

LEAN OPPORTUNITY ASSESSMENT OF CONTRACTORS' SUPPLY CHAIN IN SOUTH AFRICA

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Abstract: Although lean construction is now widely known and practiced by contractors in the developed world, contractors in developing countries such as South Africa are either unaware of it or just beginning its implementation. However, the application of lean construction practices is reported to occur with a gap between training/teaching and the actual reality of a company. To bridge this gap, a lean opportunity assessment (LOA) is usually used as a start. This paper is about LOA that was conducted among five contractors in the Free State province of South Africa. The aim of the multiple case study research design was to perform the LOA so that areas in which lean practices are in need of enhancement can be established and motivated. The study adopted an LOA protocol from the "lean supply chain and logistics management" book by Paul Myerson and then conduct further interviews to obtain more views on the LOA variables. The variables include internal communication, visualisation and workplace organisation, operative flexibility, continuous improvement, mistake proofing, quick changeover, quality of inbound and outbound materials, supply chain, balanced flow of work, total productive maintenance (TPM), pulling tasks on site, and standardized work. The data suggest that the five contractors have to address weak continuous improvement, physical construction activities, mistake proofing, and performance measurement practices in their companies.

Keywords: Assessment, Contractors, Construction, Lean, Supply Chain

1 INTRODUCTION

The application of supply chain management (SCM) concepts in construction appears to be marginal (Emuze & Smallwood, 2013a). The relative paucity of research work on SCM is existing side-by-side with the proliferation of horizontal contracting mode where almost all construction projects are undertaken and delivered by multiple parties with divergent interest (Shakantu, Tookey, Muya, & Bowen, 2007). The lack of empirical work is existing side-by-side with poor project delivery performance in construction. The principal problem of the research that is reported in this paper is 'the wrong management of supply chains may have contributed (or currently contributing)

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to sub-optimal delivery performance of projects in South Africa'. The reasoning behind the postulated problem is that SCM is now a confirmed practice in the country due to the nature of the industry (Benton & McHenry, 2010; Khalfan, McDermott, & Cooper, 2004). However, there appears to be performance problems in supply chain processes (Fontanini & Picchi, 2004; Emuze & Smallwood, 2013b).

To solve this widespread problem, some associated studies are underway in a South African research unit. This particular survey forms one of such studies, and it is aimed at assessing lean opportunities in South African construction, especially the supply chain aspect. In production environments, the best point to start a lean journey is to perform a Lean opportunity assessment (LOA) so that potentials for improvements in each company can be identified for benchmarking against best practices. The LOA addresses key performance areas in which contractors can make recovery. The LOA constitute a 'situation analysis' to each company regarding organization performance. It is important to state that LOA assessment is not done to generalize the causes and effects of a problem. Rather, it is done to know the status quo regarding lean implementation intentions of a single company. The deployment of LOA is common because of what is termed 'lean failure', which happens when lean initiatives fail in a company (Doolen & Hacker, 2005). Myerson (2012) contends that the main reason for Lean failure is lack of proper organizational and work culture to support radical changes in a lean journey. Through the use of problem-based learning, case studies and general train-do method, the implementation of lean have advanced in recent years, especially in developed and emerging economies. Despite the recorded progress, some authors have reported that there is a gap between the 'train' and the 'do' (practice). This gap between general lean training and how to implement the process is why doing an LOA is important (Myerson, 2012). The LOA is done to help a company to identify the potential for improvement by analysing various aspects/work processes from a lean perspective.

Within the lean construction research community, the assessment of lean readiness of either an entire industry (Abdul & Roza, 2006) or a particular company has been done to identify areas of improvement (Etges, Saurin & Bulhoes). In the case of a particular company, value stream mapping (VSM) provides leeway of highlighting weak areas to be addressed by the work team. Evidence from past Value Stream Mapping (VSM) based IGLC papers (Arbulu & Tommelein, 2002; Björnfort, Bildsten, Erikshammar, Haller, & Simonsson, 2011; Fontanini & Picchi, 2004) imply that when a visual map of value stream is created, people in a company would agree on how value and waste are produced in their processes.

