

*Full Length Research Paper*

# **Confined site construction: A qualitative investigation of critical issues affecting management of health and safety**

**John P. Spillane<sup>1</sup>, Lukumon O. Oyedele<sup>1\*</sup>, Jason Von Meding<sup>1</sup>, Ashwini Konanahalli<sup>1</sup>,  
Babatunde E. Jaiyeoba<sup>2</sup> and Iyabo K. Tijani<sup>3</sup>**

<sup>1</sup>School of Planning, Architecture and Civil Engineering Queen's University Belfast, United Kingdom.

<sup>2</sup>Department of Architecture, Faculty of Environmental Design and Management,  
Obafemi Awolowo University Ile-Ife, Nigeria.

<sup>3</sup>Department of Graphic design, School of Art, Design and Printing, The City University Yaba, Lagos, Nigeria.

Accepted 23 May, 2011

**The construction industry is inherently risky, with a significant number of accidents and disasters occurring, particularly on confined construction sites. This research investigates and identifies the various issues affecting successful management of health and safety in confined construction sites. The rationale is that identifying the issues would assist the management of health and safety particularly in inner city centres which are mostly confined sites. Using empiricism epistemology, the methodology was based on qualitative research approach by means of multiple case studies in three different geographical locations of Ireland, UK and USA. Data on each case study were collected through individual interviews and focus group discussion with project participants. The findings suggest that three core issues are the underlying factors affecting management of health and safety on confined construction sites. It include, (i) lack of space, (ii) problem of co-ordination and management of site personnel, and (iii) overcrowding of workplace. The implication of this is that project teams and their organisations should see project processes from a holistic point of view, as a unified single system, where quick intervention in solving a particular issue should be the norm, so as not to adversely affect interrelated sequence of events in project operations. Proactive strategies should be devised to mitigate these issues and may include detail project programming, space management, effective constructability review and efficient co-ordination of personnel, plant and materials among others. The value of this research is to aid management and operation of brownfield sites by identifying issues impacting on health and safety management in project process.**

**Key words:** Brownfield sites, confined site, health and safety management, construction management, case studies, space management, city centres, site management, project management, project planning.

## **INTRODUCTION**

The construction industry is in a point of transition. In the last four years, for the first time in history, urban population growth has surpassed rural settlement, with this trend set to continue (Cohen, 2004; United Nations, 2008). On a global scale, Cohen (2004) highlighted that urban growth is set to almost double from 2.86 billion in

2000 to almost five billion in 2030. The construction industry is therefore shifting towards increased growth in the area of urban construction and regeneration sector. Bidy (2009) argues that, contrary to belief, urban centres are not expanding, but instead, they are being redeveloped from within, with a large majority of construction in urban areas occurring on brown field, inner city congested sites. Li et al. (2007) continues by outlining that 49% of the world's population live in urban areas, a figure which is expected to grow to 61% by 2030. Bidy (2009) also emphasises that the number of

\*Corresponding author. E-mail: [l.oyedele@qub.ac.uk](mailto:l.oyedele@qub.ac.uk) Tel: +44 (0) 28 9097 4478. Fax: +44 (0) 28 9097 4278.

urban developments is increasing; suggesting that confined site construction is rapidly becoming the norm in the industry. Tindiwensi (2000) continues this point by indicating that “increased population has put a premium on inner city sites. The building that occupies virtually the whole site area is now commonplace”.

Dixon (2009) furthers this point by reporting that in 2001, 80% of the population in the United Kingdom lived in urban areas and of this, 41% of urban dwellers lived in one of the ten most populous areas. Also, this 80% of the population are spread over just 9% of the country. Li et al. (2007) furthermore outlines that with the increase in the global population at the end of the last century, there has been a noted “surge of population influx to urban centres”, further exasperating urban growth. Walker (2007) argues that with the addition of ever more demanding construction designs and the introduction of countless sub-contractors and third parties to the modern construction process, the management of this limited resource - space, becomes even more crucial to the successful completion of a proposed development. In addition to these burdens placed upon construction project managers, they too must acknowledge and facilitate legal requirements, such as implementing effective health and safety policies, effective client and personnel management, all while trying to initiate and execute the successful completion of an often complex development.

As a result of this increased development on inner city and spatially restricted environments, there is a propensity for increased accidents (Haslam et al., 2005) occurring on sites of these nature. Where spatially restricted working environments exist, research has indicated that a number of health hazards may arise, mainly due to overcrowding and operating large plant in congested spaces (Kim et al., 2005). Kartam et al. (2000) summarises the overall benefit of implementing and maintaining a high level of health and safety on-site, by documenting that the cost of implementing effective safety protocol may be as small as 2.5% of labour cost on a project, with the benefit of reducing the accident rate from between 50 to 85%. Where such instances are mitigated, there is a possibility for increased savings due to reduced insurance premiums (Leopold and Loenard, 1987), increased productivity (Sanders and Thomas, 1992) and schedule compression (Chang et al., 2005), to name a few. Through acknowledging such issues, Stenier (2005) echo's the belief that effective space management in the workplace can result in increased levels of health and safety with the ultimate goal of increasing productivity and employee satisfaction. As a whole, the construction industry must acknowledge and counteract the inherent risks associated with working in environments where spatial restrictions are evident (Lingard and Rowlinson, 2005).

