Journal of Construction Project Management and Innovation Vol. 2 (2): 345-359, 2012
ISSN 2223-7852

PERSPECTIVES FOR THE IMPLEMENTATION OF LEAN CONSTRUCTION IN THE GHANAIAN CONSTRUCTION INDUSTRY

Ayarkwa, J.,[1] Agyekum, K.[2], Adinyira, E[3], and Osei-Asibey, D[4].

[1, 2, 3&4]Department of Building Technology, College of Architecture and Planning
Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
Email: [1]ayarkwajosh@yahoo.com, [2]agyekum.kofi@yahoo.com, [3]eadinyira.feds@knust.edu.gh
Tel: +233-322060311, +233-246-010870, Tel. +233-246761879, Tel. +233-201569860

Abstract
Lean construction, if adopted could prove to be highly rewarding to Ghanaian construction organizations, resulting in the reduction of waste and improvement in productivity. This paper presents results of a study to assess the perceptions of Ghanaian construction practitioners of the lean construction philosophy and to identify the level of knowledge in the construction industry. Structured questionnaire survey was conducted on technical managers of construction organizations and consultants to assess their perceptions of the lean construction philosophy and to identify the level of knowledge in the Ghanaian construction industry and measures to bridge the knowledge gap. A quantitative approach to data analysis was employed using mean scores of factors studied. There is the existence of a good level of awareness, but a low level of familiarity and application of lean construction among practitioners in the Ghanaian construction industry. Majority are considering the application of lean concepts in future. Lean principles are considered transferable to construction in Ghana and construction practitioners suggest that to deal with the knowledge gap, firms should change organizational culture that does not promote lean construction and the construction industry should organize workshops and conferences to increase the level of awareness and bridge the knowledge gap on lean construction in Ghana. The study should have covered all categories of contractors but due to lack of reliable information on small scale construction organizations, only large firms in the highest financial classes were covered. The findings from the study enable the Ghanaian construction industry to organize training workshops and conferences for key players in the industry to increase their level of awareness and to bridge the knowledge gap on lean construction. The findings of the study are of value to construction organizations seeking to improve productivity and work quality through the adoption of the lean construction approach.

Keywords: Lean construction, perceptions, knowledge level, construction industry, Ghana

INTRODUCTION

According to Forbes and Ahmed (2004), manufacturing industries have greatly improved their competitiveness through the use of lean methods such as Supply Chain Management and Just-In-Time techniques. However, the majority of construction works is still based on antiquated techniques, especially in developing nations. Among the well-known chronic problems in construction are low productivity, insufficient quality, poor co-ordination, high costs resulting from materials wastage etc. (Alinaitwe, 2009; Kpamma, 2009). Research has pointed to a significantly high level of wasted resources in the construction industry - both human and material; up to 30% of construction costs are due to inefficiencies, mistakes, delays and poor communications (Begum et al., 2006; Forbes and Ahmed, 2004; Polat and Ballard, 2004). In developing countries where a significant percentage of materials and equipment are imported, these problems can be especially costly (Forbes and Ahmed, 2004). Lean concepts have been applied in the construction industries of Australia, Brazil, Denmark, Ecuador, Finland, Peru, Singapore, UK, USA and Venezuela (Abdullah et al.,2009; Johansen and Walter, 2007; Ballard and Howell, 2004). The surveys conducted by Johansen et al. (2002) and Common et al. (2000) in the Netherlands and the UK respectively, strongly suggest that the construction industry has generally been slow in taking up lean concepts (Johansen and Walter, 2007). Conventional construction has been criticized for being pre-occupied with managing only tasks, and flows are neglected. This is seen as the main reason why construction is characterized by a high share of non-value-adding activities (Dulaimi and Tanamas, 2001). A case study in the USA showed the following remarkable benefits of implementing Lean Construction (LC) (Dulaimi and Tanamas, 2001):

- Office construction times reduced by 25% within 18 months;
- Schematic design reduced from 11 weeks to 2 weeks;
- Turnover increased between 15% to 20% (Pacific Contracting);
- Satisfied clients eager to place repeat orders;
- Overall project cost reduced.

The significant benefits of low waste generation and high productivity from LC reported in the literature (Mossman, 2009; Lehman and Reiser, 2004) could also be gained by Ghanaian construction organizations if the concept is adopted.

There are, however, a number of factors that affect the construction industry in Ghana. The industry experiences problems of increased cost of production, delays in delivering construction products and services, incidence of waste associated with production, poor design quality, personnel issues and financial problem such as cancellation of advance mobilization, cumbersome payment process, limited access to credit and lack of adequate equipment holdings (Laryea and Mensah, 2010). The application of the LC concept in the Ghanaian construction industry is still considered a new approach, hence the objective of this study, which is to assess the perceptions of Ghanaian construction practitioners of the LC philosophy, identify the level of knowledge in the construction industry and measures to bridge the knowledge gap.

