Benefits of Adopting Lean Construction Technique in the South African Construction Industry

Opeoluwa Akinradewo, Ayodeji Oke, Clinton Aigbavboa, Mulongo Ndalamba
Department of Construction Management and Quantity Surveying
University of Johannesburg
Johannesburg 2028, South Africa
opeakinradewo@gmail.com, emayok@gmail.com, caigbavboa@uj.ac.za,
mwilambwegloria@gmail.com

Abstract

The construction industry is heterogeneous and enormously involved with projects that are exposed to an uncertainty found in design and planning, presence of various interest of stakeholders, availability of resources, environmental factors, the economy of the country and statutory regulations. However, most activities of the industry have negative impacts on the environment by generation of construction and demolition wastes. Lean Construction (LC) technique gives the opportunity to more but with less of everything, lean use less of human effort, equipment, time, and space. This study seeks to appraise the benefits of LC technique based on professionals' opinion in the South African Construction Industry. Well-structured questionnaire was prepared to collect data from respondents which include Quantity Surveyors, Architects, Construction Managers, Project Managers and Civil Engineers. Result of the analysed data revealed that clients, consultants and contractors agreed that the most significant benefits of adopting LC technique are waste reduction, efficient administration of materials and improved whole-life cost of construction projects. This implies that management of construction waste is one of the important management processes necessary to achieve project objectives. Recommendation was made that companies should use LC to identify and analyse waste to improve productivity, minimise time and accidents, improve reliability, improve quality and ensure more client satisfaction.

Keywords
Construction Industry; Lean Construction; Project delivery; Construction waste.

1. Introduction

The construction industry is heterogeneous and enormously involved with projects that are exposed to an uncertainty which is found in design and planning, presence of various interest of stakeholders, availability of resources, environmental factors, the economy of the country and statutory regulations (CSIR, U. I., & CIB, C. (2002)). The South African CI contributes to the growth of economy of the country, especially the provision of physical infrastructures (Takin & Akintoyi, 2002:545). However, most activities of the industry have negative impacts on the environment (i.e. generation of construction and demolition wastes), which can be ameliorated through changes in management of waste (CSIR, U. I., & CIB, C. (2002)). As established by Womack and Jones (2010:15), Lean Construction technique gives the opportunity to more but with less of everything, lean use less of human effort, equipment, time, and space. Therefore, the implementation of LC technique is paramount in reducing waste and to enhance the overall South African Construction Industry performance.

By implementing LC tools and principles, productivity is increased, time and accidents are reduced (Mossman, 2009), and waste generation significantly minimised. It gives the Construction Industry the opportunity to improve sustainability by optimising the utilisation of resources and safety during construction process and minimising waste through standard procedures (Nahmens & Ikuma, 2012). Lean Construction (LC) can have a positive effect on safety since it contributes to the social dimension of sustainability during the construction phase. It also helps in protecting

the human health, maintaining the environment and reducing global warming effects by forestalling the emission of carbon from landfill amenities (Nahmens & Ikuma, 2012:155).

In addition, lean management is different from traditional practice because objectives are clear when delivering project. It is targeted at increasing productivity for the client in the project construction process. As a result, LC has become a more popular method of the delivery of projects (Kirk Hochstatter, 2013:1) in many countries. According to Johansen et al. (2007) and Marhani et al. (2012), construction industries worldwide have adopted the LC technique and have reaped its benefits. Thus, the South African construction industry, like most construction industries worldwide, needs to adopt LC technique fully for the benefit of the industry as well as it ends users. This study therefore seeks to appraise the perceived benefits of adopting LC technique in the South African CI.

