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## Analysing Hidden Lean Practices in Construction: An Eastern Cape Study

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### ABSTRACT

#### Purpose

The study investigated the influence of hidden lean practice in the construction industry to develop methods, which can be used to lead lean practice in the South African construction industry. Lean practice is described as a production system used to minimize waste of materials, time, and effort to produce the maximum possible amount of value to benefit the client and other stakeholders.

#### Research Method

The qualitative research approach (phenomenology) was used in the study with the aim of understanding how lean could improve the conventional construction practice in a region where performance improvement is most needed. A semi-structured interview approach was adopted, and the collected textual data were analysed to produce the findings of the study.

#### Findings

The results show that Lean practices are not well known by the participants, and by extension by the companies where they current work. However, upon reflection of what lean practices represent, the participants elucidated if they apply the practices on projects, waste would be minimized, and more value would accrue to their clients.

#### Limitations

There are, however two limitations observed. One, the phenomenology study does not lean itself to statistical generalization, and two, the application of known lean tools was not assessed by the participants in practice.

#### Implementations

This study nevertheless provides insights into how to improve the construction practice regarding performance improvement through the adoption of lean practices.

## **Response to the Conference Theme**

Construction Management

### **Keyword**

**Clients, Construction, Lean, Practice, Waste**

## **1. INTRODUCTION**

Construction projects are executed by the project team (project consultants and contractor) on behalf of the clients. However, construction managers are experiencing challenges, which require emergent knowledge, skills, and experience to overcome. The construction industry is a very competitive environment, and new knowledges are developed to encourage construction managers to improve the delivery of projects. However, Filho, Heineck, and Costa (2016) argued that it is important to understand the effectiveness of construction methods and to recognise the distinction between complex and complicated aspects of projects. The admonition from Filho et al. (2016) is premised on the idea that majority of projects are designed through modern engineering design, which is complex and complicated enough to incline managers to produce poor project delivery service for the clients (Kalsaas, Bonnier, and Ose, 2016). Furthermore, the study by Koskela (2000) argued that poor performance is often experienced in developing countries due to low productivity, insufficient quality, tremendous waste (both physical and process waste), and poor working conditions. The problem addressed in this research is that a lack of lean practice influences the delivery performance of projects in South Africa negatively. Although the adoption of lean practice in the developed countries such as the United States of America (USA) has been the revolution to the construction industry, it is surprising that contractors in the developing countries such as South Africa are still shy from implementing lean practice. The dilemma encountered by construction managers can, however, be improved through the adoption of the Toyota Production System (TPS) that is otherwise known as lean practice.

The TPS is benchmarked by two pillars: continues improvement, and respect for people (Korb, 2016). The application of TPS has helped the Japanese manufacturing industry to revive from the effect of World War II. During the implementation of TPS, the Japanese company called Toyota Corporation had a slogan, describing the two pillars of TPS "*We make people before we make cars*" points to a philosophy that should be emulated in construction (Korb, 2016). The slogan implies that the formula to achieve 'lean' is for the employer to have a constant relationship with workers and its supply chain (Korb, 2016). The construction managers should create a healthy working environment that motivates and support construction workers and the organization to promote the type of efficiency advocated by lean construction (Forbes, and Ahmed, 2011). Therefore, it is

necessary for researchers to undertake studies relating to lean practice to assess opportunities in South African construction. This paper thus aims to highlight lean practices that could be driven by 'people' in construction when conventional practices provide platforms for changes that produce higher productivity in a firm.

