quantification of elements for the entire scope of the project took 600 minutes including checking for variations, if any.	The BIM model data used in automated quantity takeoff taking just 75 minutes for the entire scope making work 88% faster. Quantity variations easily tracked with the variation amount tending to Rs 28, 17,800 (~$ 43,062.84) for 100&200 mm blockwork reducing variability at the time of billing.
3	No verification/validation of designs before actual execution.	Verification and validation done in terms of clashes detected related to plumbing saving against rework cost of Rs.6, 16,400 (~$ 9,449.41) for 500 core cuts for the entire scope.
4	No future thoughts for designing production system for flow, value and any generation of alternatives/visualization for reducing coordination issues.	4D and look ahead helped in reducing issues during production. The duration for the activities was reduced from 358 days to 230 days. Cost saving for the shuttering material due to zone wise planning came to Rs 5, 40,000 (~$ 8,278.20).

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AN EXPLORATORY STUDY ON LEAN TEACHING ADOPTION RATE AMONG ACADEMIA AND INDUSTRY IN INDIAN SCENARIO

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POST498

Abstract

Construction sector is undergoing a paradigm shift with the adoption and implementation of new technologies and concepts such as Lean Construction. For the effective adoption of Lean construction, professionals require basic understanding of the concepts. To facilitate this, Construction and Engineering Management programs need to introduce Lean Construction concepts in their curriculum, educating students about the concept and philosophy. The main aim of the study is to determine the current scenario of Lean teaching. The data has been collected from the universities/colleges of South India through semi-structured questionnaires in addition to semi-structured interviews. Results of this study provided insights and views that is beneficial for curriculum designers in addition to the top management of the industry.

Introduction

In India, construction industry is one of the vital source for socio-economic growth. In the recent scenario, the competition in the industry has tremendously increased which calls for the adoption of newer technologies and management skills. One among the new management skills is Lean Construction. In order to create a stronger community of engineers, the colleges/universities should e updated and should teach the recent trends of the industry.

Need For Study

• To explore the importance of Lean teaching and its subsequent implementation in academic research and industry.

Objectives

• To find the awareness & demand of Lean Construction in academia and industry respondents.

•To seek insights concerning Lean construction teaching from the prerogative of the teaching faculty and civil engineers in the south Indian scenario.

Methods

In this project, both qualitative and quantitative approaches were used. Data was collected through email-based survey and direct interview with experts from both academic and construction industry.

The study was appropriately focussed on teaching fraternity of Civil Engineering Schools/Colleges, Construction Engineering & Management programs, Lean experts and civil engineers in real time projects.

In academia, the target audience were Head of Department, Professors, Assistant Professors, faculty who completed the Under graduation in civil engineering along with post-graduation in construction engineering and management, and research scholars.

Survey also included project managers, civil engineers, and Lean practitioners. The study area was the southern part of India. Few suggestions were taken from the faculties working abroad. In total 180 individuals were asked to participate in the study. Achieved yield response rate is 62%, i.e. 110 involved themselves in completing the survey with great and useful insights.

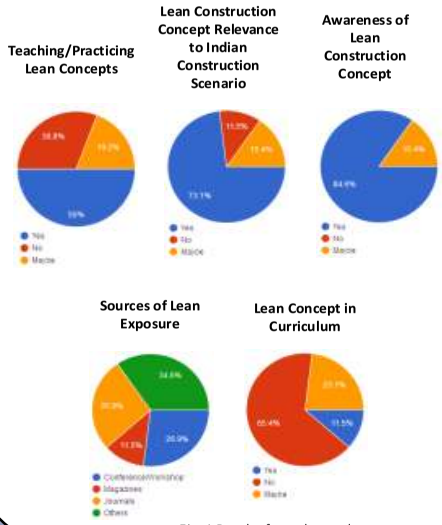

Fig. 1 Results from the study

Results

The outcomes from the detailed analysis were recorded, and are depicted in Fig.1. It is found that the percentage of Lean teaching is nearly 50%, while 30.8% is not practicing, whereas 19.2% may practice shortly. The teaching, however, is not directly through courses but in the form of projects and research work only. Relevance rate also gazes into a new way for Lean teaching in Indian construction industry. It implies that 85% are aware of it. But it does not appear in the curriculum directly. It was noted that conferences/workshops, magazines, Journals, blogs, online portals are the sources of Lean exposures.

Conclusions

- Based on the results, it can be seen that Lean construction awareness is high in the industry as Lean is considered as one of the effective Business model compared to the awareness in academia, where the premier institutes have relatively high exposure.
- Most of the colleges/universities does not offer Lean construction through their curriculum which directly impacts the development of the industry.
- When compared to senior faculties of the academia, younger professors shows more interest in learning and teaching new concepts.
- The amount of research, teaching and practices adopted in the area of Lean construction in India is comparatively low with respect to other countries.
- It is also realized that Lean Construction is in the infant stage of growth and the availability of Lean experts is limited.
- It is also observed during the study that certain SME's has practices that aligns with Lean concepts, but the group is not aware of the Lean philosophy, which is a evidence for low awareness.

Recommendations

Academia	Industry
Inclusion of Lean teaching in Civil Engineering curriculum at the UG/PG level Inclusion of separate courses/ project for Construction Engineering Management courses Research works and paper publications to be increased as per Indian context. Training programmes for Teaching Faculty – by experts should be organized. Awareness programmes can be initiated for students. Game learning can be introduced for lean Practices.	Policies can be implemented in construction companies at the contractual level itself , Client driven and client awareness drive can be initiated Awareness should be created amongst all professionals in company though company magazines, journals. Mobile Application can be developed for monitoring Lean progressing in real time projects. Short term executive courses can be conducted by experts International exposures should be showcased to civil engineers

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POST503

Large Scale Project Using Taktplanning and Taktcontrol Creating and Sustaining Multitasking Flow

Dlouhy J., Ricalde M., Cossio B. and Januncio C.

1. Abstract

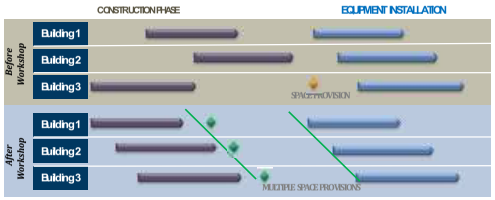
Taktplanning and Taktcontrol (TPTC) is a production system approach commonly used in individual construction projects. The approach has not yet been implemented systematically in a large-scale project. Furthermore, its use has not been documented in construction in Mexico.

This paper describes a project with over 15 different facilities using Taktplanning and Taktcontrol (TPTC), in a large scale greenfield automotive plant with 5 main general contractors collaborating together with the client. It shows the demands and the effects of large scale projects using the method of TPTC within a Lean philosophy and describes the system that was designed and implemented. As the main contribution from this paper, a system and its results for creating a Lean culture, collaboration, transparency, planning and overall project control within a multitasking flow is described and validated.

Introduction

The client's organization already possessed TPTC experience in more than 20 single projects in, before the start of the plant in Mexico. As a key enabler to meet the client's expectations, the 3 Level Model (Dlouhy et al., 2016) was used. The Taktplanning approach sought to help align the expectations with the execution of construction, synchronize and harmonize all different construction projects (Figure No.1).

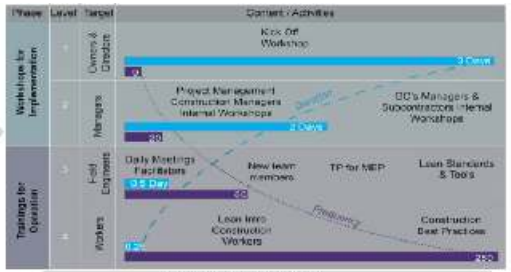
Figure No. 1 Priority Alignment



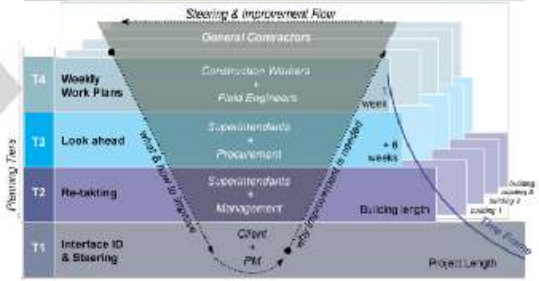
2. Operating System

The operating system of the TPTC and Lean methodologies in this project was based on 3 main subsystems: *creating and sustaining a Lean culture, continuous planning, and multilevel communication.*

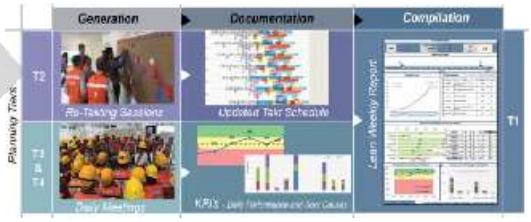
Creating and sustaining a Lean Culture : A diverse Lean training program was developed to focus on individual target groups. ***Figure No. 2***



Continuous Planning: The aim of planning a large-scale project with diverse contractors and buildings at different stages is to optimize the workflow; not only the individual demands, but also to the overall demands of the project. ***Figure No. 3***



Multilevel Communication: The communication tools were standardized to maintain transparency between all stakeholders, and focus steering efforts on collective solutions based on trustworthy data. ***Figure No. 4***



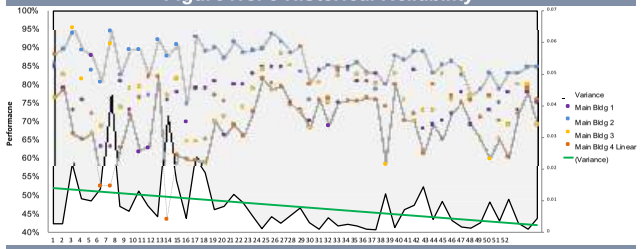
3. Results

Over 100.000 data points and 1,000 Lean Weekly Reports were generated.

Micro Level : Reliability of the Daily Plan

Less variance in the performance, endowed a higher reliability to daily planned activities, which in turn increased certainty on Takt Schedules and on Space Provision dates. The reduction of the variance and the increase of reliability on Takt Schedules decreased the complexity of working in a multitasking flow environment as experienced in large-scale projects.

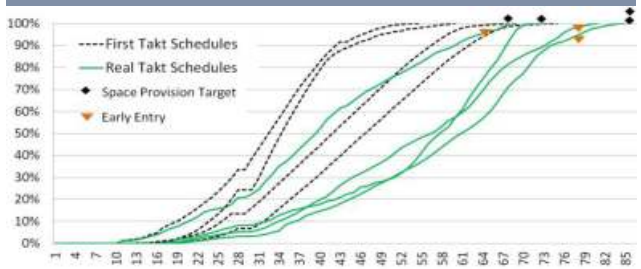
Figure No. 5 Historical Reliability



Norm Level : Takt Schedule

These curves show the first and real Takt schedules for the main buildings. On average, a construction buffer of 14 weeks was identified for each building through the TPTC method. Weekly or biweekly retakting sessions were key to adapt the construction sequence and rhythm, to maintain each project's commitments as response to disruptive elements such as: 1) clients' design improvements during construction 2) the GCs' misalignment of their procurement and design teams and 3) GC's inexperience with the TPTC method. Towards the end of the construction sequence.

Figure No. 6 Takt Progress Curves



4. Conclusions

The system described enabled a dynamic and transparent response to changes in priorities, quicker decision making based on performance metrics, and total reporting control in all stages of the construction phase. Furthermore, this system can be used as a platform for TPTC implementation in future projects of similar complexity.

The TPTC method was successfully implemented in Mexico without any previous experience on TPTC by the building teams. This showcases the possibility to implement it in other locations using similar operating systems. Three of the main buildings, studied in this paper, achieved the goal of early entry and the agreed space provision for the fourth.

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POST507

Development of An integrated BIM and Lean maturity model

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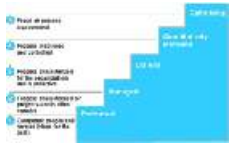
University of Salford MANCHESTER

Introduction

Due to the increased level of adoption of BIM and Lean approaches, to improve overall project productivity and performances within the construction industry, there is a need of having proper assessment tools or models to analyse the performances of these approaches. There are different assessment tools and maturity models available for assessing the performances of BIM and Lean individually. However, due to the increased adoption of these two approaches together, there is a need of having an integrated maturity model or assessment tool to analyse the performance of both BIM and Lean together. Providing an integrated BIM and Lean maturity model would enhance analysing the performances of these two collectively together so that subsequently it would enable realising the benefits of both approaches.

Maturity Assessments

Over the recent years, an interest over maturity models have increased in such way that maintaining a maturity model supports organisations in becoming more mature (Khoshgoftar and Osman, 2009). Maturity is defined as the quality or state of being mature (Andersen and Jessen, 2003).



There is a need of having an integrated maturity model or assessment tool to analyses the performance of both BIM and Lean approaches together. Since most of the existing maturity models in relation to BIM and Lean have adopted the Capability Maturity Model Integration (CMMI) approach, therefore, CMMI should also be adopted when introducing the integrated BIM and Lean maturity model (Chrissis et al., 2003).

BIM Maturities

Most of the current BIM maturities follow the CMMI, since it is more relevant and related to the background of BIM than rest of the maturity types (Aboumoemen & Underwood, 2017; Dakhil & Alshawi, 2014). Succar (2010) defines BIM maturity as a state of the quality, repeatability and degree of excellence of a BIM model within a BIM capability.

Bilal Succar BIM Maturity Matrix Index

The U.S National Institute of Building Sciences BIM Model (NIBS)

LEAN MATURITY

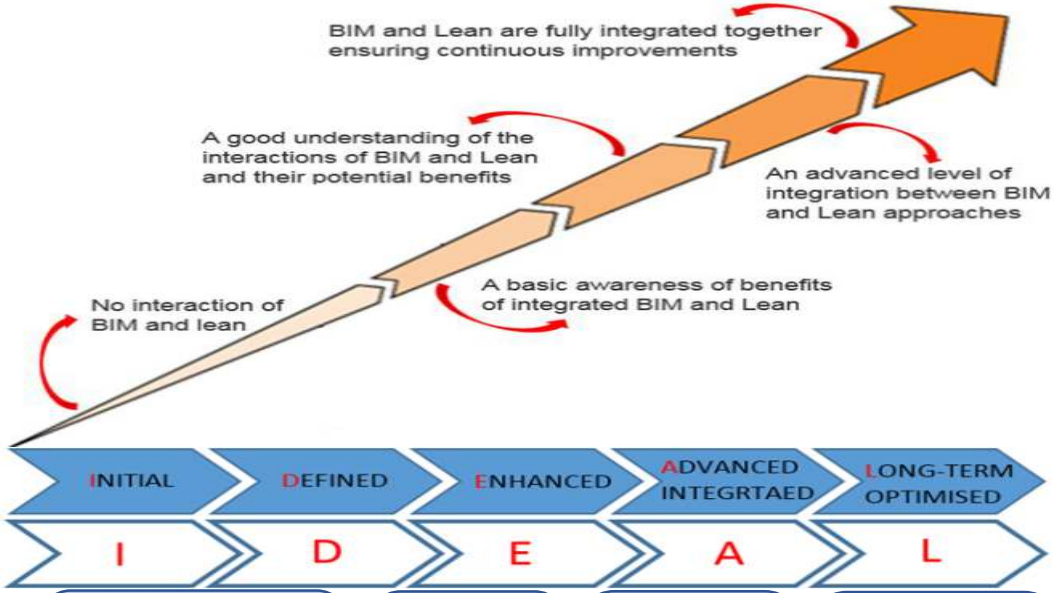
Lean construction is recognized as one of the key approaches to improve the construction productivity by reducing waste (Egan, 1998; Mollasalehi et al., 2016)

Lean Enterprise Self-Assessment Tool (LESAT)

Lean Construction Maturity Model (LCMM)

AN INTEGRATED BIM AND LEAN MATURITY MODEL (IDEAL)

This integrated BIM and Lean Maturity Model which is called "**IDEAL**" Maturity Model, not only considers the level of BIM and Lean maturities individually, but it also considers the maturity level of these approaches collectively together. This IDEAL maturity model would enhance analysis of the projects' performances where BIM and Lean approaches are implemented together. Therefore, the performance of these two approaches would be analysed and assessed to better realisation of their benefits.



Initial and Defined Levels
As BIM and Lean approaches are not fully implemented, the potential benefits of interaction of BIM and lean are not recognised and fully understood. Even though, there might be few BIM and Lean activities undertaken, but they are not in line.

