International Journal of Sustainable Construction Engineering & Technology (ISSN: 2180-3242)
Vol 6, No 1, 2015

Improving Delivery of Construction Projects in Ghana's Cities: A Lean Construction Approach

Emmanuel Kwaku Salifu-Asubay[1], Collins Adjei Mensah[2*]

[1]Works Department, Accra Metropolitan Assembly, Accra, Ghana
[2] Centre for Urban and Regional Studies, University of Birmingham (UK), B15 2TT
[2] Department of Geography and Regional planning, University of Cape Coast, Cape Coast, Ghana

*Corresponding E-mail: collinsadjeimensah@gmail.com

Received 24-12-2014; Revised 31-12-2014; Accepted 1-1-2015

Abstract

The construction industry plays a vital role in the physical and socio-economic development of cities. However, poor execution and frequent breakdown of construction works such as roads and houses obstruct the overall development of cities since most social and economic activities depend of these projects. This paper sought to assess the extent to which lean construction principles are utilised in construction activities in Ghana's cities and ways that these principles can be applied effectively to improve the delivery of construction works. The study concentrated in Accra, Kumasi and Sekondi-Takoradi cities whilst officials from the Metro Works Departments of the selected cities and various construction professionals constituted the target population. Questionnaire was the research instrument employed and Spearman Rank Correlation Coefficient Test was used to analyse the results. It was revealed that various lean construction principles such as value, value stream, flow, pull and perfection are poorly implemented with each of these principles having less than 50 percent rate of application. Barriers such as long lead time, poor procurement system and contracts, cultural and human factors, political influence, and lack of financial and management commitment were found to be responsible for that. To successfully apply the lean construction principles and enhance the sustainability of construction projects, measures such as benchmarking, process mapping, last planner procedures and continuous training of workers in the construction industry have been recommended.

Keywords: *Construction projects, lean principles, Ghana*

1.0 Introduction

The construction industry plays a significant role in the development of every country. Statistics shows that in many countries across the world the construction industry alone contributes between 5 and 10 percent of gross domestic product (GDP), and employs up to 10 percent of the working population [1]. In most developing countries, the construction sector happens to be one of the fastest growing sectors with average growth of 7-8 percent per annum [2]. This is as result of rapid expansion of infrastructural developments by both the government and the private sector to address the socio-economic needs of the general public.

In Ghana, many construction projects are being undertaken to overcome numerous demands for housing and other social infrastructure by both the inhabitants and foreigners who need these constructions for purposes such as homes, offices, business activities, schools, hospitals and other social amenities for their livelihood. Most of these construction projects are undertaken in cities where a chunk of the human population dwells and many development activities are concentrated. Studies show that over 60 percent of construction projects in Ghana are executed in big cities such as Accra, Kumasi, Sekondi-Takoradi, and Tamale [3]. These projects are mostly supervised by the Metro Works Departments which are under the Metropolitan Assemblies of these cities, and the Ministry of Local Government and Rural Development of Ghana. As part of the activities of the Metro Works Departments, they are supposed to make sure that the deliveries of all construction projects and infrastructure developments meet the needs of clients and end-users in Ghana. The main clients in this case are

the government of Ghana and city authorities whereas the end-users are the tax-payers and all the facility users.

However, evidence shows that the construction industry in Ghana is faced with a host of challenges which have reflected in poor execution of many construction projects all over the country. For example, the delivery of construction projects have been found to be characterised with delays in the preparation of technical specifications and drawings, extensive cost, time overruns, and shoddy works [4,5]. A study by Nicco-Annan [6] on the construction of office buildings in some cities in Ghana revealed cost overruns of between 60-180 percent. Time overruns of between 12-24 months was also observed. Most of the escalations in prices and much long time in completing those building projects were attributed to much waste in the construction process. Waste in this context refers to "mistakes, working out of sequence, redundant activity and movement, delayed or premature inputs, and products or services that don't meet customer needs" [7]. A study by Boakye [8] found that as much as 50 percent of all housing units in Ghana are constructed with poor quality building materials such as mud bricks and earth, and mostly with thatched roof and poor floor construction materials. The study further revealed 74,000 kiosks and containers housing several thousands of people with a large number of urban dwellers sleeping on pavements, walkways and streets.

Matters of awarding contracts to unqualified contractors, cronyism and kickbacks have also been highlighted to hinder successful delivery of construction projects in Ghana with the end result being waste of resources in the construction sector [9]. Furthermore, it has been found out that the performance of workers in the construction sector in Ghana is below 40 percent efficiency rate due to lack of good supervision, poor training and incentives [8]. Worsening this problem is the fast deterioration of construction works and sudden collapse of buildings in cities due to the poor way they were constructed. The two main cities in Ghana (Accra and Kumasi) over the past five years have witnessed several collapses of storey buildings killing many people and destroying several properties (Fig. 1). This further raise concerns about how many buildings and other construction projects are poor executed in Ghana.