## 2. LEAN CONSTRUCTION PRACTICE

Lean practice can be described as the management system developed at the Toyota Corporation (Korb, 2016). Lean practice was developed in the early 1950's by Toyota engineer, '*Taiichi Ohno*', with the purpose of finding alternatives methods to convert material waste into value while transforming craft production to mass production (Sarhan and Fox, 2013). It is necessary to recognise that Ohno's improvement of Toyota's production process was not necessarily a new technology, but rather the result of involving all existing knowledge in a new philosophy of avoiding waste of any type (Forbes, and Ahmed, 2011). Technically lean practice was designed to reduce waste while adding value in the automotive production industries, but researchers such as Koskela introduced this tool to the construction industry (Forbes, and Ahmed, 2011)

Lean practice in construction is described as a philosophical approach designed to complete complex and modest projects to clients' satisfaction (Howell, 1999). Forbes and Ahmed (2011) described lean as a production system which aims to minimize waste of materials, time, and effort to produce the maximum possible amount of value of the projects. Lean practice is based on the model of lean thinking and lean principles, which are adopted from the TPS to add value to the method of managing construction project (Al-Aomar, 2012). However, it is important to acknowledge that lean practice is grounded on lean thinking which focuses on how the project value is created rather than how the activities are being managed (Howell and Ballard, 1998). To enhance the value created for clients, Howell (2011) identified eight types of waste which are common in the construction industry. The waste types include; transportation, inventory, motion, waiting, overproduction, and over-processing, defects, and skills misuse.

In South Africa, Emuze and Ungerer (2014) argued that lean construction should be established in the minds of the clients, contractors, workers and all stakeholders for a better acceptance and implementation of projects. The suggestion by Emuze and Ungerer (2014) is the idea that it is the responsibility of the lean practitioner to identify and inform the clients about the importance, opportunity, and benefits of lean awareness and enlightenment campaigns within the construction industry (Suresh, Bashir, and Olomolaiye, 2012). Lean practice can be introduced in several ways. An example includes adopting lean thinking process which helps the lean

practitioner to manage the project based on the project principles and techniques (Forbes and Ahmed, 2011).

### **2.1. Lean practice concepts**

This study was limited to six different types of lean concepts that affect the performance of projects. The six lean practice concepts include value stream mapping, lean principles, lean project delivery systems, last planner system, just-in-time, transformation flow value.

#### *Value Stream Mapping (VSM)*

The VSM is a lean practice tool, which examines the strength gained by providing vision and plan that connect all improvement activities together. The application of VSM allows lean practitioners to evaluate and eliminate waste in the construction process. The purpose of VSM is to provide optimum value to the clients through a complete value creation process with minimum waste in design (concept to the customer), build (order to delivery), and sustain (in-use through life cycle to service) (Rother and Shook, 2009).

#### *Lean Principles*

The application of lean principles is defined by Womack and Jones (2003), through the five principles of lean production. The five lean principles are highlighted in Figure 1 as termed by Forbes and Ahmed (2011):

- Value: The procedures to identify and describes the actual worth of the project required by the clients.
- Value stream: Is the procedures to determine the value stream of each product and expose waste, while facilitating its elimination, establishing cooperation between participants and stakeholder's results in the lean process.
- Flow: Is the principles of producing a value of the project while creating procedures to be followed.
- Pull: Represents the procedures which should be engaged by the lean practitioner in keeping a good relationship with the clients and the community and meeting their demands.
- Perfection: Represents methods of construction, which should be adopted by lean practitioners to produce and deliver a project of high standards and high quality without bad publicity and destroying the client's repetitions.

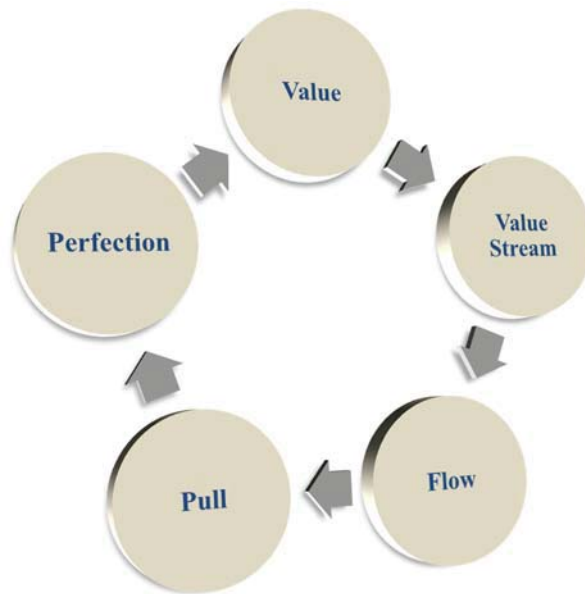


Figure 1: The five basic lean principles (Adapted from Rother and Shook, 2009).