THE CONCEPTS OF LEAN CONSTRUCTION

Lean Production (LP) was developed in the 1950s to eliminate waste (Kempton, 2006; Lehman and Reiser. 2004; Dulaimi and Tanamas, 2001). Seven wastes in mass production systems were identified as overproduction, waiting time, transportation, processing itself, having unnecessary stock on hand, using unnecessary motion and producing defective goods (Forbes and Ahmed, 2004). The term "lean" was coined by a research team working on international auto production to contrast it with craft and mass forms of production (Kempton, 2006). The original thinking was to develop a delivery process that met customers' needs with very little inventory, and failure to meet customers' needs was considered as waste. Working without inventory meant that the production line had to speed up, and each person involved in that process had to improve his skills in order to accomplish the production targets (Forbes and Ahmed, 2004). The core principle behind LP is to ensure the flow of value creating work steps while eliminating non-value steps (i.e. waste) by focusing on fast cycle times. When waste is removed from the production process, cycle times drop until physical limits are reached. In Japanese the primary goal of LP is "Muda", that is, to avoid waste of time, money, materials, equipment, etc. (Kempton, 2006). Waste in construction and manufacturing arises from the same activity-centered thinking. Waste in construction and manufacturing arises from the same activity-centered thinking. There is the need to maintain pressure on every activity to ensure continuous improvement through the reduction of cost and duration of each activity (Kempton, 2006).

Lean theory and principles taken together provide the foundation for a new form of project management (Dulaimi and Tanamas, 2001). From roots in production management, LC is a way to design production systems to minimize waste of materials, time and effort in order to generate the maximum possible amount of value (Koskela and Howell, 2002). It is also a holistic design and delivery philosophy with an overarching aim of maximizing value to all stakeholders through systematic, synergistic and continuous improvements in the contractual arrangements, product design and method of selection, the supply chain and the workflow reliability of site operations (Abdelhamid, 2004). LC has produced significant improvements particularly on complex, uncertain and quick projects. According to Dulaimi and Tanamas (2001), managing construction under LC is different from typical contemporary practice because it:

- Has a clear set of objectives for the delivery process;
- Is aimed at maximizing performance for the customer at the project level;
- Designs concurrently product and process;
- Applies production control throughout the life of the project.

THE PRINCIPLES OF LEAN CONSTRUCTION

"Lean" is essentially about getting the right things to the right place at the right time, in the right quantity whilst minimizing waste and being open and responsive to change (Kempton, 2006). Lean production has an underlying philosophy that, by eliminating waste, quality can be improved, and production times and costs reduced (Kempton, 2006). In order to reduce waste, a set of key manufacturing principles should be employed (Table 23.1).

Table 23.1 Key manufacturing principles employed to reduce waste

Lean Principle	Explanation
Perfect first- time quality	Achieve zero defects, revealing and solving problems at the source
Waste minimization	Eliminating all non-value-adding activities and maximizing the use of resources
Continuous improvement	Reduction of costs, increase quality and productivity
Pull processing	Products pulled from the consumer end, i.e. not pushed from the production end
Flexibility	The production of different mixes and/ or greater diversity of products, without compromising efficiency
Relationships	Building and maintaining long-term relationships with suppliers

Source: Kempton (2006)

RESEARCH DESIGN AND METHODOLOGY

A thorough review of literature was undertaken to extract available lean principles, benefits and possible measures to bridge the knowledge gaps on the concept of LC. The benefits and possible measures to bridge the knowledge gap gathered from literature had been successfully and sufficiently studies in similar research in other countries (Bashir et al, 2010; Kpamma, 2009; Jin, 2008; Johansen, 2007; Kempton, 2006; Salem et al., 2006). A structured questionnaire survey which targeted chief executives of construction organizations and consulting firms was used in the study. Both closed and open-ended questions were administered to contractors and consultants. The questionnaire was divided into three sections. The first part sought information about the companies' profiles, areas of operations and level of experience of respondents. The second part of the questionnaire sought to assess respondents' familiarity with the lean principles. The third part dealt with the benefits of lean construction and measures to bridge the knowledge gaps on lean construction.

Building construction organizations operating within Ghana register with the Ministry of Water Resource, Works and Housing (MWRWH) in four categories: class D, K, E and G, based on the nature of work the organizations engage in - building, civil engineering, electrical and plumbing works respectively. There are four financial sub-classifications within these categories - Class 1, 2, 3 and 4 - which set the limitations for companies in respect of their asset, plant and labor holdings, and the nature and size of the projects they can undertake. Class 1 has the highest resource base, decreasing through classes 2 and 3, to class 4 having the least resource base (MWRWH, 2011). Chief executives of D1 and D2 building construction organization who are registered with the (MWRWH) were involved in the study. The choice of D1/D2 firms was due to lack of reliable information on small scale construction organizations and also based on the assumption that large and well-established firms have good organizational set up and are more capable of undertaking lean production efforts. The MWRWH (2011) records indicate that there are 519 D1 and D2 building contractors in the Ashanti and Greater Accra Regions of Ghana. The survey also targeted consultants from quantity surveying and architectural firms fully registered with the Ghana Institution of Surveyors (GhIS) and the Architects Registration Council of Ghana (ARCG) respectively. The ARCG (2010) had 114 fully registered architectural firms, whilst the GhIS (2010) had 60 fully registered quantity surveying firms in Kumasi and Accra.