Enhanced Level
There is a good understanding of the interactions of BIM and Lean and their potential benefits. Some of the adopted BIM features are in line with the Lean principles to achieve the benefits of integrated BIM and Lean.

Advanced Integrated Level
There is an advanced level of integration between BIM and Lean. These approaches are working in parallel and towards same goals. So the interaction of BIM features with Lean principles are fully understood and the BIM and Lean implementation is practiced in line with those interactions.

Long-term Optimised Level
BIM and Lean are fully integrated together towards achieving the highest possible quality and productivity of the project's processes. Therefore, BIM features are implemented fully in relation to Lean principles to ensure continuous improvement of projects.

Conclusions

This paper proposes a maturity model named "IDEAL" which aims to assess and analyse the performances of the projects that are implementing BIM and Lean together. This IDEAL model comprises of five main levels which are in line with the level of integration of BIM and Lean. Therefore, the performance of these two approaches could be analysed and assessed through this proposed model to better realisation of their benefits.

The authors would recommend the use of the IDEAL maturity model in construction projects to both validate the model and assess their performances in relation to the adoption of integrated BIM and Lean

APPLICATION OF 4D BRIDGE INFORMATION MODEL AS A LEAN TOOL FOR BRIDGE INFRASTRUCTURE PROJECTS: A CASE STUDY

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IGLC CHENNAI 2018 International Group for Lean Construction
POST508

Abstract

Construction projects require the coordination of multiple organizations. The production flow of these projects is often hampered through sources of wastes such as improper utilization of the skills of the labours and lack of coordination with the multiple organizations involved in these projects. Bridge information modelling provides a powerful platform for visualizing work flow and collaboration between organizations throughout the life cycle of the project. In this paper, 4D bridge information models for a concrete bridge (flyover) construction project was built through integrating 3D BrIM (Bridge Information Modelling) model with the schedule. The developed 4D bridge information model enabled value addition through improved visualization,co-ordination and communication among project participants. This study provides a practical contribution by showing that project stakeholders can use 4D BrIM models as a lean tool to prevent undesirable situations and reduce the overruns and rework in Bridge construction projects.

Introduction

The poster presents the idea of using BrIM model as a tool to reduce the waste occurring in an infrastructure project. Though concepts of BIM and lean differs, they share a common synergy to improve the performance of the project.

Need for the Study

•The idea of application of lean and BIM in infrastructure projects to control project performance remain unexplored.

Objectives

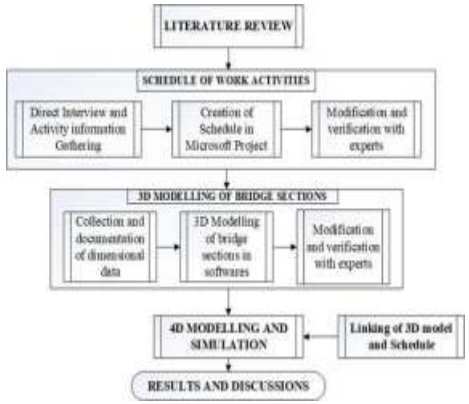
• To develop 3D and 4D BrIM models for a bridge project.

•To eliminate lean wastes and improve visualization, coordination through application of BrIM models.

Research Method

The study collects the data required to develop 3D and 4D BrIM models through direct site observations and direct interviews. A detailed research methodology is present in figure no. 1.

Figure no. 1



Case Study Details

A case study of an ongoing bridge project in Chennai, India is chosen. The bridge spans to a total length of 711 meters. The duration of completion was estimated to be 2 years. The case study image is shown in figure no. 2.

Figure no. 2

Results

•The schedule was created from the gathered information and the project's progress was measured.

•The 3D models were developed in Revit 2018 as parametric family objects and was loaded into the final model. A representative image is shown in figure no.3 and a rendered image of the bridge is shown in figure no.4.

Figure no. 3

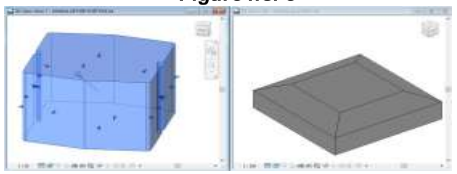
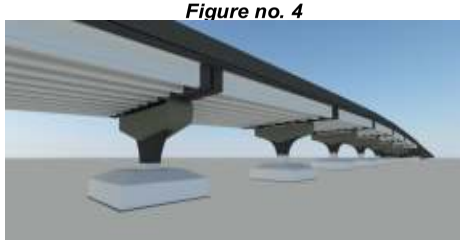
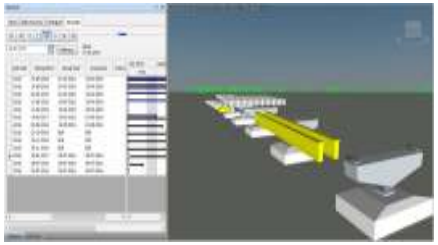


Figure no. 4



•The developed schedule and 3D models were linked together using Navisworks to develop 4D models as shown in figure no.5.

Figure No. 5



Discussions

• The visualization of 4D simulation of activities enabled the participants to visualize virtually the problems during construction and to suggest an effective way to implement the activities to complete it within the planned target dates.

• This enabled collaboration and coordination among different crews present in the process.

• 4D Brim Models were used as a lean tool to reduce rework and overruns in the project

Conclusions

• The project team used these models for their discussion to make effective decision to improve their further performance.

•The study concludes that application of BrIM as a lean tool enables value addition through improved visualization, co-ordination and communication among project participants.

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MDM-BASED BUFFER ESTIMATION IN CONSTRUCTION PROJECTS

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IGLC CHENNAI 2018 International Group for Lean Construction

POST530

Abstract

Schedule delay and cost overrun are the two major challenges for the successful project delivery in construction. It has been reported that significant delays in construction projects are caused by rework and there are several reasons for rework. A framework has been proposed to assess the delay due to two primary reasons for rework, (i.e. design changes and non-conformances), using Multiple Domain Matrix (MDM), a matrix-based technique. This methodology would help the project planners to create an as-adjusted schedule that is more appropriate compared to as-planned or as-built schedules. Further, it is possible to arrive at a meaningful estimate of activity buffer time in order to account for delays due to rework. Eventually, this would lead to successfully implement one of the key principles of lean, namely, elimination of time-related "waste" that is due to defect and/or delay.

Introduction

The current study has been focused on delay assessment of construction projects. A framework has been proposed for managing the situation arising out of 'non value adding' events - 'delays'. Rework is considered to be one of the most common reasons for construction delay . Two main causes for rework in construction projects are 'design changes' and 'non-conformances'.

Need For Study

- Delays are common in construction sites
- 'Change' in design can lead to rework and in turn delay.
- NCRs can play a vital role in time management of a project

Objectives

- To propose an alternate framework, built on lean concept for delay assessment in construction projects, can be used to model rework.
- MDM is proposed to identify and assess the delay and required time buffer

Methods

- **Step-01**: *Literature Survey*
- **Step-02**: *Data Collection*

Site Visits – Semi-structured interviews – Review of project documentation

- **Step-03**: *Data Analysis*

Statistical analysis - Some factors are repeating in nature, and the others are exclusive to a particular project only

- **Step-04**: *Formulation of Problem & Solution Framework*
  - The incorporation of hundreds of issues and probabilistic nature of uncertain events pose a complex problem and hence provides impetus to think of some potential tools other than the conventional CPM/PERT tools.
  - Recent advancements in matrix-based tools - MDM framework is used for delay analysis.
- **Step-05**: *Case study Application*

Case A

Transmission Line Project (Design Change)

Case B

Mall Construction Project (Non-Conformance)

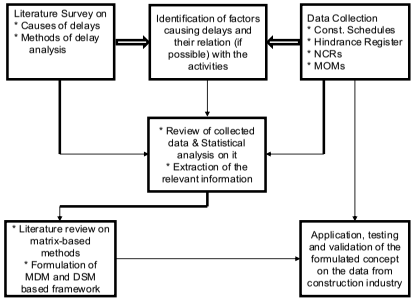

Figure No. 1 Research Methodology

Proposed Solution Framework for Delay Assessment

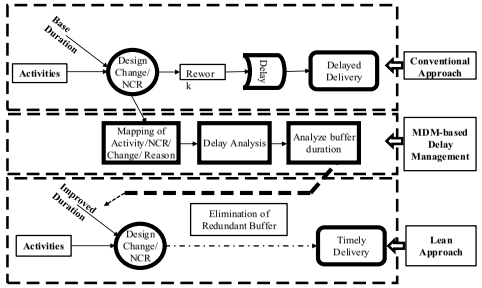

Figure No. 2 Proposed Framework

Recommended steps for implementation.

1. Analyse similar type of construction project(s) and identify all the possible reasons for the rework.
2. Formulate project specific change classification criteria and group them based on that criteria.
3. Identify the impact of each change and quantify them in terms of time delay or cost overrun.
4. Correlate the changes and reason for changes based on their likelihood or probability.
5. Construct a multiple domain matrix (MDM) model for analysing the future impact as explained in the next section.
6. Apply the same model in any existing project for assessing and forecasting the probable impact expected from the change or rework.

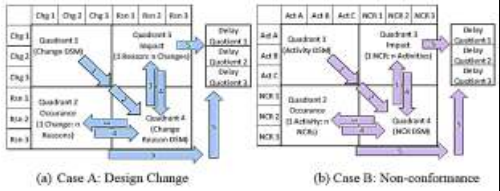

Figure No. 3 Workflow for MDM formation

Results

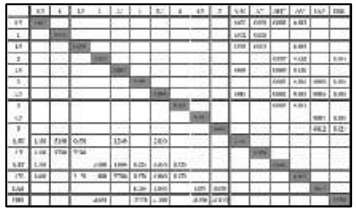

Figure No. 4 MDM for Case A

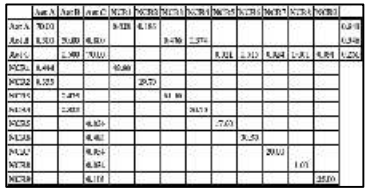

Figure No. 5 MDM for Case B

Conclusions

- MDM models captured the relationship between change and its reasons as well as the dependencies among the activities and NCRs effectively.
- MDM models have been used to estimate the delay in an objective way for meaningful buffer estimation.
- This method has been found to be very useful in the application of lean principles of eliminating/minimising the time waste by managing construction delay.

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POST109

APPLYING LEAN TOOLS TO REDUCE PILING CYCLE TIME FOR A MARINE INFRASTRUCTURE PROJECT IN WESTERN INDIA

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Abstract

This paper describes application of VSM and SMED techniques for reducing the piling cycle-time in Wharf and Approach Trestle Construction Project undertaken by Afcons Infrastructure Ltd. in Western India. Value Stream Mapping (VSM) and Single Minute Exchange of Die (SMED) are mutually aiding techniques in Lean Construction tool-kit. VSM is used for mapping the current state, identifying wastes, and designing a future state for a work process that take a product or service from its beginning through to the customer. SMED tool is used for dramatically reducing the time it takes to complete equipment changeovers.

We discuss in the paper our problem statement, methodology we adopted, techniques we used to analyse the issues, specific action plans undertaken and the results obtained. We also present our learnings from the exercise and our suggestions for other practitioners looking to implement lean principles in Infrastructure projects

Introduction

Afcons was awarded a contract to construct Wharf (1000m x 61m) and Approach Trestle (5 nos of 97.4 m long) for the Phase 1 development of the 4th Container Terminal at JNPT. Piling activity is very critical to timely completion of the project. Piling activity consists of 1290 no bored cast in-situ piles in the Wharf (776 no of 1500mm dia and 514 no of 1200mm dia) and 109 no (1000mm dia) bored cast in-situ piles in the Approach trestle. The installation of piles is done using chisel – bailor method on a floating piling gantry.

Need For Study

- After the project commenced, the initial time-cycle of piling activity was found to be double than the planned cycle-time

Objectives

- To reduce the cycle-time of piling activity

Methods

WORKSHOP 1 (2nd and 3rd Aug, 2016)

This workshop exposed the team to Lean principles as well as to simple Lean tools such as Waste, 5S and Process Control Boards (PCBs). An action plan was developed to implement 5S in different work areas and PCBs and log sheets at piling gantry locations.

WORKSHOP 2 (22nd and 23rd Aug, 2016)

The purpose of this workshop was to introduce and implement Value stream mapping. The team members identified the current 'As-Is' piling process and its interaction with other activities. 'As-Is' cycle time was identified to be 192 hrs. The 'Takt time' was calculated to be 172 hrs. Then the team members discussed the 'To-Be' process Action plan was prepared which focussed on standardising operations at bar-bending yard, liner fabrication yard and piling gantry operations.

WORKSHOP 3 (22nd and 23rd Sept, 2016)

During the third workshop the concept of Single Minute Exchange of Die (SMED) was introduced. From the data analysis, it was observed that time taken per changeover varied from 15 mins to 20 mins, and its duration was not tightly controlled. The number of changeovers in a pile cycle was observed to be 120 – 150. A video of the Chisel – Bailor changeover process captured during earlier site visits video was shared with the team members and they were asked to identify action points which can help save time. In the video, the changeover took 12 mins. After this the team broke out into smaller groups and identified a simpler Chisel – Bailor process. This new process was shared with the workers for their views and comments and a field trial was conducted. Using the experience from the field trial, the change-over process was standardised. The change-over time was standardised to 8 mins, a 30% reduction.

Results

Table 1: Baseline pile data obtained in the preliminary visit

Description	Piles started in the period 1st April to 6th June		
	All dia piles	1500 dia piles	1200 dia piles
Sample (nos)	13	12	1
Average Boring depth (m)	13.56	13.59	16.32
Max (hrs)	784:05	784:05	311:00
Min (hrs)	232:00	232:00	311:00
Mean (hrs)	416:09	424:56	311:00
Standard Deviation (hrs)	154:22	157:32	0:00
Median (hrs)	367:30	369:37	311:00

Table 2: Pile data after Workshop 1

Description	Piles started in the period 3rd August to 21st August		
	All dia piles	1500 dia piles	1200 dia piles
Sample (nos)	46	30	16
Average Boring depth (m)	13.49	13.33	13.77
Max (hrs)	356:45	356:45	228:50
Min (hrs)	64:05	134:50	64:05
Mean (hrs)	170:28	197:07	120:29
Standard Deviation (hrs)	58:33	50:29	36:19
Median (hrs)	164:09	182:42	116:40

Table 3: Pile data after Workshop 2

Description	Piles started in the period 22nd August to 21st September		
	All dia piles	1500 dia piles	1200 dia piles
Sample (nos)	97	57	40
Average Boring depth (m)	13.35	12.87	14.04
Max (hrs)	330:25	330:25	183:10
Min (hrs)	68:44	105:00	68:44
Mean (hrs)	161:58	193:28	117:05
Standard Deviation (hrs)	50:16	56:11	29:43
Median (hrs)	150:45	178:30	115:27

Table 4: Pile data after Workshop 3

Description	Piles started in the period 22nd September to 1st November		
	All dia piles	1500 dia piles	1200 dia piles
Sample (nos)	77	40	37
Average Boring depth (m)	16.08	16.08	16.12
Max (hrs)	413:10	413:10	211:30
Min (hrs)	76:20	167:50	76:20
Mean (hrs)	196:59	250:00	139:41
Standard Deviation (hrs)	69:02	51:23	27:14
Median (hrs)	185:25	246:17	141:10

After workshop 3 the performance was found to be very poor in both 1200 mm and 1500 mm dia piles. This deterioration in performance was seen till December 2016. The reasons attributed to this were as follows:

1. Geology of the founding strata was found to be different the tender investigations.
2. Strength of the hard rock (N value > 100) was substantially more than anticipated
3. Significant increase in boring depth (23% increase in boring depth)
4. Marine equipment and staff were diverted to start the Civil
5. Labour migration due to festival season in October and November
6. Action points from action plan not being implemented in totality.

Conclusions

- The feedback from the project team members working on the Lean initiative was positive.
- Several team members felt involved and empowered in their work.
- The use of log sheets was appreciated, as it made the performance transparent to all and led to fruitful discussions on how to improve performance.
- The analysis and capturing of RNCs allowed the team to introspect their performance and work towards resolving the. issues.
- The team got into a habit of weekly tracking the performance, identifying issues and working towards continual improvement.
- The workers liked being recognised for their efforts.
- First time, an attempt has been made to use Lean tools such as VSM and SMED for improving cycle-time of marine gantry piling for an infrastructure project and the results have been encouraging

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POST110

LEARNINGS FROM IMPLEMENTATION OF LAST PLANNER IN A MARINE INFRASTRUCTURE PROJECT IN SOUTH INDIA

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Abstract

This paper describes the implementation of Last Planner System (LPS) for civil works at a Coal Jetty project undertaken by AFCONS Infrastructure Ltd. in Southern India. The two main objectives of LPS are to make assignments to workers through continuous learning and corrective action and to cause the work to flow across production units. Hence it is imperative that LPS focuses on making a rolling 6 to 8 week look ahead schedule from a milestone plan that captures the overall project schedule. The performance of the weekly plan is rolled up to ensure that the milestones are being adhered to and the non-performance of the weekly plan is used as a learning to improve the productivity, coordination and execution of the project.