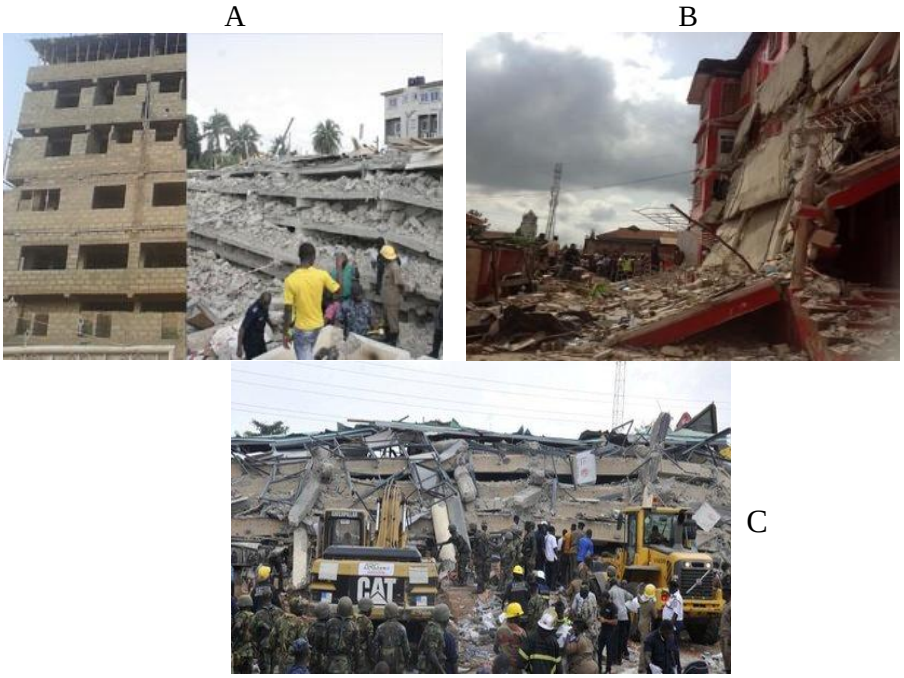

Figure 1: Images of recent collapse buildings in Accra and Kumasi
Source: [10-12]

A*: Collapse building in "Nii Boi Town" (Accra),* ***B****: Collapse building in "Krofrom" (Kumasi)*
C*: Collapse of Melcom building in Accra*

Despite all these challenges, not much effort have been made by the government of Ghana and various city authorities to find appropriate measures to enhance the delivery of construction projects in Ghana. It is therefore to bridge this knowledge gap that this study was undertaken to assess the extent to which lean construction principles are utilised in construction activities in Ghana's cities and ways that these principles can be applied effectively to improve the delivery of construction works. The next section provides theoretical underpinnings of lean construction which is followed by the methodology and the main findings of the study.

2.0 The Lean Construction Theory

The lean construction theory traces its origin from Japan in the 1950s [13]. It was derived from a Japanese word "Muda" which means waste. The theory generally covers elimination of waste in the manufacturing and construction sector [14]. The primary goal of lean construction theory is to minimise or avoid waste in the construction process as well as construction cost [13, 14]. Kotelnikov [15] asserted that the application of lean principles help in checking defects in construction works by selecting the best contractor who has the best resources and experience to manage construction projects. According to Abdelhamid et al. [16], lean construction involves the holistic pursuit and continuous improvements in the entire construction processes by integrating design and construction phases, product cycles involving clients, consultants, contractors as well as the entire supply team (supply chain).

The theory has five main principles which help to bring efficiency in the construction process. The five principles are value, value steam, flow, pull and perfection. The value principle deals with getting maximum outcomes at minimal cost which is often the basic aim of many sectors, be it corporate, manufacturing, or the service sector [17, 18]. Kelly et al. [17] stated that in value management, value is articulated in worth or money, and for high value to be achieved the construction sector has to observe and appreciate organizations effort to achieve its customer's or client's value. According to Kerzner [19], total quality management is one particular objective which forms the basis of lean construction. This means that the value of a customer in the construction process is of great concern. Hence, the value of a client should be achieved at the early stage, transformed into the design process and incorporated into the final product.

The value stream principle involves the identification of all current processes involved in realising the clients' value so that each of the stages or processes can individually be analysed [20]. Value stream becomes necessary once clients value for a project is established and available as benchmarking tool for waste identification, reduction or elimination. It is more effectively done if each individual process is identified and mapped up [14]. It thus involves all the basic steps in the planning and execution of construction processes with the aim of identifying what is beneficial and non-beneficial so as to eliminate waste in the entire construction process.

The flow principle covers the movement of materials and information through 'input - process - output' chain [21]. According to Howell and Ballard [21], stabilizing work flow in this chain reduces waste. Any labour shortage, delay in the supply of materials to project site, lack of equipment and late delivery of vital information are as a result of bad planning and this can badly affect the smooth and continuous flow of the project. It is necessary to know what work will be available (planning) so that labour can be matched to it and so do any other resources. Hence, with the flow principle, workload and various resources must be coordinated with the actual competence of those to whom task are assigned [22].

The pull principle in the lean construction theory deals with the delivery of products and services according to the specific demand of the clients [14]. The pull principle works to facilitate the effectiveness of the flow strategy by delivering products to the customer as soon as specified by clients [20]. One of the strategies of achieving this is through the use of buffers which help in compensating for differing average rates of supply, sequence and uncertainty [23]. It is pertinent for an organization to utilize buffers in the construction process as it helps in the elimination and management of waste especially during delivery difficulties. The customer occupies a grand place in the pull principle as he or she is much affected by this principle. Logistic pull is a strategy under the pull principle which specifies the materials that should only be brought to a project site

based on demand and "just in time" philosophy [24]. The "just in time" (JIT) philosophy concerns an organization meeting its customers' demand in terms of time and proportion thereby ensuring smooth flow in the delivery process [24, 25].