A sample size of 226 site managers of D1/D2 of construction organizations was determined using the following formula recommended for such studies by Israel (1992).

$$n= \frac{N}{1+N(e)^2}$$

Where n is the sample size, N is the population size and e is the desired level of precision (±5%).

A simple random sampling approach was used to select the 226 D1 and D2 firms. Each questionnaire was administered through a face-to-face session which ensured that 188 questionnaires out of the 226 were returned complete and used in the analysis, representing a response rate of 83%. All the 114 architectural firms (ARCG, 2010) and 60 quantity surveying firms (GhIS, 2010) fully registered with their professional institutions were covered in the study. Out of the 174 questionnaires sent to the consultants, 124 were completed, representing a response rate of 71%.

A quantitative approach to data analysis was employed. Statistical Package for Social Scientists Version 16 (SPSS V16) was used to analyze the data. Concerning the principles of lean construction, the respondents were asked to indicate their level of agreement to the application of the principles on a five- point Likert scale (from 1= 'highly disagree' to 5 = 'highly agree'). For the achievability of customer values, respondents were asked to score factors from 1 = 'highly unachievable' to 5 = 'highly achievable'. The respondents were also asked to score benefits of lean construction from 1 = 'highly unbeneficial' to 5 = 'highly beneficial', and measures to bridge the knowledge gap from 1 = 'highly unimportant' to 5 = 'highly important'. Mean scores of the factors and their standard deviations were graphically compared. A factor is deemed to be significant to the study if it has a mean value of 2.50 or more (Field, 2005).

RESULTS AND DISCUSSIONS

Company profile

The average years of experience of the firms surveyed in the construction market are between 10 and 20 years. This implies that all the firms have significant experience in the building industry. With regards to the average number of permanent and temporary employees, none of the firms contacted was willing to disclose.

The main reason given was that it is confidential. The respondents, however, indicated that they had enough employees and could recruit additional employees when necessary.

Architects constituted 58% and quantity surveyors constituted 42% of the consultant. For the contractors, project managers constituted 68% and site engineers constituted 32%. Forty percent of the contractor-respondents and 50% of the consultant-respondents had bachelors' degree, and 36% of the contractors and 34% of consultants had Higher National Diploma (HND) certificates. The study further showed that 15% of consultants and 8% of the contractors had Master's degree. Nine percent of the contractors and 1% of the consultants had doctorate degree. The results also showed that majority of the firms (58% of contractors and 60% of consultants) had both public and private sector clients. Seven percent of contractors and 15% of consultants had public sector clients and 35% of contractors and 25% of consultants had private sector clients.

Familiarity with the concept of lean construction

On the level of awareness of LC, 80% of the contractors and 66% of the consultants indicated that they were either just aware of the lean principles or had adopted them in their construction projects. Only 20% of the contractors and 34% of the consultants were not aware of the lean principles. For the 39% of the contractors and 32% of consultants just aware of LC, they became aware through interaction with their colleagues in other firms or heard about it in school, but they have not gone beyond thinking of introducing it. For 41% of the contractors and 34% of consultants with experience on LC, the study showed that only few lean principles such as 'just in time' and 'use of prefabricated components' had actually been adopted in their construction projects. The 39% of the contractors and 32% of consultants just aware of LC admitted that although lean principles are not applied in their activities, they are considering its application in the future. This result gives hope about future implementation of lean principles in the Ghanaian construction industry. The results indicate a good level of awareness, but a low level of familiarity and application of lean concepts in the Ghanaian construction industry.

The above results compare with findings from the literature regarding the initial level of familiarity and application of lean concepts in the UK, the Netherlands and in Germany.

In the UK survey, Common et al (2000) found a distinct lack of understanding and application of the fundamental techniques required for a lean culture to exist. In the case of the Netherlands, Johansen et al. (2000) concluded that the lean concept appeared to be largely unknown although some issues associated with it had some low penetration in the industry.

Application of lean principles to project execution

On the level of agreement of respondents to the application of basic principles of LC, the results (Figure 1) show that all the 10 principles evaluated have mean scores greater than 2.5 (Field, 2005) for both the consultant- and contractor-respondents. This indicates that the respondents agree that all the ten basic principles of LC should be considered during project execution. The results further show that the respondents consider 'establishing continuous improvement', 'delivering what the client wants', 'constantly seeking better ways to do things' and 'minimizing waste' as the first four important lean principles to be considered in project execution. Other important principles include 'building and maintaining long term relationships with suppliers' and 'avoiding defects in the works done'.