It is on this basis that this study aims to identify various issues relating to health and safety management on a

confined construction site. Effective management and co-ordination is essential to mitigate the possibility of accidents occurring on-site (International Labour Office, 1995). Through highlighting the numerous issues in the management of health and safety on a confined construction site, it is possible for on-site management to identify those issues relative to their surroundings and incorporate appropriate strategies to alleviate such risks. Using an explorative qualitative approach, multiple case studies by means of unstructured interviews and focus group discussions were conducted for data collection. The case studies involve project team members and site personnel of three different construction sites in Ireland, UK and USA. Causal loop diagram was used to supplement the presentation of data findings. The key findings of this research will assist in the overall management of confined site environments coupled with aiding on-site management in the continuous strive towards achieving an unblemished health and safety record in a particularly risky environment such as confined construction site.

## LITERATURE REVIEW

When reviewing the numerous publications on the subject of health and safety in the construction industry, it is worth noting that in the vast majority of cases, the focus of attention is on the management of confined spaces on a construction site and not on the management of a confined construction site where space is a limited resource, as in the case of urban and inner cities developments. On assessing the various pieces of literature available on health and safety on construction sites, the majority fails to acknowledge the increased managerial burden on health and safety in relation to confined site construction. The International Labour Office (1995) briefly illustrates the potential problems of working in confined sites by providing a concise summary of available strategies. There are numerous books and articles written on project management and managing construction process. Levy (2006), Walker (2002) and Gould (2001), all outline the various obstacles with which management must overcome from project inception to completion and handover, to ensure successful project completion, but all fail to detail the effective management of spatially congested sites.

Many studies have indicated and underlined the importance of appropriately designing and managing site layout, to ensure that adequate levels of health and safety are attained (Elbeltagi et al., 2004; El-Rayes and Khalafallah, 2005; Sanad et al., 2008). This design is mainly illustrated in cases where space is plentiful, which is not often the case on inner cities' urban developments. Illingworth (2000) and Cooke and Williams (2004) also highlight the importance of an effective and well designed construction site layout, but gave little emphasis on the importance of such practices in confined site locations,

particularly in relation to health and safety. In today's environment, even with the sustained global recession that has led to the lowering of value to majority of these sites, the cost of development land is still a significant factor when purchasing development land in these areas (Cunningham, 2007). Barnes (2009) outlines that after two years of a decline, development land prices are beginning to rise once more in the United Kingdom. Other such instances where health and safety issues arise are due to the close proximity in which personnel have to work with each other (Sowman, 2006; Thomas and Horman, 2006). Cotton (2009) highlighted that overcrowding of the workplace can be a risk factor, particularly in cases where the program of works is accelerated or already congested.

The United Kingdom's (UK) Health and Safety Executive (HSE) (2003a) identified overcrowding of construction sites as a major factor and that better management is essential to overcome this issue. An additional variation, onto which research has been conducted, is that of the construction site planning with respect to the surrounding environment and its effects on health and safety. Sanad et al. (2008) identifies the need for efficient on-site layout planning to an acceptable level of consideration with regards to the surrounding environment along with safety considerations. When exploring the various research papers, detail articles and literature on issues affecting health and safety in confined site construction are very limited. This area of concern is very important to today's construction practice due to the increased risk posed to project site employees and the associated public particularly in cases where spatial restrictions are evident on-site.

## METHODOLOGY

Since there are few references in construction addressing confined site construction, it was imperative for the research team to use a methodological approach that would be explorative in nature in order to identify relevant issues impacting health and safety management in confined site construction. Accordingly, a philosophical tradition of empiricism was adopted using multiple case studies methodology. The multiple case studies would ensure construct validity and reliability of the study's results, since more than one case would be analysed. The multiple case studies consist of three confined site construction in Ireland, United Kingdom and USA – United States of America. The selections of the three case studies were based on convenience sampling technique using the research team network of contacts in the construction industries of the three countries, as compared to random sampling. This was done in this study because not all construction works operates in confined construction environment. Examples of studies within the realm of construction management that have used this type of sampling approach include Akintoye et al. (1998), Li et al. (2005), Oyedele and Tham (2005, 2007).