2. Literature Review

2.1 Lean construction techniques

The Lean Construction techniques are the backbone of LC and have evolved since its adoption in the construction industry. Antillon (2010) defined Lean Construction Techniques as procedures, structures, conceptions, models, methodologies, and products which when implemented assists corporations apply lean across the workplace. There are various Lean Construction Techniques encountered in the construction industry namely: Look-ahead planning, Constraint analysis, concurrent engineering, the Percent Plan Complete (PPC) measurement, resources managing, just-in-time, standardization, immediate problem detection, process evaluation, detection of incompatibility and discrepancy, use of visual indicators, team integration and continuous improvement (Antillón, 2010). Amongst the LC techniques one of the most important and popular is Last planner system (LPS).

2.1.1 Last Planner System (LPS)

The LPS gives an outline to plan and control construction activities of project. In addition, LPS is a system that forms workflow and attends to project variableness in construction (Salem *et al*, 2005). LPS also reduces waste by rapidly reducing uncertainty and producing more predictable and reliable workflow (Arlacon *et al*, 2011). The important role of LPS is to change expectant planning with accurate planning by assessing the workers' performance in relation with their aptitude to consistently attain their attentions. It can be performed by a site foreman. The process of adopting LPS tools encompasses four levels Master Pulling Schedule (MPS), Phase Schedule, Lookahead Plan and Weekly Work Plan (WWP).

2.1.2 Master Pulling Schedule

The MPS is the complete project timetable with milestones (Salem et al., 2005). MPS is formulated based on the design standards that affirms the client's project targets which is influenced by breaking the project into smaller activities and showing their successive relationships (Antillón, 2010). It does not depict the run of demands within and between tasks or activities beyond simple successive relationships (Antillon, 2010). In the early preparation, MPS is a tool used to understand the project definition and cannot be used as the instrument for handling activities before being formulated in the phase schedule to endorse master schedule milestones completion (Salem et al., 2005).

2.1.3 Phase Schedule

The PS is devised by the teams involved in each phase and it is more practical than the preliminary optimal schedule which is the master schedule. It has to be prepared minimum of six weeks before the number one activity. MPS produces the Reverse Phase Scheduling (RPS) which is a tool that develops the schedule which works conversely from the completion date to starting date of the project by team planning to ensure the incorporation of tasks with value that leads to other work (Ballard & Howell, 2003).

2.1.4 Look-ahead Planning

Look-ahead Plan places the workflow into the best achievable order. It also rates and corresponds labour with related resources to the work flow (Antillon, 2005). It helps supervisors to control blacklog of activities in more flexible and workable way. Activities are jointly planned by all the involved trades while tasks that are highly interdependent are grouped together, so that the work method can be designed for the whole activities (Salem et al., 2005). Look-ahead planning is the procedure to diminish doubts in achieving possible constraint free activities for project success (Koskela et al. 2000).

2.1.5 Weekly Work Plan (WWP)

WWP is generated according to SWLA. WWP meeting covers quality issues, safety issues, weekly schedule, needs of material needs, methods of construction, reserves of prepared work and any difficulty that can come up in the field. Therefore, it improves quality, safety, flow of work and material, performance and the relationship among stakeholders. Moreover, WWP meetings plays a major influence in LC management practice by alleviating the clear communication of consignments made by all task contractors taking part on the project.

2.2 Benefits of adopting Lean Construction Technique

Although the construction industries worldwide encountered several challenges when implementing LC, some industries have recognised the opportunity to embrace improvements through lean implementation (Vilasini, 2014). Various benefits and advantages have been recognised by the researchers. The most important benefits of using LC in organisations is the reduction of waste (Luo *et al*, 2005). By eliminating waste in the construction, LC encourages the following:

- Minimise double handling and movement of equipment and workers
- Balance team, coordinate flows
- Take off material constraints,
- Minimise variance in input
- Minimise changeovers and difficult setups
- Reduce interpersonal dynamics

According to Womack, & Jones (2010), the most important benefit is greater customer satisfaction, construction companies when implementing lean construction under customer focus, they are able to:

- Meet the needs of the client.
- Outline value from the project viewpoint.
- Use flexible resources and adaptative planning in responding to opportunities and changing needs.
- Use target costing and value.