The above results agree well with the literature which lists basic principles of LC to include 'delivering what the client wants', 'establishing continuous improvement', and 'doing the right things the first time' (Kempton, 2006; Mathew Hunter Associates, 2005; Salem and Zimmer, 2005; Dulaimi and Tanamas, 2001).

Transferability of lean principles to construction

On transferability of lean principles into the construction industry, all the consultants and the contractors admitted that it would be possible to transfer the principles of LC to the construction industry. This positive indication should motivate the industry to intensify efforts towards successful implementation of LC, as construction environment becomes increasingly demanding, and processing of modern-day projects almost certainly determined by increasing technological and financial pressure (Johansen and Walter, 2007). Transferability of lean principles into the construction industry can help to change current practices such as the generation of excessive waste and sub-standard products.

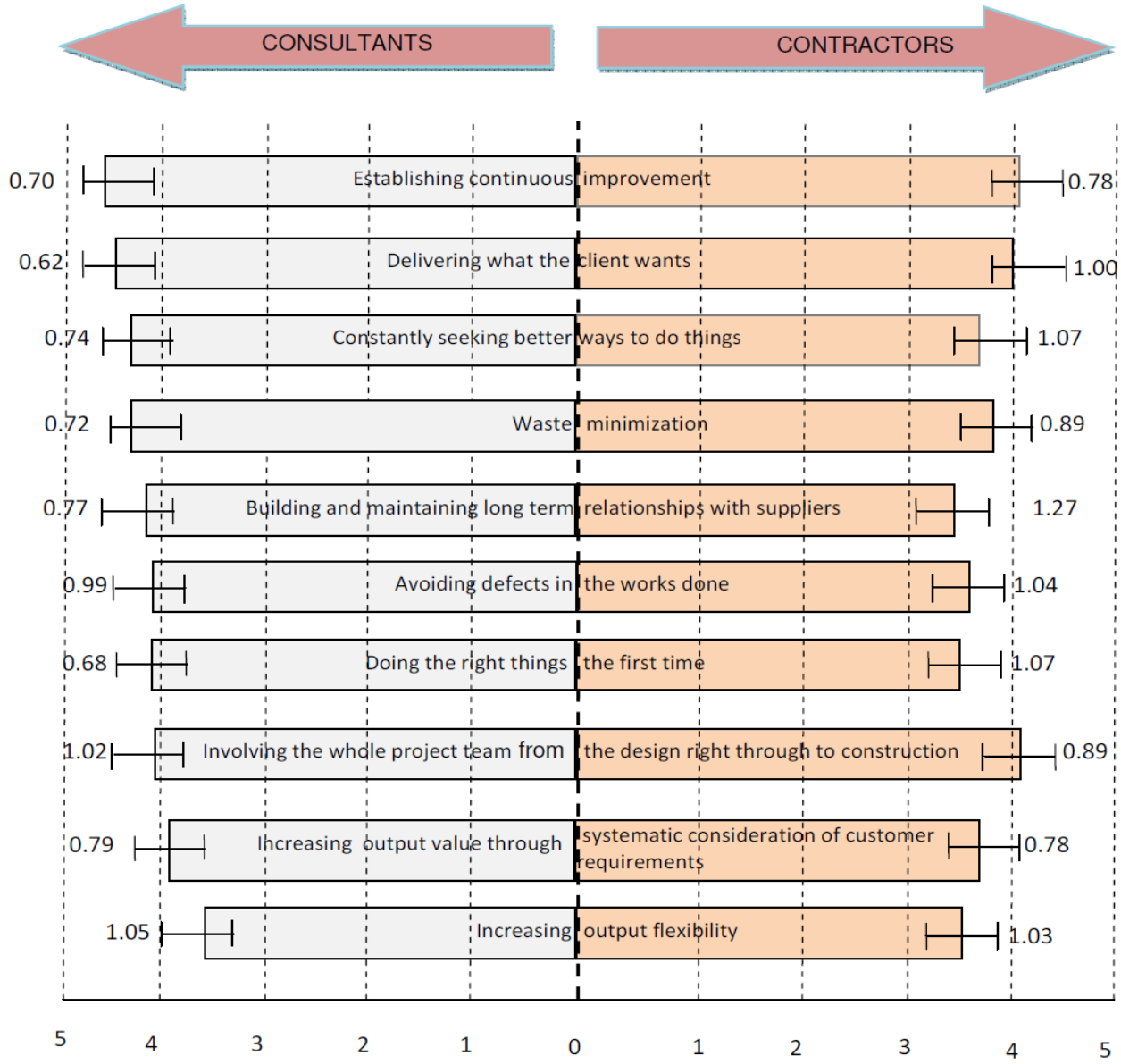

Fig 1 Level of agreement of respondents to the application of ten basic principles to project execution

Achievability of customer values

All the respondents were of the opinion that customer values are very important and highly achievable in their firms. The respondents' evaluation of the level of achievability of various customer values is presented in Figure 2.

