

# CONFINED SITE CONSTRUCTION: A QUALITATIVE REVIEW OF ISSUES REGARDING HEALTH AND SAFETY ON-SITE

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The construction industry is inherently hazardous, with a significant number of accidents and incidents occurring, particularly on confined construction sites. This research identifies, clarifies and tabulates the various managerial health and safety issues encountered on confined construction sites, based on a qualitative approach, to aid in the management of the complex health and safety concerns. The methodology is based on qualitative research incorporating case studies, interviews, causal loop diagrams and mind mapping. The key findings in the managerial issues in the management of health and safety on confined construction sites can be summarised as follows; (1) A lack of space, (2) Increased management of site personnel, (3) Overcrowding of the work place. The implication for the industry is that due to the sustained development of urban centres on a global scale, coupled with the increasing complexity of architectural designs, the majority of on-site project management professionals are faced with the onerous task of completing often intricate designs within a limited spatial environment, under strict health and safety parameters. The value of such research is to aid management professionals successfully identify the various managerial issues highlighted, resulting in the successful management of health and safety on a confined construction site.

Keywords: health and safety, human resource management, personnel, project management.

## 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) details that urban growth is set to almost double from 2.86 billion in two thousand to almost five billion in twenty thirty. As a result, the construction industry is shifting towards increased growth in the area of urban construction and regeneration. Bidy (2009) argues that, contra to belief, urban areas 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 forty nine percent of the world's population live in urban areas, a figure which is expected to grow to sixty-one percent by 2030. Bidy (2009) also emphasises that the number of urban developments is increasing; suggesting that

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confined site construction is rapidly becoming the norm in the industry. Tindiwensi, (2000), continues this point by indicating “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, eighty percent of the population of the United Kingdom lived in urban areas and of this eighty percent, forty one percent of urban dwellers lived in one of the ten most populous areas. Yet, eighty percent of the population of the United Kingdom is spread over just nine percent of the country. Li *et al.* (2007) also 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 such legal and humanitarian requirements as implementing effective health and safety policy's, 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, spatially restricted environments, there is a propensity for increased accidents and incidents (Haslam, *et al.*, 2005). Effective management and co-ordination is essential to mitigate the possibility of accidents occurring on-site (International Labour Office, 1995). With the emphasis on confined spaces on-site and not confined construction sites the norm in both the industry and academia, it is essential to highlight the issues pertaining to this subject, particularly in the case of the health and safety of personnel on-site. 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. 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 hazardous environment that is a confined construction site.

## **EXISTING LITERATURE**

When reviewing the countless 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 spatially restricted construction sites. With regards the Safety, Health and Welfare at Work (Confined Spaces) Regulations (2001), this and many other pieces of literature, encompass the management of confined spaces on-site and not the management of a confined construction site, where spatial limitations occur, as in the case of urban, inner city developments. The International Labour Office (1995), briefly illustrates the potential problems, as a result of working in confined sites, but only gives a concise summary of available strategies. Levy (2006), Walker (2002) and Gould (2005), 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 the importance of an appropriately

designed and managed site layout, to ensure adequate levels of health and safety (El-Rayes, *et al.*, 2005; Sanad, *et al.*, 2008; Elbeltagi, *et al.*, 2004). This design is mainly illustrated in the context of large, open sites, which is not often the case on inner city, urban developments. Illingworth (2000) and Cooke, *et al.*, (2004) also highlight the importance of an effective and well designed construction site layout, but give little emphasise of the importance of such practices in confined site environments.

In today's environment, with land costs at a premium, even with the sustained global recession, the cost of development land is still at a premium. Yolande Barnes in Property Wire, (2009) outlines that after two years of a decline, development land prices in the United Kingdom, are beginning to rise once more. Illingworth (2000) and Cooke *et al.* (2004) highlight the importance of an effective and well designed construction site layout, but give little emphasise of the importance of such practices in confined site locations, particularly in relation to health and safety. Other such instances where health and safety issues arise are due to the close proximity in which personnel have to work to each other (Sowman, 2006; Thomas *et al.*, 2006). Robinson, as cited in Cotton (2009) highlight that overcrowding of the workplace can be a risk factor, particularly in cases where the program of works is accelerated or already congested. An additional variation, onto which research has been conducted, is that of the construction site layout 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 ascertain an acceptable level of consideration with regards the surrounding environment along with safety considerations.

When exploring the various research papers, articles and literature on the effects of overcrowding, particularly to health and safety, detailed articles are almost non-existent. This area of concern is predominantly associated with that of confined construction sites and must be addressed accordingly. As a result, it can be concluded that there is a vast amount of literature on health and safety in relation to construction sites and confined spaces on-site, but little information regards confined site construction and the increased risk posed to employees and the associated public in cases where spatial restrictions are evident.

