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Common Construction Site Hazards in Nairobi County, Kenya

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Abstract: This study included collection of field data using questionnaires and analysis of secondary data from Kenya's Directorate of occupational safety and Health (DOSH) covering the period between 2010 and 2014. Perhaps due to inadequate training in safety and lack of experience, 74% of the workers who were injured or killed when accidents occurred in construction sites were below 40years old. Some 26% of the accidents occurred during the busiest months of the year, June and July, a period which coincides with the closure of financial year. Also, about a third of construction site accidents occur during the busiest hours of the day (10-11 am, and 3-4 pm). Falling from height and being hit by falling objects contributes towards about 64% of all construction site accidents. The majority of construction companies in Nairobi allocate less than 1% of project budget to health and safety. This could be because most companies do not have a clear accident prevention policy. Five administrative factors rated on a scaled of 0-5, were thought to contribute to accidents: (1) reluctance to provide resources for safety (4.10 ± 0.2); (2) lack of staff training (4.07 ± 0.2); (3) safety regulations not enforced (3.98 ± 0.2); (4) workers not safety conscious (3.83 ± 0.2); and (5) top leaders not being safety aware (3.71 ± 0.2). It is recommended that investment in Occupational Health and Safety (OSH) and also in health and safety training should be prioritized in construction industry. DOSH should be empowered to provide customized safety training, workshops and seminars to enable construction workers minimize accident occurrence.

Keywords: Safety, Occupational Safety and Health (OSH), Construction Sites, In Personal Protective Equipment (PPE)

1. Introduction

Each construction site is unique in the sense that projects may require different equipment and skills; and projects are multitasked requiring a multidisciplinary approach [1]. Careful planning and discipline are necessary in order to avoid accidents in such sites. In Kenya, the construction sector contributed 4.9% of the Gross Domestic Product (GDP) in 2014 [2] while in the U.K. and Japan the sector accounted for 10% and 17% of GDP, respectively [3]. Kenya's construction the sector grew by 62% between 2007 and 2013 [2]. In 2014 the industry employed 130,300 workers [2]. However, the construction industry has been recognized as one of the most hazardous industries in the world [3]. In a market-driven society, construction companies compete to complete projects to the required quality within minimum time and cost. Safety is therefore regarded as a secondary concern.

Various combinations of factors and circumstances influence the incidences of occupational accidents. A number of studies by workers have revealed that the factors influencing accidents occurrence include (1) personnel factors such as gender, age and work experience [4]; (2) Environmental and equipment factors [5]; (3) Project factors including the type of work and contract amount [6]; (4) Management factors such as the population of workers and the experience of managers [7] and (5) time factors such as the season in the year and time of the day [7]. Following a study conducted in Uganda, the findings of the study established that inadequate supervision, use of incompetent

personnel and use of inappropriate construction techniques, affect safety in construction sites [8]. According to research done in Portugal [9] and Thailand [10] it was established that, inadequate safety measures and poor safety awareness contribute significantly towards the occurrence of occupational accidents in construction industry.

Ale *et al.* (2008) [11] examined 3000 records of reported accidents from 1998-2003 and found that out of the 31 fatal falls from height, 50% were reported to be caused by failure in edge protection for which the main issue was lack of edge protection (which may have been removed at the wrong time, never installed or not properly constructed). Some 30% were caused by insufficient user ability manifested as a slip, trip, misstep; illness or loss of balance. They also found that out of 8 fatal accidents involving falling objects, 85% of the affected persons were hit by large building materials. Management commitment to safety was recorded and although not specified for fatal accidents alone and only detailed for a subset of accident types, the authors suggest that motivation/commitment, plans/procedures, equipment, communications and competence were causal factors in all types of accidents. Hinze *et al*. (2005) [12] examined 743 'struck by' accident case and found that in the USA, misjudgment of hazardous situations, failure to follow procedures for securing operations and lack of warning signs contributed to 36%, 10%, and 7% of accidents.

The main causes of construction site accidents are related to the unique nature of construction industry, human behaviour, technical aspects, difficult work site conditions and poor safety management which result in unsafe work methods and procedures [13]. Compared with other labour intensive industries, the construction industry has experienced a disproportionally high rate of injuries, disability and fatalities [14]. In their study, Cattledge *et al*. (1995) [15] established about a third of construction workers had less than 2 years' experience and that 63% of workers who made claims after injury, had received safety training against falling from heights. However, the workers failed to consistently use protection devices provide in their work sites [15].

The difference in accident rates between developed and developing countries is high. In industrialized countries, the construction sector has embraced zero accident policy as their goal and implemented effective health and safety practices but developing countries are still unable to identify their hazards [14]. Proper accident recording and notification systems are non-existent in many developing countries [14]. In Sub-Saharan Africa, the fatality and injury rates in the construction industry stand at 21 and 16,012 respectively, per 100,000 workers [16]. The number of deaths in 2013 in the UK [17], USA in 2013 [18], China in 2013 [19], India in 2013 [20] and South Africa in 2013 [21] were 2, 3.2, 3.8, 10.5 and 25.5 per 100,000 workers in construction industry (Figure 1). The statistics for average fatality rate in developing countries are higher than the average fatality rate of 4.2 and injury rate of 3,240 per 100,000 in developed countries [12].