The results show that mean scores of all the customer values evaluated are greater than 2.5 (Field, 2005), indicating that in the opinion of the respondents, these customer values are significantly important and achievable within their firms' activities. Whereas the consultants

consider ‘minimizing waste, eliminating all non-value adding activities and maximizing the use of resources’ as the most important and achievable customer value, the contractors consider ‘keeping everything simple right from design to completion’ (Figure 2). Other customer values such as ‘perfect first time quality, achieving zero defects, revealing and solving problems at the source’, ‘continuous improvement, reduction of costs, increase quality and productivity’ and ‘increasing output flexibility including the production of different mixes and/ or greater diversity of products, without compromising efficiency’ are also considered significantly important and achievable by both the contractors and the consultants.

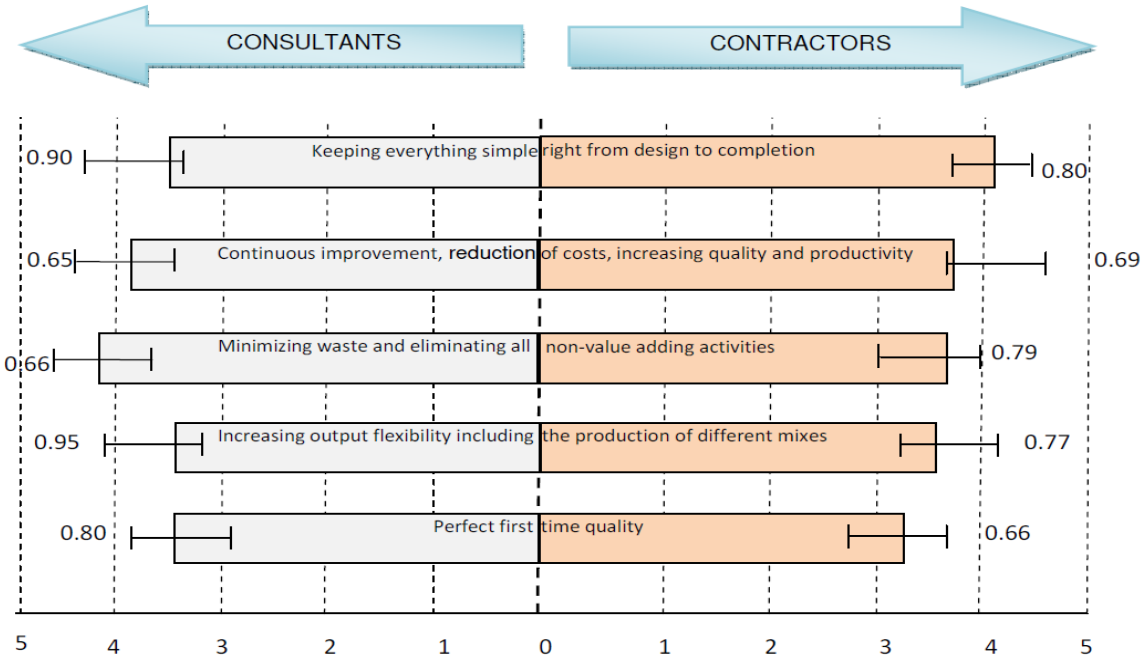

Fig 2 Respondents evaluation of the level of achievability of various customer values

Benefits of lean construction

The respondents were asked to evaluate nine benefits of LC gathered from the literature and confirmed through interviews. Mean scores and rankings of the benefits are presented in Figure 3. In the opinion of the consultants, the first three most important benefits expected from the application of LC are ‘improvement of project delivery methods’, ‘promotion of continuous improvement in project delivery methods through lessons learned’ and ‘delivery of products or services that enable clients to better accomplish their goals’ (Figure 3). To the contractors, however, ‘delivery of products or services on time and within budgets’, ‘promotion of continuous improvement in project delivery methods through lessons learned’

and 'delivery of products or services that enable clients to better accomplish their goals' are the first three most important benefits likely to be achieved from the application of lean principles (Figure 3). The results show that all the benefits of LC evaluated have mean scores greater than 4.00, indicating that they are all highly beneficial to construction organizations. The findings from this study confirm those from the literature. Mossman (2009) and Lehman and Reiser (2004) reported of benefits from LC such as 'more satisfied clients', 'productivity gains', 'greater predictability', and 'shorter construction periods'.