## **METHODOLOGY**

On conducting research into the topic proposed, an in-depth literature review was undertaken, to ascertain all of the various managerial issues in the management of confined site construction. Secondly, to complement and clarify the various issues highlighted in the literature review, an extensive interview procedure was conducted, based on three separate case studies. This ensured triangulation of data to aid verification, thus aiding the compilation of an exhaustive list of managerial issues to the management of health and safety in a confined site environment. The interview process encompassed three semi-structured interviews from three on-site professionals taken from each of the three separate case studies adopted.

In total, twelve interviewees were approached, with an average of fifteen years confined site construction experience within the project management profession. The three case studies that were selected to aid in the research were a low rise apartment complex, a mid rise hotel and a high rise development. Each of the case studies was located in Ireland, England and United States of America respectively, thus giving a further insight and holistic overview of the management of confined site environments, both in various geographical locations and an assortment of developments. Each of the case studies was also selected due to the confined nature of

the projects in relation to the overall site layout. 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. From the interviews, each of the sets of data was cognitively mapped along with causal loop diagrams produced, thus depicting the various aspects leading to a synopsis of the issues in the management of health and safety on confined construction sites. From the research undertaken, possible conclusions and implication for practice can be identified coupled with indicating a need to conduct further research within the area of confined site construction.

## **ANALYSIS**

Qualitative analysis encompassed three separate case studies, where three individuals from each project were interviewed and questioned in relation to their relevant confined construction site. Based on the three interviews and resulting cognitive maps from each of the case studies, three distinct cognitive maps and causal loop diagrams were compiled to identify and clarify the various managerial issues outlined. On compiling the resulting data from the cognitively mapped case studies and combining the issues highlighted in the literature review, an overall insight into the issues was attained. The following list catalogues the various managerial issues to the management of confined site construction in relation to health and safety;

- Positioning of temporary facilities to improve the safety to crane operations & accidents from falling objects.
- Control of hazardous material and equipment on site.
- Ensuring the proper arrangement and collection of waste materials on-site.
- Close proximity of individuals to large plant and machinery.
- Increased possibility of over-crowding the workplace due to the lack of available space.
- Effective lighting of confined areas on site to ensure the health and safety of all concerned.
- Intersections between heavily travelled routes of construction resources.
- Ensuring personnel can get to and from their place of work safely.
- Ensuring the site is tidy and all plant and materials are stored safely.
- Adequate temporary facilities on-site to cater for the needs of the site effectively.
- Difficulty in the management of on-site traffic.
- Difficulty in the management of the movement of traffic on to and off site.
- Increased risk due to various tasks being executed in close proximity to each other.
- Difficult to account for and manage personnel due to the restricted working conditions.
- Difficulty of facilitating several different types of contractors within a limited space.
- Workplace becoming over-crowded.
- Lack of adequate room for the effective handling of materials.
- Lack of adequate storage space.
- Increased concerns of large plant being operated in close proximity to other personnel.
- Lack of available space on-site to facilitate the effective storage and removal of material waste.

Based on the numerous issues highlighted, it was then possible to group the issues as perceived by the interviewees through a process of cognitively mapping each of the interviews. As a result of the cognitive mapping of the interviews, the numerous issues to the management of health and safety on confined site environments were summarised under the following headings;

- Lack of space
- Increased management of site personnel
- Overcrowding of the workplace.

## **DISCUSSION**

### **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. Varghese *et al.* (1995) emphasizes that there is a health and safety issue with the close proximity at which individuals have to work with large plant and machinery. Sawacha *et al.* (1999) furthers the spatial issue by highlighting that a site must be tidy and all materials and plant stored safely, to benefit the health and safety of those on-site. Dutt, as cited in Sharma, (2009) outlines the increased concerns of site management due to the lack of adequate space management by those involved, particularly subcontractors. The International Labour Office (1995) further outlines the issue of spatial constraints on-site through identifying that the lack of space ‘prevents the safe movement of workers and vehicles and causes accidents’, thus resulting in an increased concern for the health and safety of personnel on-site.

Harris *et al.* (1998) and Dawood *et al.* (2000) identify that the lack of space on a construction site can lead to “space conflicts, long journey paths, unavailability of access to rooms, time lost, and therefore lack in performance”. Mallasi *et al.* (2002) furthers this by identifying that construction project planning is facing “new challenges due to the complexity in architectural and engineering design, short deadlines, enormous pressure from clients, and the need to build faster”. This coupled with the increased difficulty of project managing various tasks in limited spatial surroundings, illustrate the continued and heighten management pressure present, due to the 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. As a result, it can be concluded that the lack of space within a confined construction site environment, is an underlying issue with respect to the health and safety of the employees on-site and the general public as a whole.