2 METHODOLOGY

This research was conducted to establish how contractors in South Africa can begin to consider and adopt lean construction practices. To realize the intent of the study, a multiple case study research design was used based on its suitability for addressing the 'how' questions in research (Thomas, 2015; Yin, 2013). The study was conducted with construction contractors operating in the central region of South Africa. The selection of the companies was based on purposive sampling techniques (Ritchie, Lewis, & Elam, 2003). Out of the eleven contractors that were approached, only nine agreed to participate in the study. However, the screening of the completed survey questionnaire reduced accurate responses to five companies. Two techniques were used for the

collection of primary data from the companies – survey questionnaire and follow-up semi-structured interviews. The field work started with the survey questionnaire that was compiled from the LOA template provided in Myerson (2012). From page 237 to 248 in Myerson (2012), a reader can discern what is relevant regarding the assessment of a company in need of lean adoption. Apart from Myerson (2012), other LOA templates can be used for similar business self-assessment/evaluation. In brief, the template in Myerson (2012) was modified to suit construction contractors instead of manufacturers. The close ended questions in the template are on a scale of 1 to 5 and each category have a minimum of four variables (questions) and a maximum of eight variables (questions). The variables in each category range from 4 to 7. The questionnaire produced from the adaptation is freely available from the lead author of this paper. The analysis is after that rated against best practices (see Table 2 for illustration). The template in Myerson (2012) highlights areas to be evaluated regarding internal communication, visual systems and workplace organisation, operator flexibility, continuous improvement, mistake proofing, quick changeover, quality, supply chain, balanced production, total productive maintenance, pull system, standard work, engineering, performance measurement, and customer communication.

From these areas, 15 areas were revised and used for the contractor LOA survey in South Africa as shown in Table 1. With the use of two field workers who co-author this paper as evaluators, users of the questionnaire rated their performance in each category. The results of the rating are compared to Lean best practices to see where opportunities for improvement exist in their companies (please see Table 2 for illustration). The protocol for the administration of the LOA form was followed by:

- Notifying the key people in the contracting companies before the actual data collection.
- Obtaining the organogram of the contractors to identify functional managers for each category of the LOA to be completed.
- Sending the LOA, at least, a week ahead of the evaluation.
- Explaining the rationale behind the LOA evaluation.

After the collection of the self-administered questionnaire data and its descriptive analysis as described in Myerson (2012), additional interviews were conducted with the contractors who are hereafter labelled C1, C2, C3, C4 and C5. The five interviews were recorded and transcribed verbatim (Gugiu & Rodriguez-Campos, 2007; Longhurst, 2009; Yin, 2013). After transcription, the resultant information was analysed using content analysis method (Krippendorff, 2012). The resulting information from the analysed data were validated using follow-up discussions, which serve as a way to double check perceptions recorded in the field work.

3 RESULTS AND DISCUSSION

3.1. Opinions from LOA survey

As mentioned in the methodology section, organizations wanting to begin a lean transformation often ask, “Where do we start?” (Myerson, 2012). Even companies in the middle of a Lean transformation strategy must also determine the status of their progress to know the opportunities for enhancing the policy. The LOA is used to tackle such questions by assessing and measuring the potential for improvement and lean implementation success in a company. Depending on the size of a company, LOA is

done between 5 to 30 days and it usually involves management and operational staffs. In this study, functional management and operational teams of the contracting companies were involved and the entire duration of the exercise did not exceed a month. It stretches to a month because of the need to visit the contractors located in different cities multiple times in 2016. The LOA itself is made up of 15 categories and a total of 80 questions. To compute the percentage of each group based on the responses that were recorded and evaluated, percentages for individual category was assessed by dividing the total score in category by the maximum possible score. For instance, the maximum possible score in a category with four questions is 20 because the points range from 0-5. Based on this procedure, Table 1 was produced from the LOA.

Table 1: Lean opportunity summary for five South African contractors

Lean Practices	Score (%)					Practice Average (%)	Rank
	C1	C2	C3	C4	C5		
Construction supply chain	63	80	100	83	100	85	1
Client communication	75	70	85	90	80	80	2
Visualization & workplace layout	60	67	57	80	97	72	3
Internal communication	74	60	89	69	43	67	4
Quality of movement of materials	48	48	72	68	92	66	5
Balanced flow of work	60	60	75	60	60	63	6
Quick activity changeover	60	48	56	60	80	61	7
Worker/operator/driver flexibility	44	64	48	68	68	58	8
Pulling tasks	72	60	48	68	0	50	9
Total productive maintenance	51	60	83	49	0	49	10
Standardized work	40	68	60	64	0	46	11
Continuous improvement	32	56	32	68	0	38	12
Physical construction activities	20	63	57	33	0	35	13
Mistake proofing	64	0	56	48	0	34	14
Performance measurement	0	52	20	40	0	22	15
Company Average	51	57	62	63	41		