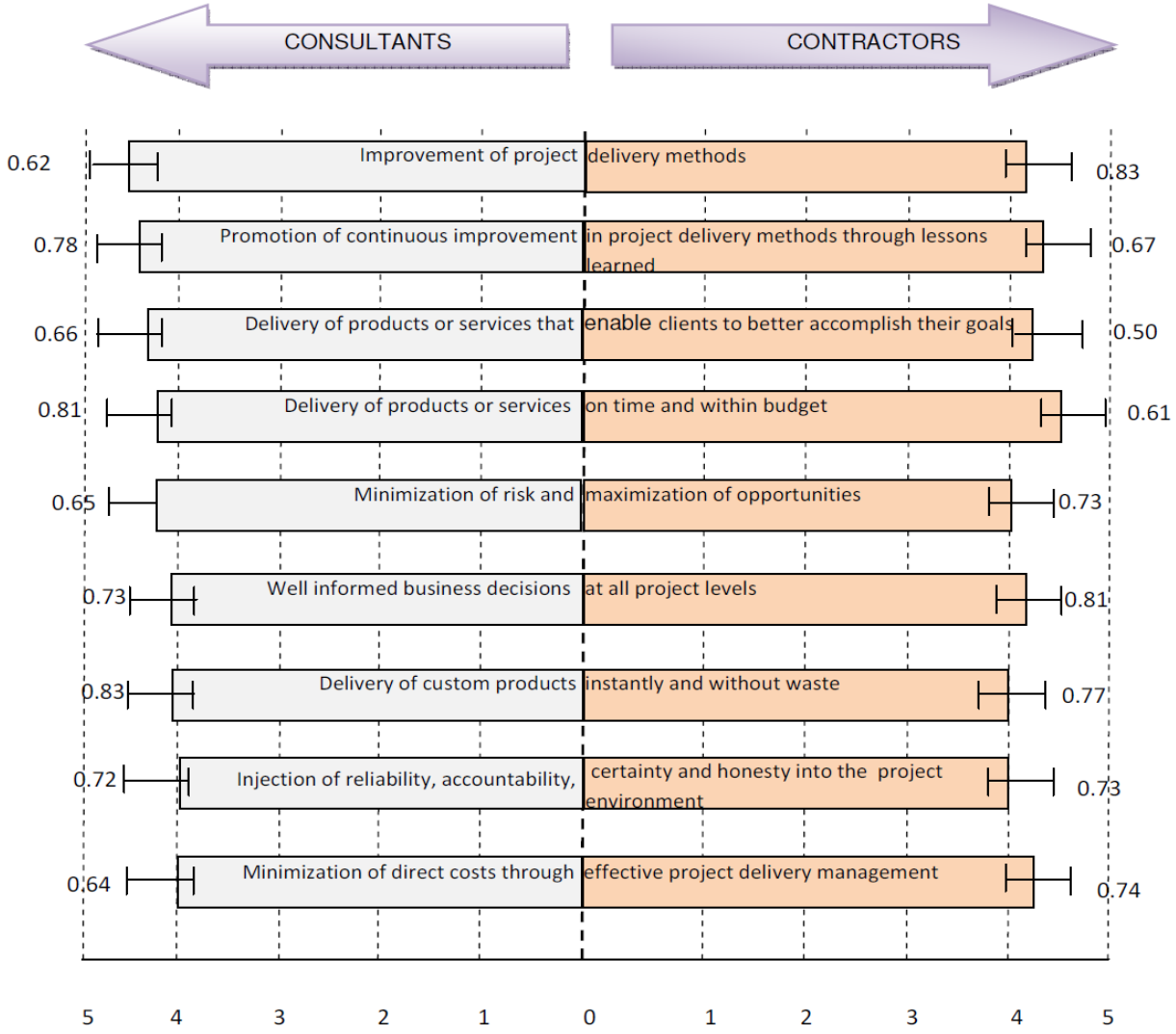

Fig 3 Respondents evaluation of the benefits of LC

Measures to bridge the knowledge gap

In the opinion of the consultants, the first three most important measures to bridge the knowledge gap are 'firms should change organizational culture that does not promote LC', 'firms should promote the LC concept to all stakeholders' and 'the construction industry should fund workshops and research conferences to promote transfer of knowledge on LC' (Figure 4). To the contractors, however, 'firms should train employees at all levels on LC', 'firms should engage competent and skilled site operatives' and 'firms should promote the LC concept to all stakeholders' are the first three most important measures (Figure 4). All the measures evaluated in the study have mean scores greater than 2.5 (Field, 2005) and therefore considered significant and important for bridging the knowledge gap on LC.