Introduction

Civil works is that portion of work which involves a number of minute activities which are interdependent on each other for their completion. Therefore, planning and tracking these activities requires a more detailed methodology and a lot of coordination among various gangs. And hence it was decided to adopt the Last Planner System™ (LPS) for its effective execution.

Need For Study

- Improve the reliability of the plan.
- Build trust and collaboration within the project team.
- Induce Lean culture

Objectives

- To measure the delays due to interface issues in construction site.
- To illustrate coordination delays can be minimized using Last Planner System ™

Methods

The Five recurring conversations in LPS are "should – can – will – did – learn" planning. Keeping all of the above in mind the following steps were involved in implementing the LPS at site:

- Collective Weekly Planning was done to do pull planning and identify what tasks should be done
- Identification & Resolution of Constraints to 'make ready' for the identified tasks above
- Agreeing to Commitments in a weekly planning session with a set of promises on tasks to be done by their responsible execution supervisors
- Day-to-day Monitoring to see if the commitments were achieved or missed and identify the root causes of failure where the commitment was missed
- Continual Improvement based on Planned Percentage Complete (PPC) based on open discussions among the site team management, planning, and execution team members

Figure No. 1

Results

- **Reduction of Time Cycle :** A reduction in the time cycle for construction of coping beam above the diaphragm wall was observed. Better coordination and some pre-planning of the activities helped reduce the overall cycle time.
- **Timely Built-Up for Dynamic Load Test (DLT):** Dynamic Load Test (DLT) had to be done on a few piles to ensure that adequate strength had been gained per design in the piles. LPS helped us in coordinating the sub-contractor who was responsible for the chipping work and the DLT built-up, the third party who conducted the DLT's and our site team who needed front for pile muff and beam placing. Finally, we were able to conduct the DLT's on time, as a result of which the precast placing wasn't delayed.
- **Continual Improvement Based On Planned Percent Complete (PPC):** At our site the daily and weekly PPC did vary time to time and, as and when there was a drop in PPC, corrective measures were taken to ensure that the same problem/hindrance did not occur more than once.

Figure No. 2

Conclusions

- The team was able to adopt LPS for a marine jetty project successfully and although the transition to LPS was done midway in the project, adopting LPS showed both tangible and intangible benefits.
- The importance of timely interaction between different teams such as the sub-contractor, third party agency, execution team and the planning team became very evident during the LPS session for the completion of civil works.
- This timely interaction helped to reduce the time-cycle for coping beam as well as ensure that DLT test was not delayed which would have lead to delay in precast placing
- Though LPS had a positive impact in the execution of civil works in a marine jetty project, more research needs to be done in the methodology to suit it better for Indian conditions.

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5s Implementation at Godrej Khalapur Industrial Mega Project

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POST122

Abstract

Lean construction study involves various tools which can be implemented on construction project sites. Among all tools, 5S is one of the simple, vital and powerful tool to work with for provision of safe and better quality environment at work place.

Introduction

Lean 5S is easy to implement and have a systematic approach to cleaning, organising and maintaining the work area as per principles and standards. Further it is very clear that premise with a clean and highly organised work area is a safe and efficient work area with little waste

More specifically the poster explains the implementation of 5S followed by audit observations and results against each of the 5 steps. Format for 5S audit is prepared to review each of the steps with rating system based on the site condition.

Need For Study

The problem is time and energy loss during material findings which can be overcome by keeping everything systematically at proper places. The poster gives overall experience of 5S implementation on an ongoing construction site.

Objectives

To have systematic approach to cleaning, organising and maintaining the work area, improve Productivity, Safety, and waste reduction.

Secondly to have a audit result with % rating given with color codes for each of the 5 steps so that we can have a clear idea about the specific step which needs improvement as per 5S standard.

Methods

The commencement was simple and started with training if 5S to all concern stakeholders directly working on jobsite. Timeline decided to work on respective areas for implementation of 5 steps of 5S (Sort, Set in Order, Shine, Standardize & sustain).

Team Formation: Based on allocated construction execution area one team was formed and area wise responsibility distributed team formation done

Application: Application started with in house stores . Accordingly sort, set in order, shine, standardize and sustain related 5S journey begun Subcontractors stores and site premises also covered under 5S implementation.

One standard checklist prepared for audit purpose which is having % weightage for each of the S.

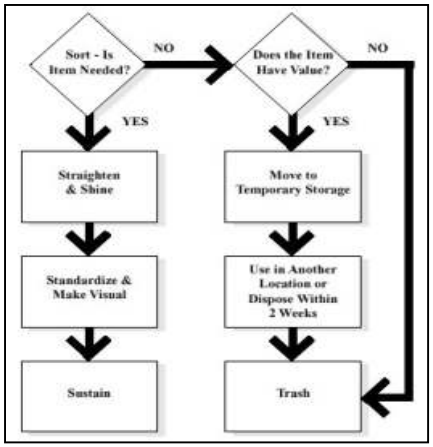


Figure No. 1 5S Flow Chart

Results

5s was being done at Khalapur from the year 2016 and in line with various 5S exercises held for various stakeholders at site has given remarkable improvement to maintain good housekeeping standards.

Post trainings monthly 5S audit is being done and the audit results are as follows (Fig no 6) As per the audit report it is clear that the 5S system is rationalized to sort & set in order for incoming reinforcement material arrival to scrap disposal.

Fig 2- Stacking of Steel Diameter-wise

Fig 3- Stacking of waste Steel Diameter-wise for reuse

Fig 4- Stacking of Shuttering material

Fig 5 - 5s at Site Stores

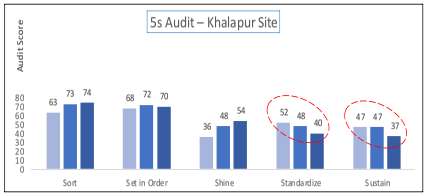
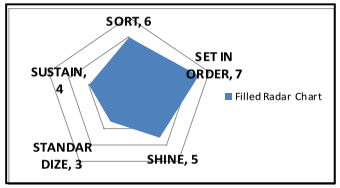


Fig 6 - 5s Audit Score

Conclusions

Based on overall audit results it is clear that the system is well implemented from improvement point of view. All the stakeholders including subcontractors have participated actively for the implementation and however it easy to sort ,set and shine but frequency of internal training and audit will help to, standardize and sustain the process in Lean way. The work area has influenced to sort and set in order to a great extent. All the team is well aware of 5S steps but procedure shall be standardized

- All the different types of material are well sorted and placed at main stores area in view of safety precautions
- Scrap sorting and storage are the area for improvement.



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POST096

Effective Project Delivery using Lean Principles in a Industrial Mega Project in a Developing Country Environment

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Godrej | CONSTRUCTION

Abstract

This Poster Depicts Lean Implementation by leveraging powerful Last Planner System on a significantly large industrial project spread more than 300 acres with a BUA of 3.3 million sq. with a more Comprehensive Approach helping timely project delivery.

A Lean project management workshop with all stakeholders for effective deployment of lean was conducted .The biggest challenges in this project were multiple customers and the complexities in their requirements causing frequent design changes thus making leading to project delays.Collaborative Big room meetings was introduced to review percent plan complete, identify root causes and develop corrective and prevention action, review look ahead plans for constraint identification and their resolution. Unresolved issues were also taken up in "Steering Committee" which comprised of senior management.

Need For Study

- Multiple customers and complexities in their requirements.
- Frequent design changes which made communication a big challenge and caused project delays.

Objectives

- To measure the delays due to interface issues in construction site.
- To illustrate coordination delays can be minimized using Last Planner, Big Room Meeting & Steering Committee
- Collaborative Contract Management.
- Meeting Customer Expectations.

Methods

- A Lean Project Management Orientation workshop with various stakeholders such as Design, Material & Contracts Procurement, HR, Planning & Delivery Assurance, MEP, Engineering teams for effective deployment of Lean and collaborative thinking the organisation deployed Last Planner System which was highly useful for effective communication within the teams and it ensured decision making at right time by involving Senior Management. A project based Lean Organization structure was prepared comprising of Lean Mentor, Lean Champions, Lean Coordinator and Project Engineers.

- The Concept of Big Room Meetings & Steering Committee was formed to resolve issues which were put up

	Monday	Tuesday	Wednesday	Friday
Agenda	1. Individual team meeting 2. Submission of PPC	Submission of Look Ahead Plan (LAP)	1.Big Room Meeting : Issues / challenges faced by each team discussed collectively 2. Operational Issues	Steering Committee meeting : Unresolved challenges / Strategic issues with empowered senior management team
Purposes of Meeting	Review of "Root Cause Analysis" & Corrective & Preventive Action"		Review of PPC	Direction on unresolved issues
Stakeholders Involved	1.Engineering 2.Procurement 3.Construction 4.Planning	1.Engineering 2.Procurement 3.Construction 4.Planning	1.Engineering 2.Procurement 3.Construction 4.Planning	1.Steering Committee 2.Other Stakeholders (Need Based)
Remarks / Output from Meeting	1.PPC measurement of each team for Previous week 2.Root Cause Analysis report	1.Rolling 6 week LAP including cross functional constraints	1.Unresolved Issues escalated to steering committee 2.List of Unresolved Issues	Issue resolution Escalation to Business Head

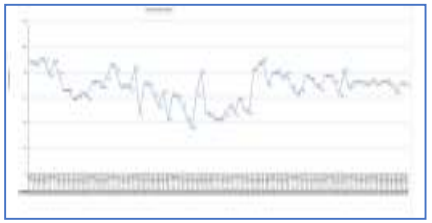
Results

Big Room Meetings & Steering Committee were instrumental as mentioned below

- The entire Project Delivery to the customer was looked upon in a holistic manner by using Last Planner with Weekly Plans, Look Ahead and Constraints Analysis for collaborative planning. This helped us ensure timely handover to the customers as per the committed terms of the agreement.
- Improved transparency with concerned stakeholders through team meetings for the LPS.
- Resolution of issues which were put up by the teams working on the project which required senior level support and could not be resolved in Big room meetings
- Resolution of issues related to Contractual deviations in time and cost to review impact on stakeholder commitments
- Timely communication from Management to the Project teams.

Big Room meeting

Steering Committee Meeting

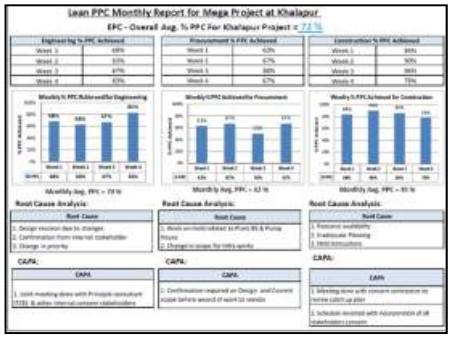


Improved PPC Trends

Conclusion

We have witnessed improvements in Communication and Collaboration Management by implementing LPS on the project.

Almost all the stakeholders have expressed that LPS has helped them to resolve their constraints early and get the work done as per the schedule milestones.



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PROJECT DELIVERY USING LEAN AT HIGHRISE RESIDENTIAL TOWERS

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IGLC CHENNAI 2018 International Group for Lean Construction
POST097

Abstract

This poster depicts how an organisation adopting Lean effectively used Constraint Management to improve project performance with Lean Tools, Value Stream Mapping (VSM) and Location based planning system (LBPS).
Along with VSM, LBPS ensured adequate visual controls and enabled completion of the Façade works as per the planned schedule. Deviation in planned versus actual were closely monitored.

Introduction

Having gained a better understanding of certain Lean principles, the organization was now ready to deploy a few Lean tools on our next project - Construction of Tower B1 ,B2 and B2 (FY 13-14) from the early construction stage of the project.
Lean tools such as Last Planner System, Work Sampling, Value stream mapping, etc. were applied across various trades for effective conflict resolution and reduction of the non-value-added activities. The poster depicts how lean culture helped successful project delivery.

Need For Study

Focus on Partnering and Resource Optimization initiatives for successful project delivery.

Objectives

- Creation of better partner relationships Identification of constraints and non-value adding activities
- Trust & transparency
- Waste minimization & 5S
- Better monitoring and control
- Early flag off to arrest delays
- Enhanced work safety

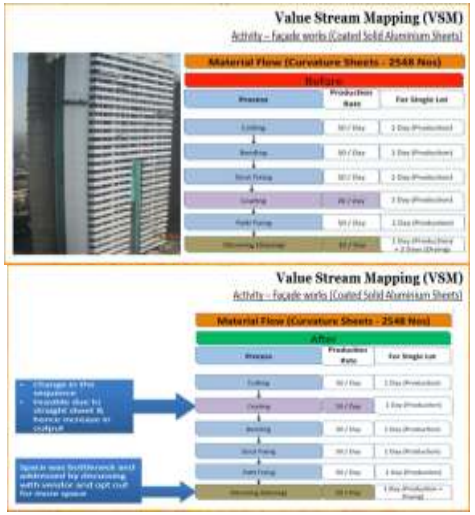
Methods

The Lean tools deployed at Godrej Platinum were

- Value Stream Mapping
- Collaborative Planning System
- Last Planner Systems
- Work Sampling
- Location Based Management System
- Visual Controls
- 5S
- Standardization

To make the planning process predictable and create commitment based culture the organization amalgamated Lean into CPM by creating a Milestone Schedule given by the Top management.
The Phase Schedule is derived from the Milestone Schedule and further broken down for weekly tracking into Look Ahead Plans (LAP). The LAP is prepared by field teams and is rev.iewed using Last Planner Meetings (LPS).

Figure No. 1 An Illustration of VSM



Results

- Timely Project work Completion of Tower B1 , B2 and B3
- Improved Customer Feedback across projects
- No cost overruns. Better planning and coordination the cost of construction of Tower B2 was 4% lower than that earlier completed Tower B1.
- For LEED certified building construction projects, the adoption of Lean principles helps waste minimization, recycling and reuse.
- Improved morale of workmen, supervisors and project engineers ***Figure No. 2***

Godrej Trends on Key Focus Areas

Discussions

Most of our project team members and stakeholders confirmed that adopting Lean principles helped them reduce conflicts,reduce rework, smoother project delivery and ultimately creating customer value by delivering a quality product as per customer expectations.

Conclusions

Godrej plans to further strengthen the Lean Culture in its business operations through the following initiatives:

- Implementing Lean in Conceptual Design stage of the project
- Quarterly Lean Newsletters.
- Improving the Productivity of Operations at Construction sites by Lean Principles
- Reduction of Customer Complaints by 33%
- Cost Reduction by Value Engineering and cost control mechanisms by 10%
- Reduction in rework by 50%
- Creating a Lean Culture in the organization through Human Resources Trainings.

Figure No. 3

Key Takeaways based on Godrej Lean Implementation

References

1. Why Lean Projects are safer?-Howell, G., Ballard, G. and Demirkesen, S-2017
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IGLC CHENNAI 2018 III International Group for Lean Construction

POST098

DESIGN VALUE ENGINEERING IN THE CONSTRUCTION OF AN INDUSTRIAL BUILDING – MOHALI

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GODREJ CONSTRUCTION

Godrej | CONSTRUCTION

Abstract

This poster presents how Design Value engineering can be implemented in the construction of Industrial project during Design and Pre-Construction phase. A Case Study for Design and Construction Phase at Godrej Appliances, Mohali is discussed in which the Conventional Design Approach is changed to Lean Design Approach to create stakeholder delight by meeting their expectations .

The conventional structural grid was not fully meeting the functional requirements of manufacturing process and was adding up to the cost, so the structural grid was re-evaluated ,optimized to go hand in hand with the manufacturing processes.

Introduction

Project Details:

- Factory expansion (Godrej Appliances at Mohali, Punjab)
- Built Up Area: 2.2 Lakh Sq. ft.

The Design consultant had designed the structure with a grid size of 10m X 15m as it was previously followed in all other plants of Appliances Division, Mumbai.

