

ELIMINATION OF WASTES IN CONSTRUCTION: A CASE-STUDY

Dr. Subhash Chandra Rastogi¹

ABSTRACT

One of the most important focuses of Lean is to provide enhanced value to the customer, by eliminating all the wastes. This paper clearly defines the EIGHT WASTES with reference to various type of Building construction. It also mentions the various Lean Tools related to People, Processes, Products and Technologies, which help in eliminating or at least minimizing those eight wastes

A case-study of a multi-storied towers of a world-class hotel-cum-apartments of 1.5 million Sq. Ft. is presented, which focuses on the elimination of Defect/ Snags as the main waste, and the associated additional rework cost and project delay. Although most Constructions companies have their Quality Management System with various certifications of ISO etc., the clients are not generally happy with the quality of the end product. The author has observed that their focus is more on Quality Control, rather than Quality Assurance, especially with the low skilled workmen and site supervision. This paper provides the details of how some of the snags prevention and containment lean tools and best practices, like Historical Statistical Snags analysis, Pareto Analysis, Root-Cause Analysis, 1st Piece mock-up and inspection, inter-trade collaboration & optimizing the sequences of activities saved tens of thousands of USD, and 6 weeks of project delay, giving close to zero-defect product to the client.

KEY WORDS

Lean Digital, Eight Wastes, Lean Tools, Snag Preventer, Change Management

INTRODUCTION

Construction Industry is undergoing metamorphosis globally, and now is the time for India to reimagine its construction strategies. This is specially so because more than one trillion USD is proposed to be invested in this sector in next 6-7 years, which has to be utilized optimally, looking at paucity of capital in the country. Besides these, due to demographic shift, bigger global exposure and globalization in general, customers have also changed a lot in India, on one hand the demand for buildings is growing very fast, on the other hand, customer wants more (quality) for less (cost) due to paucity of funds. The older methods of making profit in Construction Industry

¹Chairman, BT & BT Management Consultancy, Hyderabad – 500 034, India. E-mail: rastogi@btbt.co.in

(through unrealistic land-price increases, channelizing fund of one project to other, and early collection of payments from End Customers/users) are no more workable. Therefore there is no choice with Industry to relook at the way it has been executing the construction projects today.

Most construction projects are getting delayed, getting over-budget, delivering poor quality leading to unhappy customers. In our opinion the top ten reasons are given below:

- Low labor productivity for various reasons
- Poor Planning and many interruptions in the work
- Very high % of efforts on non-value adding activities from Customer' end-users perspective
- Low trust, integrity among the trades
- Management & project Team always busy and no time to improve project performance
- Poor communication and collaboration among trades
- (Too) many Contractors/ Consultants/ Sub-Contractors involved and (unnecessarily) leading to a high level of specialization & division of labor.
- Contract based execution creates several silos of functioning rather working for common goals of the project and its success.
- Measurable and controllable KPIs are not defined for various roles for project success.
- Claims & disputes due to several deviations/ changes / rework during the execution process

In order to drive a positive change and address most of these issues successfully, there is a need for alternative thinking. Doing same thing again and again do not yield better results. New methods, tools, techniques and practices have to be introduced in construction projects to drive positive change. The author recommends to use **Lean Digital™**, a new philosophy which brings alternate project execution and produce positive results. This will integrate the Digital technology to Lean and multiply the benefits of Lean. We have defined the following 12 principles for this.

12 PRINCIPLES OF LEAN DIGITAL™ PHILOSOPHY

1. Enhance CUSTOMER VALUE at an Optimized Cost
2. Emotionally ENGAGE Employees continuously (using social media, mobile, analytics)
3. Design & Deliver SUPERIOR EXPERIENCE to Customers with empathy

4. DIGITALIZE business building blocks
5. Eliminate Eight Project WASTES
6. Identify, Exploit & Remove Business CONSTRAINTS
7. Make Decisions COLLABORATIVELY in REAL TIME
8. Build INTERNAL CUSTOMER attitude among business units
9. Reduce HUMAN INTERVENTIONS in business operations
10. PREDICT business performance, issues in REAL TIME and take Right Decisions at Right time
11. Access information, documents & get the work done from ANYWHERE & ANYTIME
12. Learn, Innovate & Improve business Performance CONTINUOUSLY

The current paper focuses more on the 5th principle listed above, that is elimination of eight project wastes, therefore will focus more on that. Based on our experiences, the following eight wastes have been identified in construction:

EIGHT MOST COMMON WASTES IN CONSTRUCTION

Although, wastes should be related from Customers perspective, because the Value defined by different customers may be different. For some, 'Timing' may be more valuable, while for others 'Cost' may be more important, while for some others the 'Exchange Value' may be of greater importance. Therefore the best way to define the wastes is with reference to the Customer values. However, for this paper, following eight categories are defined, including the Design part of Design-Build Construction projects.