The use of different case study in three different countries would enable transferability and wider applicability of the research findings. Each case study in the three countries was selected due to the complexities, difficulties and overall lack of space evident on each of the sites assessed. The three case studies that fulfilled the criteria were a low rise apartment complex, a mid rise hotel complex

and a high rise condominium development in Limerick (Ireland), Liverpool (United Kingdom) and Chicago (USA – United States of America) respectively. In each case, the majority of the site was occupied by the building footprint, leaving very little room around the perimeter of the building for the accommodation of the various facilities and amenities necessary to complete such a project. For each of the case studies, a two-way research approach that consists of individual interviews and focus group discussions with key personnel were used as techniques for gathering data for the study. For each case study, three individual interviews and a focus group discussion were conducted with project team members.

Using this two-way research approach was based on three major reasons. Firstly, this was to enable identification of all relevant issues affecting health and safety in each confined site. Secondly, while the individual interviews serve as the initial step to explore issues, the focus group discussions helps to validate the issues identified in the interviews by enabling deeper insights into group thinking and shared beliefs (Sommer and Sommer, 2002). Finally, the focus group discussion further explores other relevant issues that the interviews did not previously identify. The choice of three interviews for each case study was based on the principle of triangulation, which helps validate any assertions made by any of the project participants. All these motives lead to credibility (authentic representations) and operationalization with confirmability that are essential evaluative criteria for empiricism research (Lincoln and Guba, 1985). Imperfections of focus group discussion that include dominations by few individuals were mitigated through proactive approaches of the research team. These include, steering conversations across the group to allow contributions from every member of the focus group, at the same time maintaining openness and neutrality, so as not to allow research team biases into the discussion. All interviews and focus group discussion were taped and video recorded and were later transcribed and checked alongside all the notes taken, so that any valuable data is not omitted. Each of the case studies is further discussed in detail as follows.

### Case study 1: Low rise apartment in Limerick, Ireland

This is a six-storey development in the heart of Limerick city in Ireland. It encompasses retail units on the ground floor, office facilities to the front and residential property to the rear. The site is bound on two sides by roads with the remaining sides bounded by existing property, and has a central courtyard over underground parking. The construction phase of the project was still in progress as at the time of data collection with over 70% completion. The main contracting organisation handling the project has been in existence for about 21 years both as a main contractor and developer and has handled eleven confined site constructions throughout its history. Three separate interviews were conducted with personnel working on the case study project and include, contract manager, project director and site engineer.

On average all the three personnel have fifteen years of experience and have been involved on average in more than seven confined site construction throughout their professional career as at the date of the interviews. The interview format was an unstructured interview to achieve the explorative intent of the study and avoid biases on the part of the research team on possible issues relating to health and safety on the confined site. All the three interviews last for an average duration of 45 min. After conducting these interviews, a focus group discussion was conducted, involving different personnel that were not interviewed to ensure result validity. Seven personnel participated in this focus group discussion and include, project manager, site manger, foreman and four site operatives (a joiner, two bricklayers and a carpenter). Including site operatives in the focus group discussion allows the research team to hear the views of personnel at the lowest cadre of the project team, who are

mostly affected by health and safety issues on site. The focus group discussion lasted for about 75 min and was conducted in the project site office.

### **Case study 2: A mid-rise hotel complex in Liverpool United Kingdom**

This is a thirteen story hotel complex, located in Liverpool, England. It is a city centre development, located beside a train station in the heart of Liverpool, United Kingdom. Just like the first case study, this site is bound on two sides by roads with the remaining sides bounded by existing property. As at the time of data collection, construction phase was just about 30% completed, having just finished the substructure. The main contractor handling the project have handled more than seven confined site construction in its history of operation and has been in existence for about 37 years. Three separate unstructured interviews were also conducted and include senior site manager, site foreman and finishing foreman, all having an average of 12 years experience in the construction industry. The focus group discussion includes five personnel – the project architect, site engineer and three site operatives (two bricklayers and an electrician), and lasted for about 55 min in the project site office.

### **Case study 3: A high-rise condominium development in Chicago USA**

Located towards the south side of Chicago, Illinois in North America, it comprises of a large thirty-five story tower of condominiums, along with a smaller tower of loft apartments, coupled with retail, leisure and ample parking facilities. The site is bound on three sides by road, with the fourth side bounded by an existing property. As at the time of data collection, construction phase was about 90% completed. Constructing high-rise and loft apartments is the core business of the main contractor handling the project, having been in operation for about 43 years. Just like the first two case studies, three separate unstructured interviews were conducted and include chief operations officer/director, senior site engineer and senior site manager. The focus group discussion includes the project manager, three site superintendents and the facade finishing co-ordinator. One average the interviews duration was 53 min while the focus group discussion lasted for 70 min in the site office. The findings of the three case studies are discussed subsequently.