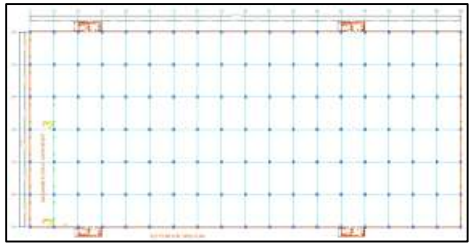
With years of experience from existing manufacturing units in terms of operations, manufacturing process and maintenance of plant, customer was overall in agreement with the existing grid size proposed.

However, with the new emerging manufacturing technologies and existing operational and functional space requirements the conventional grid size was not helping much to give the business scope for business growth by process optimisation due to the design layout.

Methods

- Post Interactions with the Plant Manager, Operational Head, Manufacturing Head and other stakeholders we found that the existing grid of 10m X 15m was having more columns thus giving less circulation space for Production.
- For grid of 10m X 15m Structural design was heavy with respect to lesser imposed load configuration. Overall, increasing cost and time for construction.
- Various grid sizes were evaluated i.e. 9 m X 20m, 9m X 25m and 9m X 30m and we found that 9 X 30m grid gave 3 equally and optimally spaced bays against other combinations.
- Post Approval the new design was found in sync and more suitable for their manufacturing layout.
- The Structural consultant redesigned the entire structure with the new grid layout along with Pre Engineered Building (PEB) contractor.
- Collaborative Planning ,Lean Design, Value Engineering ,Kaizen tools used to ultimately create Customer Value and Customer Delight and boost Lean culture.

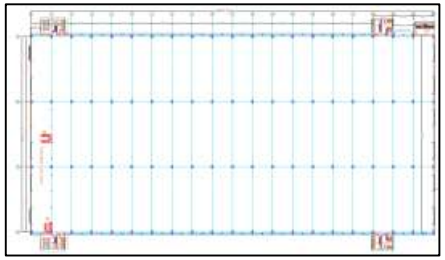
Figure No. 1 Earlier section of Plant



Results

- Bay size was doubled which lead to less number of columns.
- Clean, clear and open floor plate provided better circulation space
- Major reduction in number of columns
- Saved huge quantity of concrete, steel, PEB tonnage, shuttering works.
- Construction Time saved by new design.
- Better structural performance against earthquake and wind loads.

Figure No. 2 Revised section of Plant



Reduced number of columns (36%) generating **Cost savings** in steel, concrete, etc. (Rs. 3.8 Cr)

Revised design **increased circulation space** and **Flexibility** for future manufacturing operations

Time savings of 4 months in Construction phase

Selection of right design partners/vendors will help create better value

Discussions

- Value engineering exercises at early Design phase brings about substantial gains in time, cost, quality and safety.
- Partnering helps in upgrading technology and resource optimization.
- Kaizens taken up during various phases of the project also helped in overall timely delivery of the project.

Conclusions

In order to reduce wastes and deliver projects as per customer expectations ,it has become crucial to create Lean designs for successful project delivery.

Design remains the one of the biggest factors in optimizing overall cost, quality and time for any project and aids to create maximum customer value.

Collaboration with relevant stakeholders ,kaizens complement the design process leading to resource optimisation and profitability for the organisations adopting the Lean culture.

Figure No. 3 : Ariel View of Plant

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POST099

DESIGN VALUE ENGINEERING IN THE CONSTRUCTION OF AN INDUSTRIAL PROJECT AT DAHEJ

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Abstract

This poster presents how Design Value Engineering can be implemented in the construction of an Industrial project during the Design and Pre-Construction phase. A case study of design for a Heavy Engineering Unit at Dahej where the Conventional Design Approach is changed to Lean Design Approach being identified as a value engineering proposition.

This case study is indicative of the original design with Conventional Welded Truss Analogy which was difficult to fabricate and unsafe to erect. Hence after collaborating with stakeholders at various stages, design alternatives and iterations were evolved. The benefits of partnering with the fabricators and design consultants whereby the entire super-structure was analysed and fabricated into Welded Plate Girders with bolted connections resulting in major gains is explained.

Introduction

Godrej Process Equipment Division is a leader in fabricating unit static equipment for process industries. Dahej is a fair-weather lighterage port, situated at the junction of Guljaria overlooking the Arabian Sea on the West Coast of India. Moving to Dahej was a strategic decision as it is in SEZ and provided a water front for dispatching cargos. Hence, with a built-up area of 0.35 million square feet, proximity to the sea, unique customer requirements and budget of Rs. 335 crore, it provided opportunities for applying Lean Thinking and Lean Innovation through Design.The structure under discussion is a single storey industrial structure with cranes at 2 levels of capacity 20 ton, 50 ton, on one level and 150 ton and 300 ton on another respectively.

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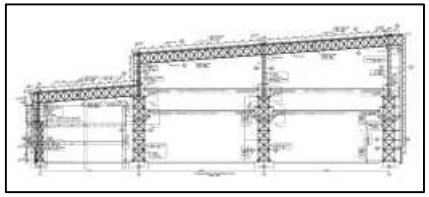
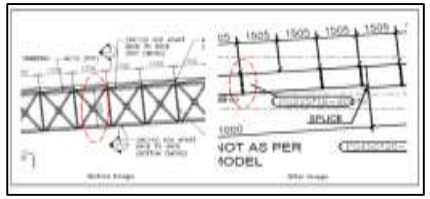
Methods

- **ORIGINAL DESIGN**: It was designed as conventional Steel building with structural members designed as open web trusses, Rolled Steel Joists. These need extensive welding to fabricate and are difficult to transport and erect on site. The height of structure which is 32 meters, span 27 meters and size of the girders (2.5m X 0.6m), made it very difficult to handle those safely at site.
- **LEAN VALUE ENGINEERED DESIGN:** After partnering with main contractor, Design alternatives and iterations by engaging with the Vendor and Engineering team, the structure was redesigned as Prefabricated Plate Girders with bolted connections. Due to Design revisions in structural sections height of the Structure reduced. Plate girder sections of 1.0m depth was proposed against existing section of open web truss of 2.5 m depth which enabled us to restrict the height to 30 m.

Figure No. 1 Earlier section of Plant



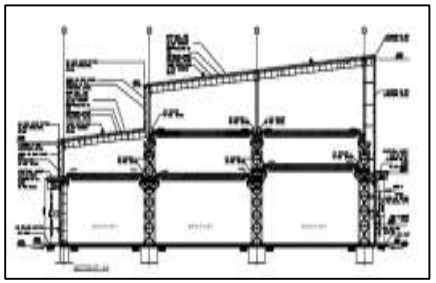


Results

The new Lean design and construction methodology led to following advantages:

- The Plate Girder were easy to transport to site and erect
- Due to larger thickness of flange and web of plate Girder the corrosion resistance was more as compared to open web truss of sections.
- Superior quality controls on structural work were possible since it was factory made with advanced machinery and better-quality checks.
- As entire structure was prefabricated in factory and connections were bolted on site hence eliminating on site welding was eliminated thus reducing safety hazards.
- Improved structural performance in all Crane, Service, Wind and Seismic loads respectively.

Figure No. 2 Revised section of Plant



Discussions

- Value engineering exercises at early Design stage brings about substantial gains in time, cost, quality and safety.
- Partnering helps in upgrading technology and resource optimization.
- Kaizens taken up during various phases of the project also helped in overall timely delivery of the project.

Conclusions

Design remains the biggest factor in optimizing overall cost, quality and time for any project hence adopting Lean Design brings maximum value to the project. Design can be complemented by involving all stakeholders for early collaboration. The structure was fundamentally disrupted and redesigned to gain maximum value. However further value engineering can be brought by continual improvement and evaluation of past projects with adoption of progressive design philosophies and technology available for construction and partnering.

Figure No. 3 : Internal view of Plant

References

1. Design for manufacture: strategies, principles and techniques, Corbett et al. (1993). Massachusetts, Addison-Wesley.
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LEVERAGING DIGITAL TECHNOLOGY FOR SAFETY - I REPORT APP

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POST100

Abstract

In order to address the operational challenges of delivering "Projects with the aim of zero accidents". Godrej Construction took up the task of exploring digitization for creating Lean Safety processes. This poster portrays how the organisation used "Lean philosophy" with stakeholder collaboration to develop the I-report App to improve safety processes by stakeholder empowerment to reduce non value adding activities and to have an efficient system for leveraging technology to strengthen its Occupational Health and Safety (OHS) culture .

Introduction

The poster demonstrates how the efficacy of development and implementation of the Application were enhanced using a Lean approach adopting Lean philosophy by stakeholder collaboration, innovative thinking, continuous improvement and value Stream Improvement. It also shows statistics of improvements in safety achieved by using the Lean based safety app "I report".

Need for Study

Safety data analytics for improvement in efficiency and effectiveness of Safety processes

- Requirement of a digital platform for ease of Hazard Reporting
- Need a Lean tools for ensuring psychological safety with stakeholder empowerment
- Usage of lead versus lag Indicators for safety improvements across sites.

Objectives

- Zero Accidents /Incidents by agile action on hazards reported.
- Improved psychological safety
- Stakeholder empowerment.
- Real time reporting of safety non conformances for risk mitigation

Methods

Methods used prior to App Development and Implementation:-

- Reporting hazards & incidents on printed formats.
- Online system to report hazards & Incidents - The speed-flow system
- Reporting on social media through WhatsApp groups.
- Monthly reports to Senior Management using Power Point presentations.

Figure No. 1 – Why Analysis

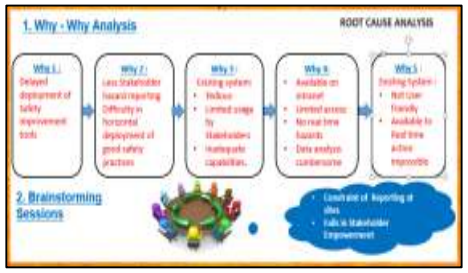
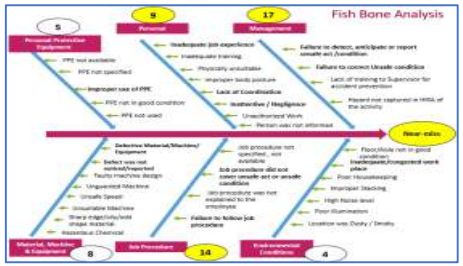
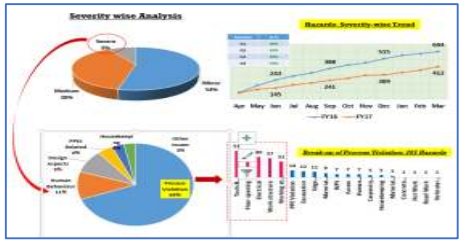


Figure No. 2 – Developing the Application

Results

- Increased Hazard Identification
- Automated Trend Analysis for safety strategy
- Going green with paperless records
- Stakeholder empowerment
- Increased psychological safety
- Continuous improvement of safety Processes





Discussions

Customer Verbatim during Feedback :-

Customer A

· "I report App" - Great Initiative by the organisation to attain the goal of Zero Incident.

Customer B

· User Friendly App , now my team can capture all the hazards without going to desk to report it and saving a lot of time

Customer C

· Great App, for safety, looking forward to using new apps reducing work load

Conclusions

Adopting a safety philosophy emphasizing "Respect to Human Life "which improves morale of all stakeholders ultimately leads to improved business performance. Apps such as "I report" facilitate collaboration for creating accident free sites by providing a platform for quick hazard reporting and their immediate closure thereby reducing probable accidents which can cause human losses, productivity losses ultimately affecting overall project performance and hampering brand image.

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Digitization for Customer Delight in Ready Mix Concrete Business

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IGLC CHENNAI 2018 III International Group for Lean Construction

POST101

Abstract

The Concrete industry in India is subjected to challenges such as aggressive work schedules, space constraints and requirement of concrete with high strength and quality which has created an increasing awareness of Ready Mix Concrete (RMC) due to its many advantages. While doing business for the RMC supply business, the organisation felt that in addition to focussing on the financial parameters it need to improve the customer experience to get an upper edge over the many competitors. Detailed analysis of customer grievances and issues faced right from Order Booking to Delivery across its entire production lifecycle were mapped. Internal and External Third-Party Feedback Mechanisms were deployed to analyse stakeholder pain areas and highlight possible areas of improvement.

Introduction

In this age of digitization, Godrej Construction felt a urgent need was felt to formulate a customer service oriented mobile based application (App) for addressing customer concerns. In order to make the App relevant and to give real-time updates, the organisation mapped customer issues so that it could improve customer value and create delight.

Need For Study

•Feedback was taken in the year 2016-2017 by a reputed third party for RMC customers from Mumbai and Pune Region a batch size of 105 companies were considered and personal interview to address the service of Godrej RMC

Objectives

- Cumbersome booking process & Follow up for orders on Phone
- Non- adherence to committed delivery timelines.
- Detailed metrics of order i.e. dispatched and pending loads to all relevant teams.
- Real-time status update was not available.

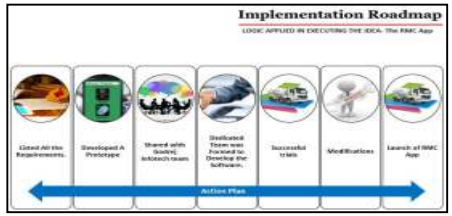
Methods

A Third Party Survey was carried out to understand the performance on various parameter vis a vis its competition. Also, in line with the company's vision to set standards as builders to the nation and to get an advantage over aggressive competition in the market place, it was decided to leverage technology to enhance customer experience by providing a hand held Virtual Assistant for the Concrete Supply business.

The company collaborated with their internal Information Technology team to develop a customer friendly Mobile App which would address customer concerns and reduce wastages in time and material by creating a platform for effective communication management across all stakeholders.

Figure
Third Party feedback indicating the need for the organisation to focus on Product Order & Delivery processes by attention to
1. Commercials
2. Post Sales Service
3. Company Image
4. Pre- Sales Service

Figure
This portrays the Live Tracking feature of the Transit Mixer



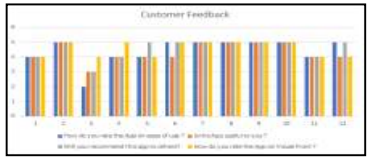
Results

(a) Customer related results

- Online Order Booking without the need for calling the RMC sales engineers, the CC and rigorous follow up.
- Real Time Order Tracking and Quick Confirmation after booking of order with flash message and Unique Order ID
- Elimination of follow up for TMs to be batched at the RMC plant due to Live updates of the order booked.
- Increased transparency due to tracking of the TMs in transit during the pours.
- Information available on Total Due amount for a site for RMC deliveries.

(b) Supplier related results

- Waste Reduction: Empowered teams due to reduced wastages in time, cost and increased productivity due to reduction in non-value adding work
- Ready-Mix Concrete Supply Chain process due to its ability to notify RMC truckers of delivery
- Instructions, location based tracking of trucks.
- Systemic view of Information for better decision making.: The solution integrates
- Improved Truck Turnaround Time(TTT)



Discussions

Customer A

· Transit Mixer are updated with real time status so better site planning is possible.

Customer B

· It minimises the gap of communication between despatch and consumer, easy to operate.

Customer C

· Overall good, my team can manage order through a virtual hand-held assistant during concrete pours

Conclusions

- Digitization helps to a large extent to address customer and supplier issues in a service industry such as "Ready Mix Concrete "where multiple stakeholders need to be given product related real type updates and communication management poses challenges.
- In today's technology driven era, adopting digitization to improve customer satisfaction and to make the organisation "Lean "in terms of process optimisation, waste minimization is the need of the hour.
- Continuous improvement based on periodic Stakeholder feedback for digital Apps is a must so that new needs are converted into digital features and to prevent the App from becoming obsolete.
- For the service providing organisation, digitization helps creating a real-time database for getting insights on production, delivery, product quality, customer issues and helps analyse and use trends to get a competitive advantage and enhance brand image.

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POST111

Developing Recycled Concrete Block - A Green Pro certification for Sustainable Construction

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Godrej | CONSTRUCTION

Abstract

In India, the brick and block manufacturing industry is the third largest consumer of limited non-renewable resources such as coal, crude oil etc. and also leads to air pollution due to emission of pollutants such as carbon dioxide, carbon monoxide, Sulphur dioxide, nitrogen oxide and minute suspended particulate matter. Also, the Central Pollution Control Board (CPCB) has recognized the brick production industry as a highly resource and energy intensive and polluting industry owing to prevalence of obsolete production technologies. Recycled Concrete Blocks is another step by Godrej Construction to focus on waste minimization by recycling and reuse and to reinforce its commitment towards sustainability.