Cleanliness and organization are important benefits because without them opportunities for improvement and sources of problems are often obscured. Salem et al (2005) stated specifically that cracks, missing parts or leaks on equipment are more visible when you have a clean workplace which improves safety at work and reduces to the minimum the chance of accidents. Also, lean construction results in efficiency of equipment, skilled operators, the use of relevant equipment and high performance of adequate equipment. It is worth repeating that housekeeping is a good starting point and a way to develop and reinforce the work custom, behaviours and skills important for reducing waste, continuous improvement in productivity and lean construction. Furthermore, according to Mossman (2009) the LC benefits that flow from construction organisations and which are known to be the most important gains of adopting LC technique in the construction industry are as follow:

- Improve safety
- Less waste
- Eliminate cost
- Increase productivity
- Shorten schedules
- Improve reliability
- Improve quality
- Improve client satisfaction
- Increase predictability
- Improvement to design to enhance buildability

According to Modi and Thakkar (2014), the practisers of LC believe that LC helps organisations to reduce inventory, make delivery on demand, increase the use of multi-skilled employees, drop the management structure while focusing resources on the most effective tasks. Furthermore, Modi and Thakkar (2014) believe that gains of adopting LC technique in the construction industry are: Reduced lead time, Reduced cost, Improved productivity, Reduced waste, Improved quality or Reduced defects and Reduce cycle time. The benefits of lean construction in labour related discussed by Modi and Thakkar (2014) are as follows:

- Labour reduction while maintaining or increasing output
- Maximise the use of multi-skilled employees

- Improve effective communication between stakeholders
- Encourage collaboration
- Encourages lean thinking to all employees involved in the project.

3 Methodology

This study selected the quantitative research method to determine the benefits of adopting LC technique in the South African CI by using both secondary and primary data. In achieving the objective of the research, well-structured questionnaire was developed on two sections. The first section seeks the background information of professionals and the other section of the questionnaire was developed using a 5point likert-scale with 1 = 'strongly disagree' and 5 = 'strongly agree' to seek perceived benefits of LC practice in the SACI using information gathered from literatures reviewed. 145 respondents who participated in this survey includes Quantity Surveyors, Architects, Construction Managers, Project Managers and Civil Engineers involved in construction projects within Western Cape province of South Africa and affiliated to their respective professional bodies. Descriptive statistics and Mean Item Score (MIS) as well as Standard Deviation were used in analysing data for this study.

4 Findings and Discussion

The findings revealed that the professional qualification of the sampled respondents and it reveals that 35.0% are Quantity surveyors, 18.3% construction managers, 12.2% Project managers, 23.1% civil engineers, and 9.2% Architects. Result also showed 62.2% had experience that ranged from 1-5 years, 20.0% 6-10 years, 11.1% 11-15 years, 4.4% 16-20 years while 2.2% had more than 20 years of experience in the construction industry. Further result showed 16.5% of the respondents works for private clients, 39.9% consultants, 36.4% contractors and 7.2% works for public client/government. The result revealed that 17.8% of the respondents have been involved in 1-2 projects, 26.7% in 3-4 projects, 37.8% in 5-6 projects, 8.9% in 7-8 projects and 8.9% of the respondents were involved in more than 8 projects. The research result shows that 20.0 % of the respondents weren't involved in projects in which Lean Construction was practiced, 51.1% of the respondents were involved in 1-2 projects, 22.2% in 3-4 projects, 6.7% in 5-6 projects, and none of the respondents has been involved in more than 6 projects that LC was practiced on. It was also gathered from the result that out of the projects in which Lean Construction was practised, 23.6% are school projects, 21.3% are hospital projects, 15.6% are housing estates projects, 8.2% are road construction projects, 4.6% are other civil works (dams etc.) projects, 14.5% are government offices projects and 12.2% are renovation projects (residential, civil etc). With this demographic information of the respondents, it is evident that the respondents possess enough experience in Lean Construction Technique in the South African CI and therefore their opinion can be relied upon for this study.