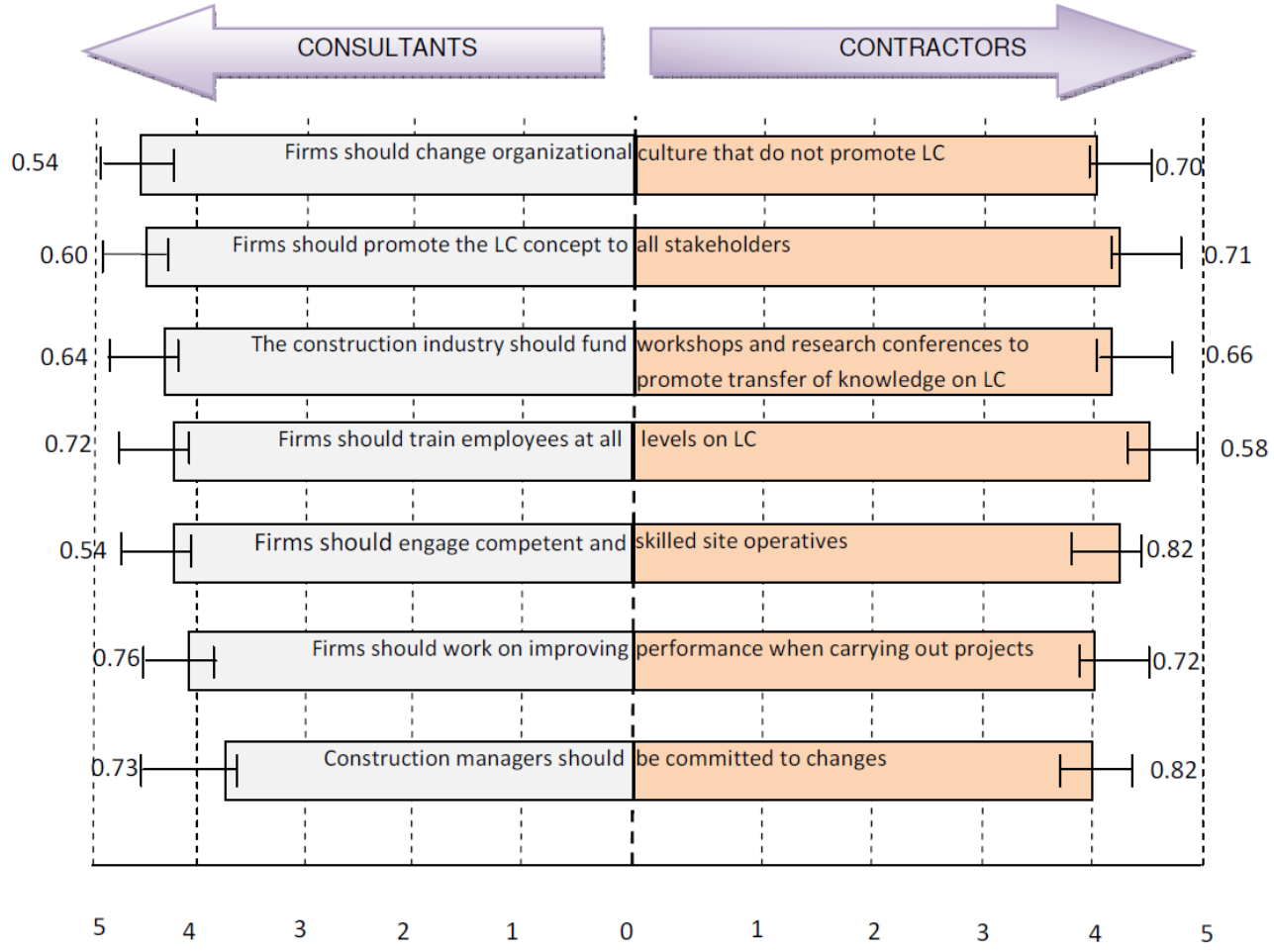

Fig 4 Respondents evaluation of measures to bridge knowledge gaps

CONCLUSION AND RECOMMENDATIONS

The study has shown the existence of some level of awareness among professionals in the Ghanaian construction industry on the concept of LC. Principles adopted by construction organizations in their activities such as 'delivering what the client wants', 'establishing continuous improvement', 'constantly seeking better ways to do things', 'minimizing waste' and 'avoiding defects in works done' are found to be generally consistent with LC practice. Majority of the construction professionals surveyed are receptive to lean principles implementation in the construction industry, and are also of the opinion that the transfer of LC principles into the construction industry would bring a lot of benefits including 'improvement of project delivery methods' and 'delivery of products or services that enable clients to better accomplish their goals'. In order to bridge the knowledge gap, it is suggested among others that construction firms should change organizational culture that does not promote LC and also promote the LC concept through workshops and conferences.

Although the study failed to cover all categories of contractors due to lack of reliable information on the large number of small scale contractors, the fact that Ghanaian construction practitioners are ready to accept and implement the concept of LC gives hope for the future. The findings are of value to construction organizations seeking to improve productivity through work efficiency and materials waste reduction in their operations. The adoption of LC would prove to be rewarding in these regards. Further research is suggested on the perceptions of construction clients of the LC philosophy.

REFERENCES

Alinaitwe H. M.,2009, "Prioritizing Lean Construction Barriers in Uganda's Construction Industry". Journal of Construction in Developing Countries. 14, 15-30.

Abdelhamid, T.S., 2004, The self destruction and renewal of lean construction theory: A prediction from Boyd's Theory. In Proceedings of the 12th Annual Conference of the International Group of Lean Construction, Helsinga, Denmark.

