A BRIEF STUDY ON VARIOUS PRINCIPLES AND CONCEPTS OF LEAN CONSTRUCTION

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ABSTRACT

Present study deals with the various principles of Lean Construction where the concepts of POKA-YOKE, Visual Management, Just-In-Time, Total Quality Management, Employee Involvement, KAIZEN, KANBAN, 6S, Last Planner System (LPS), Value Stream Mapping are discussed along with their benefits and application in real field. In Lean construction the above-mentioned concepts and ideas play major role in success of many projects.

Keywords: POKA-YOKE, KAIZEN, KANBAN, 6S, Last Planner System (LPS)

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1. INTRODUCTION

1.1. POKA-YOKE

Poka-yoke is a Japanese term that means mistake-proofing. Hence, it is any mechanism in a Lean Manufacturing process which helps an equipment operator avoids mistakes, thus preventing the production of defective products (Schmidt, 2013). They are also known as goof-proofing and fail-safe work methods.

There are large numbers of Poka-Yoke devices used in manufacturing units and they are often called as error proofing devices (Aguinaldo dos Santos, 1999; Ramin Sadri, 2011). They all have same purpose which is the customer should not get any defective products.

Figure 1

Dr. Shigeo Shingo from Japan has defined three methods used for zero defect quality control. At least one method out of the three is used today out of all Poka-Yokes in the industry. Hence, they are as follows (Ramin Sadri, 2011):

- In the first method “**Self Checks or Contact Method**”, the products physical appearance is tested by checking its shape, color, size and other characteristics.
- The second method is called “**Fixed Value or Constant number**” which signals the operator of the machine if there is any perfection needed.
- The Third method is called “**Motion Step or Sequence**”, the last step in an industry production is read and checked properly, whether, earlier step is done properly or not.

BENEFITS: (Blogpost, 2010)

- Improve quality and minimize errors
- Decreased set-up times with associated reduction in production time and improved production capacity
- Safety increase
- Cost reduction
- Less skill required
- Flexibility in production increased

EXAMPLE: (Ramin Sadri, 2011)

The figure below shows the Poka-Yoke process. Figure (A) and (B) shows the same work done by two different methods. In Figure (B), worker B is released and made available to do other work, where worker A can do the whole crane work by himself.

Figure 2 Poka Yoke Process in Construction

2. VISUAL MANAGEMENT

Due to complex technology and innovation in industry, sometimes heaps of information is gathered from the machines. It makes work difficult and confusing. To make it simple and easy for the, some of the organisations are using some simple and effective tool to filter the information flow for daily work trades (Algan Tezel, 2010). This effort is generally called Visual Management (VM).

Figure 3 Visual Workplace (Algan Tezel, 2010)

Hence, Visual Management can be defined as system for managing performance in the industry by proper organization, goal, core value and culture with other system of management, process of work and stakeholders, by means of which it directly address one of the five human senses. When lean community practice it for greater or lesser degrees of effectiveness, it is called lean Visual management. Visual Management is well accepted in Japan basically in the form of visual display, card (Kanban), notice board, etc. One of the best ways of visual management is by using colour in each step, which helps to identify the particular job (Agency, 2010).

BENEFITS: (Gong Dejun, 2011)

- Improvement in communication.
- All workers in the industries are provided with same image.
- It promotes teamwork and confidence.
- All workers can put their own thought in a forum.
- It helps to identify and solve any industrial problem.
- Easy to focus and establish goals.

EXAMPLE

Using visual management in construction industries is not a new concept. The Visual management in an organisation started around 4500 years back with “The Egyptian Royal Cubit” (Algan Tezel, 2010), a visual measuring standard on construction sites. For small work on construction site, you will only need one Visual management system. Where, the supervisor will be responsible for enabling Stand-up Meetings and writing progress to senior administration on a steady and on-going basis.

3. JUST-IN-TIME

It is strategy which a company employs to increase the efficiency of production and decrease the waste by receiving goods only when they are needed. It is basically done to reduce the account cost. Therefore, the materials just arrive before they are needed for operation. In short, the Just-in-Time account system emphasis on “the right material, at the right time, at the right place, and in the exact amount” (M. W. Iris D. Tommelein, 1999).

Figure 4 JIT Framework for the Prefabrication Industry

BENEFITS: (G. S. Low Sui Pheng, 2011)

- Improve the competitive environment of the firms by meeting client's requirement.
- Advance the excellence of construction materials and its components.
- Enhance the productivity.
- Reduction of cost in terms of list of items needed.
- Helps the production to go in advance of schedule time.
- Improve the cleanliness of construction locations.

EXAMPLE

On good example of a project in Singapore, where JIT was used by receiving and installing precast concrete product and other related products on site. The benefit was the reduction of storage space on site, where there was less storage available. Therefore, the contractors met the specified JIT delivery needs on time (A. E. Y. L. Iris D. Tommelein, 1999).