The last lean construction principle which is the perfection principle focuses on improvement to achieve the best desired outcomes. Koskela [13] pointed out that it is important for strategies to be put in place in construction industry to stimulate continuous improvement. Once an improvement has been made and the flow and pull strategies are established, the next thing to do will be to standardize the process [21]. To achieve this, the client organization and all the supply chain organizations are required to identify, quantify and measure all the key indicators of their project performances in order to arrive at the target or required standard [26]. The lean construction theory has therefore been illustrated diagrammatically to simplify the whole idea and the interrelationships that exist among the five principles as shown in Fig. 2 [27].

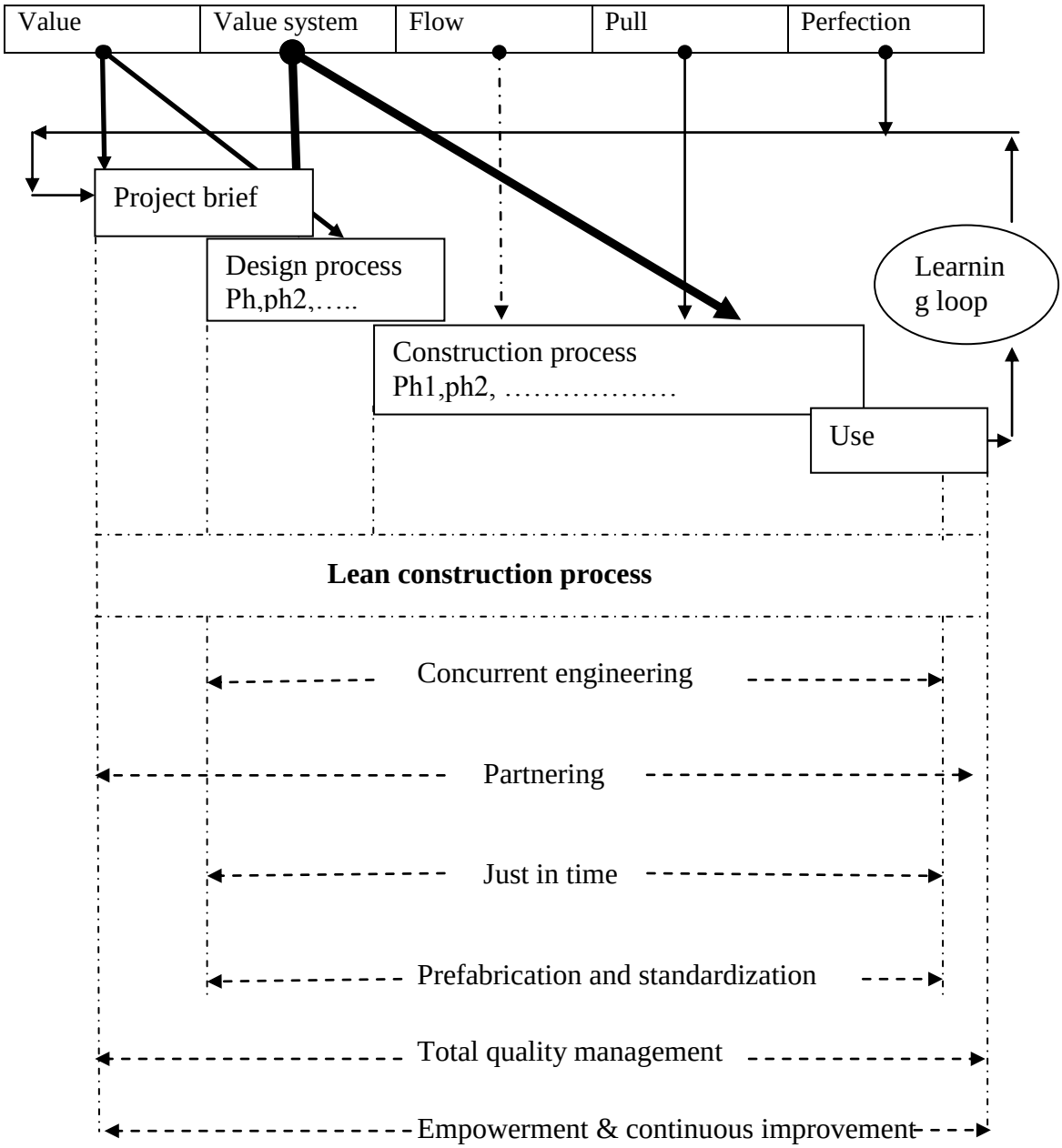

Figure 2: The lean construction model

According to Kaleshie [27], the model has two hierarchies which work in a complementary manner. The first hierarchy covers the five principles, and their intersections and links with other processes within the model¸ while the lower hierarchy describes how all the principles and processes combines into one homogenous entity in the construction process.

The upper hierarchy of the model has the value principle which subdivides into project brief and design process phases as its main components. The value stream in related terms branches like value into the design process and construction process phases. This shows some similarities in the operation between value and value stream as indicated in the model (Fig. 2). The flow and pull principles all link directly to the construction process phases, while perfection principle connects with all the processes: project brief, design process and construction process phases. At this integration and intersection stage, all the principles and processes melt and flow vertically into the second hierarchy where the real or actual construction is done. At the actual construction level, the practical construction practices such as the concurrent engineering, partnering, just in time, prefabrication and standardization, total quality management, empowerment and continuous improvement are applied to give rise to maximum waste management, reduction or elimination in the construction process for clients and end users to get value for their money.