#### *Lean project delivery system (LPDS)*

The LPDS is the lean tool, which defines the role of the project implementation team in that they are not responsible for putting the need of the clients first before the need of the project. It is important for the project delivery team to understand what the customer needs and what the project entails in the community (Womack and Jones, 2003). This process changes all the variables: ends, means, and constraints. Forbes and Ahmed (2011) listed the LPDS phases as follow:

- Define the project.
- Define lean practice for the project.
- Design lean practice for the project.
- Connect the supply chain process.
- Assemble or construct the project to the client's requirement.

### *Last planner system (LPS)*

Mossman (2009) defined the last planner as a system for collaboratively managing the network of relationships and conversations required for programme coordination, production planning, and project delivery. The LPS uses lean practices to provide improved project control. The last planner is in the best position to match labour and material resources to accomplish assignments in response to downstream demand. Work planning may establish time frame but is not very effective in establishing that the tasks assigned are capable of completion (Hamzeh, Ballard, and Tommelein, 2012). The LPS originally was designed to address shortcomings of the critical path method, specifically, task continuity that was never addressed in the project schedule planning (Dave, Hämäläinen, Kemmer, Koskela, and Koskenvesa, 2015). The LPS is grounded on four levels of schedules and planning which include the master pull schedule, the look-ahead schedule, the weekly work plan, and a daily plan.

### *Just in time (JIT)*

Forbes and Ahmed, (2011) described Just-in-Time (JIT) as a method, which allows a minimum number of units or items to be produced using fewer quantities of materials in an appropriate period to reduce waste and improve quality. The JIT method attempts to smooth the flow of materials from the suppliers to the customers (supply chain process), thereby increasing the speed of the production process. It could also change the production system gradually rather than a drastic change (Koskela, 2000).

### *Transformation, flow and value (TFV)*

Koskela formulated the TFV theory of production to improve performance when applied in construction. The TFV exposes the need to evaluate construction production as a combination of conversion and flow process to remove waste. It is recommended that for achieving an internal position among other theories, two different understandings should be clear which are the 'thing'-based theory of TFV and the process-based theory of TFV (Miron, Kaushik, and Koskela, 2015). Koskela differentiates the term transformation, flow, and value through the term 'world views'. The Transformation view focuses on the actual problems relating to adding value to the activities; the flow view focuses on improving the value adding activity by reducing non-value adding activity; and value view focuses on the interest of the customer by improving value for the customer (Senior, and Nafe, 2016).

### 3. METHODOLOGY

The research study adopted qualitative research method. Thorne (2016) described qualitative research as the exploratory research where researchers are using it to gain an understanding of the underlying reasons, opinions, and motivations of the problem they are trying to solve. The problem of this study was grounded on the fact that the construction professions in South African construction are failing to adopt lean practice during the design and construction of projects. The aims of this study were to identify the impact of hidden lean practices in construction. The scope of this study was limited in the Eastern Cape Province.

A semi-structured interview guided the procedures for designing the methodology and for collecting the study data. The interviewees (participants) were selected based on their roles in their respective firms, and only participants involved in the project decision-making and management position were interviewed. The data were collected through In-depth interviews with project consultants (civil engineers and quantity surveyors) and contractors. Purposive sampling technique was used to select the member of the project consultants and contractor's team as recommended by Ritchie, Lewis, Nicholls, and Ormston, (2013). Purposive sampling technique is a type of non-probability sampling that is most effective when one needs to study a certain cultural domain with experts (Tongco, 2007).

The research data were collected between September and October 2016. The sample of this study resulted to 16 (9 contractors, 4 civil engineers, and 3 quantity surveyors) out of 20 participants who were proposed to be interviewed by the researcher. The demographic of this study shows that 56% (9 out of 16) were the member of the contractors, while 25% (4 out of 16) were the member of the civil engineers, and 19% (3 out of 16) were member of the quantity surveyors. The data were analysed by focussing on the research questions and eliminating responses, which did not answer the research questions.

