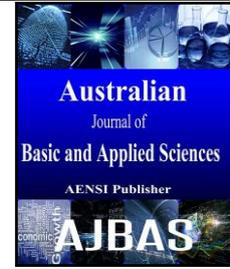




ISSN:1991-8178

Australian Journal of Basic and Applied Sciences

Journal home page: www.ajbasweb.com



Green Lean Construction Tools Framework for Malaysian Construction Industry

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ARTICLE INFO

Article history:

Received 12 October 2014

Received in revised form 26 December 2014

Accepted 17 January 2015

Available online 28 February 2015

Keywords:

Green lean construction, lean construction, tools, project performance

ABSTRACT

This paper has discovered the gaps in knowledge towards green lean construction (GLC) tools implementation for the Malaysian construction industry. It is also provided an overview of extensive critical literature review conducted whereby it leads to the findings that there is a need for GLC implementation framework to improve overall project performance in Malaysia particularly in addressing lean construction (LC) issues. Furthermore, growth of this GLC tools strategy is deemed to contribute significantly towards progressive evolution of the Malaysian construction industry to produce better value, quality and sustainable upcoming construction projects hence improving better quality of life. Currently, research is in the pipeline to ensure this issue can be addressed appropriately.

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To Cite This Article: Aini Jaapar, Mohd Arif Marhani and Nor Azmi Ahmad Bari, Green Lean Construction Tools Framework for Malaysian Construction Industry. *Aust. J. Basic & Appl. Sci.*, 9(7): 68-71, 2015

INTRODUCTION

The current demand for construction projects in Malaysia resulted in construction waste of 28.34% is being produced (Begum, 2010; Ping, 2009). It was proven that construction waste influences the success of a project due to its impact on cost, time, productivity and sustainability of the project (Nagapan, 2012).

Currently, the Malaysian construction industry needs to transform its method of delivery from traditional, labour consuming, energy inefficient and highly waste generated method of construction to a more environmentally friendly, energy efficient and less waste generation approach (Ahmad Bari, 2012), in-line with the Government Transformation Programme (Construction Industry Development Board Malaysia, 2015). The programme urged the industry to use better and more innovative construction methods with the support of appropriate information technology system.

According to Strickland and Kirkendall (Strickland, 1997), LC approach produces a better construction environment with far better cooperation and far less conflict. In addition, implementation of LC will improve the project performance of a construction project (Cho, 2011; Howell, 2008). Salem *et al.* (2005) agreed and believed that a construction company can possess these benefits by adopting the appropriate tools in their works.

Therefore, to embrace the superior performance in project, stakeholder must have the desirable attributes and work in an integrated manner. Desirable attributes of LC tools will enable the future stakeholder to gain better benefits from its implementation.

This on-going research investigates the performance of sustainable practices LC tools in the Malaysian construction industry. The ultimate aim is to establish a framework for GLC tools strategies. By having this framework, it will reduce the construction waste and improve the project performance for the future construction projects in systematic manner. In addition, it will address value (Jaapar, 2009) and productivity issues of the future construction projects. The objectives of this research are to investigate the availability of LC tools and its implementation process in the Malaysian construction industry, to assess the implication of LC tools in reducing construction waste; and to establish a framework of GLC tools.

Research Methods:

This paper provided the relevant existing knowledge relating to the LC tools strategies in construction projects. This paper discusses on the LC tools that influence the project performance in order to achieve the research objectives. Research methodology employed consists of several strategies such as observations, questionnaires and interviews of selected construction projects and respondents.

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Preliminary Findings:

LC is a strategy, which was adopted and modified from the manufacturing industry mainly aimed to minimise waste in the construction projects (Huovila, 1998). It is different from other construction management owing to its clear set of objectives (Ballard, 1998) leading to sustainable green practices. It is aiming for a better delivery process, concurrent project design and process, and production control throughout the life of the project. In addition, Womack and Jones (Womack, 2003) stated that this approach is able to reduce the overall cost and cycle time while maintaining the quality standards and improving the project performance (Cho, 2011; Howell, 2008). Hence, by having the sustainable practices being injected to the construction process, LC approach is capable to minimise waste in construction.