Abdullah S., Abdul-Razak A., Abubakar A. and Mohammad I. S., 2009, Towards Producing Best Practice in the Malaysian Construction Industry: The Barriers in Implementing the Lean Construction Approach. In Proceedings of the International Conference on Construction Industry, Padang, Indonesia.

Architects Registration Council of Ghana, 2010, List of fully registered architectural firms in Ghana, available at http://www.archghana.org. [accessed 13/05/2011]

Ballard, G. and Howell G., 2004, Competing Construction Management Paradigms. Lean Construction Journal, 1, 38-45.

Bashir, M.A., Suresh, S., Proverbs, D.G. and Gameson, R., 2010, Barriers towards the sustainable implementation of lean construction in the United Kingdom construction organizations. In: Proceedings ARCOM Doctoral Research, Construction and Infrastructure, School of Engineering and the Built Environment, University of Wolverhampton, U.K.

Begum, R.A., Siwar, C., Pereira, J.J. and Jaafar, A.H. (2006) Implementation of waste management and minimization in the Malaysian construction industry. Conservation and Recycling, 51, 190-202.

Common, G., Johansen, E. and Greenwood, D., 2000, A survey of the take-up of lean concepts among UK construction Companies. Proceedings of the 8th International Group for Lean Construction Annual Conference. Brighton, United Kingdom 2000.

Dulaimi, M.D. and Tanamas, C., 2001, The principles and applications of lean construction in Singapore, Proceedings of the IGLC 9, Singapore.

Field, A., 2005, Discovering Statistics Using SPSS, 2nd ed. Sage, London.

Forbes, L. and Ahmed, S., 2004, Adapting lean construction methods for developing nations. Second LACCEI International Latin America and Carribean Conference for Engineering and Technology (LACCEI'2004) "Challenges and Opportunities for Engineering Education, Research and Development" 2-4 June 2004, Miami, Florida, USA.

Ghana Institution of Surveyors, GhIS, 2010, List of fully registered quantity surveyors in Ghana. Available at http://www.ghisonline.org. [accessed 13/05/2011]

Israel, G.D., 1992, Sampling the evidence of extension program impact. Program Evaluation and Organizational Development, IFAS, University of Florida. PEOD-5, October.

Jin, V.L.A., 2008, Lean construction. Knowledge and barriers to its implementation in the Malaysian construction industry. An unpublished Thesis at the Universiti Teknologi, Malaysia.

Johansen, E. and Walter, L., 2007, Lean Construction: Prospects for the German Construction Industry. Lean Construction Journal, 3, 19-32.

Johansen, E., Glimmerveen, H. and Vrijhoef, R., 2002, 'Understanding Lean Construction and how it penetrates the Industry: A Comparison of the Dissemination of Lean within the UK and the Netherlands', Proc. 10th Ann. Conf. Intl. Group for Lean Constr. Gramado, Brazil, 6 - 8 August 2002. Available at: http://www.cpgec.ufrgs.br/ (Accessed: 08 June 2005).

Kempton, J., 2006, Can lean thinking apply to the repair and refurbishment of properties in the registered social landlord sector? Structural Survey, 24(3), 201-211.

Koskela, L. and Howell, G., 2002, The Underlying Theory of Project Management is obsolete. Proceedings of the PMI Research Conference, 2002, 293-302.

Kpamma, E.Z., 2009, The practice of lean thinking at the pre-contract stage of building construction projects by selected Ghanaian firms. Unpublished MSc Thesis, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

Laryea, S. and Mensah, S., 2010, The evolution of indigenous contractors in Ghana. In: Proceeding of West African Built Environment Conference, Accra, Ghana, 579-588.

Lehman, T. and Reiser, P., 2004, Maximizing value and minimizing waste: Value engineering and lean construction. In SAVE International 44th Annual Conference Proceedings, July 12-15, 2004.

Mathew Hunter Associates, 2005, Lean Thinking Works in Construction Too. Available at http://www.contractormag.com/articles/newsarticles.

Ministry of Water Resource, Works and Housing, MWRWH, 2011, "List of registered building contractors in Ghana", available at http.//ghana-net.com/ Ministry of Water Resources Works and Housing_Ghana.aspx

Mossman, A., 2009, Why isn't the UK Construction Industry going lean with gusto? Lean Construction Journal, 5 (1), 24-36.

Polat, G. and Ballard, G., 2004, Waste in Turkish Construction- Need for Lean Construction Techniques. Proceedings of the 12th Annual Conference of the International Group for Lean Construction IGLC-12, August, Denmark, 488-501.

Salem, O., Solomon, J., Genaidy, A. and Minkarah, I., 2006, Lean construction: From theory to implementation. Journal of Management in Engineering, 4, 168-175.

Salem, O. and Zimmer, E., 2005, Application of Lean Manufacturing Principles to Construction. Lean Construction Journal, 2(2), 51-54. Available at www. Leanconstructionjournal.org