4. TOTAL QUALITY MANAGEMENT

Total Quality Management (TQM) is a working business technique previously started in Japan and recently used in United States, it is a complete and planned method for structural management which seeks to recover the quality of goods and facilities through on-going alterations in response to nonstop feedback (David Arditi, 1997). TQM requirements may be defined separately for a particular organization or may be in devotion to accepted standards, like the International Organization for Standardization's ISO 9000 series (J. A. T. Low Sui Pheng, 2004).

Figure 5 Total Quality Management during construction process

BENEFITS: (David Arditi, 1997)

- The number of defects in the industry is reduced.
- There is a ease of problem solving because of TQM. Failure analysis and defects can be analysed and addressed.

- There is continuous improvement of processes and products, also improves people and machine efficiency.
- It hints to quality produces, which promotes customer satisfaction.
- Finally, it reduces cost and increase savings by less maintenance on machines.

Fulfilment of proper level of quality product in the construction industry has been a problem. A huge amount of time and money is spent on both human and material, are missed because of unproductive quality management procedure. All these problems are accomplished by Total Quality Management, an example in construction sector is shown below (Agha).

EXAMPLE

From Personal experience, In Ready Mix Concrete (RMC) plant, the quality is the most important factor as it should quality the strength test required for construction process. Hence, total quality management procedures are applied in the firm, to get “do it right the first time” application. For this, proper planning, training and awareness about the quality is given which changed their attitude in work. Also, proper meeting is generated to follow the proper work to get the maximum quality assurance.

5. EMPLOYEE INVOLVEMENT

The organisation believes that every employee is a unique human being and not just a machine working in the firm. Each employee is involved in its effort to run the organisation, which impact on their decision and actions, to establish its objective (Heathfield, 2013). Hence, it can be defined as “*The direct participation of staff to help an organization fulfil its mission and meet its objectives by applying their own ideas, expertise, and efforts towards solving problems and making decisions*” (Apostolou, 2000) Therefore, each employee is value by its management and hence believes that they are involved in running the business. Employee involvement can also be defined by regular participation of employees in;

- Daily work progress.
- Making improvement suggestions.
- Proper planning and setting of goals, etc.

Figure 6

Hence, Employee involvement is a distinct practice (Hongyi Sun, 2000).

BENEFITS: (Owen E. Richason IV, 2013)

- Improved confidence - Employees make improved decisions using their skilled knowledge of the process
- More productivity - Employees have an increased commitment to unit goals because they are involved

- Healthier co-worker relationships - Employee involvement reduces labour/management friction by cheering more effective communication and cooperation
- Creative thinking- Employee involvement increases morale by creating feeling of belonging to the organization

EXAMPLE

One practical example of Employee involvement was noticed in a construction firm in India, was the implementation of “Suggestion system”. They are very useful as employees have some ideas that can help improve work methods and reduce hazards, like new ideas in health and safety to reduce hazards, etc. Sometimes, these ideas get lost because there is no effective way to present them. Therefore, a well-organized suggestion system is placed to put everyone’s idea and can be reviewed by majors.

6. KAIZEN

Kaizen, the name came from Japan, which means ‘continuous improvement’ or ‘change for better’ (AKS-Labs, 2012). It literally means good change or change way to better. Kaizen is about many small changes for the better overtime. It helps the company to improve internally. In a specific company, continuous improvement or Kaizen is not done by the management to the employees but it is done by the employees. Hence, it can be implemented by giving the employees proper tools and blame free environment needed to make nonstop improvement happen. So that employees can able to identify the problems and bring it to the surface, so that they can be solved. So when we are solving problems, we are improving. Problems are the thing which often gets into the companies target, providing defective things to the customer (Styhre, 2001). Therefore, the Kaizen based companies generally find work easier and enjoyable.

KAIZEN = CONTINUOUS IMPROVEMENT

BENEFITS: (Cheser, 1998)

- Better productivity, excellence, better security, quicker transport, and great client satisfaction.
- Kaizen decreases wastes in areas like employee aids, transport, over production, etc.
- It improves product volume, public services, and space consumption and employee preservation.
- It provides instant results.
- Kaizen involves every employee in process of change.

Figure 7

EXAMPLE

In construction industry, the stakeholder in a construction projects are benefited the most from Kaizen. Also, external stakeholders like vendors, customers, etc. are benefited. Hence, using Kaizen idea assures the shareholder that their investment returns would be maximum through improved business process and eliminate wastes in construction sector.

7. KANBAN

Kanban is a Japanese word that literally means “Sign” or “Sign board”. It is a tool of just-in-time system and refers to the visual signals that authorise the production of movements or items in an industry (Roberto Arbulu, 2004). It sometimes refers to the nervous system of lean production system. Just like our human brain send instructions to our various body parts, a Kanban system gives production control instructions to each and every work area. It does it by connecting information flow by material flow by Kanban cards to actual goods. It was developed by “Taiichi Ohno” from Toyota to make the vision of “Just-in-time” manufacturing on production floor .

Kanban goal is to create “one piece flow” in a production factory;

One Piece Flow

Figure 8

BENEFITS: (Berkley, 1992)

- Kanban sets limits
- It also physically link material and information flow through a card like a bar code scan
- Makes abnormalities noticeable

TYPES: (Roberto Arbulu, 2004)

2-Card System

Example: In Supermarket, the shaded portion needs to be refilled (Item missing).