3.0 Materials and Methods

Cross-sectional survey design was used and this deals with collecting data from a given population about a particular phenomenon at a definite point in time [28, 29]. This research design helped the study to gather data from different respondents, and draw inferences from their views on the topic understudy to make inform conclusion within a short period of time. The study covered three major cities in Ghana; Accra, Kumasi and Sekondi-Takoradi. The rationale is that these cities are well known in Ghana to be hot spots for many development and trading activities. As a result of that huge amount of construction activities and infrastructural developments are undertaken in these areas. These made their inclusion very essential so as to help the study gather much data about construction projects to give true reflections of construction activities in Ghanaian cities. The Metro Works Departments (clients) and their supply team (supply chain) constitute the target population for the study. Professionals such as structural engineers, architects, construction managers, building inspectors were selected from the Metro Works Department. The supply team or supply chain comprised of representatives from the design team, the management team, contractors, sub-contractors, and nominated contractors. The nature of the study which demands technical and expert knowledge of professionals involved in construction activities in cities made the involvement of these broad categories of people vital.

In all, 90 respondents were randomly selected with 30 respondents each from the three cities covered in the study. Information from the Metro Works Departments and the city authorities in each of the cities were used to generate a sample frame from which the respondents were randomly selected. The study was quantitative in nature and questionnaires were administered to the selected respondents. The questionnaire was dominated by 5 point likert scale form of questions. The spearman rank correlation coefficient test [30] was therefore used to analyse the results of the two categories of respondents (clients and the supply chain). It was done using the following formula:

$$rho = 1 - \frac{6\sum d^2}{N(N^2 - 1)}$$

Where:

d = the difference in ranking between each pair of factors
N = number of factors/questions

Before performing the spearman rank correlation coefficient test, the mean scores of the responses of the respondents were first calculated out of the formular:

$$Ms = \frac{\sum(f \times s)}{N}, (1 \leq MS \leq 5)$$

Where:

s = score given to each factor (question) by the respondents and ranges from 1 to 5 where 1 is never and 5 is always
f = frequency of response to each rating (1-5) for each factor.
N = total number of response concerning that factor.
Ms = Mean score.

4.0 Results and Discussion

This aspect of the paper provides in-depth analyses and discussion of the findings of the study. The results of the spearman rank correlation coefficient test are provided in Tables 1 and 2. For the purposes of clarity and easy understanding, the findings on the application of the lean construction principles have been grouped into two. The first aspect combines the results of all the respondents to have a general overview about how lean construction principles are applied in construction projects in Ghana (Table 1). The second aspect separates the respondent's responses to know the differences and similarities in their responses (client and supply chain) on the application of lean construction principles in the study area (Table 2).

Table 1: The level of application of lean construction principles in the study area (All Respondents)

NO.	ITEM	N	Min	Max	Mean Score	Rank
	VALUE:					
1	Meet the requirements of the customer	90	1	5	3.18	5
2	Stakeholders involvement	90	1	5	2.67	29
3	The use of value management workshops to obtain project briefs	90	1	5	3.08	10
4	Selecting contractors and project execution companies base on value for money	90	1	5	2.59	30.5
5	Selecting contractors and other execution companies based on lowest price	90	1	5	2.52	33
	VALUE STREAM					
6	Process Mapping	90	1	5	2.79	25
7	Work and process standardisation	90	1	5	3.13	7
8	Ensure management commitment	90	1	5	3.03	17
9	Fast track and concurrent engineering	90	1	5	3.12	8
10	Encourage employee empowerment	90	1	5	3.47	1
11	Employee training at every level	90	1	5	3.01	19.5
	FLOW:					
12	Long term partnering	90	1	5	2.39	36
13	The use of the last planner/reliable production scheduling/	90	1	5	3.06	13.5
14	The use of JIT principles/supply chain management	90	1	5	3.11	9
15	The right organizational culture	90	1	5	3.14	6
16	Reduce difficult set-ups and change overs	90	1	5	2.72	28
	PULL					
17	Heaping material on site (material buffer)	90	1	5	3.06	13.5
18	The end-user driving project initiation	90	1	5	3.04	15.5
19	Use of small batch sizes	90	1	5	2.82	23
20	Understand buffer size and location	90	1	5	2.76	26
21	Reduce difficult set-ups and change overs	90	1	5	2.81	24
	PERFECTION					
22	Continuous performance measurement	90	1	5	2.99	21
23	Benchmarking	90	1	5	3.01	19.5
24	Project documentation	90	1	5	3.27	3
25	Financial/ Non-financial measurement	90	1	5	3.21	4
26	Best practice	90	1	5	3.07	11.5

Table 2: The level of application of lean construction principles in the study area (Client and Supply Chain)