## **RESULTS**

The transcribed data from the individual interviews and focus group discussion under each case study were amalgamated and examined. A comprehensive list of issues impacting health and safety management on each case study site was compiled and shown in Table 1. A total of 17 issues were identified from all the three case studies. While some issues are common to all the three, some were peculiar to a particular case study. For example, issues such as “difficulty in ensuring proper arrangement and collection of waste materials on-site”, and “close proximity of individuals to large plant and machinery”, among other issues, were common to all the three case studies. On the other hand, issues such as “difficulty in providing temporary facilities on-site to cater

for the needs of the site effectively”, and “difficulty in controlling hazardous materials and equipments on site”, were peculiar only to case study 1 and 3 respectively. Of the total 17 issues identified, 10 were widespread, signifying 58.8% commonality of issues across the three case studies. 88.2% (15 out of 17) of the issues are common in at least two of the three case studies. This shows some level of universality among the issues identified, irrespective of the geographical location of the confined construction sites used as case studies.

The transcribed data also showed that some of the identified issues are interrelated and influenced by other variables based on the views of the interviewees and members of the focus groups. These are deciphered and presented using causal loops diagram shown in Figure 1. Sterman (2000) illustrates that where a positive relationship (+) occurs, when the cause increases, the effect increases proportionately or when the cause decreases, the resulting effect decreases. In the case of a negative relationship (-), where the cause decreases, the effect increases and alternatively, when the cause decreases, the resulting effect increases. The implication of the causal loop diagram is that although the various issues largely occur in isolation, there are cause and effect actions among the variables. Where changes or deviations occur within the parameters of the influencing variables, there is a propensity for the associated issues to exhibit a causal sequence.

This sequence, once interrupted by a change or deviation from the norm, results in influencing neighbouring characteristics or variables within different causal loops. This can often adversely affect the interrelated sequence of events among the associated variables once a particular issue is not efficiently or effectively tackled, thus adding to the severity of the whole system. The implication of this is that project process shown be seen from a holistic point of view as a unified single system and quick intervention in solving any particularly issues should be the norm. Further scrutiny of the transcribed data shows that there are some core issues, which were echoed on numerous occasions throughout the interview process and focus group discussions. The core issues were perceived by the interviewees and focus group participants as the critical underlying factors influencing the 17 issues identified in Table 1 and the various variables in the causal loops diagram presented in Figure 1. These core issues include:

1. Lack of space,
2. Problem of co-ordination and management of site personnel, and
3. Overcrowding of workplace.

In addition, each of these factors was further validated through discussing the results of the analysis with participants to the research. This aided in the validation

**Table 1.** Issues affecting health and safety management across case studies.

| Issues affecting health and safety management in confined site construction |  | Case study 1 | Case study 2 | Case study 3 |
|---|--|--------------|--------------|--------------|
| 1   | Difficulty in positioning temporary facilities to avoid accidents from falling heights               | X            | X            |              |
| 2   | Difficulty in controlling hazardous materials and equipments on site.                                |              |              | X            |
| 3   | Difficulty in ensuring proper arrangement and collection of waste materials on-site.                 | X            | X            | X            |
| 4   | Close proximity of individuals to operation of large plant and machinery.                            | X            | X            | X            |
| 5   | Increased possibility of over-crowding the workplace due to lack of available space.                 | X            | X            |              |
| 6   | Effective lighting of confined areas on site to ensure health and safety of all concerned.           | X            | X            | X            |
| 7   | Intersections and collisions of personnel in heavily travelled routes during construction operations | X            | X            | X            |
| 8   | Difficulty in ensuring personnel getting to and from their area of work safely.                      | X            |              | X            |
| 9   | Difficulty in ensuring site is tidy and all plant and materials are stored safely.                   | X            | X            | X            |
| 10  | Difficulty in providing temporary facilities on-site to cater for the needs of the site effectively. | X            |              |              |
| 11  | Difficulty in the management of on-site traffic.   | X            | X            | X            |
| 12  | Increased safety risk due to various tasks being executed in close proximity to each other.          |              | X            | X            |
| 13  | Difficult to account for and manage personnel due to the restricted working conditions.              | X            | X            | X            |
| 14  | Difficulty to move materials around site safely  | X            | X            | X            |
| 15  | Workplace becoming over-crowded.   | X            | X            | X            |
| 16  | Lack of adequate room for the effective handling of materials.                                       | X            |              | X            |
| 17  | Lack of adequate storage space.  | X            | X            | X            |

■ = Issues common to only one case study; ■ = Issues common to two case studies; ■ = Issues common to three case studies.

of the results along with confirming the cogency of the findings. To continue the confirmation of the information attained, external experts from the industry were also consulted to discuss the results. These external industry experts were 11 professionals with membership affiliation to various professional bodies that include ASCE (American Society of Civil Engineers), ICE (Institution of Civil Engineers) in the UK and CIOB (Chartered Institute of Building) and RICS (Royal Institute of Chartered Surveyors) in Ireland and UK. Similarly to the earlier data collection, they were selected in Ireland, UK and USA construction industries based on convenience sampling technique and have an average of 17 years experience. They have worked on average in more than five confined construction sites

throughout their professional careers as at the time of data collection. They all confirmed that the three core issues are the main underlying factors influencing many of the problems encountered during health and safety management in confined construction sites. To assess the content provided from the industry experts along with the individual inter-views and focus group discussion, each of the core issues is further discussed under discussion, with a close emphasis on existing literature to aid in further validating of the results of the qualitative analysis.