| SR# | TYPE OF WASTE | SOME EXAMPLES of WASTES |
|-----|------------------------------|--|
| 1 | DELAYS | Idle time of staff; waiting for: Work-front; Completion of previous activity, Clarification in Drawing/ RFI; Plans/instructions, Approvals, Materials, right Workmen, Equipment, Tools, Payments; Favorable Weather Conditions; Appropriate Space to work; Any local requirements (like religious) |
| 2 | DEFECTS/ REWORK | Products requiring Inspection, sorting, needing repairs for any snag/ punches/ defects due to poor Quality Work (functional/ aesthetical); any rejected work by client/ scrapped material or labor work, due to whatever reason (including Changes) ; Rejected by Client/ third party etc |
| 3 | INVENTORY | Unnecessary Inventory causing Space cost & working constraints (early delivery; rejected material) at Site/ yard/ warehouse/ WIP; Unused Tools; Unused/ excess material; Packaging & other Material Wastage, Damaged/ poor quality material; |
| 4 | MOTION | Workers' unnecessary movement, Searching for people (co-workers, foremen, Engineer), Hand-Tools, Drawings, equipment from a distant places, both in big campuses and multistoried buildings etc |
| 5 | TRANSPORTATION | Double/ Excess material movements, unnecessary shifting materials; searching for materials, unnecessary moving bulk and heavy material (steel, cement, excavation waste, equipment etc); any transshipments (changing storage places) |
| 6 | OVER-PROCESSING | Any non-value-adding steps like excessive supervision; Frequent design changes/ iterations; over/under-qualified deployment of equipment, leading to rework, defects, duplication of efforts; redundant reporting, multiple approvals/ sign-offs, which adds no value from customer's point of view. |
| 7 | OVER-PRODUCTION | Making more, earlier or faster than is required by next process, Incomplete work, not useful to (internal or external) customers; Ordering too soon; ordering much more than required, constructing something client is not willing to pay for. |
| 8 | UNUTILIZED CAPABILITY | Underutilization of creativity and capability of various Experts/ Project Managers/ Designers/ Foremen/ Workmen |

LEAN DIGITAL™ TOOLS TO ELIMINATE THE WASTES

Various Lean Digital™ Tools that can be used to eliminate these wastes are listed below. Later a case-study is described, where Snags Preventer Tools was used to prevent and contain snags and reduce the cost of rework and delays associated with that.

| S. No | Lean Digital Feature | Illustrative Lean Instruments | Illustrative Digital Instruments |
|-------|------------------------------------|---|--|
| 1 | Waste Eliminator | <ul style="list-style-type: none"> Waste Observation Walks (WOW), Value Stream Maps Standardized Work | Digital Technology Apps based on Mobile, Sensors, Embedded Software, Wearable, Analytics, Social Media.. <ul style="list-style-type: none"> Smart Badges, Smart Helmets for Worker Productivity Tracking Sensor & Mobile based Equipment Tracking Sensor & Mobile based Inventory Monitoring Light & Temperature sensors for Energy Conservation GPS based Trucks & Material tracking Preventive Maintenance of Tools using Sensors & Mobile |
| 2 | Snag Preventer | <ul style="list-style-type: none"> Root Cause Analysis (Pareto, Ishikava diagrams, 5W1H, 5WHYs) Mini Mockups, First Piece Inspection, Self Inspection | Digital Technology Apps based on Mobile, Social and Analytics <ul style="list-style-type: none"> Auto Snag Prediction (based on history data) Auto generation of potential SNAGS for work planning in a week (using SNAG Bank) |
| 3 | Construction ExPress | <ul style="list-style-type: none"> 360 Lean Planner Visual Control Management Structural Problem Solving | <ul style="list-style-type: none"> Social Collaboration Platform Visual Control Management using Mobile & Analytics Auto BOM Estimator based on Architecture (Mobile & Analytics App) Camera Based Work Progress Monitoring |
| 4 | Construction Talent Gardner | <ul style="list-style-type: none"> Leadership Trainings Workmanship Skills Lean Tools, Techniques | <ul style="list-style-type: none"> Digital Learning using Videos, Mobile, Social Media |
| 5 | Work Place Organizer | <ul style="list-style-type: none"> 5S Kaizen | <ul style="list-style-type: none"> Safety Alerts and Reports using Mobile and Sensor technologies Theft Control using Sensors and Mobile Electronic Time Logging |
| 6 | Constructability Enhancer | <ul style="list-style-type: none"> Value Engineering Kaizen | <ul style="list-style-type: none"> Mobile App with Constructability Questionnaire |
| 7 | Cost Controller | <ul style="list-style-type: none"> Target Value Design | <ul style="list-style-type: none"> Cost Control Mobile App integrated with Project Costing system - daily tracking |

THE CASE STUDY

Project Scenario

Valued at more than AED 500 Million, a premium Hotel-cum-apartments twin-towers project with 300 Guest Rooms & 100(2 and 3 bed-rooms) Apartments in Middle-East, was already completed 30 months and was having 36% schedule overrun. Client has allowed only further 6 months extension to complete huge pending work. A large amount of work was incomplete as only about 75% of Civil & MEP works completed and 10% of Interior fit-out works completed. Management wanted to exploit Lean philosophy for next 4 month time, in order to cut further delay & cost by identifying, containing and preventing SNAGS in the remaining phases of project. This was because, more snags and rework due to that could cause further delays in handing over, which was not allowed.