Introduction

This poster portrays how waste management of concrete rubble from demolition sites and conversion into Recycled Concrete Block (RCB), A Green Pro Certified Recycled Concrete Block plant aims at waste minimization by recycling and reuse. The production unit has been set up in Vikhroli to manufacture recycled concrete blocks (solid, hollow, fly ash, insulated) & pavers (of different shapes) by processing concrete debris.

Need For Study

- Brick and block manufacturing industry being the third last consumes non renewable resources causing an harm to the ecological balance.
- There was a need to find an alternative to and focus on recycling of products.

Objectives

- To minimize the landfill waste and landfill space
- To use recycled material for manufacturing of concrete blocks
- To conserve the top soil by using the concrete debris as raw material.
- To Reduce the carbon footprint.

Methods

Rubble which is supposed to be transported to landfills for dumping is transported to the rubble stack yard at the RCB plant at Vikhroli after removal of other foreign materials. Quality checks of the received rubble is done and then the rubble is sent to the sand plant processing unit located in the plant and the finished raw material is stored in stock. Concrete debris become the source for aggregate for new concrete blocks and pavers after the right amount and mix of materials contribute in making the final product. Post production the blocks and pavers are palletised from the curing chamber and then the finished packed and transported as per the clients requirement.

Figure 1- Flowchart indicating the Manufacturing and operation of the Recycled Block Plant

Figure 1- RCB Manufacturing Plant at Vikhroli

Results

Major benefits of using recycled concrete:

· It offers a way to reduce landfill waste and landfill space

· Using recycled material reduces the need for mining for virgin raw materials.

· Recycling one ton of cement could save more than 5000 liters of water.

In terms of Carbon Footprint:

· Recycling one ton of cement could save more than 900 kg of CO_2.

· Reduction in carbon monoxide, Sulphur oxides, nitrogen oxides and other harmful gas emissions as concrete waste need not be transported to landfills

· Recycled concrete blocks can also be used in place of bricks, given the environmental impact of brick production like top soil erosion.

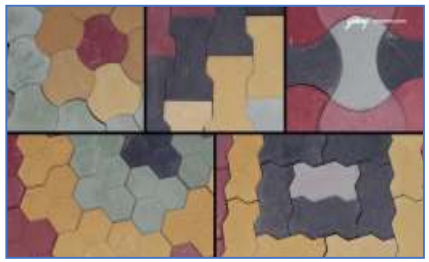

Figure 2 - Recycled Concrete Pavers

Figure 3- Recycled Concrete Products

Conclusions

The simple act of recycling the concrete reduces the amount of material that must be landfilled. The waste concrete, itself acts as an aggregate and any embedded reinforcement can be removed and recycled as well. As space for landfills is slowly becoming premium, this not only helps reduce the need for landfills, but also reduces the economic and ecological impact of the project. Moreover, using recycled concrete aggregates diminishes the need for virgin aggregates. This in turn reduces the environmental impact and hazards of the aggregate extraction process. By removing both the waste disposal and new material production needs, transportation requirements for the project are also significantly reduced.

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CLIMATE CHANGE MITIGATION BY MANGROVES – A GODREJ INITIATVE

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IGLC CHENNAI 2018 International Group for Lean Construction

POST112

Godrej | CONSTRUCTION

Abstract

Godrej & Boyce Mfg Co Ltd is conserving large areas of mangrove forest along western bank of Thane Creek since many decades. In this rich biodiverse forest 16 species of mangrove and mangrove associated plants are recorded that provide ecosystem services like prevention of coastal erosion, habitat for wildlife, livelihoods for local fisherfolk, research and education avenue for academia and regulation of local climate

Introduction

Mumbai is India's one of the most polluted city as it experiences huge urbanization and thus obviously at the peak of air pollution. Mangroves acts as green lungs of Mumbai and absorbs CO_2 release O_2 and stores Carbon in their body stock in the form of cellulose. Godrej is taking enormous efforts to conserve this unique ecosystem by implementing various activities focused on three pillars Awareness, Research and Conservation.

Need of the Study

To demonstrate the importance of conservation of mangroves and its impact on the Ecosystem by Carbon Sequestration

Objectives

To estimate the total carbon stock in the mangrove forest at Godrej, Vikhroli.

- Determine the biomass and carbon density in the aboveground pools of the mangrove stands.
- Assess the amount of carbon sequestered in the soil.

Methods

To study the land use & land cover class of study area, Remote Sensing technique has been employed. Five different land use classes obtained from the analysis.

- Dense vegetation : This includes thick vegetation cover with different types of trees or plants covering land in an undefined manner.
- Moderate vegetation: Vegetation cover which is represented by a land category with open type of vegetation.
- Grassland: These are the areas of natural grass along with other vegetation.
- Mud-flats: These are categorized under coastal wetlands that are formed when mud is deposited by tides or rivers.
- Open area: The open area within the study area comprises of open land areas with no vegetation cover.

For deriving the number of permanent sample plots required to estimate the carbon stock it was necessary to collect a standard deviation of carbon stock of each stratum. This was done through a pilot sampling carried out in each stratum.

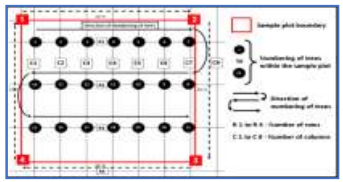

Figure No. 1 Layout of sample plot

Results

The carbon pools that can be considered for carbon stock estimation are Above ground biomass (AGB), Below ground biomass (BGB), Dead wood (DW), Litter, Soil organic carbon (SOC). . These five pools likely comprise >95% of the true ecosystem carbon stock of mangroves.

The carbon stock estimation of trees i.e. for the above ground biomass & below ground biomass carbon pool was done by using the approved A/R CDM methodological tool: "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" version 03.0.0.

The total carbon stock is estimated by adding all the five components of the carbon pool. The equation for total carbon stock for a given project area is as follows:

$$C_{PROJECT,t}=C_{TREE.t}+C_{DW,t}+C_{LI,t}+C_{SOC,t}$$

Project area	CTREE,t tCO2e	CDW,t tCO2e	CLI,t tCO2e	CSOC,t tCO2e	CPROJECT,t tCO2e
Total	208032	12362	67	376649	597112

Table No - 01 - Total Carbon Stock

Discussions

Annually this forest sequesters 6 lakh tons of CO_2 and its annual increment value is around 60000 TCO_2e. This carbon sequestration service is very valuable considering high emission of CO_2 in the Mumbai Metropolitan Region and its impact on climate change.

Conclusions

This study is first of its kind in the state of Maharashtra. It highlighted remarkable contribution by a corporate house in mangrove conservation. The ecosystem services of carbon sequestration delivered by the Godrej mangroves benefit entire Mumbai Metropolitan Region which needs green lungs to absorb the Greenhouse Gases (GHGs) emitted by countless anthropogenic activates. Extrapolating the carbon sequestration services of Godrej mangroves to entire mangrove ecosystem of the Mumbai Metropolitan Region, this study makes clear case for wetland conservation for climate regulation. Godrej thanks CEED-India for their valuable support during this project.

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GODREJ MANGROVES - AN INTEGRATED SUSTAINABLE HABITAT

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IGLC CHENNAI 2018 III International Group for Lean Construction

POST114

Godrej | CONSTRUCTION

Abstract

The Godrej Pirojshanagar Township a role model of integrated sustainable habitat boast of nature conservation that provides several ecosystem services such as habitat for wildlife, prevention of coastal erosion, control on air, water and soil pollution. In addition to the standing stock of six lakh tons of carbon dioxide, Godrej mangroves sequester additional sixty thousand tons of carbon every year. It also serves as a means of livelihood for local fisher folk of Vikhroli and a living laboratory for research and education.

Introduction

Godrej initiated the mangrove conservation formally in 1985. However, history of mangrove conservation dates back to the decade of 1940s when Godrej family acquired Vikhroli. The mangrove forest was conserved as family philanthropy which was later integrated in the organization's environment management system.

Need of the Study

To sensitize stakeholders on importance of integrating habitat conservation with urban industrial development

Objectives

Conservation of the coastal diversity through research, on-site conservation, awareness building and regular monitoring to build resilience towards climate change.

Methods

Godrej has set up the Wetland Management Services Department to protect hundreds of hectares of mangroves adjoining their industrial, commercial and residential township of Pirojshanagar in Vikhroli, Mumbai.

WMS is engaged in conservation of this ecosystem through regular monitoring to check possible destruction of existing mangroves and protecting rare species of mangroves; ecological restoration of degraded mangroves by raising nurseries and replenishing degraded mangrove areas through artificial regeneration in different areas and the establishment of a 'Mangrove Information Centre' for dissemination of information regarding the importance of mangrove conservation through film/slide shows, seminars, nature trails, poster exhibitions etc.

Results

- First mangrove area in India to formally adopt ISO 14001 standards for Environment Management Systems.
- Biodiversity conservation: 16 species of mangroves and mangrove associates, 208 species of birds, 30 species of reptiles, 13 species of crabs, 7 species of prawns and 20 species of fish have been identified in the area so far
- The mangrove area acts as a carbon sink for 50,000 tonnes of CO2 per year with a standing Carbon stock of around 6 Lakhs equivalent tonnes of CO2.
- Awareness about diversity and importance of mangroves through http://www.mangroves.godrej.com/ and a portable set of eight posters for 'beyond fence' awareness
- On-site awareness among 6000-7000 Godrej employees, schools and college students of Mumbai and nature enthusiasts through nature trails every year
- Development and dissemination of a mangrove mobile app with pictorial and textual information on 24 mangrove and mangrove associate species and mangrove ecosystem. The app has been downloaded by 1850 users from 50 countries so far
- Rescue and rehabilitation of wild reptiles, birds and mammals of Pirojshanagar Township on regular basis in collaboration with subject experts

Discussions

Godrej's mangrove conservation is relevant to 8 of the 17 Sustainable Development Goals (SDGs) of United Nations

SDG1: No Poverty - By supporting livelihoods of local fisher folks
SDG4: Quality Education - By providing living laboratory for research and awareness for academic institutes;
SDG9: Industry, Innovation and Infrastructure - By providing green cover to an industrial complex;
SDG11: Sustainable Cities - By providing ecosystem services to Mumbai;
SDG13: Climate Action - By providing natural carbon sink and sequestration service;
SGD14: Life Below Water - By providing roosting and nesting habitat for Thane creek's aquatic biodiversity;
SDG15: Life on Land - By providing roosting and nesting habitats for terrestrial biodiversity;
SDG17: Partnerships and Goals - By providing collaboration of various stakeholders like industry, academia, NGOs-CBOs, industrial consortiums and Government

Conclusions

Godrej's Pirojshanagar mangroves is second largest green lung of the Mumbai Metropolitan Region, after Sanjay Gandhi National Park. The role of mangrove ecosystem is storage of rain water and prevention of flashflood in Eastern suburbs of Ghatkopar, Vikhroli and Kanjurmarg has been well acknowledged by the residents.

References

Website http://www.mangroves.godrej.com/

Godrej Sustainability Strategy of 'Good & Green'

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Godrej & Boyce Mfg. Co. Ltd.

IGLC CHENNAI 2018 III International Group for Lean Construction

POST115

Godrej | CONSTRUCTION

Abstract

In 2011, Godrej Group formally adopted an overarching Sustainability strategy called `Good and Green' with a vision and goal to make social and environment investments and build a greener and inclusive India by adopting a shared value approach.

Introduction

As part of Good & Green, Godrej Group has three goals which we aspire to achieve by 2020. The first goal is to 'Ensure Employability' through which Godrej intends to train one million youth in skills that will enhance their earning potential. Second focuses on 'Greener India' which aims to achieve zero waste to landfill, carbon neutrality and water positivity, while reducing specific energy, water consumption and optimising the use of renewable energy. The third goal is 'Product Innovation' which aims to achieve one third share of the total revenue from Good and Green products.

Need

In order to commit sustainable business practices considering the triple bottom line approach of Economic, Societal and Environmental sustainability there is a need to develop a strategy to mainstream these goals and green practices with business operations.

Objectives

Guide and mentor all Godrej businesses in creating, developing and implementing innovative and sustainable programs that support in achievement of Good & Green goals.

Methods

In the company's effort to make business sustainable, all business units/ divisions are working towards embedding "Good & Green" in the systems and processes in the organization. Over 300 passionate and committed employees are engaged in executing these goals, who form the part of various task forces & sustainability forums. The responsibilities of task force members includes but not limited to the following:

1. **Evaluation of projects and partners as per the developed framework:** The respective task forces in consultation with the Corporate Good & Green team undertakes a need assessment study to understand the social and environmental needs.

2. **Building collaborations with other organizations on CSR projects**

3. **Implementing projects based on set targets and action plans:** Projects are implemented either by company itself or with the help of outside agencies. Projects approved by the CSR committee will be handed over to the task forces who in turn breaks down the projects into time-bound targets and action plans.

4. **Regular monitoring of project activities:** The task force members are responsible for executing and monitoring of approved projects based on the milestones and success indicators defined for the project together with the implementing agency.

5. **Sharing quarterly reports with the CSR committee:** The reports are prepared and submitted to the CSR Committee for review, on quarterly basis.

Results

- **Scale across businesses:** Through skill training programmes across India in the areas of beauty and hair care, sales, rural entrepreneurship, construction, blue collar trade, technical training, agriculture and animal husbandry, around 4.5 lakhs candidates have been trained till date.
- **Focus on Quality:** Conducted centre audits for 24 centers
- **Focus on Impact:** Impact analysis through divisions by calling 10% of candidates trained in calendar year 2017. Average 70% candidates got placement / self employment.
- **Partner Engagement:** We partner with non-profits across India that work in the areas of skills development and vocational training. Our partners help provide training and create market linkages that connect our trainees to job prospects.
- **Systems & process development** – Central CSR team conducted online portal training for divisions & partners, simplified the partnership process by drafting a single service level agreement to establish partnership.
- Godrej & Boyce Good & Green Products achievement in FY 2017-18 in terms of Revenue is Rs. 2120 Crore *(As a % of NBV : 22.2%).*
- Godrej Interio received Green guard certification for 15 products, Indoor Advantage certification for 14 seating products, BIFMA Level Certification for 6 products and Green Pro certification for 2 products
- LCA study of 8 products is in progress: Ready Mix Concrete (RMC), Upbeat Desk Based Office system, Care beds, Pulse Chair, Spin Range, Edge Duo, Split AC and Defender+ Safe.

Figure 1- Indicators

Conclusions

At our manufacturing plants we have relentlessly focused on productivity and environmental sustainability. To strengthen our approach, we have invested in a robust technology solution that has revolutionised the speed and accuracy of our data monitoring. It has enabled us to map, understand and analyse our complete environmental footprint, from raw materials to finished goods, across factories. Our strategy to achieve our sustainability goals including a range of efforts from energy efficiency, water conservation and waste management at our manufacturing plants, to promoting IGBC/LEED-certified green buildings has helped us improve our sustainability performance and hence overall business performance.

- Godrej Construction received GreenPro certification for Recycled Concrete Block and Tuff Block AAC in 2017-18

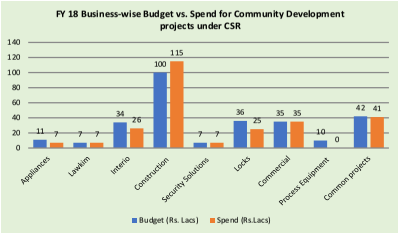

Figure 2- Business-wise Budget vs. Spend for Community Development projects under CSR

PARTNER FEEDBACK MECHANISM COLLABORATIVE PARTNERING

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POST119

Abstract

This poster depicts how Godrej Construction as a part of its Lean journey took up Collaborative Partnering in the Procurement function. How Partner Feedback Mechanisms help in understanding partner expectations and organizations performance over time is evident from this poster. A scientific approach has to be adopted to define the scope and coverage of feedback and the parameters against which feedback is sought need to be relevant to the organization's strategy. Detailed analysis from the feedback data helps to derive the focus areas which a Lean organization should pay attention to for effective partnering.

Introduction

This poster depicts how Godrej Construction effectively used Feedback Mechanisms to drive Collaborative Partnering and shows encouraging results due to timely action taken on meeting the expectations of its partners.

Need For Study

- Understanding of Partner Expectations
- Business Growth with resource optimization and innovation
- Assess the satisfaction level amongst partners and identify focus areas.

Objectives

- Capturing key expectations and organization's performance during business association.
- Understanding of the Partner Satisfaction level and Company Perception.
- Seek opinion about the organizations policies, values, personnel behaviour etc.
- Learning emerging trends, innovative business ideas relevant for the future.