It is notable that construction supply chain, client communication, visualization and workplace layout, internal communication, and quality of movement of materials constitute categories in which the contractors perceive that they are performing well. It is also notable that C1 record '0' score for performance measurement, C2 record '0' score for mistake proofing, and C3 record '0' score for pulling tasks, TPM, standardized work, continuous improvement, physical construction activities, mistake proofing and performance measurement. The LOA is further interpreted with the metrics provided in Myerson (2012) as shown in Table 2. The aggregated (average) percentage score of contractors shows that C3 and C4 can be likened to be using integrated supply chain as opposed to lean focus companies given the fact that lean as a strategy is lacking in the companies. Also, C1, C2, and C5 that are likened to be making Lean progress on this metric scale are only implementing work and management practices that resonate with tools and principles found in Lean.

Table 2: Company characteristic of the surveyed contractors

Category (%)	Explanation	C1	C2	C3	C4	C5
0-20	Traditional supply chain and logistics					
21-40	Getting started with lean					
41-60	Lean progress	x	x			x
61-80	Lean focus/integrated supply chain			x	x	
81-90	Lean continuous improvement culture					
≥91	World class lean supply chain					

Adapted from Myerson (2012: 247)

3.2. Perceptions from follow-up interviews

Given that the five contractors rated themselves high on the management of their construction supply chain, the follow-up interviews were used to better understand their views on the characteristics and influence of a supply chain as well as the nature of supply chain on practice. As a start, the contractors expressed different views about the importance of managing supply chain in the industry. In their opinion, managing the supply chain involves understanding the breakdown and traceability of products and services, organizations, logistics, people, activities, information and resources that transform raw materials into a finished product that fits for its purpose. The proper integration of business functions that ensures that there is cohesiveness and high performance was also mentioned. These views were not at variance with the description of the supply chain in the literature. In fact, C2 (contractor 2) characterized supply chain as directing all material to the construction site where the object is assembled from incoming materials.

However, the contractors differ on how the characteristics of supply chain influence project delivery. One contractor stated that the features of a supply chain affect the effectiveness of supply information across a site, from management to workers so as to make sure that everyone understands their role. The contractor noted that *“On a building project, design consultants are first tier suppliers, working for the client, and the contractor has a supply chain of subcontractors and specialist suppliers.”* Another contractor said that *“there must be roles played in every tier and the characteristics of supply chain will be performed by each as best as their roles require them. All material needed for assembling a certain structure in a construction site will be delivered on time to speed up the assembling of a structure on a construction site.”* These responses show that the contractor knows what it means to work with subcontractors and suppliers in an environment where projects are delivered by multiple parties (Emuze, 2013; Emuze & Smallwood, 2013a).

As a result of these views, the interviewers asked the contractors to describe their individual supply chain in practice. The contractors indicate various ways in which supply chain is practiced in their organization. For example, C1 says, *“Supply chain at our company is agile where communication is much easier and the young employees at the company can adapt to the constant change in the channel of communication. Although to a great or complex projects, responsibility and performance cascades down the supply chain to a plethora of suppliers sometimes unknown to management at the*

top of the chain". In addition, C2 says, "our system can be described as healthy and flexible because as we have been able to adapt to changes whilst still managing to maintain good communication and relationship within the various structures in and out of the company" whereas C3 perceive that in the companies, the supply chain works well because channels in procuring items are followed before an activity can take place.

When asked "how are construction events organized on site to enhance productivity", C1 notes that the key to SCM is to provide a strategy that aligns it with the project program, which shows the schedule of works to be completed. He further stated that the strategy starts at the design stage, scoping the work into packages straight to site so that each work package can be directed to the required working space on site. C2 also states that activities will be organized strategically starting from the design stage where work is divided into packages and then these activities will be sent to respective areas on site where they are required. C3-C5 concur with this idea as they report that activities are organized on site to enhance productivity by the use of plant and equipment schedule, labour's schedule, material schedule and making sure that all works are finished with specified time frame.