Besides, Common *et al.* (2000) had introduced four key areas in executing lean culture, which was procurement, planning, control and management. The stakeholder should consider these four key areas in implementing LC in their construction projects. Later, Johansen and Walter (2007) expand the areas into eight key areas, which are procurement, management, planning or control, collaboration, behaviour, design, supply and installation. These areas are much comprehensive in order to accommodate the construction industry. Within each of these areas, variety of tools are used as instruments in implementing LC (Johansen, 2007). It was discovered that these tools influenced the successful implementation of LC to construction projects (Salem, 2005).

Project Performance:

Literature review revealed that construction waste causes losses to the client as well as to the entire construction industry in Malaysia (Begum, 2010; Ping, 2009). Furthermore, it has direct impact on the success or failure of any construction project (Nagapan, 2012). Even, the stakeholder should know the expected goals from every single of their project. This issue is even occurring. Basically, most of the stakeholder are looking for quality, time and cost (Johansen, 2007; Koskela, 1992; Santos, 1999; Paez, 2005; Salem, 2006; Suresh, 2011; Engineers Australia, 2012; Building Research Establishment Ltd, 2013; Construction Industry Research and Information Association, 2013). In addition, safe environment also is expected from a construction project (Suresh, 2011; Construction Industry Research and Information Association, 2013). Thus, it is important in order to minimise the construction waste problem.

LC Tools:

A construction organisation needs to adopt specific tools, key concepts or techniques appropriate

or suitable for the organisation accordingly. These tools should be applied to the delivery process of a construction project (Blakey, 2008). By using appropriate tools (Salem, 2005; Koskela, 1992; Suresh, 2011; Alinaitwe, H., 2009), LC processes will provide greater gains to the organisation. Even though inappropriate practices of LC tools are still occurring in the construction industry that leads to ineffective project performance (Salem, 2005). LC tools included teamwork and value based management (Harris, 1997); Just-In-Time (JIT), Total Quality Management, business process re-engineering, concurrent engineering and last planner system (LPS) (Alinaitwe, 2009). Moreover, Suresh *et al.* (2011) suggested LPS, productive meetings, increased visualisation, off-site prefabrication, 5S/5C (housekeeping), mistake-proofing, root cause analysis, first run studies and JIT as tools that can be executed by any organisation in the United Kingdom construction industry. However, most of researches conducted in Malaysia only discussed on the barriers and challenges; and stated that LC should be the key for the Malaysian construction industry enhancement (Abdullah, 2009; Lim, 2008; Wan Muhammad, 2013; Ahamad Jeni, 2013; Marhani, 2013; Marhani, 2012) rather than its actual implementation of LC tools and it discovered currently there is no available framework how to implement GLC.

Therefore, this research will address the issue of construction waste by introducing the related GLC tools strategies framework. This framework will elaborate on how LC tools practice could improve the project performance. Expert panel from the Malaysian construction industry will be invited to validate this framework.

Conclusion:

An extensive literature review on LC tools strategies in the construction project has been conducted to gain in-depth understanding on the stated issues. The growth of this GLC tools strategy is to contribute towards better value, quality and sustainable upcoming construction projects as well as improving the Malaysians' quality of life. Furthermore, stakeholder shall get better quality of product, better safety awareness at site, better client or customer satisfaction, better collaboration of team members, shorter construction duration, better value for money and reduce wastage in their project from the GLC framework. Before broader adoption of this alternative constructiveway can be implemented, particularly in Malaysia, there must be a better understanding of the concept and potential of LC in enhancing sustainability. The research is designed to find ways to improve project performance through the establishment of a GLC tools framework for the Malaysian construction industry.

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