The Problems & Challenges Observed

Initial 3-4 days were spent in visiting the sites, meeting various key internal & external people, including key Contractors in different trades, and also see the 'current state' of working. Following are the key observations in brief:

- **Recurrence of Snags:** Repeated snags in various guest rooms & apartment rooms, but no clear plan to avoid recurrence
- **Focus on higher output:** Most trades were focusing on completing output (e.g., Sq. Mt. of tiling) got getting invoices paid, forgetting the quality requirements & possibility of rework later. This was resulting in low quality productivity due to rework, later and the delays.
- **Silo work environment:** among trades/contractors leading to high snags (lack of dependency analysis and consequent action plan)
- **Blame Game:** No collaborative problem solving, mainly blame game from one trade to other & finger pointing, but not aligned to the overall objective of project
- **Ineffective Sequencing of Work:** No focus on RIGHT sequencing of activities among trades, hence lot of snags & rework
- **Apprehensions** of considering proactive snag identification as an overhead
- **Firefighting & reactive:** Project Director is always busy fire-fighting
- **Skill Gaps:** Shortage of skilled manpower and supervisors
- **Mediocre Supervision:** Supervisors' low understanding to interpret drawings

Lean Solution Implemented

Since the time was very limited, very quickly following solutions were discussed and implemented that started to resolve the challenges listed above.

- **Snag Observation Walks:** Arranged Snag Observation Walks thrice-a-week, with all Trades and resolved many simple problems on the spot and discussed plan of action for handling & preventing other snags
- **Root Cause Analysis:**
 - Conducted Pareto Analysis, to identify top 7 major snags contributing to 70% of the potential extra rework, causing further delay of 40 days
 - Conducted Root-cause Analysis for each of these seven major snags
- **Classified snags** on the basis of: Efforts & cost required to repair/ rework & Business Criticality and created a plan of action
- **Collaborative Problem Solving:**
 - Used 5W1H (What, When, Where, Why, Who and How) for brainstorming among trades to resolve day to day problems
- Conducted two **joint problem-solving workshops** among trades to find best methods of rework for minimizing impact on project cost & delays
- **Mini Mock-ups:** Organized mini-mock-ups for each of the seven snags as per current workmanship to study gaps for improvisation.
- **First Piece Inspection:** Conducted 1st Piece inspection and reviewed workmanship and process, addressing the current gaps. Trained people to avoid recurrence in remaining hotel & apartment rooms
- **Self-Inspection:** Introduced a concept of Self-inspection of Snags by workers + (internal) certification before external consultants inspect
- **Re-Sequencing of Tasks:** Changed sequence of work in collaboration with relevant trades **and** prevented already identified snags in the remaining construction work
- **Policy Changes:**
 - Defined policy for rework (prioritization based on business criticality & efforts to be spent to fix SNAGs)
 - Introduced combination of PUSH-PULL: Reward-Penalty (sharing the rework cost among all, based on who caused and who have to put efforts)
- **Appreciation Certificate** & small gift for team following standard process.
- **Management Attention:** The Seven snags identified in one floor have potential to recur in other rooms of Hotel & Apartment with total of 2000+

snags, needing maximum rework efforts and costs. The rework cost and delay is forecast to bring senior management attention for quick plan of action

- **Daily Stand-up Meeting:** Used Daily Stand-up meetings at site, among trades for ensuring that standard processes are being followed to prevent further snags and rework.
- **Crew-size optimization and multi-tasking:** convincing Helper to do part of mason work for bath-room tiling, with financial incentive. Actually achieved win-win-win for workers, contractor and client.
- **Trained Client's PM/ CM Team :** to carry this exercise further for next 6 repetitive mid-size and small snags, having potential of leading to 4000+ final snags , for prevention & containment

Benefits Delivered By Snags Preventer

- Improved Quality of Product by preventing 40% of 2200 snags and contained another 35% of snags
- Reduced Rework Cost by 200,000 AED, leading to increased profit
- Reduced further delay of 1.3 months by planning rework and preventing further snags
- Tiling Productivity improved by 60%
- Trained Client's team, to save another 800,000 AED in next 3 months by preventing & containing 75% of 4000 future snags
- Lesser conflicts of Contractors / their savings, which was not quantified
- Cost of project's further delay was also not quantified
- Better Customer feedback

CONCLUSIONS

This paper defines the common eight types of Waste with reference to various types of Buildings construction, and recommends a new Lean Digital™ philosophy and tools to resolve most of the problems facing in construction industries. Then it briefs about a multinational case study, where Snags Preventer tool was actually used and benefits delivered to the Client. It is hoped similar interventions will help others also to get the benefits of Lean.

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