Figure 9

I-Card System

Example: Mail Box Flag; when the flag is up, something inside to be mailed.

Figure 10

2-Bin System

Example: 2 bins are prepared in case one is finished but the other is ready to be used before all parts are consumed.

Figure 11

EXAMPLE

Material management is a crucial part in construction management. Hence, application of Kanban has been very useful in supply and management of construction materials.

One good example given during the supply of construction material like “Bricks”, where special Kanban stickers with all details are specified, signal and pull the materials from preferred suppliers to sites on a Just-in-time basis.

From Supplier	To Construction Site
Product Description Bricks	
Location 1C4-1	SKU N° 03015322
Kanban Signal Bin or Card	Kanban Qty 100

8. 6S

6S is a process for maintaining and creating a controlled, clean and high performance work place, which serves as a basis for non-stop development activities (Corporation). It provides a

precise location for everything and removes anything which is not required. It implants quality into the workforce.

Earlier 5S was started by Japanese company but later 6th S (Safety) was added by some US company.

ELEMENTS: (Womack, 2007)

- **Safety** – it is the number 1 priority in all processes.
- **Sort** – distinguishing between the important and unimportant.
- **Set in Order** – all items are organised to use properly.
- **Shine** – Equipment, floor and furniture are cleaned to keep the shine.
- **Standardize** - Sustaining and refining the morals of the first three S's.
- **Sustain** – maintaining the whole 6s procedure.

6S Wheel

Figure 12

BENEFITS: (Coorporation, 2012)

- Safer work environment.
- More satisfying jobs.
- More pleasant workplace.
- Higher quality of goods.
- Low cost.
- Greater consumer satisfaction.

EXAMPLE

In construction, there is complete chaos of all the work going on site because of absence of safety, unsorted resources, low standard work, etc. As a result, there have been delays and accidents on site. Application of 6S is very useful in construction industry. Because of this, the site is much safer to work and workers are happier to work in a pleasant environment, which result in higher productivity. Like application of 6S concrete production

Figure 13

9. LAST PLANNER SYSTEM (LPS)

The Last Planner System (LPS) is a manufacture control and assurance management system for projects. LPS is the process that helps to start lean implementation in the projects. It also creates a collaborative environment and creates a collaborative plan with the input of the workers (last planners). It helps to share the risk among all participants of the project and reduce the execution time of the project (consulting, 2013).

LPS Gives the company strategic advice in the construction business, because it helps to change the way of project approach (traditional to collaborative). It also helps the organization to engage with other foreign organisations to explore new opportunities for more work (Patel, 2011).

BENEFITS: (Patel, 2011)

- LPS helps to establish a solid leadership in the construction business by providing different approach to the project.
- It helps to obtain the best use of your resources by giving stable plan.
- Increases safety at the job site.
- Reduces operational cost.

EXAMPLE

The table summarise the general details about the project from “Last planner system” (Fazenda, 2008). There are many subcontractor for diverse projects. Different contractor works according to different contractor classification.

Table 1 Description of studied project (Fazenda, 2008)

Project	Contract	Duration	% time elapsed when LPS starts	Subcontractors	Organisation classification
(1) Faculty of Business and administrative sciences	\$21Million	17 Months	50%	Electrical	Class 1
(2) General classrooms and Laboratories	\$10 Million	17 Months	50%	Structural Architectural Mechanical Electrical	Class 2

Figure 14 LPS implementation strategy in the studied project (Fazenda, 2008)

9. VALUE STREAM MAPPING (VSM)

VSM is a planning activity which involves selecting a value stream. The value stream is a set of all actions necessary to bring a product or service to a customer (Cequea, 2013). Mapping of group of products and services, which have similar processing, can be done. Example; if you had a set of products, then you might call a product family. Hence, you can map these on a value stream map. Therefore, It is an unusual kind of flow chart that uses signs known as "the language of Lean" to portray and progress the flow of account and information. Thus, this can be done by getting the functional team of the company together and a leader that can manage the implementation of the future state. After selecting a team, current state mapping process is done, there after the team put on lean principal to create future state with less waste. It show higher productivity, Lead time and better quality (Nielsen, 2008).

Purpose: to create minimum waste in Design (concept to customer), Build (order to delivery) and Sustain (in-use through life cycle to service).

Value stream analysis:

Figure 15

BENEFITS

- Gives you a great overall picture of the process
- It helps portray the process from the start of the production process to the end
- It's an inexpensive tool – all you need is a paper and pen!
- Value Stream Mapping helps identify waste
- It's not just for manufacturing! Value stream mapping has been used in workplaces, service trades healthcare, etc.
- Makes it easy to make improvements to your business

EXAMPLE

One example from a construction product manufacturing unit is show in the figure below. The figure shows the visual system mapping of the production unit, with daily checking of each item to the flow towards construction site.

Figure 16 Visual Stream Mapping in construction product manufacturing unit

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