### **Increased Management of Site Personnel**

The second fundamental issue to the successful management of health and safety in a confined construction site environment is the increased management of the personnel on-site. Loosemore *et al.* (2003a) highlights the importance of human resource management in construction projects, particularly where the author outlines the importance of employee’s health and safety. Loosemore *et al.* (2003a) argues that ‘people are an organisations most valuable asset and so safe guarding their health,

safety and welfare should be central to an organisation...’ This point is further emphasised by Egan, (1998) who indicates that people are the greatest asset on-site and must be treated as so. Due to the lack of space in which to successfully manage personnel on-site, the managerial burden also increases. Loosemore *et al.* (2003a) continues by indicating that the workplace environment can have a negative effect on employees' health and safety. One such negative aspect is the lack of space in which to manage and execute the various tasks successfully and in a safe manner.

Karaa *et al.* (1986) identifies 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 *et al.* (1986) continues 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, 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”. As a result, through researching the various literature available on the subject, it is evident that managerial issue require extensive deliberation and planning to ensure the success of a development, particularly in the case where spatial conflict is inevitable.

### **Overcrowding of the 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. 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. Loosemore, *et al.*, (2003b) illustrates that ‘the use of dangerous machinery within a congested work 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 over-crowding the workplace can have negative effect on both productivity and safety issues on-site (Black, 2009; Li, *et al.*, 2000).

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.

### **IMPLICATION FOR PRACTICE**

With the continued growth of inner city, confined site construction (Singer, 2002) coupled with the mounting costs of these inner city locations (Ellis, 2002), the need for management to complete projects in a reduced time frame, become more apparent. As a result, the need for management to identify the issues with regards the implementation if health and safety on-site is of paramount importance. This becomes

increasingly difficult due to the complex and detailed designs requiring completion (Wideman, 1990; Remington, *et al.*, 2007). This results in an amplified burden on site management in the effective organisation of health and safety on-site both on a day to day basis and throughout the life of the project (Winch, 2009).

As the findings highlight, it is evident that to embark on a development in a confined environment, increased health and safety concerns will inevitably arise. Coupled with the increasing direct and indirect cost of both time and money in relation to accidents on-site, it is beneficial to all involved, particularly on-site project management, to envelop the proactive practices that aid in the management of these inherently hazardous working conditions. Therefore, through management identifying the numerous issues highlighted, on-site management can mitigate and counteract, the health and safety issues acknowledged in relation to confined site construction, resulting in increased monetary and schedule savings, over the life of a project.

## CONCLUSIONS AND RECOMMENDATIONS

From the research, it may be noted that confined construction sites, by their very nature, illustrate characteristics that are likely to increase the health and safety concerns, over conventional, open plan construction sites. Due to the prevalence and size of many of today's modern confined construction site environments, coupled with the increasing health and safety concerns, the need for project management professionals to acknowledge the research findings, become more apparent. When reviewing the interviewees comments coupled with the data obtained from the literature reviewed, it is evident that health and safety in confined site environments, is an issue for all concerned. Through cognitively mapping and depicting the core issues in causal loop diagrams, the issues were summarised as, (1) A lack of space, (2) Increased management of site personnel and (3) Overcrowding of the work place.

On reviewing the case studies and the interviews, these three issues emerged in each of the discussions held, regardless of the case study discussed. As a result, it can be concluded that these three issues are fundamental to the management of health and safety in confined site environments. Therefore, to conclude, through identifying and acknowledging the numerous managerial issues to the management of health and safety within a confined site environment, management can reduce proportionately, the various health and safety concerns that can and do arise, often on a daily basis.

Based on the literature on health and safety in confined construction site environments, coupled with the concerns voiced by the interviewees approached, it is evidential that further detailed research in the area of confined site construction is required. With various areas such as personnel, plant and material management, core to the project management profession, it is essential to fill this void in knowledge with regards confined site construction. Some of the core research questions may include "what are the issues and resulting strategies in the management of personnel, plant and materials on a confined construction site?" or "To what extent does a confined construction site have an effect on personnel productivity on-site?"

Through fulfilling this gap in knowledge, it is envisaged that further advances can be gained in the area of construction project management, thus further enhancing the plethora of health and safety aspects, in conjunction with other facets of construction management. Through encouraging advancements in the area of health and safety coupled with that of effective project management, the construction industry can strive to become more efficient along with proactively encouraging and introducing better

working environments for all concerned. As a result, the void of knowledge in the realm of confined site construction requires redress, due to its prominent nature within today's construction industry.

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