NO.	ITEM	CLIENT		SUPPLY CHAIN	
	VALUE:	Mean	Rank	Mean	Rank
1	Meet the requirements of the customer	3.05	11	3.23	4
2	Stakeholders involvement	2.67	29	2.67	29
3	The use of value management workshops to obtain project briefs	2.86	21	3.09	10.5
4	Selecting contractors and project execution companies base on value for money	2.59	30.5	2.59	30.5
5	Selecting contractors and other execution companies not based on lowest price bid	2.53	34	2.47	34
	VALUE STREAM				
6	Process Mapping	2.79	24	2.79	25
7	Work and process standardization	3.13	7	3.13	7
8	Ensure management commitment	3.03	13	3.03	18
9	Fast track and concurrent engineering	3.12	8	3.12	8.5
10	Encourage employee empowerment	3.47	1	3.47	1
11	Employee training at every level	2.76	25.5	3.12	8.5
	FLOW:				
12	Long term partnering	2.52	35	2.33	36.5
13	The use of the last planner/reliable production scheduling	2.99	17.5	3.07	13.5
14	The use of JIT principles/supply chain management	3.20	4	3.07	13.5
15	The right organizational culture	3.14	5.5	3.14	6
16	Reduce difficult set-ups and change overs	2.72	28	2.72	28
	PULL				
17	Heaping material on site (material buffer)	3.01	15.5	3.07	13.5
18	The end-user driving project initiation	3.04	12	3.04	17
19	Use of small batch sizes	2.82	22	2.82	23
20	Understand buffer size and location	2.76	25.5	2.76	26
21	Reduce difficult set-ups and change overs	2.81	23	2.81	24
	PERFECTION				
22	Continuous performance measurement	2.99	17.5	2.99	21
23	Benchmarking	3.01	15.5	3.01	20
24	Project documentation	3.27	2	3.27	3
25	Financial/ Non-financial measurement	3.21	3	3.21	5
26	Best practice	3.10	9	3.05	16

4.1 Value

Under this lean construction principle, the respondents shared similar views on two factors. These are "the selection of contractors and project execution companies based on value for money", and "selecting contractors and other execution companies not based on lowest price bid". The low rankings of 30.5 and 34 respectively by the client and the supply chain on the two factors indicate that both are aware of their wasteful activities in construction projects (Table 2). These low rankings mean that the clients and the supply chain consider it less important to select contractors and other project execution companies' based on value for money. They also consider it less important to award contracts not based on lowest price bid.

According to lean construction principles, contractors and other project execution companies must be selected based on value for money and not based on lowest price bid in order to give clients/end-users value for money [7, 31]. What was found by the study about contracts being awarded based on lowest price bide is contrary to the lean construction principles and requires greater attention if lean practices are to be improved and value for money is to be achieved [16, 17, 32]. Similar findings came up in a study by Bekoe et al. [33] which revealed that many construction projects in Ghana are awarded to contractors based on low price bid resulting in many shoddy construction works. This is because such poor way of selecting contractors often results in selecting low qualified contractors who lack the needed skills, experience and equipment to undertake projects that will last long.

4.2 Value stream

Two main factors in the value stream that are very important to the lean construction process were ranked low by the respondents. These factors were "process mapping" and "employee training at every level". The joint ranking of the respondents for process mapping was 25. This implies that the process mapping as a tool which is suitable for identifying and eliminating waste is less used in construction activities in Ghana. Furthermore, employee training as a factor was also ranked 19.5 by the respondents indicating that this is also less valued in Ghana's construction industry. This is very critical as it denies the employees in the construction industry the opportunity to be exposed to innovative practices that can help the construction industry to perform good works and improve their performance in general. This reflected in the respondents advocating for local planning authorities to empower employees in the construction industry by ranking the factor "encourage employee empowerment" 1 (Table 2). From the literature on lean construction principles, employee empowerment in a form of additional training and upgrading of skills is very important as it plays a role in helping to change the site-based manufacturing nature of the construction industry to the factory based nature. This factor if well implemented helps to standardised most of the construction activities for improved and efficient products to be produced.

4.3 Flow

The literature on lean construction principles shows that 'long-term partnering' is one way the construction industry could avoid unnecessary waste and drive in value for money [24]. Long-term partnering received very low rankings by the two categories of respondents. The clients ranked it low at 35 whilst the respondents in the supply chain category also ranked the same factor at 36 (Table 2). This shows that there are limited long-term partnering arrangements in Ghana's construction sector which do not help eliminate unnecessary conflict that characterise most construction projects. This problem do not allow the realisation of benefits such as reduction in cost and time in the production/construction circle which are often derived from long-term partnering with other organizations [34, 35].

One other factor worth commenting under the flow principle is the use of 'last planner' procedures for planning construction works. Individual rankings given to this factor by the client and the supply chain were 17.5 and 13.5 respectively. The factor was also ranked 13.5 when the scores of the two categories of respondents were put together. This indicates less use of this factor by both clients and the supply chain. The last planner procedure forms part of the core elements of lean construction practices. It is found to be a suitable method of planning construction activities and for eliminating buffers [36]. The low use of the last planner principles in the construction activities in Ghanaian cities was found to hinder fast completion of projects. This is because the necessary resources, time and money that the last planner procedures could provide to enhance construction projects are not utilised in the construction sector. For example, the long delays and large sums of money that go waste in many construction projects in Ghana as observed by Nicco-Annan [6] can therefore be linked to the poor usage of the last planner procedures since those projects did not had better planning before they commenced.

Similarly, the JIT philosophy which facilitates the last planner procedures and also works well based on the 'pull' strategy was ranked 4 and 13.5 by the client and the supply chain respectively. This indicates that the JIT philosophy is applied by the clients and rarely by the supply chain. Both respondents ranked the application of the JIT philosophy in their activities at 9. Inadequate use of this this philosophy means that benefits attached to it such as eliminating unnecessary waste in a form of double handling, inventory management, and the cost associated with acquiring storage space are not achieved in the study area [34].

4.4 Pull

Concerning the pull principle, some disparities were observed in the views of the respondents on the factor that covers "the end-user driving project initiation". Whilst this factor was ranked 12 by the clients, the supply chain group ranked it 17. Although this shows inadequate compliance of the pull lean principle in Ghana, but it was observed that it does not cause much problem in the construction sector since most of the projects are driven by the end-user [36].