Table 1: Benefits of adopting lean construction technique

Benefits of adopting Lean Construction	**Contractors**			**Client and Consultants**			**Overall**		
	MIS	**SD**	**R**	**MIS**	**SD**	**R**	**MIS**	**SD**	**R**
Reduced waste	4.13	0.640	1	4.33	0.547	1	4.23	0.501	1
Efficient administration of materials	4.07	0.799	3	4.30	0.466	2	4.20	0.611	2
Improved whole-life cost	4.13	0.640	1	4.17	0.747	4	4.19	0.760	3
Improved customer satisfaction	4.00	0.756	4	4.13	0.681	5	4.13	0.711	4
Improved safety	3.80	0.941	8	4.13	0.730	5	4.08	0.810	5
Increased productivity	3.87	0.915	7	4.07	0.691	7	4.03	0.800	6
Improved risk management	4.00	0.655	4	3.97	0.556	8	3.99	0.655	7
Reduced project timetable	3.27	0.884	11	4.27	0.740	3	3.97	0.564	8
Efficient communication among the client and construction team	4.00	0.535	4	3.87	0.937	11	3.90	0.882	9
Improved Quality	3.73	0.799	9	3.93	0.691	9	3.89	0.758	10
Effective system with less cost	3.53	0.915	10	3.93	0.785	9	3.76	0.881	11

SD=Standard Deviation; MIS= Mean Item Score; R= Rank

Table 1. Presents the respondents ranking of benefits of adopting lean construction technique in the CI. Interesting to note that all the factors ranked above average Mean Item Score of 3.00 which is an indication that South African Construction Industry experts knows the value of LC technique and they are benefiting from these techniques. The results as given in the table indicates that contractors ranked reduced waste as well as improved whole-life cost as most important benefits with a MIS of 4.13 and SD=0.640 respectively; efficient administration of materials on site was ranked third with MIS of 4.07 and SD=0.799; reduced project timetable was ranked the lowest with MIS of 3.27 and SD=0.884.

Clients and consultants also ranked reduced waste first with MIS of 4.33 and SD=0.547, followed by efficient administration of materials with MIS of 4.30 and SD=0.466; reduced project timetable was ranked third with MIS of 4.27 and SD=0.740; Efficient communication among the client and construction team was ranked lowest with MIS of 3.87 and SD=0.937.

Jointly, the two category of respondents ranked reduced waste first with the MIS of 4.23 and SD= 0.501; efficient administration of materials on site was ranked second with MIS of 4.20 and SD= 0.611, while improved whole-life cost was ranked third with MIS of 4.19 and SD=0.760; improved customer satisfaction was ranked fourth with MIS of 4.13 and SD=0.711; Improved safety was ranked fifth with MIS of 4.08 and SD=0.810; The effective system with less cost is the least benefit, with the MIS of 3.76 and SD of 0.881. It was noted in the opinion of both category of respondents that the SD is below 1.00 which indicates that there is little difference in their opinion on the benefits of LC technique in the South African CI.

Findings of this study are in concordance with those of Aigbavboa, Oke and Momoti (2016), Luo & Horman (2005) and Mossman (2009), the study revealed that clients, consultants and contractors agreed that the most significant benefit in adopting lean construction technique is reduced waste however it seems like all the mentioned benefits are important since the overall mean item score is more than 3.5. The findings were not ranked the same but there are similarities with what the respondents agreed to be the most significant benefits. Considering individual opinions of the categories, it was observed that efficient communication between the client and the construction team ranked lowest by the clients and consultants while it was ranked fourth by the contractor which indicates that although there are significant benefits of LC to the CI, clients and consultants are of the notion that it has average effect on improving effective communication in the construction industry. Same situation was observed for Reduced project timetable which ranked lowest by the contractor of which the clients and consultants ranked it third, the differing opinions shows that the perspective of the benefits of LC technique by both category of respondents is based on their services rendered on a construction project.