In particular, the contractors use their relationship with suppliers to buttress their points regarding supply chain practice. For instance, C1 says that "The suppliers know each of their roles to play in every given project and deliver quality products." The interviewed contractors note that their reported good relationship with suppliers is responsible for their ability to deliver quality projects. C3 said, "If I were to rate our relationship with our suppliers will give it nine stars simply because when we place an order they will make it a point that they deliver specified material and on time." The good relationship between contractors and their suppliers should however be viewed with caution as most of them perceive that the level of professionalism keeps suppliers on their toes and this help to reassures the punctual process needed in each project." While C2 states that, "The good faith between us assures us that punctuality and quality is a standard norm in the multiple projects we engage in. This impacts our projects substantially because we are then also able to deliver on our deadlines", C3 opine that, ".... our suppliers help us a lot in terms of time because they never fail to deliver on time and having material needed on site delivered on time results in high productivity."

The positive review of construction SCM by the five contractors that are not exposed core Lean principles and tools suggest that their use of Lean would only enhance and not harm their projects.

4 CONCLUSIONS

The LOA delivers crucial outputs, which include 'as-is' analysis, current-state VSM, future state VSM, and recommended improvement opportunities. For instance, Figure 1 shows where value is being delivered and where wastes may be hindering efficiency within the five contractors that were evaluated in this study. While the LOA is a first step that helps to identify, and plan for improvements, a VSM provides a road map for the journey.

As an illustration, Figure 1 gives insight into waste elimination opportunities in the work processes of the five South African contractors. The figure shows the weaknesses and strengths of the contractors regarding the need to embrace mistake proofing, ensure workflow in their physical construction activities, promote continuous improvement, standardize their work, and think about using total productive maintenance where

necessary. The embrace of the both LOA and VSM concepts would however depend on evidence to be produced through the development of current-state and future-state VSM for the contractors in 2017. It is expected that the VSM would show various connections between activities, information and material flow that can impact upon both value adding activities and wastes in the companies. The overall purpose of working with the same contractors in 2017 is to establish priorities for improvement efforts based on the LOA, encourage a common language about construction processes and create a basis for an implementation plan regarding Lean transformation.

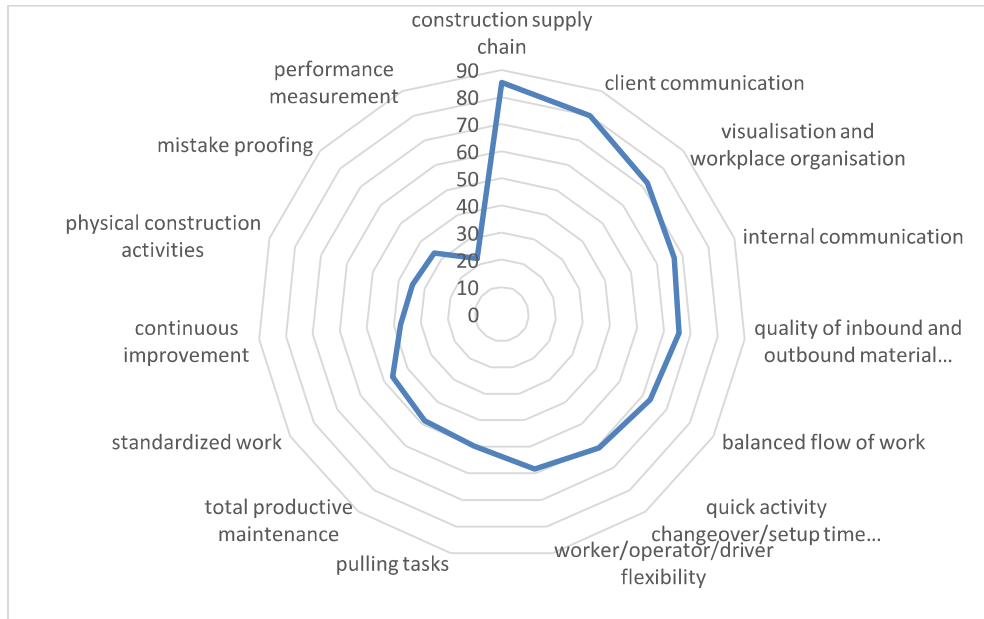


Figure 1: Lean opportunity summary graph for five South African contractors

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