Safety Science 64 (2014) 109–120

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/ssci

Spatial analysis of construction accidents in Kampala, Uganda

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ARTICLE INFO

Article history:
Received 8 July 2012
Received in revised form 9 September 2013
Accepted 22 November 2013
Available online 21 December 2013

Keywords:
Accident
Construction industry
Regression modeling
Spatial analysis

ABSTRACT

Construction work is one of the leading sources of occupational injuries and fatalities in Uganda. This paper set out to investigate the causes of construction accidents in Kampala, Uganda using ordinary least squares regression and spatial regression modeling. A cross-sectional survey of 201 large-size building projects commissioned by Kampala City Council in 2008 was undertaken. Data collected from the survey was supplemented by building records from Kampala City Council, safety statistics from the Department of Occupational Safety and Health, and accident investigation reports. The injury rate for Kampala is deduced to be 3797 per 100,000 workers and the fatality rate is 84 per 100,000 workers. The three most prevalent causes of accidents in Kampala are mechanical hazards (i.e. struck by machines, vehicles, hand tools, cutting edges, etc.), being hit by falling objects and falls from height. Congestion, a phenomenon which arises when there is evidence of high building density amidst many fulltime workers on site, is discussed. Through spatial statistical analysis, construction accidents that occur at one location were found to be related to those that occur in the neighborhood. To mitigate accidents occurrence, policies on regulating working hours, provision of safety equipment, equipment maintenance and on standards of acceptable building densities are suggested.

1. Introduction

The construction industry is regarded as one of the major indicators of economic performance especially for developing countries (Ofori, 1990; Finkel, 1997). Periods of prosperity are usually associated with high levels of construction output. However, despite its clear economic benefits, the construction industry, globally, has a poor safety record (Rowlinson, 2004; Hinze, 2007). In Europe, the construction industry produces 30% of fatal industrial accidents, yet employs only 10% of the population (Peckitt et al., 2004). In the United States of America (USA), the incidence rate of accidents in the construction industry is reported to be twice that of industrial average. According to the USA National Safety Council (NSC), there are an estimated 2200 deaths and 220,000 disabling injuries each year (Rowlinson, 2004). Construction fatalities account for 30–40% of industrial fatal accidents in Japan and 50% in Ireland (Peckitt et al., 2004). In the United Kingdom (UK), reported major injuries to employees in construction was 3677 in 2005/6, compared to 3768 in 2004/5 and 4386 in 1999/2000 (HSE, 2007).

The difference in accident rates between developed and developing countries is remarkable (Hamalainen et al., 2006). While many construction businesses in developed countries have embraced a zero accident policy as their goal and implemented effective health and safety practices (Hinze and Wilson, 2000), construction businesses in developing countries are unable to even identify their hazards (Hamalainen et al., 2006). Proper accident recording and notification systems are non-existent in many developing countries (Hamalainen et al., 2006).

In Sub-Saharan Africa, the fatality and injury rates in the construction industry are at 21 and 16,012 per 100,000 workers, respectively (CIDB, 2010). In South Africa, a largely industrialized economy, the fatality and injury rates by 2010 were 19.2 and 14,626 per 100,000 workers, respectively (CIDB, 2010). This was a remarkable improvement compared to a fatality rate of 53.51 per 100,000 workers in the 1990s (see Smallwood, 1998). In Ghana, a largely agro-based economy with construction contributing 3.1% of Gross Domestic Product (GDP) and employing 1.4% of the population, construction contributed 291 out of 6917 (or 4.2%) of workplace accidents reported in 2000 (Kheni et al., 2006). In Tanzania, an agro-based economy, where construction contributes 4.5% of GDP, 3 fatal accidents and 147 injuries were reported on 63 sites in 2001 (Mwombeki, 2006). In general, accident statistics from African Countries are higher than the average fatality rate of 4.2 and injury rate of 3240 per 100,000 workers in developed countries (see CIDB, 2010). Comparatively, the accident record for Sub-Saharan Africa is similar to that of Asia which has fatality and injury rates of 21.5 and 16,434 per 100,000 workers, respectively (CIDB, 2010).

Similar to trends observed elsewhere in Africa, Uganda has registered high accident rates in the recent past. Between 1996 and 1998 a total of 146 accidents were reported in the construction

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0925-7535/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.ssci.2013.11.024

industry, 17 of which were fatal cases (Lubega et al., 2000). During the period 2001–2005, the annual averages were 54 cases on building sites, 103 cases on construction sites including buildings and 384 cases for all industries, construction inclusive (Alinaitwe et al., 2007). Overall, during the period 2001–2005, although the industry contribution of construction accidents was 27%, 4% lower than the accidents rate reported in the late 1990s, the number of incidences actually increased.

During the period 2006–2010, although a detailed study has not been undertaken in Uganda to establish the incidence rates, based on cases that have been reported by Irumba et al. (2010), it is evident that the construction industry in Uganda has continued to witness fatal accidents with a total of 49 fatalities reported in Kampala metropolitan area alone.