Methods

The methods adopted by Godrej Construction for deploying the Partner Feedback Survey for better collaboration and mutual business growth through third party survey is pictorially represented as below.

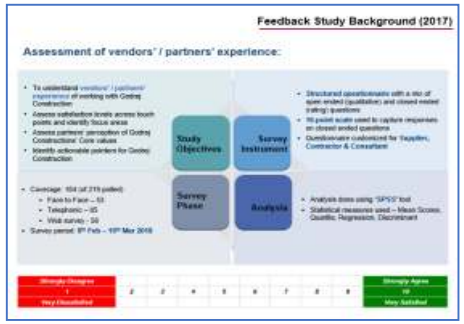


Figure 01- Feedback Study for Assessment of experience.

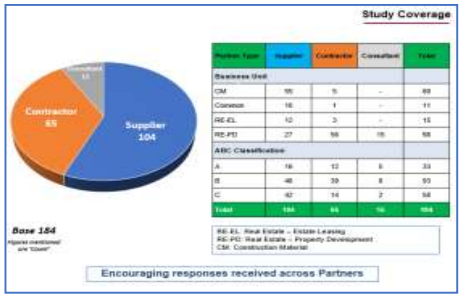


Figure 02- Responses received From Partners via Third Party Survey

Results

- Lean implementation and Partner Feedback Survey help understand needs and expectations of partners
- It assists to identify Key Focus Areas for efficient and effective contracting processes.

Figure 03- Way Forward for Partner Evaluation

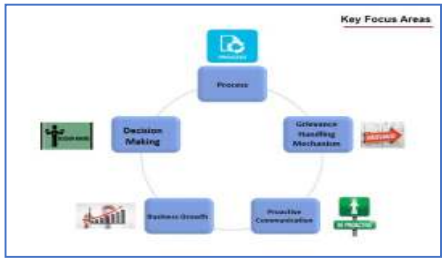
Discussions

Areas of Improvement identified post Feedback :-

1. Value Engineering driven approach
2. Sustainable sourcing
3. Business growth aiming for innovations and cost optimization
4. Sharing of Best Construction practices in the market

Conclusions

Organizations implementing Lean need to understand the needs and expectations of their partners and indulge in collaborative contracting models to leverage technology, innovation and know-how of best in industry practices. Partner Feedback Mechanism when well design provides crucial information which helps organizations derive their focus areas and improve their Partner Satisfaction levels.



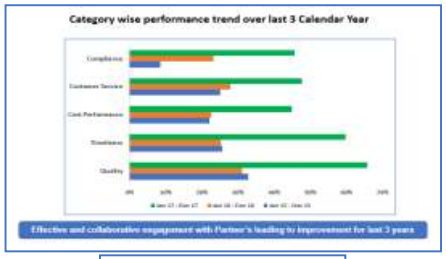


Figure 05 – Performance Trend

References

1. Closer Than "Arms Length" Understanding the Factors Associated With Collaborative Contracting, AA Amirkhanyan, HJ Kim
2. Early contractor involvement in building procurement: contracts, partnering and project management, Mosey - 2009
3. Strategic alliances: Partnering for success, JC Mason , 1993

STRATEGIC PARTNERS MEET FOR LEAN CONTRACTING

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POST120

Abstract

Godrej Construction as a part of its Lean implementation conducted a Strategic Partners Meet to collaborate with its partners for ensuring sustainable mutual business growth. This acted as a forum to celebrate the success of various initiatives taken up at various projects with its partners and to understand the expectations of all the partners for better working relationships, driving value engineering initiatives and to keep updated the latest technology .

Introduction

This poster portrays how Godrej Construction conducted a Strategic Partners Meet as a part of its Lean journey. It also gives insights about how partner insights and benefits for mutual growth can be reaped by adopting relational contracting as against transactional contracting.

Need For Study (Strategic Partners Meet)

- Need to collaborate with partners for cost benefits.
- Partner Feedback Mechanisms.
- Partner Engagement and Commitment towards business ethics and goals

Objectives

- To **strengthen** relations with **key partners**.
- To **inculcate Godrej Construction's values and** business ethics in partners.
- To **identify strategic opportunities** for engaging key partners contribution towards **Predictable, Profitable and Sustainable** business plans.
- To develop the culture of **Sustainable Long-term Partnerships**

Methods

The methods used by Godrej Construction for Lean Relational Contracting are:-

- Quarterly/Annual Partners performance Evaluation
- Annual Partners Feedback.
- Sharing of Organisations Expectations to Partners while transacting.
- Celebrating success with key partners by conducting Strategic Partners Meet.

Figure no 1- GC Procurement transformation Journey

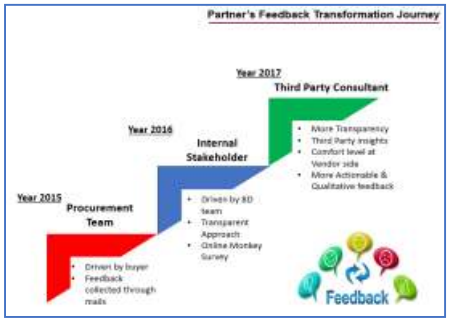

Figure no 2- Partners Feedback transformation Journey

Results

- Building a sustainable relationship with key partners.
- Win-Win approach based on mutual trust, respect and openness.
- Supporting one another with expertise, resources and knowledge.
- Alignment with Organization Strategies

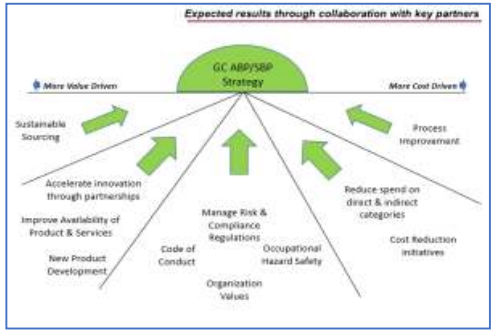

Figure no 3 – Expected Results through collaboration with Key Partners

Discussions

Verbatim of Strategic Partners Meet

- We are thankful to Godrej & Boyce to invite us in such a wonderful event & Give a Such great respect to us. We really feel proud to work with Godrej & Boyce .This kind of event will be motivate us..
- If you share with us feedback about performance evaluation yearly it will help us in improving in the next delivery.
- The event was quite insightful for vendors like us and it helped us create a stronger bond with the GC Team.
- As mentioned in the Meet, such regular Meets will help understand your needs and enhance relations between GC and strategic partners. Hats Off to you and your Team..!

Conclusions

Godrej Construction has benefited by Lean implementation in Contracting by conducting initiatives such as Strategic Vendors meet to capture expectations of its partners and plan strategies in collaboration with its partners for value engineering, knowledge sharing, better resource management to foster mutual trust and transparency ultimately resulting in business growth and better relationships with its partners.

Figure 4 – Strategic vendors meet 2017-2018

References

1. Closer Than "Arms Length" Understanding the Factors Associated With Collaborative Contracting, AA Amirkhanyan, HJ Kim
2. Early contractor involvement in building procurement: contracts, partnering and project management, Mosey - 2009
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EZStrobe Simulation for Effective Resource Planning at RMC Plant

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Indian Institute of Technology Bombay, Mumbai

Abstract

Ready Mix Concrete (RMC) industry is growing rapidly in the developing countries, like India. Assessing the productivity of a RMC industry is one of the most challenging task of a plant Manager. Productivity of any resource can be improved by simulating the actual operational process. In this study a RMC plant was taken and preliminary analysis was done to develop a model in EZStrobe. This simulation model was used to optimize the resources involved and helped in increasing the productivity.

Introduction

The principle of RMC industry is to achieve efficiency in production and effective delivery of concrete to the construction sites. This can be done through proper sequencing of activities, optimizing the resources and by reducing various recognized wastes. This study focuses on proper utilization of transit mixers (TM) such as optimum number required for peak demand and cycle time of the TM. For this case study a RMC plant located at Central Mumbai, India was considered. A model was developed with the help of EZStrobe and was validated.

Need For Study

•In RMC industry, one of the source of wastage stems from under utilisation of resources such as TM, loader etc.,

•A statistical tool is essential to take proper decision at crucial situation.

•Productivity of RMC plant need to be improved by identifying, eliminating or reducing the various wastes involved.

Objectives

• To develop a model for a particular case study and validate the same.

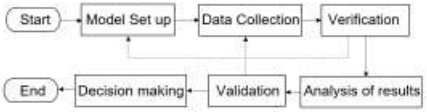
•To measure the cycle time of TM and analyze the sensitivity of this cycle time towards the duration of various activities involved.

•To obtain an optimum number of TM required for continuous operation for this particular case study.

Methodology

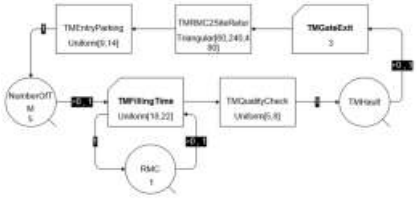
The research methodology adopted for this case study is shown in the Figure 1.

Figure 1 : Research methodology



• A detailed study was done at site to get familiarized with different activities involved. These activities are sequenced in such a way that they replicate the current operational RMC. The entire model was developed in EZStrobe Visual programming (Figure 2). The assumptions made were, continuous demand and continuous supply of materials.

Figure 2 :A basic EZStrobe Network for TM movement in RMC plant



•Data collection was done through observations and records. This data was authenticated by the Project Manager.

•The developed model was verified with the higher authorities at that site.

•A pilot run was done on the developed model and the obtained results were in line with the practical scenario which was again validated by the Project Manager. This reflects that the developed model is applicable to the current case study.

• The output obtained from this simulated model are given in Table 1 and 2.

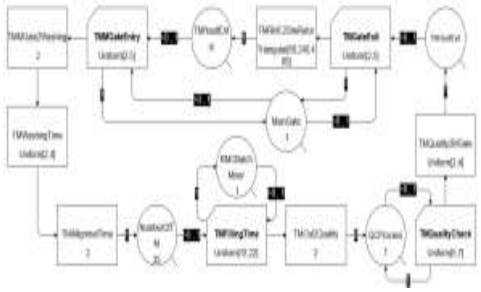
Table 1 : Result obtained from the stimulation of model given in figure 2

Activity	Cur	Tot	AvDt	LstDt	AvWr	SDWr	MinW	MaxW	AvInt	SDInt	MinI	MaxI
TMEntryParking	0	1699	366.59	99973.00	11.95	1.67	9.00	33.99	61.56	55.26	0.00	379.91
TMFillingTime	0	1626	0.00	99900.01	19.97	1.57	16.01	25.99	61.61	67.66	16.01	290.26
TMGateExit	0	1623	26.68	99967.87	2.00	0.00	2.00	2.00	61.62	67.63	15.51	297.06
TMQualityCheck	1	1624	39.10	100007.25	6.00	0.07	5.00	8.00	61.61	67.67	16.01	297.25
TMRMC25AteRater	4	1625	29.68	99970.87	204.01	80.85	67.46	474.29	61.62	67.63	15.51	297.06

Queue	Res	Cur	Tot	AvWait	AvCont	SDCont	MinCont	MaxCont
NumberOfTM	#25	0.00	1624.00	2.56	0.06	0.26	0.00	5.00
RMC	#25	1.00	1625.00	61.59	0.60	0.67	0.00	1.00
TMRault	#25	0.00	1623.00	0.00	0.00	0.00	0.00	1.00

A detailed simulation model is required to obtain more accurate results. A developed detailed model for the same case study was given in Figure 3.

Figure 3 : A detailed EZStrobe Network for TM movement in RMC plant



Results and Discussions

•Through simulation model, the cycle time of TM was calculated accurately and variation in cycle time was also measured at various duration of activities.

•Detailed statistics of queue "NumberOfTM" was extracted and was given in Table 2.

Table 2 : Statistical Result Depicting % of Time the TM Remained Idle

Detailed statistics on content of queue NumberOfTM

Content	TotTime	%Time
< 1.00	94778.34	94.77
< 2.00	99522.90	99.52
< 3.00	99961.05	99.95
< 4.00	99988.19	99.98
>= 4.00	19.10	0.02

•It was observed that almost 94% of time less than 1 TM was available at RMC. At least one TM was available for only 6% of time. Hence for running the RMC plant without any interruptions an optimum number of TM should be required which can be identified by modifying the queue "NumberOfTM" value.

•A very accurate model can supports in critical decision making, which plays a crucial role in effective resource management by reducing the idle time and wastage in terms of both cost and time.

Conclusions

• Optimum number of TM can be calculated for a particular site. This network can be customized for different sites as well.

• Cycle time of TM was calculated, taking the duration of various activities involved.

•The sensitivity of cycle time with variation in duration of different activities was observed which helped in identifying the critical activity.

•This model can be applied for optimizing various equipment's involved and thereby reducing their idle time.

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POST126

EZStrobe Simulation for Effective Resource Planning at RMC Plant

Sagar Jain (sagarjain@iitb.ac.in) and Abhishek Raj Singh | Supervisor: Prof. Venkata Santosh Kumar Delhi

Indian Institute of Technology Bombay, Mumbai

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Objectives

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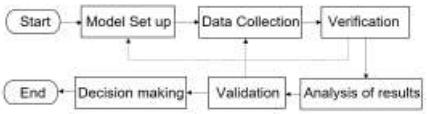
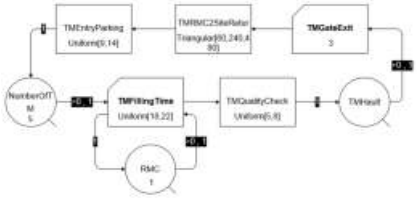
Figure 1 : Research methodology



• A detailed study was done at site to get familiarized with different activities involved. These activities are sequenced in such a way that they replicate the current operational RMC. The entire model was developed in EZStrobe Visual programming (Figure 2). The assumptions made were, continuous demand and continuous supply of materials.

Figure 2 :A basic EZStrobe Network for TM movement in RMC plant



•Data collection was done through observations and records. This data was authenticated by the Project Manager.

•The developed model was verified with the higher authorities at that site.

•A pilot run was done on the developed model and the obtained results were in line with the practical scenario which was again validated by the Project Manager. This reflects that the developed model is applicable to the current case study.

• The output obtained from this simulated model are given in Table 1 and 2.

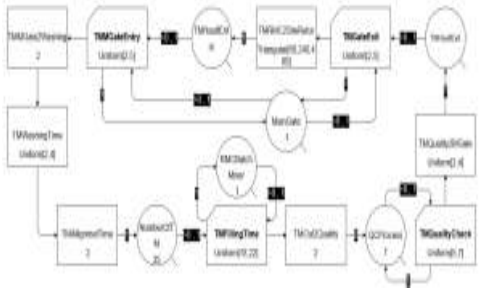
Table 1 : Result obtained from the stimulation of model given in figure 2

Activity	Cur	Tot	AvDt	LstDt	AvWr	SDWr	MinW	MaxW	AvInt	SDInt	MinI	MaxI
TMEntryParking	0	1699	366.59	99973.00	11.46	1.67	9.00	33.99	61.56	55.26	0.00	379.91
TMFillingTime	0	1626	0.00	99900.01	19.97	1.57	16.01	25.99	61.61	67.66	16.01	290.26
TMGateExit	0	1623	26.68	99967.87	2.00	0.00	2.00	2.00	61.62	67.63	15.51	297.06
TMQualityCheck	1	1624	39.10	100007.25	6.40	0.67	5.00	8.00	61.61	67.67	16.01	297.25
TMNMC25toMixer	4	1625	29.68	99970.87	204.01	80.85	67.46	474.29	61.62	67.63	15.51	297.06

Queue	Res	Cur	Tot	AvWait	AvCont	SDCont	MinCont	MaxCont
NumberOfTM	#25	0.00	1624.00	2.56	0.06	0.26	0.00	5.00
RMC	#25	1.00	1625.00	61.59	0.60	0.67	0.00	1.00
TMWait	#25	0.00	1623.00	0.00	0.00	0.00	0.00	1.00

A detailed simulation model is required to obtain more accurate results. A developed detailed model for the same case study was given in Figure 3.

Figure 3 : A detailed EZStrobe Network for TM movement in RMC plant



Results and Discussions

•Through simulation model, the cycle time of TM was calculated accurately and variation in cycle time was also measured at various duration of activities.

•Detailed statistics of queue "NumberOfTM" was extracted and was given in Table 2.