## DISCUSSION

The three core underlying issues of lack of space,

problem of co-ordination and management of site personnel and overcrowding of workplace are discussed as follows.

### Lack of space

The most identifiable characteristic of a confined construction site is the inherent lack of space in which to manage and accommodate the various tasks and ancillary items required to ensure successful management of health and safety on-site. On reviewing the various interviews, focus group and industry experts' discussions, they highlighted that the lack of space was the core issue in the management of a confined construction site. Also, the point was made that



engineering design, short deadlines, enormous pressure from clients, and the need to build faster". This coupled with the increased difficulty of managing various project tasks in limited spatial surroundings, illustrate the continued and heighten management pressure, due to lack of space on-site and its resulting effect on health and safety.

On analysing the various spatial requirements, it is evident that effective management and planning is essential to the success of a project and this is even more critical in the case of a confined construction site environment. Other strategy to combat this issue is through well-organized design site layout. The lack of space within a confined construction site environment is therefore an underlying issue with respect to the health and safety of the employees on-site and the general public as a whole.

### **Problem of co-ordination and management of site personnel**

The second fundamental problem to successful management of health and safety in a confined construction site environment is the problem of co-ordination and management of the personnel on-site. Zhang et al. (2000) argues that due to the ever increasing number of project participants coupled with the increasing complexity of a modern development, it is essential that on-site personnel be effectively managed. Loosemore et al. (2003) highlights the importance of human resource management in construction projects, particularly in relation to employee's health and safety. They argued that 'people are an organisations most valuable asset and so safe guarding their health, safety and welfare should be central to an organisation...' (Loosemore et al., 2003). This point is further emphasised by Egan (1998) who indicates that people are the greatest asset on-site and must be treated as such. Due to the lack of space in which to successfully manage personnel on-site, the managerial burden of coordination and management also increases. Loosemore et al. (2003) continues by indicating that the workplace environment can have a negative effect on employees' health and safety. One such negative aspect is co-ordination and management of various tasks and operation in a successful and safe manner. Karaa and Nasr (1986) identify the importance and complexities of resource management in construction.

The author states that "in order to control costs, equipment and labour, resource management should be utilised in the most efficient way possible." Karaa and Nasr (1986) continue by arguing that "allocation of resources of different types to a construction project is a difficult managerial problem". This highlights, even over twenty years ago, that resource management on-site was a burden on managerial professionals. In the last number of years, this managerial burden has increased

dramatically due to the increasingly complex developments coupled with the increasing addition of countless resources to the construction process (Winch, 2009). Faniran et al. (1994, 1998) suggests that "construction planning effectiveness, and hence construction project performance, can be improved by increasing the amount of resources invested in construction planning activities". Examining the various literature's available on the subject of resource management, it is evident that it is a managerial issue that requires extensive deliberation and detail project programming to ensure the success of a project development, particularly in the case where spatial conflict is inevitable.

### **Overcrowding of workplace**

The third core issue in the management of health and safety on a confined construction site environment is overcrowding of the workplace. This issue can arise with respect to plant, materials, facilities and personnel on-site. The United Kingdom's (UK) Health and Safety Executive (HSE), (2003a) highlights the increased burden due to overcrowding of a construction site, indicating this factor as a major contributor to slips, trips and falls on-site. Furthermore, Sanad et al. (2008), argues the importance of noise reduction on-site through minimising overcrowding of the workplace.

In relation to plant and machinery, Harris et al. (2006) outlines the increased health and safety concerns due to the close proximity of personnel to operating plant and machinery on-site. Uher and Loosemore (2004) illustrate that 'the use of dangerous machinery within a congested working environment' can have an adverse effect on the health and safety for those in its immediate vicinity. With the movement of large plant on-site, Harris et al. (2006) again provides further insight into the associated problems in relation to health and safety on-sites where space is at a premium. It has been noted that overcrowding the workplace can have negative effects on both productivity and safety issues on-site (Black, 2009; Li et al., 2000). There were also health and safety aspects to be considered in a confined construction site with the HSE identifying various cases where accidents occurred due to the congested nature of various construction site environments (HSE, 2003b). Overcrowding on construction sites – particularly those which are prone to spatial congestion, may suffer from adverse health and safety issues, due to the close proximity in which personnel have to work.

This issue is often exasperated when working with chemicals or other dangerous agents, thus further increasing the concerns to on-site management (Singh et al., 1999). With the continued increase in the number and complexity of trades required in the construction of ever increasingly complex developments, over-crowding of the workplace is set to be a key managerial issue, particularly in cases where sites are of a confined nature. Therefore,

on-site management must acknowledge and counteract such instances and issues in the aim of increasing the health and safety of personnel on confined construction sites.