### 4. FINDINGS AND DISCUSSION

This study was focussed on the central research question "*what are the hidden lean practices in the Eastern Cape construction industry?*" which guided 16 interviews. The interview procedures were unstructured so that the participants could express their knowledge and experience while answering each question. At the start of each interview, a detailed description of lean construction was introduced to the participants through aided presentation of five slides. The following sub-questions are used to present the analysed data of this study and to answer the central research question.

*Question 1: Which construction delivery method did you use for your project?*

This question focussed on the construction methods which were used by the participants to manage their project. The findings show that the majority of participants used traditional methods 'design-build concept' in their projects. The response from one of the participants was as follow:

*"I follow the programme planning and instruct my foreman to carry out the construction according to the drawing plans and specifications as instructed by the engineers."*

A participant from the consulting engineers said that his responsibility is to design and make sure that the contractor follows his instruction and he is not concerned about the method of construction used by the contractor; he is concerned about construction production. Furthermore, some participants from the contractors explained that they design a programme planning for their project during the tendering stage and should they be awarded the project, they would then update the programme after the appointment letter has been issued by the clients. The programme planning helps the contractors to carry out the project according to the designed project period. A participant from the quantity surveying firm stated that it is the responsibility of the construction team to define the methods, which they are going to use after the client had issued an appointment letter for them because the correct methods will help the contractor to deliver the project and meet the client needs without disputes. Another quantity surveyor explained that majority of small and medium-sized contractors pay little attention to material supply on site and they end up increasing the period of the project due to this negligence. The participants emphasized that small and medium sized contractors often fail to negotiate and communicate with the material suppliers concerning payment of their accounts and the delivery schedule of materials to the site. These problems often force material suppliers to fail to honour their agreement regarding the delivery schedule of materials to the site.

*Question 2: Identify the construction activities which are lean related*

This question focused on how the construction activities are executed on site and whether they are lean related. The findings show that majority of the interviewed participants are not familiar with the term lean practice. Few participants from the contractor's team explained that the construction activities are determined in the programme planning, and the construction activities are revised and updated on a monthly basis. Furthermore, the participants explained that they are providing training for the construction workers (unskilled labours) with the aim of sharing knowledge and improving their work services. The unskilled labours are taught how to make a critical decision regarding bricklaying, casting of the concrete,



installation of plumbing, and how to reduce wastage of materials on site. The participants further explained that they never worry about the method of construction, and their company will start to adopt the lean practice to improve their methods of managing the project. The participants from the civil engineer's firm explained the importance of lean practice and expressed that the member of the contractor's team should adopt lean and reduce waste (especially waiting period) while adding value to the projects. Furthermore, the contractor's participant explained the situation they once had; they were advised to change the design of the roof truss from using timber to use steel due to high maintenance of the timber roof truss. The participant's responses are as follow:

*“Even though steel roof truss is more expensive than timber truss but it is more durable and cost less on maintenance when compared to timber truss, which should be replaced after few years.”*

*Questions 3: What are the impacts of lean related activities on projects?*

This question focused on the impact of lean related on the project and how the lean practice can be introduced to the project team. The participants explained that lean practice should be introduced to the project team during the design to the execution of the project by both the project consultants and the contractor to improve the project performance. The participants from the contractor's team explained that lean practice should be introduced to the construction workers because they are handling activities leading to major material wastage on site. The participants further explained that communication between the construction workers and the construction leader should be improved. In most cases, the construction workers are restricted from expressing their opinion on the site. However, the participants from the consultants disagreed with other participants on how to introduce lean practice by saying:

*“The client will be compelled to pay the contractor for training the construction workers. Lean practice will just be a waste of money; the client does not have capital to train people to understand how to minimize waste and add value to the project. The current traditional method is working successfully even though it has its weakness; there are no methods which are perfect in the construction industry.”*