The findings also agree with Womack & Jones (2003) who opined that there are six (6) typical benefits of LC technique to the CI. Among the highlighted six benefits are less process waste, reduced inventory, financial savings and reduced lead time. These highlighted benefits are in tandem with reduced waste, efficient administration of material, improved whole-life cost and reduced project timetable respectively as suggested by construction professionals in the South African CI. It also agrees with the findings of Modi & Thakkar (2014) that LC technique helps in encouraging collaboration, improves effective communication and increases productivity. It also agrees with a similar research carried out by Oguntona, Aigbavboa and Mulongo (2018) which focused on Gauteng province of South Africa.

5. Conclusions and Recommendations

This study has been able to identify the benefits of lean construction technique to the South African Construction Industry as also identified by many researchers for other developing countries. Therefore, it is concluded that among others, reduced waste and efficient administration of materials are the main benefit which are the core objectives of LC technique. Since managing construction waste is one of the most significant management processes necessary to achieve project objectives, it is hereby recommended that companies should use lean construction to identify and analyse waste to improve productivity, minimise time and accidents, improve reliability, improve quality and ensure more client satisfaction. For further studies, this research can also be carried out in other provinces of South Africa to have a wider knowledge of the opinion of Construction Industry professionals on the benefits of LC technique.

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Biographies

AKINRADEWO, Opeoluwa Israel is a graduate of Quantity Surveying who bagged his Bachelor degree from Federal University of Technology, Akure, Nigeria (FUTA). He developed interest in research during his undergraduate days which spurred him into writing articles and reviews. He was chosen to represent FUTA in the ReCon2 Student Essay Writing and Presentation competition organised by the Nigerian Institute of Quantity Surveyors (NIQS) which was contested for by higher institutions across Nigeria and he came first. He was presented a Productivity and Excellence award by the Federal University of Technology, Akure for his contribution to excellence and research in the institution. He is a probationer member of the Nigerian Institute of Quantity Surveyors presently pursuing his Masters degree in Quantity Surveying at University of Johannesburg, South Africa.

OKE Ayodeji Emmanuel is a Quantity Surveyor by training and a Ph.D. holder in the same discipline. He bagged his B.Tech degree in Quantity Surveying from Federal University of Technology, Akure, Nigeria in 2006 with a first

class (Hons.). He is a reviewer for various local and international reputable Journals. To his name and in collaboration with academia within and outside Nigeria, he has authored a good number of journals and conference papers both locally and internationally. He received 2016 Emerald Literati Award for the article on Structural Equation Modelling of Construction Bond Administration, as a highly recommended paper in the Journal of Financial Management of Property and Construction. He is one of the authors of the book titled sustainable value management for construction projects. He is currently a Research Fellow at the Department of Construction Management and Quantity Surveying, University of Johannesburg, South Africa.

AIGBAVBOA Clinton Ohis is currently the Vice-dean: Postgraduate Studies, Research and Innovation (PSRI) of the Faculty of Engineering and the Built Environment (FEBE) of the University of Johannesburg. He also serves as the Head: Sustainable Human Development and Construction Research Centre, in the Department of Construction Management and Quantity Surveying, School of Civil Engineering and the Built Environment, FEBE. He is an Associate Professor in the Department of Construction Management and Quantity Surveying, University of Johannesburg, South Africa. As a Ph.D. candidate in 2013, he was among the top 10 researchers in UJ; while in 2014 and 2015, he was the leading research output contributor in the University. Prof Aigbavboa has published more than 400 peer-reviewed articles in journals, conference proceedings and in book chapters.

NDALAMBA Mulongo is a graduate of the Department of Construction Management and Quantity Surveying in the Faculty of Engineering and Built Environment, at the University of Johannesburg. He bagged his Bachelor Degree from the department in 2017.