## Conclusion

With the continued growth of inner cities construction (Singer, 2002) coupled with the mounting costs of lands in these locations (Ellis, 2002), the need for construction organisations to complete projects in a reduced time frame, becomes more apparent. This is becoming increasingly difficult due to the complex and detailed designs requiring completion (Wideman, 1990; Remington and Pollack, 2007). This results in an amplified burden on site management particularly effective organisation of health and safety on-site both on a day to day basis and throughout the life of the project (Winch, 2009). The overall objective of this paper is to determine if there were any supplementary issues in the management of health and safety in spatially restricted construction sites and if so, to document what these issues are. Through adopting a qualitative research approach on three geographically diverse case studies, it was possible to ascertain the issues in the management of confined construction site.

Using data collection techniques that include individual interviews and focus group discussions, critical issues affecting management of health and safety in a confined site environment were gathered and transcribed. After a thorough scrutiny of the transcribed data of all the three case studies, 17 issues were identified with 88.2% of them common to at least two of the three sites. They were characterised by three core underlying issues that include:

- (i) Lack of space,
- (ii) Problem of co-ordination and management of site personnel, and
- (iii) Overcrowding of workplace.

These core issues were further validated with 11 experts across Ireland, UK and US construction industries and supported with relevant literatures. It is therefore feasible to suggest that the three core issues are fundamental to the management of health and safety in confined site environments. Within the realm of construction management, particularly on project sites, construction organisations and their personnel should see project process from a holistic point of view as a unified single system, where quick intervention in solving a particular issue should be norm, so as not to adversely affect interrelated sequence of events in project operations. They should dedicate proper attention to these three core issues by devising appropriate strategies in form of proactive practices to mitigate their impact on health and safety management particularly on confined construction

sites. The strategies may include detail project programming, space management, effective constructability review and efficient co-ordination of personnel, plant, materials and logistic among others on project sites.

From the study's findings, it is evidential that further detailed research in the area of confined site construction is required. The void of knowledge in the realm of confined site construction requires redress, due to its prominent nature within today's construction industry. Future research may conduct a quantitative study using the issues identified to confirm their importance and wider occurrence in other construction sites. Other studies might decide to investigate appropriate strategies in detail in relation to tackling the health and safety issues identified in this study. There are still other areas of research in confined site construction that require further research. These include, plant and equipment management, labour and personnel productivity, materials management, space management among others - all in relation to confined site construction. Addressing all these issues would not only help in improving the efficiency of the global construction industry, but also the performance of project processes, particularly on brown field sites, which are becoming rampant in most cities across the world.

## REFERENCES

- Akintoye A, Taylor C, Fitzgerald E (1998). 'Risk analysis and management of Private Finance Initiative projects', *Eng. Constr. Archit. Manage.*, 5(1): 9-21
- Barnes Y. (2009). "Development Land Prices Rising in UK after Two Years of Decline" *Property Wire – Premier Global Property News Service*, p. 1.
- Biddy P (2009). "Land Use in Britain" *Land Use policy* 26(1): 2-13.
- Black K. (2009). "Wise Geek – What does a Construction Site Manager do?" Available at: <http://www.wisegeek.com/what-does-a-construction-site-manager-do.htm>, accessed on 29th August, p. 1
- Chang C-K, Hanna AS, Lackney JA, Sullivan KT (2005). "Quantifying the Impact of Schedule Compression on Construction Labour Productivity" *Construction Research Congress*, April 5<sup>th</sup> – 7<sup>th</sup>, San Diego, California, CA, USA, pp. 1-2.
- Cohen B (2004). "Urban Growth in Developing Countries: A Review of Current trends and a Caution Regarding Existing Forecasts". *World Dev.*, 32(1): 23-51.
- Cooke B, Williams P (2004). "Construction Planning, Programming and Control" 2nd Ed. United Kingdom, Wiley-Blackwell Publishing, pp 292-299.
- Cotton R (2009). "Crowded Construction Sites can spread to Smaller Towns, Suburban Areas". *Memphis Bus. J.*, Friday, 9th January, p. 1.
- Cunningham CR. (2007) "Growth Controls, Real Options and Development Land" *Rev. Econ. Stat.*, 89(2): 343-358.
- Dawood N, Heesom D, Winch G, Penn A (2000). "The virtual construction site (VIRCON): A Decision Support System for Construction Planning". *Proceedings of CONVR 2000 Conference on Construction Applications of Virtual Reality*, Middlesbrough, Teesside University, pp. 17-29.
- Dixon T (2009). "Urban Land and Property Ownership Patterns in the UK: Trends and Forces for Change". *Land Use Policy*, 26(1): 43-53.
- Egan J (1998). "Accelerating Change – A report by the strategic forum for construction" Chaired by Sir John Egan" *The report of the Construction Task Force to the Deputy Prime Minister, John Prescott, on the scope for improving the quality and efficiency of UK construction*, Strategic forum for construction, Department of trade and Industry, Crown Copyright. England, p. 15.