In addition to this, an average ranking of 15.5 and 13.5 was given by the respondents in the clients and supply chain group respectively on the factor 'heaping materials on site (material buffer)'. This factor is referred to as waste in the lean construction theory [23]. The cost associated with buffer management in lean construction has been found to be very high and must be avoided or minimised but this was not the case in Ghana [36]. Studies on waste management problems in Ghanaian cities revealed that many construction activities create heaps of waste materials at construction sites which disrupt many activities including even construction projects that are on-going at those sites [37, 38]. Such heaps of waste materials also cause poor sanitation conditions and health problems for residents living around construction projects.

4.5 Perfection

One factor that was ranked very high by both respondents in the client and supply chain group was "project documentation" (it was ranked 3, see Table 1). This was because the respondents felt that the Metro Works Departments have a duty to play in the area of project documentation. The literature on lean construction shows that most of the bad performance records in the construction industry are due to the industry's inability to document its project processes [39]. Base on project documentation, lessons learnt from previous project can be transferred onto future projects for continuous performance improvement.

A closer look of individual results obtained from the respondents in the client and the supply chain showed an agreement in opinion on the "financial and non-financial performance measurement" factor. Both respondents consider the factor as being very crucial, and therefore ranked it very high (Tables 1 and 2). This means that this factor is highly used in the construction sector. However, there are other performance improvement factors like 'benchmarking and best

practice' was ranked at 15.5 and 20, and 9 and 16 respectively by both respondents under the client and supply chain category (Table 2). Such performance measurement factors are very useful for pursuing performance improvements. According to Garnett and Pickrell [40], companies should adopt performance improvement strategies such as best practice (learning the good practices adopted competitors) refers to as benchmarking to remain competitive.

Taking into account the views of the respondents on all the lean construction principles, it came out that these principles are poorly put into practice in Ghana. None of the principles was able to achieve 50 per cent application rate in the construction sector. All the principles had low application rate of less than 45 per cent with the perfection principle having the lowest rate of 30 per cent as shown in Fig 3.

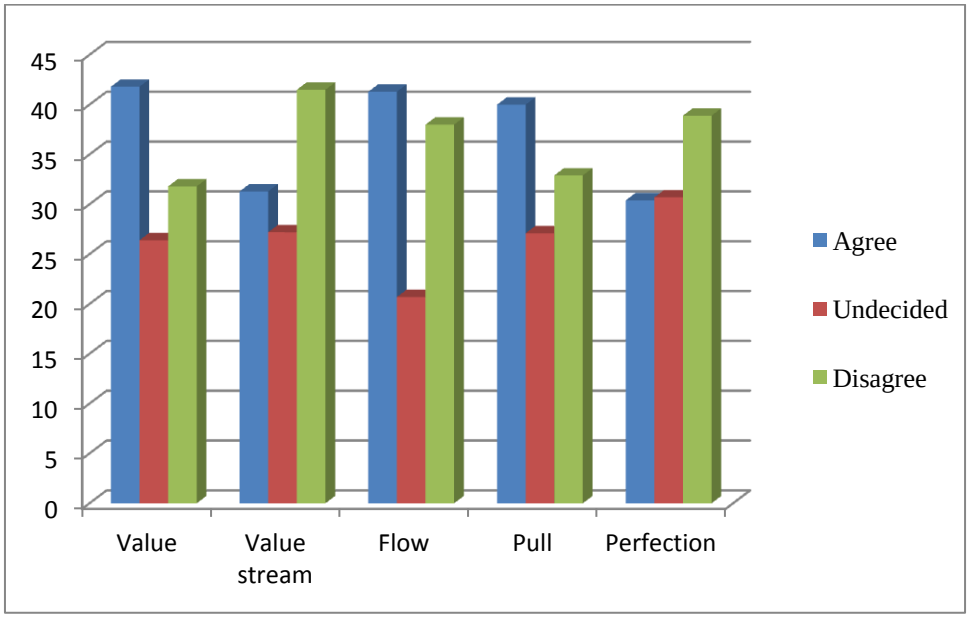

Figure 3: Respondents views on the application of lean construction principles in Ghana

4.6 Barriers to successful implementation of lean construction principles

After knowing that there is poor application of the lean construction principles in Ghana, it became very important to probe further to know the various barriers or challenge responsible for that. The major barriers that were found to hinder successful implementation of lean construction principles in Ghana included long lead time, poor procurement system and contracts, cultural and human factors, political influence, and lack of financial and management commitment. The long lead time was ranked high as a key barrier to successful implementation of lean construction principles in Ghana (Table 3). This problem covers long time duration in executing projects and associated delays in in the supply of materials for a project. This long time was observed to have caused many projects in the study area to be in standstill for several years causing many resources pumped into those projects to go waste. This constitutes time and cost overruns which have been highlighted as major problems affecting many construction projects in Ghana [4, 5].