Table 2 : Statistical Result Depicting % of Time the TM Remained Idle

Detailed statistics on content of queue NumberOfTM

Content	TotTime	%Time
< 1.00	94778.34	94.77
< 2.00	99522.90	99.52
< 3.00	99961.05	99.95
< 4.00	99988.19	99.98
>= 4.00	19.10	0.02

•It was observed that almost 94% of time less than 1 TM was available at RMC. At least one TM was available for only 6% of time. Hence for running the RMC plant without any interruptions an optimum number of TM should be required which can be identified by modifying the queue "NumberOfTM" value.

•A very accurate model can supports in critical decision making, which plays a crucial role in effective resource management by reducing the idle time and wastage in terms of both cost and time.

Conclusions

• Optimum number of TM can be calculated for a particular site. This network can be customized for different sites as well.

• Cycle time of TM was calculated, taking the duration of various activities involved.

•The sensitivity of cycle time with variation in duration of different activities was observed which helped in identifying the critical activity.

•This model can be applied for optimizing various equipment's involved and thereby reducing their idle time.

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IMPLEMENTING WORK SAMPLING AS A LEAN TOOL IN INDIAN CONSTRUCTION INDUSTRY

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IGLC CHENNAI 2018 III International Group for Lean Construction

POST129

Abstract

The use of lean tools and concepts, in Indian construction industry is presently at a nascent stage, but gradually gaining importance.Currently,productivity measurement system is the only tools used to monitor construction progress at grass-root level across large construction projects in India. However, without any established nationwide benchmark on productivity, it is difficult to assess and evaluate construction progress only with productivity rates.

Introduction

Time and cost overruns are the major issues **concerning construction projects in India**

About **50%** of the ongoing projects are experiencing **time overrun** and about **32.5%** are experiencing **cost overruns** (As per MOSPI-GOI, 2009)

Waste of resources and **low productivity rates** are the **major sources of the cost and time overrun**

Indian construction **industry started adopting lean tools**, to improve the efficiency by identifying and eliminating waste

But **not all lean tools can be easily adopted** because of the varying prerequisites in terms of knowledge and supervision

Success of a project largely **depends** on, how well it is **monitored and controlled at micro level**

Large Indian construction companies **widely use productivity measurement system** for micro level control

Without any established nationwide benchmark on productivity, it is difficult to assess and evaluate the performance using productivity rates alone

In this context, **simple tool like work sampling, can be very useful**; as it is both easy to adopt as well as time & cost effective

The key idea is to implementing work sampling and productivity measurement in complementary roles to overcome the shortcomings of individual tools and have a better informed project management

Methodology

- Data collection Methodology
  - Crew based work sampling and productivity measurements are conducted on crews working on high rise residential projects
  - Both these data are collected in micro scale as well as on a macro scale as illustrated in the figure below

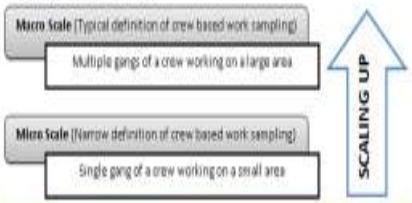
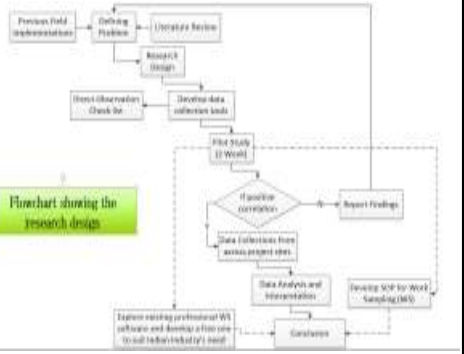


Illustration showing the micro and macro scale for data collection



Flowchart showing the research design

Work Sampling as a lean tool

- The central idea lean philosophy is to maximize customer value,
  - by eliminating wastes and
  - through continuous improvements

7 Types of waste as described by Shigeo Shingo	Ability to identify using work sampling technique
Overproduction	NO
Inventory	NO
Wait	YES
Motion	YES
Transportation	YES
Rework (Defects)	TO SOME EXTENT
Over Processing	NO

Results

Direct Observation Sheet

Date :	Location & Condition:				WS Type:		Ref No.	
TIME	Start Time	Stop Time	Start Time	Stop Time	Start Time	Stop Time	Start Time	Stop Time
Trade/Craft								
Head Count								
Work Details (No. & Size of panels)								
Direct Work								
Material Handling / Supporting Work								
Preparatory Work								
Instruction/Safety								
Waiting / Idle								
Travel								
Personal/ Breaks/ Others								
COMMENTS								

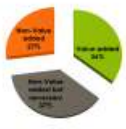
Investigation of Relationship - Micro Scale

Shuttering work using Aluminium formwork system			
Shuttering of slab panels	Shuttering of wall panels	Shuttering of beam panels	Shuttering of end joints
De-shuttering of slab panels	De-shuttering of wall panels	De-shuttering of beam panels	De-shuttering of end joints

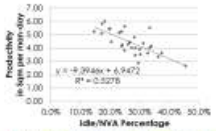
Sub categories of shuttering work at micro level

Photographs showing slab panel (Left) & wall panel (Right) shuttering works taken during the work sampling study at an ongoing construction project in Chennai

Investigation of Relationship - Macro Scale



Overall work sampling results at macro scale



Plot between productivity rates and idle category of work sampling at macro scale

Discussions

- The work sampling was conducted with a minimum **confidence level of 75% and an accuracy of ±10% for micro scale** and a **confidence level of 90% and an accuracy of ±10%** for **macro scale** of investigation.
- In both the cases of micro and macro level of investigation, the following are the main outcomes:
  - *Proves the existence of relationship between the two techniques at both scales of investigation*
  - *Idle category has a strong correlation with productivity rate*
  - *Direct work category of work sampling has essentially no correlation with productivity rates*

Conclusions

Reasons to endorse work sampling on construction projects:

- It helps to **identify site specific factors that have positive or adverse on productivity**
- work sampling provides an easy, inexpensive, and **quick way to analyse effectiveness** of workforce
- Can be **used at any point of time** during an ongoing activity to evaluate effectiveness
- Is very useful **to find the overall performance of a group of workers** from different trade involved in a given activity
- It can be used as indicator to **evaluate the effectiveness of implementation of any new technique** or method in a project site
- **Validates the existence of relationship** between values obtained from work sampling and productivity rates
- Shows that **idle category of work sampling has the strongest correlation** with productivity rates and direct work category of work sampling has no correlation with productivity rates
- The first step in **developing a Standard Operating Procedure (SOP) for work sampling** has been taken. The SOP here needs field validation and refinement to better suit the need of the industry
- It is seen that the **use of modern software and hardware can alleviate a lot of the tedious procedural issues** involved in conducting work sampling studies
- Easy to use **application developed for catering to the needs of Indian construction industry**

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DESIGN MANAGEMENT FOR BUILDING PROJECTS IN INDIA: AN INVESTIGATION ON PROCESS STANDARDIZATION

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POST130

Abstract

The influence of design in the initial stages of a construction project is high whereas the cost incurred in implementation is low. The compressed fast track schedule can cause disruptions in construction and thus, it is imperative to allocate appropriate efforts during design. A preliminary study revealed that design processes in Indian construction industry were generally unstructured. A more detailed study of the design processes of four Indian developer organizations mapped the current design processes as swim lane diagrams. Analysis of these processes showed that design at each organization was driven by certain priorities and the design stage durations varied significantly, especially in the concept design stage where these priorities have maximum influence. Based on the analysis, it is apparent that standardization within an organization/project type is required and more feasible, than a single industry-wide standardization of the process. A preliminary SIPOC methodology has been used to develop generic process charts from the design processes mapped for the organizations sampled.

Introduction

Complexity in design arises from the fact it is iterative, interdisciplinary, and done by specialists from different teams. Based on industry inputs obtained from an exploratory review meeting with industry participants it was identified that developing a standard for the building design process would enable better management of design.

Objectives

- develop a generic process template based on type of project
- determine average duration of different design stages based on project data
- develop a methodology by which an organization could map a standard process, gather data for specifying stage durations and continuously improve it design process performance.

Methodology

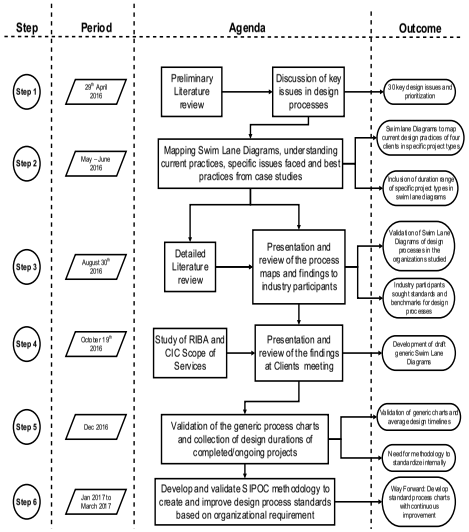

Figure No. 1

Results

- Invariably every organization (or types of projects done by organizations) had a specific design objective and strategies to achieve those objectives.
- The duration of the design process is largely dependent on the priority of the organization/project needs(Figure 2)
- In an informal interview with a few professional architects, it was understood that architects refer Neuferts or NBC and the likes, as standards for spatial requirements in the stages of design after concept. Absence of any sort of standard for the concept design is another cause of variability. Such variability adds uncertainty to the process which brings in unpredictability.

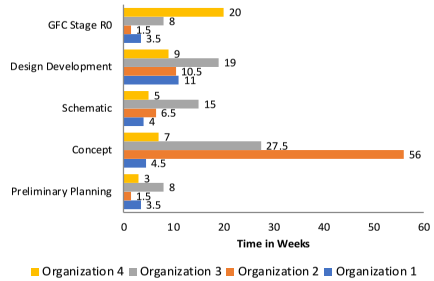

Figure No. 2

- It is inferred that significant variability exists within an organization for similar project types. Availability of Design standards with defined activities and expected durations can enable organizations to reduce this variability.
- It can be inferred that the stages after the "project brief" are nearly typical. In each of those stages, the main architect takes the lead and develops his part. This is taken as input by other consultants, who develop and then send their respective parts back to the main architect.(Figure 3)

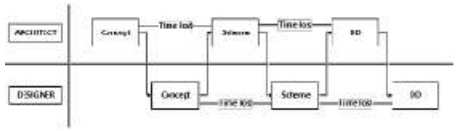

Figure No. 3

Discussions

Current design practices need to focus not merely on the creativity, but the longevity, as most of the current buildings are more often than not, functioning as utility spaces. This is how design could become more effective. Therefore, by essentially putting a one-time well thought out plan to standardize the design could enable substantial improvement in the effectiveness of design and hence construction. This project attempts to bridge the standardization gap by introducing a framework for design workflow and timelines.

Recommendations

SIPOC Methodology for developing standard process chart has been recommendedStandards will have to be made based on classifications of the targeted customer pools for different project types.

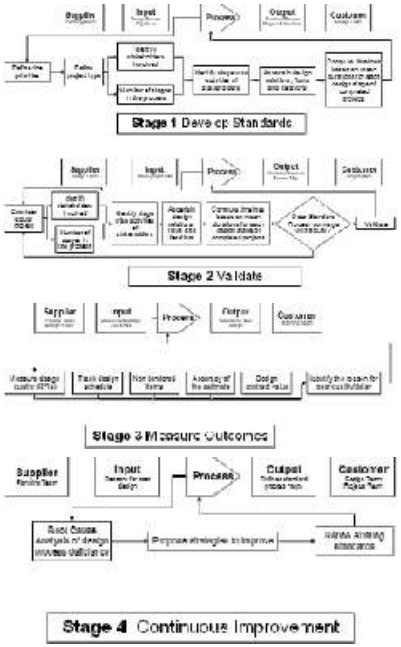

Figure No. 4

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EVALUATION OF LAST PLANNER® SIMULATION GAMES

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POST131

Abstract

The Last Planner System (LPS) is a planning tool developed by Glenn Ballard and Greg Howell as a response to the high level of variability found in the current construction industry. LPS is pull-based planning, as opposed to the traditional push-based Critical Path Method. Studies have shown that the current teaching methods are ineffective in communicating the theory behind LPS due to its complex nature. Using alternate teaching methods like hands-on simulations give out better learning outcomes over traditional teaching methods as the former enables active involvement of participant. The current study aims to evaluate some existing LPS hands-on simulations and check their feasibility in the Indian context and to design an LPS simulation fit for Indian use.

Introduction

The current study is aimed to evaluate the Villego simulation. This evaluation was carried out by running three trial runs of the simulation on three different groups. After running the simulation, the learning outcomes of Villego and the level of understanding of LPS concepts by the participants post-simulation were identified by means of post-simulation discussions and by conducting a test on LPS concepts for the participants.

Need For Study

- To convince people with hierarchical tendencies that bottom-up approach in planning can be much more efficient than the usual centralized planning
- Slide show presentations are not an effective way of teaching LPS
- Simulations allow the participants to test different conditions or courses of action

Objectives

- To evaluate a set of simulation games that are currently being used to teach LPS
- To establish the features of a simulation game for teaching LPS in Indian scenario and to propose a pilot draft of LPS

Methods

- Learning about Villego and LEAPCON (LEan APartment CONstruction) games from the literature and giving an overview of the game containing the following points for each game:
  - What does the game focus on teaching the participants?
  - What does the game simulate?
  - What is the end goal of the game?
  - Is there a tracking mechanism to measure the progress in the game?
  - Is there a game currency (a unit of measure like time, points, money, etc.)?
  - Who is the target audience for the game?
  - What kind of background knowledge is required by the participants before playing the game?
  - Is there any form of reward to the participants?
- Running the game simulation with different groups of students and professionals
- Identifying the learning outcomes of the game by observing the simulations and taking feedback from the participants
- Evaluating Villego game from the data gathered from running the simulation.
- Identifying the requirements of a new simulation game that would be able to teach the Last Planner System effectively to the participants in the Indian context. Suggesting improvements to the existing games based on these requirements.
- Creating a Pilot Draft of a new LPS game that can meet all the identified requirements.

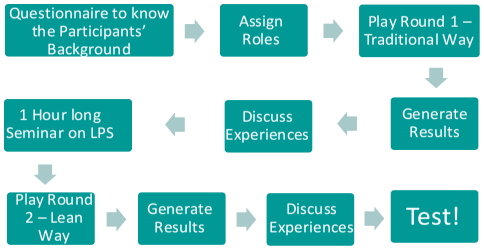
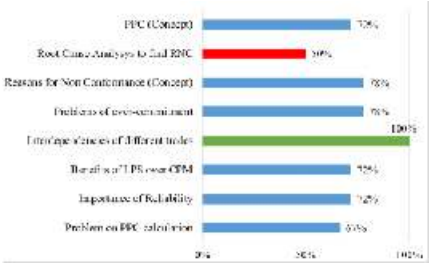


Figure No. 1 - Methodology to Run Villego Simulation

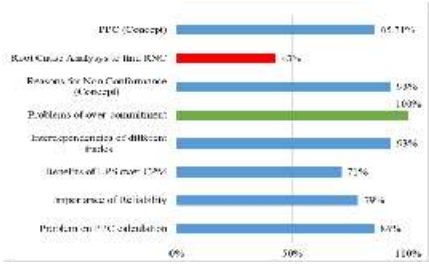
Results

- After the Run 1 and Run 2 of the simulation, the participants were asked to fill a Test on LPS. The test comprised of 8 questions of descriptive type. Each of the questions was aimed to test the understanding of a particular concept of LPS after the game was played. The learning outcomes of the game were identified from the test results.

Results of Run-1 (Original Villego Game)



Results of Run-2 (New LPS based Game)



Discussions

From the trial runs of the games, it was observed that the game is capable of delivering the following concepts: Pull Planning, Identification of RNCs (Reason for Non-Conformance), Importance of work sequencing, good drawings, verifying predecessor's work, reliability, realization that inventory is a waste, Interdependencies of different trades, Problems with over-commitment and working towards one common goal with collaboration.

Conclusions

- The new LPS based game is designed such that the whole simulation can be completed within two hours, unlike Villego that took at least five hours. This makes the game ideal for both university classroom teaching and industrial training.
- The designs are directly adopted from LEAPCON simulation which are much easier to understand and execute. The game has fixed timings and also includes Look-Ahead and Uncertainty elements in the form of Controllable and Uncontrollable Risk Cards.
- The uncertainty elements not only add randomness to the game but also make each of the runs of the simulation different from another. Due to this, the game can be played multiple times with the same participants and each time the participants will encounter a different challenge.
- All of these modifications make this game much more realistic and simpler compared to Villego and also suitable in the Indian context.