- Elbeltagi E, Hegazy T, Eldosouky A (2004). "Dynamic Layout of Construction Temporary Facilities Considering Safety" *J. Constr. Eng. Manage.*, 130(4): 534-541.
- Ellis M (2002). "Regional Land Values" available at: <http://www.advicelandforsale.co.uk/land-for-sale-regional.htm>. p. 1.
- El-Rayes K, Khalafallah A (2005). "Trade-off between Safety and Cost in Planning Construction Site Layouts" *J. Constr. Eng. Manage.*, 113(11): 1186-1195.
- Faniran OO, Oluwoye JO, Lenard D (1994). "Effective Construction Planning" *Constr. Manage. Econ.*, 12: 485-499.
- Faniran OO, Oluwoye JO, Lenard DJ (1998). "Interactions between Construction Planning and Influence Factors" *J. Constr. Eng. Manage.*, 124(4): 245-256.
- Gould FE (2001). "Managing the Construction Process: Estimating, Scheduling, and Project control". 3rd Ed., University of Michigan, Pearson/Prentice Hall, pp. 297-299.
- Harris F, McCaffer R, Edum-Fotwe F (2006). "Modern Construction Management" 6th Ed., England, Wiley-Blackwell, pp. 99-151.
- Haslam RA, Hide S. A, Gibb AG F, Gyi DE, Pavitt D, Atkinson S, Duff A R (2005). "Contributing Factors in Construction Accidents" *Appl. Ergon.*, 36(4): 401-415.
- Health and Safety Executive – Bomet Limited (2003a). "Sample Analysis of Construction Accidents Reported to the HSE – Research report 139" London, England, Crown Copyright, pp. 133-145.
- Health and Safety Executive (2003b). "Causal Factors in Construction Accidents" Prepared by the Loughborough University and UMIST for the Health and Safety Executive, Research Report 156, Health and Safety Executive, pp. 26-35.
- Illingworth JR (2000). "Construction Methods and Planning" 2nd Ed., United Kingdom, Taylor and Francis, pp. 20-25
- International Labour Office (1995). "Safety, Health and Welfare on Construction Sites – A Training Manual" The International Labour Organisation, 4 Route Des Morillons, CH-1211, Geneva, 22, Switzerland, pp. 9, 43-45.
- Karaa FA, Nasr AY (1986). "Resource Management in Construction" *J. Constr. Eng. Manage.*, 112(3): 346-357.
- Kartam N A, Flood L, Koushki P (2000). "Construction Safety in Kuwait: Issues, Procedures, Problems and Recommendations" *Saf. Sci.*, 36(3): 163-184.
- Kim C, Hass CT, Liapi K A (2005). "Rapid, on-site Spatial Information Acquisition and its uses for Infrastructure Operation and Maintenance" *Autom. Constr.*, 14(5): 666-684.
- Lane DC (2008). "The Emergence and Use of Diagramming in System Dynamics: A Critical Account" *Syst. Res. Behav. Sci.*, 25(1): 3-23.
- Larkin JH, Simon HA (1987). "Why a Diagram is (Sometimes) Worth Ten Thousand Words" *Cogn. Sci.*, 11(1): 65-99.
- Leopold E, Loenard S (1987). "Costs of Construction Accidents to Employers" *J. Occup. Accid.*, 8(4): 273-294.
- Levy SM (2006). "Project Management in Construction" 5th Ed, McGraw-Hill Professional, pp. 77-109.
- Li B, Akintoye A, Edwards PJ, Hardcastle C (2005). "Critical success factors for PPP/PFI projects in the UK construction industry", *Constr. Manage. Econ.*, 23(5): 459-471.
- Li H, Love PED, Drew DS (2000). "Effects of Overtime work and Additional Resources on the Project Cost and Quality" *Eng. Constr. Archit. Manage.*, 7(3): 211-220.
- Li K, Zhang P, Crittenden JC, Guhathakurta S, Chen Y, Fernando H, Sawhney A, McCartney H, Grimm N, Kahhat R, Joshi H, Jonjevod G, Choi YJ, Fonseca E, Allenby B, Gerrity D, Toeens PM (2007). "Development of a Framework for Quantifying the Environmental Impacts of Urban Development and Construction Practices". *Environ. Sci. Technol.*, 41(4): 5130-5136.
- Lincoln Y, Guba E (1985). "Naturalistic Inquiry, Sage, London. Pp. 319.
- Lingard H, Rowlinson SM (2005) "Occupational Health and Safety in Construction Project Management" Taylor & Francis, pp. 30-32.
- Loosemore M, Dainty A, Lingard H (2003). "Human Resource Management in Construction Projects" Spon Press, London England pp. 211-221.
- Mallasi Z, Dawood NN (2002). "Registering Space Requirements of Construction Operations Using Site-PECASO Model" International Council for Research and Innovation in Building and Construction CIB w78 conference 2002, Aarhus School of Architecture, p. 1.