Table 3: Barriers to successful implementation of lean construction principles

NO.	ITEM	N	Min	Max	Mean Score	Rank
	Barriers to successful implementation and maintenance					
27	Poor procurement system and contracts	90	1	5	3.02	18
28	Cultural and Human Factor	90	1	5	3.07	11.5
29	Political influence	90	1	5	2.98	22
30	Concept not familiar	90	1	5	2.73	27
31	Delay in payments	90	1	5	2.49	35
32	High interest rate	90	1	5	2.38	37
33	Materials availability	90	1	5	2.51	34
34	Trust	90	1	5	2.59	30.5
35	Less utilization of standard components and prefabrication, modular systems	90	1	5	2.24	38
36	Variation in designs during construction	90	1	5	2.56	32
37	Long lead time	90	1	5	3.31	2
38	Lack of financial and management commitment.	90	1	5	3.04	15.5

The problem of poor procurement system and contracts was found to result from the authorities in charge not putting in place appropriate procurement system for different construction companies to bid for projects. Sole sourcing is most often done and contracts are awarded straight away to low bidders without the necessary procurement system being followed. This finding corroborates Frimpong et al.'s [41] observation in many developing countries which linked poor delivery of construction projects to inappropriate way contracts are given to contractors. This problem had some connection with the political influence barrier which was found to result from government officials interrupting the laid processes for awarding construction contracts to give projects to contractors that they have close political and social ties with but not based on the competence of those contractors.

Another major barrier to successful implementation of the lean construction principles in the study areas was lack of financial and management commitment. Many construction projects were found to be characterised with long delays of payments to contractors. This problem does not motivate contractors to undertake public construction works which have been commissioned to start or are already underway. Such poor financial and management commitment from the clients especially the government of Ghana and local city authorities do not support effective application of the lean construction principles especially the flow and pull principles. The flow and the pull principles for example require the provision of various materials and services to perform specific tasks on construction projects which demand much financial and management commitments. Absence of such commitment really affects the smooth delivery of construction projects. The human and cultural barrier was also very critical since some construction projects were observed to be still undertaken using traditional methods which consume much time and often produce low quality works. Most construction workers lacked the necessary skills and knowledge on modern construction practices such as application of the lean construction principles. This makes it difficult for the lean construction principles to be well applied in many construction projects in Ghana.

5.0 Conclusion and the way forward

In all, based on the findings of the study it can be deduced that lean construction principles are poorly applied in Ghana's construction sector especially in the construction activities in cities such as Accra, Kumasi, and Sekondi-Takoradi where the study was carried out. The gross inefficiencies and waste of resources in construction projects revealed by the study clearly confirmed this. All the five broad lean construction principles (value, value stream, flow, pull and perfection) were found to be poorly implemented. Hence, to minimise and possibly completely avoid undue waste of resources on public construction projects, the local city authorities must show committed effort to apply lean construction principles for its benefits to be realised. Taking into account the findings of the study, some strategies offer useful approaches for successful implementation of the lean construction principles in Ghana. One of such strategies is benchmarking, which is a performance measurement activity that compares an organisation's performance internally and externally with a competitor as a way of acquiring knowledge to improve performance. The use of this strategy by local government authorities and Metro Works Departments will help in awarding construction contracts to companies whose performance are of high standards and activities conform to lean construction practices. This will help to address problems such as delays in completion of construction projects and shoddy construction works which is a major problem in Ghana.

Another useful strategy is process mapping. It deals with identifying value and non-value activities which can be added or not added to construction projects to make such projects viable devoid of unnecessary use of resources. Application of this strategy will help to eliminate activities that cause excessive cost and time overruns. Furthermore, the application of "last planner" procedures for planning construction works also serves as another important strategy. This covers careful planning of construction activities before and during the execution of construction projects to ensure effective delivery of projects. The local government authorities using the "last planner" ideology can plan very well to secure enough funds and other essential materials in advance before awarding any construction contracts. Such planning will help easy flow of materials, and elimination of buffers for projects to be delivered on time. It will generally help to address lack of financial and management commitments by local government authorities which often cause many construction projects to be in standstill for long time before they are completed. Training of employees under the construction sector by way of upgrading their skills and knowledge on lean principles is also important. This will help the employees to be well abreast with the lean construction principles and hence conform to such principles to undertake construction projects efficiently and effectively.

References

[1] Lopes, J. (2012). Construction in the economy and its role in socio-economic development. In: G. Ofori (Edi), *New perspectives on construction in developing countries*. Spon, Abingdon, pp. 40-71.

[2] Osei, V. (2013). The construction industry and its linkages to the Ghanaian economy-polices to improve the sector's performance. *International Journal of Development and Economic Sustainability*, 1(1): 56-72.

[3] Salifu-Asubay, E. K. (2014). *The application of lean construction practices to the building construction projects delivery in Ghana.* Master's dissertation, University of Birmingham, UK..

[4] Essabra-Mensah, E. (2014). *Gov't concerned about construction industry challenges.* Retrieved October 31, 2014 from http://thebftonline.com/content/gov%E2%80%99t-concerned-about-construction-industry-challenges.

[5] Odonkor, A. K. (2011). *The effect of strategic risk management on project delivery; A case study of the construction industry in Ghana.* Master's thesis, Institute of Distance Learning, Kwame Nkrumah University of Science and Technology.