#### 4.1. Discussion

The Last Planner System (LPS) is a Lean tool designed to improve the performance of the project relating to programme planning by redesigning the production units, grouping activities per location and similarity of the tasks (Murguia, Brioso, and Pimentel, 2016). The findings show that it is standard practice for the construction team to develop the programme planning of the project. It would be an advantage for the construction team to adopt LPS and utilise it fully to improve their performance relating to revising and updating of the construction activities per their location and resemblance. This will help the construction manager to improve the construction period, reduces waste, and to establish the suitable team per task. The success of the Toyota philosophy of minimising waste while adding value to the production has inspired other industries to adopt this method, predominantly into the construction industry. Young, Hosseini, and Lædre, (2016) cited Howell (1999) who differentiate lean construction from traditional practice. In particular, lean construction:

- has a clear set of objectives for the delivery process;
- is aimed at maximising performance for the customer at the project level;
- designs concurrently product and process, and
- Applies production control throughout the life of the project.

The findings show that majority of the participants are relying on the traditional method. It would be in the best interest to differentiate traditional method from lean practice, to eliminate waste, meet the client's requirements, and add value to the project, while pursuing perfection. It can be concluded that the application of lean practice is not well used in South African construction. Therefore, Figure 2 constitute a proposal from an endeavour to introduce lean practice to South African construction. The diagram shows that training between the construction employers and employees is very important. It is advisable for the construction companies to invest in training to teach people working in construction the application of lean practices. Lean practices should be communicated during the design stage by the project consultants, and thereafter should be communicated by the contractors during the construction stage. The Lean training between the construction workers and the management would be addressed through open communication to accommodate everyone in a training. Appropriate lean training and open communication would lead to continuous working relationship on the construction site. Therefore, it is necessary to understand the importance of lean practice; the lean guideline would be the pillar of supporting the training, communications, and continuous working relationship for the lean practices.

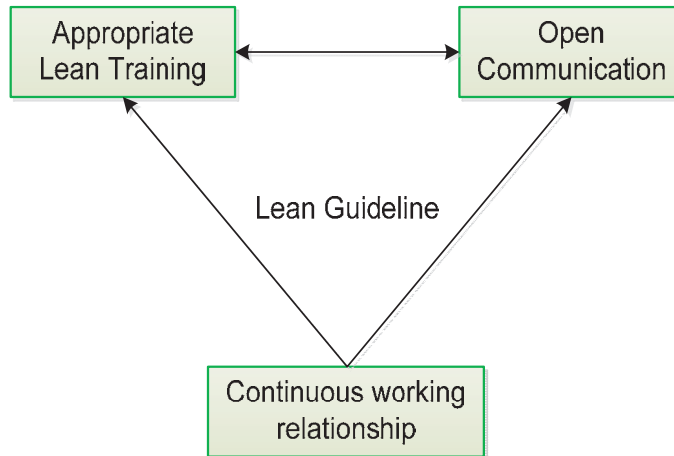


Figure 2: Lean Practice Guideline

## 5. CONCLUSIONS

This paper presented an outline of the common lean practice defined to improve the construction manager's decisions when managing the construction project. Lean practice is designed to improve the management of a project by minimizing waste to maximize value. The initial findings support the notion that it is the time the construction managers to adopt lean practice by using some of the concepts emphasized in this paper to improve planning and construction. It is important to report that a single lean practice was not discovered in the interviews. The non-discovery of a single lean practice implies that there is no 'hidden' lean practice in South Africa construction. In essence, construction managers together with the construction workers should be introduced to lean practice so that they can produce and deliver projects, which minimize delays and waste in construction. The project consultants should also adopt lean practice during the design stage; the project design (drawing plans and specifications) should allow contractors to carry out the project in a manner which would minimize waste and add value to the clients. The working relationship between the contractor and material suppliers should be technical adequate and transparent. The Lean practice can be adopted to improve the communication and create continues relationship between the contractor and material supplier. Lean researchers have developed a lean practice as described in the literature to help the construction members to reach the construction goals while adding value to their clients, and improving service to the customers. Therefore, the lean practice guideline is an attempt to close this bride of hidden lean practice in South African construction. This research established some of the advantages that lean construction practice can bring to improve the management of the

construction project and to reduce waste and construction period on site while adding value without reducing the project standard.

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