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ANALYSIS OF TRACK LINKING IN RAILWAY PROJECTS

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IGLC CHENNAI 2018 International Group for Lean Construction

POST132

Abstract

One of the time-consuming tasks in a railway construction project is the track laying activity. For the timely completion of the project, it is necessary that the track linking activity be completed on time. But in practice, this activities get delayed the most. The aim of the study is to identify the attributes affecting track laying and to suggest a solution for the significant attributes. To validate the qualitative data a triangulation approach was used. Data from project documents, questionnaires were used for this and to get the impact of the factors. The track laying activities were streamlined and the resource flow was also improved using linear scheduling technique with the help of two tools i.e., Microsoft Excel and VICO Control 2009. The solution suggested was found to bring work continuity and helped in taking better proactive steps by forecasting the status of the project. The solution suggested also shows a way to improve shared resource flow across projects to increase its utilization.

Need For Study

- To study the application of lean construction tools in Railway Projects.
- The track linking activities are the most delayed sequence of activities in a railway project, and any delay in this would affect the other set of activities like overhead electrification. Thus increasing the overall project duration.
- So the study aims at analyzing the track linking activities and to find key areas to be focused to make track laying more streamlined.

Objectives

- To analyze the various factors affecting track linking activities in railway projects
- To find a possible solution to the problems and improve the flow of equipment across projects.

Methods

1)Field study
2)Semi structured interviews
3)Analyzing data from current projects
4)Questionnaires
5)Using Lean concepts of LSM to streamline

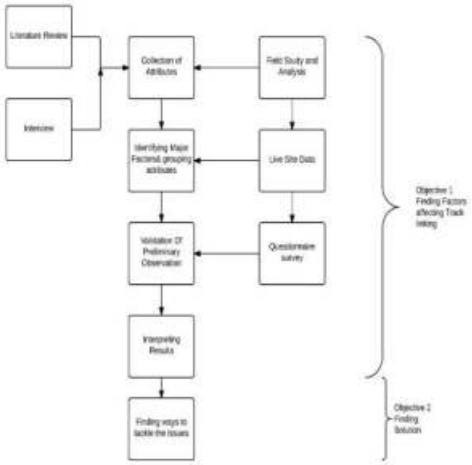

Figure 01- Methodology Flowchart

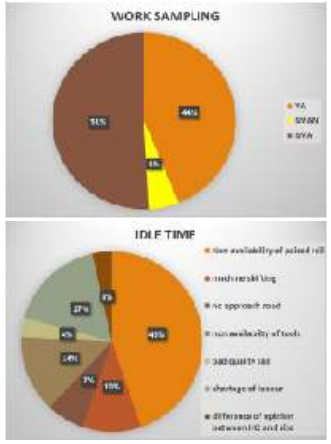

Figure 02- Work sampling results

Results

The attributes from interviews were analyzed based on counts.
To get a proper rank on to those factors, an impact rating should be given.
For this, loss of money incurred per day to the series of activities was considered as an analogue of severity and frequency of these factors.
.
From these various sources it can be concluded that the most important factors are:

- Rail pairing
- Lack of continuous work front
- Delay in bridge works
- Less mechanization
- Access road issues

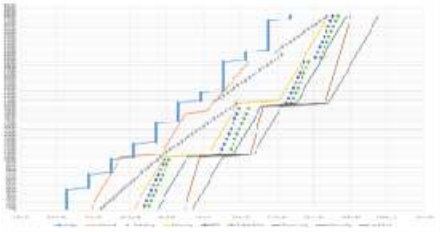

Figure 03- LSM in Excel after class correction

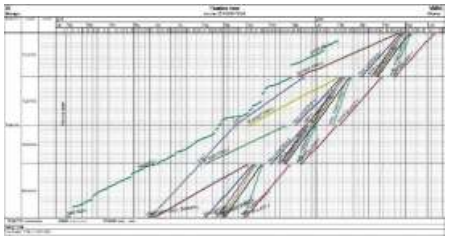

Figure 04- Modelling of Project in VICO CONTROL 2009

Conclusions

1. It was found out from the study that, on an average a project site was losing money equivalent to Rs. 4,88,000 because of the FBW machine being idle.
2. It was observed in the study that by increasing the level of mechanization the there could be cost savings of 5.5%
3. Linear scheduling and coordinated planning helps in making the schedule for the shared resource and thus increasing its utilization.

Future Scope of Work

- This study could be extended by including other packages of the railway project like overhead electrification and signaling and telecommunication.
- Actual field implementation of the solution
- Trying to bring in the functionalities of VICO Control into Microsoft Excel using programming techniques would also be good as it would reduce the reluctance of industry to change, as Excel is already a familiar tool.

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SIMULATION EXERCISE FOR COLLABORATIVE PLANNING SYSTEMS (COLPLASSE)

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POST133

Abstract

The Last Palnner System™ is becoming popular all over the world for project management. A variant, the Collaborative Planning System is being practiced in India but structured templates or simulations are not available in the public domain for common practice. The available tools are somewhat complex and not well amenable for customizing COLPLASSE - COLlaborative PLAnning System Simulation Exercise) has been designed to meet this felt need.

Basics

COLPLASSE is based on simple Excel spreadsheets and uses work plans for developing Look Ahead Plans and Weekly planning over the many weeks required for project completion. It has provisions to simulate random delays due to inclement external environmental conditions or variations in productivity due to various causes. It computes PPC automatically and simultaneously draws continuous charts for PPC and Root Cause Analysis over the Project completion period.

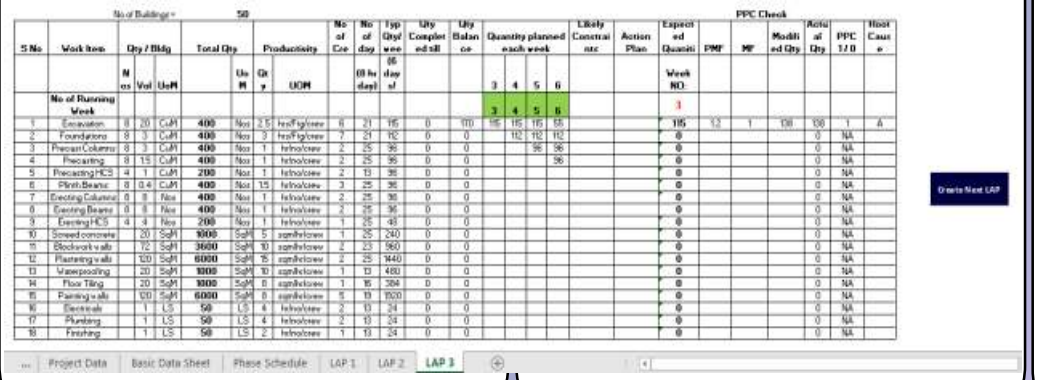
Initial Sheet (Figure.1) contains a list of activities and for each activity the quantities of work to be done, number of crews available, and average productivity. A Period of Inclement Conditions (such as monsoon) can be specified for specific weeks, when productivity of all activities performed in such periods gets reduced. Probabilistically-evolved Productivity Modification Factors can be introduced for each of the work weeks, which increase or decrease the quantity of work performed during that week for the specified activities. Root Causes can be assigned for such reductions in productivity from a library of Causes.

Three spreadsheet systems are there in this tool: Basic Data, Running Plans and Analysis Sheet.

Basic Data contains all required information regarding activities, etc. (Figure. 1). Initially, a Milestone Schedule and Phase Schedules have to be prepared, forming the basis for the LAPs. The Running Plan is a spreadsheet for the Current Week and is also a Look-Ahead Plan (LAP) covering four weeks starting with the Current Week, with all the activities listed along with their original quantities as well as the Balance Quantity as of the beginning of the Current Week. There will be as many Running Plan sheets as the number of work weeks.

Figure No. 1 - Initial Sheet Screenshot

Figure No. 2 – Typical Running Sheet Screenshot

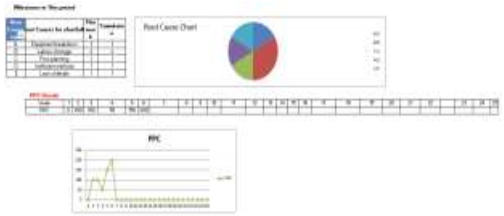


The Final or Analysis Sheet contains summaries- PPCs, Root causes Analyses (Figure. 3), Productivities, etc.

Using COLPLASSE

There are different ways of using COLPLASSE: As a simple planning tool which can be used to trach the early students in the LPS templates; as a group exercise involving 8 to 9 people simulating various responsibilities; running COLPLASSE by an entire class independently and comparing "efficiencies" of various players, as the random number generation system used for Productivity Modification Factors will ensure different results for each player; using COLPLASSE for actual problems at site week after week

Figure No. 3 Automated Graphs – PPC / RCA



Conclusions

This tool has been deliberately kept in a simple form for beginners to use easily and to enable customizing and for further development by the various users. The Tool is available in the Open domain.

An Example problem covering 20 work weeks and 18 activities has been given along with all required basic data. Students and trainees can practice with the example problem to get a good feel of the LPS process. Actual practitioners can also input data from their projects and run COLPLASSE week after week to automate the templates for easy operations.

Limitations: The inherent designed simplicity precludes complex planning exercises. The Excel macros currently built-in are not very advanced but the user can always develop them further in view of the open architecture.

Further research is proposed to be done using this simulation with various groups to evaluate its capabilities for helping nascent practitioners to use LPS.

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A FRAMEWORK TO MANAGE SUPPLY AND LOGISTICS-NET CONSIDERING TAKT TIME IN A HOUSING PROJECT IN GHANA

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IGLC CHENNAI 2018 III International Group for Lean Construction
POST091

Abstract

The current case study was applied in a Housing Project in Ghana considering the takt time planning as a tool to dimension logistics nets. Considering the global supply chain, the portuary aspects and the size of the project a framework for logistics and procurement was developed during in partnership with the Construction Company and a Consultancy Company specialized in Lean Construction

Introduction

This paper is based on using takt time as a planning and management tool for a global supply chain in a Housing Project in Ghana, West Africa. The project is an Engineering, Procurement and Construction Project and comprises running 2000 houses and its infrastructure in a new residential zone around Accra, the countries' main city. The supply process must attempt to a 24 months schedule and link a huge international Supply Chain composed with more than 80% of imported items.

The case study was a partnership between the Construction Company and a Consulting Company focused on Lean Construction and Operational Improvement.

Objectives

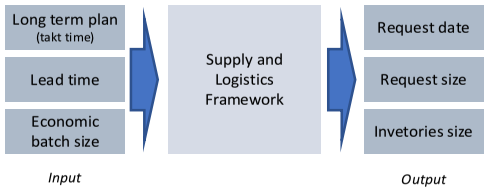
The problem considered the complexity of obtaining the right resources on time, added to the lack of local suppliers and the high diversity of materials. In this scene, the objective of this study consists:

- to develop a framework integrating the supply chain and logistics-net processes with the construction necessity considering the takt time established for the production.
- to develop a tool to dimension logistics inventories along portuary and land crews involved in the supply process.

Methods

The research method consist: (a) to define the takt time for the project; (b) to identify the core activity which define the speed of construction – for this understanding is used the Value Stream Mapping (VSM) and Operator Balance Chart (OBC); (c) to define the long term plan considering takt time to all the activities; (d) to plan the supply forecast for each construction phase and activity considering lead time for delivery, and supply origin; and (d) to analyze the volume of delivery, considering takt time, lead time (production and transportation from supplier to the site) and batch size (containers, NAVIOS E road transportation). In the end, will be drawn a framework for managing supply and logistics to this project considering the demand defined by the takt time. Figure 1 illustrates the inputs and outputs for the designed framework.

Figure No. 1



Results

TAKT TIME AND CRITICAL ACTIVITY

Were identified the time for each house or pavement be delivered to the client. So, was drawn the VSM (Figure 2) and calculated the estimated cycle time for each activity. Thus, using the OBC (Figure 3), was identified that, frames and steel assembly as the bottleneck activity. The speed of this assemble would define the rhythm that all other activities must follow.

A long-term plan was stablished considering the rhythm stablished by structure assemble and the best sequence thought to minimize transportation rate. The long-term plan avoids the starting point to dimension the supply and logistics net.

Figure No. 2

SUPPLY AND LOGISTICS NET FRAMEWORK

Contractors had already identified suppliers with capacity to produce and delivery the amount of materials needed for the project in China, Europe, South America and South Africa. The prices could vary considering the batch size. A spreadsheet using Visual Basic Software was designed to cross the long-term information (demand) with the cycle time (production + transportation) and the more economic batch size. The output was the quantity that should be bought to answer to the production demand, the frequency that the contractors should enter with a request and the size of the order. With size information, the contractors were able to dimension the inventories sites. Figure 3 shows the framework developed.

Discussion

- The described study was developed in the mobilization phase of the Housing Project Ghana and was the tool used to dimension the supply network and the inventories sites that were rented for the contractors.
- Unfortunately, the long-term plan thought in this project phase changed during the execution because of changes in design and in the investment strategy of the contractors.
- Nevertheless, the presented study achieved the main objective and developed a framework that integrated long-term-planning based on takt time with a complex supply chain and logistics-net.
- The repeatability is a positive characteristic of the tool, that were also used in other projects of the main contractor company in other projects with similar supply and logistics complexity.

Figure No. 3

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VALUE STREAM MAPPING OF DESIGN PROCESS

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POST127

TATA REALTY AND INFRASTRUCTURE LTD.

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Abstract

Integrated Design, an approach to design which brings together specializations usually considered separately, is quintessential to a smart design delivery process.

Another fundamental aspect which predominantly decides the quality of project delivery is "Clarity of Design Process". It is essential that the design is divided into clear stages to establish clarity on level of detail.

Further, for effective Project Management it is essential to understand, improve and eliminate waste from various Design Stages.

TRIL and CEPT engaged in a Lean Thinking Approach to understand and identify wastes in TRIL's existing Design Process with a view to smarten and tighten the process.

Introduction

Lean thinking suggests simplification and bringing clarity to processes so as to make them effective and enable future improvements. We used VSM as a lean tool to map current state of design process.

Need For Study:
- Clarity of scope at every design stage.
- Identify most optimum time taken in value adding activities.
- Eliminate Waste.

Objectives:

— Map Non-Value add activities in TRIL's current Design Process.

— To integrate the Design Process and incorporate suggestions for Future Improvements.

Methods

Steps Adopted :

- Listing of Activities.
- Discussion with TRIL Architecture, Design and Services (ADS) team for shortlisting relevant activities.
- Capturing Duration, Milestone Stages and Precedence.
- Identifying non-value add activities and mapping them.
- Alignment of all suggestions for future and mapping onto BIM platform.

Figure No. 1

Figure No. 2

Results

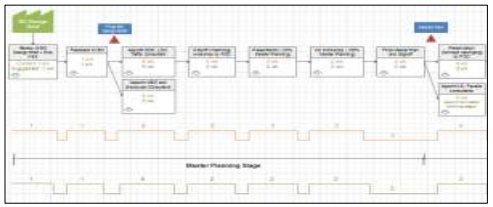
- Stage wise Value Stream Map was developed and reduction in design time was established in current process:

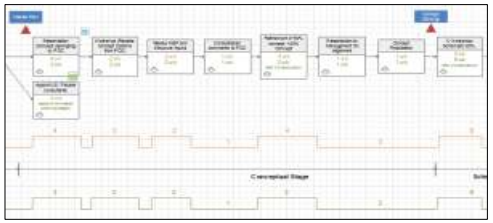
•Figure No. 3 – Master Plan Stage

•Figure No. 4 – Concept Stage

•Figure No. 5 – Detailed Design

(QR Code Link for VSM – Design Process)





- ***Before VSM analysis: 69 Weeks***
- ***After VSM analysis: 64 Weeks***

Conclusions

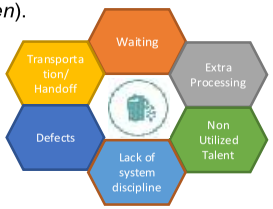
- Value Stream Mapping improves understanding of design process.

- Potential of VSM for waste identification and visual representation has been realized.

- Process Gap Analysis, Bridging Gaps and Alignment of all Stakeholders is essential to enable Collaborative Work Culture and avoid Silo Working.

- With technology intervention (like BIM) the duration for design can further be reduced from current 69 Weeks to 49 weeks, in the long term. Hence, it is recommended that Design Teams adopt new technologies in Design Development at early stages.

- Various areas where waste is generated were captured for continuous improvement (*kaizen*).



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Chennai, India, 16th to 22nd July, 2018

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Venue: Radisson Blu Temple Bay Resort Hotel Complex, Maha-Bali-Puram, Chennai			Venue: IIT Madras, Chennai

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