[6] Nicco-Annan, J. (2006). Partnering in construction. *The Quantity Surveyor*, 1:14-19.
[7] Constructing Excellence (2004). *Lean construction*. Retrieved December 17, 2014 from http://www.constructingexcellence.org.uk/pdf/fact_sheet/lean.pdf.
[8] Boakye, C., K. (2010). *Addressing Ghana's housing and job creation challenge*. Retrieved December 15, 2014 from http://www.ghanaweb.com/GhanaHomePage/features/ artikel.php?ID=179235.
[9] National Audit Office (2000). *Modernising construction*. Victoria: NAO Press Office.
[10] Spy Ghana (2014). *Too many building collapse in Ghana.* Retrieved November 21, 2014 from http://www.spyghana.com/too-many-building-collapse-in-ghana/.
[11] Alhassan, I. (2013). *Collapsed building kills two in Kumasi.* Retrieved November 21, 2014 from http://thechronicle.com.gh/collapsed-building-kills-two-in-kumasi/.
[12] BBC (2012). *Melcom shop collapse in Ghana: Search for bodies ends*. Retrieved November 13, 2014 from http://www.bbc.co.uk/news/world-africa-20280712.
[13] Koskela, L. (1992). *Application of the new production philosophy to construction*. Technical report No.72 Centre for integrated facilities engineering, Stanford University.
[14] Womack, J., & Jones, D. (1996). *Lean thinking: Banish waste and create wealth in your Corporation.* New York, NY: Simon & Schuster.
[15] Kotelnikov, V. (2005). *Lean production: Doing more with less.* Retrieved March 6, 2014 from http://www. I000ventures.com/business guide/lean production main.html.
[16] Abdelhamid, T. S., El-Gagy, M., & Salem, O. (2008). Lean construction: Fundamentals and principles. *American Professional Constructor Journal*, 4: 8-19.
[17] Kelly, J., Male, S., & Graham, D. (2004). *Value management of construction projects.* Oxford: Blackwell Science Ltd.
[18] Ikovenko, S., & Bradley, J. (2004). *TRIZ as a Lean Thinking Tool.* ETRIA TRIZ Future Conference, Florence, Italy, November 3 – 5.
[19] Kerzner, l-I (2003). *Project management: A system approach to planning, scheduling and controlling* (eight edition). New Jersey: John Wiley and Son Inc.
[20] Ballard, G. (1999). *Improving workflow reliability*. IGLC-7 Proceedings, University of California, Berkeley, USA.
[21] Howell, G., & Ballard, G. (1997). Lean production theory: Moving beyond can do. In: Alarcon, L. (Ed), *Lean construction* (17-23). Leiden: Balkema.
[22] Randolph, H. T., Horman, M. J., Minchin Jr., R. E., & Chen, D. (2003). Discussion of Improving labour flow reliability for better productivity as lean construction principle. *Journal of construction engineering and management*, 129(3): 251-261.
[23] Howell, G., & Ballard, G. (1995). *Implementing lean construction: Reducing inflow variation.* A presentation made at the 2nd Annual Conference on lean construction at Catolica Universidad de Chile Santiago, Chile.
[24] Cain, C. T. (2004). *Profitable partnering for lean construction*. Oxford: Blackwell publishing.
[25] U.S. Environmental Protection Agency (2005) *Lean thinking and methods*. Retrieved January 12, 2014 from http://www.epa.gov/innovation/lean/thinking/.
[26] Ellis, R. D. (1997). Identifying and monitoring key indicators of project success. In: Alarcon, L. F. (Edi), *Lean construction*. Santiango: Pontificia Universidal Catolica de Chile.
[27] Kaleshie, G.Y. (2006). *The application of lean construction practice to urban roads infrastructure projects in Ghana*. Master's Dissertation, Heriot-Watt University School of Built Environment.
[28] Hall, J. (2008). Cross-sectional survey design." In: Lavrakas, P. J (ed), *Encyclopedia of survey research methods* (pp.173-174). Thousand Oaks, CA: Sage.
[29] Mann, C. J. (2003). Observational research methods. Research design II: Cohort, cross sectional, and case-control studies. *Emerg Med J*., 20:54–60.
[30] Myers, J. L., & Well, A. D. (2003). *Research design and statistical analysis* (2nd ed.). Lawrence: Erlbaum Associates Inc.
[31] Murdoch, J., & Hughes, W. (2003). *Construction contracts: Law and management* (3rd ed.). London: Spon Press.
[32] Kelly, J. R., & Male, S. P. (1991). *The practice of value management: Enhancing value or cutting cost?* London: Royal Institution of Chartered Surveyors.
[33] Bekoe, R., Quartey, E. F., & Dumolga, A. (2013). Assessing the performance of local contractors on government projects in the Akuapem North Municipal Assembly, Akropong-Akuapem Eastern Region – Ghana. *European Journal of Business and Management*, 5(8):111-124.

[34] Pheng, L. S., & Chuan, C. J. (2001). Just-in-time management in precast concrete construction: A survey of the readiness of main contractors in Singapore. *Integrated Manufacturing Systems*, 12: 416-429.

[35] Balamuralikrishna, R., Athinarayana, R., Song, X. (2000). The relevance of concurrent engineering in industrial technology programs. *Journal of Industrial Technology*, 16:3.

[36] Ballard, G. (1997). Implementing lean construction: Stabilising work flow. In: Alarcon, L. F. (ed), *Lean construction*. PontificiaUniversidalCatolica de Chile, Santiango, Chile.

[37] Ayarkwa, J., Agyekumand K., & Adinyira, E. (2011). Exploring waste minimization measures in the Ghanaian construction industry. *Built Environment Journal*, 8 (2):22-30.

[38] Tsiboe, I. A., & Marbell, E. (2003). A look at urban waste disposal problems in Accra, Ghana. Master's thesis, Roskilde University.

[39] Fisher, D. J. (1997). The knowledge process. ln: Alarcon, L. F. (ed.), *Lean construction.* Santiango: Pontificia Universidal Catolica de Chile.

[40] Garnett, N., & Pickrell, S. (2000). Benchmarking for construction: Theory and practice. *Construction Management and Economics*, 18 (1): 55-63.

[41] Frimpong, Y., Oluwoye, J., & Crawford, L. (2003). Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study. *International Journal of Project Management*, 21: 321–326.