- Oyedele LO, Tham KW, (2005). "Examining Architects' Performance in Nigerian Private and Public Sectors Building Projects", *Eng. Constr. Archit. Manage.*, 12(1): 52-68.
- Oyedele LO, Tham KW (2007). "Client's Assessment of Architects' Performance in the Building Delivery Process: Evidence from Nigeria", *Build. Environ.*, 42(5): 2090-2099.
- Remington K, Pollack J (2007). "Tools for Complex Projects" Gower publishing limited, pp. 17-27.
- Sanad HM, Ammar MA, Ibrahim M (2008). "Optimal Construction Site Layout considering Safety and Environment" *J. Constr. Eng. Manage.*, 134(7): 536-544.
- Sanders SR, Thomas HR (1992). "Factors Affecting Masonry Labour Productivity" *J. Constr. Eng. Manage.*, 11(4): 626-644.
- Sawacha E, Naoum S, Fong D (1999). "Factors Affecting Safety Performance on Construction Sites" *Int. J. Proj. Manage.*, 17(5): 309-315.
- Sharma R (2009). "Lack of Space around Construction Site Delaying Airport Modernisation" *Indian Express.com*, posted Monday, 17th August, 2009. Available at: <http://www.indianexpress.com/news/lack-of-space-around-construction-site-dela/502830/>, accessed on: 22nd of December, p. 1.
- Singer B (2002). "Building on Confined Sites Poses Construction Challenges" *BNET United Kingdom – Real Estate Weekly*. Available at: [http://findarticles.com/p/articles/mi\\_m3601/is\\_12\\_49/ai\\_93793391/](http://findarticles.com/p/articles/mi_m3601/is_12_49/ai_93793391/) p. 1.
- Singh A, Hinze J, Coble RJ (1999). "Implementation of Safety and health on Construction Sites" Conference of CIB Working Commission W99, Honolulu, Hawaii, 24<sup>th</sup> to 27<sup>th</sup> March, pp. 483 - 490.
- Sommer R, Sommer B (2002). "A practical guide to behavioral research: tools and techniques", 5<sup>th</sup> Edition, Oxford University Press, Oxford, UK, pp. 131-135.
- Sowman C (2006). "Safety on Sight". *Contract Journal – plant managers' Journal*. Available at: <http://www.contractjournal.com/Articles/2006/05/04/51078/safety-on-sight-operator-aids.html>. p. 1.
- Steiner J (2005). "The Art of Space Management" *J. Facil. Manage.*, 4(1): 6-22.
- Sterman J (2000). "Business Dynamics: Systems Thinking and Modelling for a Complex World" Boston: Irwin McGraw-Hill, pp. 137 - 190.
- Thomas HR, Horman MJ (2006). "Fundamental Principles of Workforce Management" *J. Constr. Eng. Manage.*, 132(1): 97-104.
- Tindiwensi D (2000). "Integration of Buildability Issues in Construction Projects in Developing Economies" Department of Civil Engineering, Makerere University P. O. Box 7062, Kampala, Uganda, p. 2.
- Tommelein ID, Zouein PP (1993). "Interactive Dynamic Layout Planning" *J. Constr. Eng. Manage.*, 119(2): 266-287.
- Uher TE, Loosemore M (2004). "Essentials of Construction Project Management" University of New South Wales Press, Sydney, Australia, p. 375.
- United Nations (2008). "World Urbanisation Prospects: The 2007 Revision - Highlights" Department of Economic and Social Affairs – Population Division, NY, New York, pp. 1-12.
- Varghese K, O'Connor JT (1995). "Routing Large Vehicles on Industrial Construction Sites" *J. Constr. Eng. Manage.*, 121(1): 1-12.
- Walker A (2002). "Project Management in Construction" 4<sup>th</sup> Ed., Canada, Wiley-Blackwell, pp. 31-44.
- Walker A (2007). "Project Management in Construction" 5<sup>th</sup> Ed., Canada, Wiley-Blackwell, pp. 139-142.
- Wideman RM (1990). "Total Project Management of Complex Projects Improving Performance with Modern Techniques" Presentation to the Construction Industry in the cities of Bangalore, Bombay, Calcutta, Madras and New Delhi on behalf of the Consultancy Development Centre New Delhi, India, pp. 23-40.
- Winch G (2009). "Managing Construction Projects: An Information Processing Approach" John Wiley and Sons, pp. 346-377.
- Zhang JP, Anson A, Wang Q (2000). "A New 4D Management Approach to Construction Planning and Site Utilisation" Proceedings of the Eight International Conference on Computing in Civil and Building Engineering, Stanford, California, pp. 15-22.