This paper investigates the causes of construction accidents in Kampala, Uganda using Ordinary Least Squares (OLS) regression and spatial regression modeling. Using spatial statistics (i.e. statistical methods that use space and spatial relationships in their mathematical computations), this paper demonstrates that accidents that occur at one site can be associated with those that occur in the neighborhood. Indeed, the use of spatial statistics in accident causation modeling is not widely explored in existing literature.

This paper is structured into six sections. Accordingly, Section 2 highlights the hypotheses tested in the paper and Section 3 presents methodology. The data is presented in Section 4 and results discussed in Section 5. Finally, conclusions are presented in Section 6.

2. Hypotheses

Accidents rarely just happen. They are usually as a result of failures of technology, failures of people or a combination of both (Priemus and Ale, 2010). The causes are seldom simple or singular; they are complex constellations of events, existing preconditions and of system properties (Priemus and Ale, 2010).

The causes of accidents in the construction industry are numerous. Toole (2002) summarizes them under eight categories: lack of proper training in recognizing and avoiding job hazards, deficient enforcement of safety standards, lack of safety equipment, unsafe methods of work and/or poor planning of project activities, unsafe site conditions, workers not using the provided safety equipment, poor attitude of workers towards safety, and isolated sudden deviation of a worker from prescribed behavior. Similarly, Yung (2009) reviewed the factors affecting construction safety based on 17 published studies drawn from different parts of the world. Yung (2009) concluded that from the micro perspective of project management, top management support and safety training are two of the most important factors affecting construction safety. Failure to employ a safety officer on site and poor working conditions (or otherwise called unsafe environment) were also cited amongst the top factors affecting safety (Yung, 2009).

A qualitative study conducted by Haslam et al. (2005) in UK corroborates most of the factors cited by Toole (2002) and Yung (2009). Haslam et al. (2005) cites problems emerging from workers, work place issues, shortcomings with equipment (including personal protection equipment), problems with suitability and condition of materials and deficiencies in risk management as top factors affecting construction safety.

Furthermore, congestion on construction sites is increasingly becoming a challenge for safety management especially in urban centres. Findings by Spillane et al. (2011) based on case-studies taken in Ireland, UK and USA reveal that lack of space, challenges of coordination and management of site personnel, and overcrowding of the workplace affect management of safety and health on congested sites. Similar arguments on space constraints and their effects on safety have been raised by Haslam et al. (2005). In addition to the issues raised above, the effects of congestion on safety are likely to take various forms in different places because of the diversity of construction technologies employed.

Occupational stress resulting from working overtime can compromise safety on construction sites (Goldenhar et al., 2003). Working overtime has damaging effects on the health (for example, more worker illnesses) and safety (for example, inattention to necessary details) of employees (Spurgeon et al., 1997; Savery and Luks, 2000). In addition, working for long hours leads to lower productivity and higher absenteeism on duty (Spurgeon et al., 1997).

In summary, based on findings by Toole (2002), Goldenhar et al. (2003), Haslam et al. (2005), Yung (2009) and Spillane et al. (2011), the root causes of construction accidents can be classified into two broad categories: firstly, causes of accidents due to faults by a worker and secondly, causes of accidents due to faults by the employer (client or contractor).

In Uganda, previous research has shown that construction accidents that can be attributed to faults by the employer are more prevalent compared to those that can be attributed to faults by workers. For example, Lubega et al. (2000) based on a survey conducted in five districts identified the major causes of accidents as inadequate supervision of projects, use of incompetent personnel and use of inappropriate construction techniques. Similarly, following a country wide survey, Alinaitwe et al. (2007) identified the five major causes of accidents during the period 2001–2005 as collapse of parts of buildings under construction, falls from height, machines, being hit by vehicles and cuts. Many falls are due to poor scaffolding that is employed on building sites in Uganda and the many cases of accidents from machines and vehicles are due to lack of experience and training by the operators (Alinaitwe et al., 2007).

In this paper, based on preceding literature, six main hypotheses have been developed. These hypotheses address some of the concerns cited above and are presented below:

Hypothesis 1. occurrence of accidents on construction sites is dependent on the level of congestion on site. In this context, the level of congestion is measured in terms of building density (defined as the ratio of gross floor area to plot acreage) and size of workforce. Two sub-hypotheses will be tested:

Hypothesis 1A. The number of accidents registered on a construction site is positively associated with building density.

Hypothesis 1B. The number of accidents registered on a construction site is positively associated with the size of workforce.

Hypothesis 2. occurrence of accidents on a construction site is dependent on the availability and condition of safety equipment.

In relation to Hypothesis 2, safety equipment will be categorized as personal protection equipment (including helmets, hand gloves, heavy duty shoes, gumboots and noise filters), fall protection equipment (including drop-lines, deceleration devices and body harnesses), scaffolding and ladder system, cranes and lifting equipment, guard rails and mechanical equipment. In addition to the above categories of safety equipment, the effects of appropriate handling of electrical equipment (including inspection tests, lockouts and warning signs) on safety will be tested.

Hypothesis 3. occurrence of accidents on a construction site is dependent on systems for appropriate handling of construction materials.