This study was undertaken to establish the common construction site accidents in Nairobi County and identify the factors contributing towards such accidents.

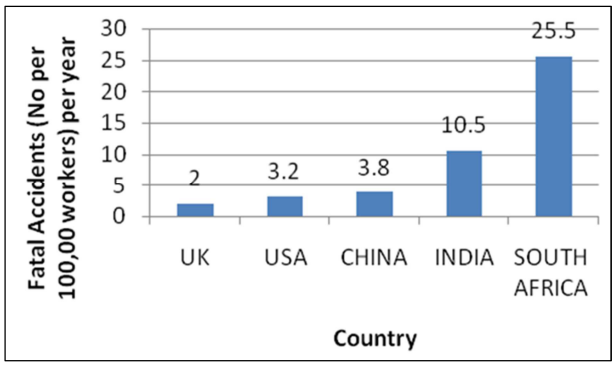

Figure 1. *The 2013 Fatal Accident Statistics in different countries.*

2. Research Methodology

This study is based on a questionnaire survey and analysis of secondary data from Directorate of Occupational Safety and Health (DOSH). Construction site accidents and incidents studied were those confined to building contractors (including main contractors and subcontractors) within the study area (Nairobi County). This study focused on projects which had been registered with the National Construction Authority (NCA) and the Directorate of occupational safety and Health (DOSH). NCA categorizes Kenyan contractors from NCA1 (large) to NCA 8(small). The study was limited to (NCA1 [large] to NCA4 [medium]).

2.1. Field Data Collection Using Questionnaires

Fieldwork involved data collection using semi-structured interviews, formal and informal meetings with key stakeholders in construction building projects within the study area. Data was collected from eight administrative regions of Nairobi County; namely Central Business District (CBD), Dagoreti, Embakasi, Kasarani, Kibera, Makadara, Pumwani and Westlands. Then qualitative data from purposefully selected construction sites was collected and analysed. A total of seventy two (72) questionnaires were distributed. Out of the distributed questionnaires, 41 (57% of the questionnaires) were returned. Some 36 of the returned questionnaires were from NCA1 contractors, 2 were from NCA2 contractors, 2 were from NCA3 contractors and 1 was from an NCA4 contractor.

The sample size was determined using sample size formula as shown by Israel (1992) [22]. In the equation, N is the required sample size; Z is the value of standard variance of 1.96 at 95% confidence interval; p is the proportionate target population with the particular characteristics being measured, d is the statistical significance level set and q is equivalent to 1-p.

Assuming that 95% of the target population are operating in construction sites and at any time are likely to be involved in construction accidents (p = 95%) and taking a 95%

confidence interval; Z = 1.96 (tabulated). Taking a statistical significance level of 5%, d = 0.05 and q = 0.05. This gives a sample size (N) of 72 (Equation 1).

$$N = Z^2pq /d^2$$

$$N= 1.96^2(0.95) (0.05)/ 0.05^2 \quad (1)$$

$$N=72$$

Based on this, a total of 72 questionnaires were distributed to various construction sites in Nairobi County. The survey questionnaire consisted of closed and open ended questions to examine the significance and incidences of health and safety practices in construction industry within the study setting and the constraints they face in managing health and safety. The data obtained using the questionnaire was the type of construction site accidents, factors contributing to construction site accidents and investment in health and safety by clients and construction players. The data obtained was used to determine associations between independent variables identified in the literature and occupational, health and safety management practices. Construction industry players' relation and interaction with the relevant institutions in occupational health and safety system were also examined. The questionnaire survey provided a descriptive analysis of the health and safety management.

Part of the questionnaire survey facilitated evaluation of the relative importance of accident factors. Some 25 accident factors were considered. Respondents were required to indicate the importance of a factor on a scale of 0 'not important' to 5 'very important' (Oppenheim, 2004) [23].

2.2. Secondary Data

Analysis of 237 archival construction accident data from DOSH, covering the period between Jan 2010 and Dec 2014, was done. Data provided by DOSH included the name and age of the injured worker and the company he/she worked for, the date, time and month the accident occurred, the location of the construction site, date and time of accident, occupation of the construction worker, the cause of the accident and part of the body injured during the accident. The access to this data was authorized by DOSH officials but the confidentiality of the worker and the companies affected by the accident were to be maintained.

3. Results and Discussion

3.1. Types of Construction Site Accidents in Nairobi County

According to field data, the three most common types of accidents for the period 2010 – 2013 included being hit by falling materials (rating of 2.5 ± 0.2 out of 5), falling from height (rating of 2.1 ± 0.2 out of 5) and injury from use of motor (rating of 1.8 ± 0.2 out of 5) (Figure. 2). In Nairobi County, the likelihood getting injured as a result of falling from height, or being hit by falling objects, or being injured by machines is comparable to the likelihood in South Africa [16]. In the USA, (Suazo and Jaselskis, 1993) [24] and China (Che Hassan et al, 2007) [25], falling from heights contributes 37-50% of construction accidents, while electrocution, being hit by falling objects, collapsed earthworks and injuries by heavy machinery contribute (5-13%), 12-21%, 9% and 9% of construction accidents respectively.

To reduce injuries that occur as a result of falling from heights at construction sites, Che Hassan *et al*. (2007) [25] suggested that primary prevention measures for fatal falls would include fixed barriers, such as handrails, guardrails, surface opening protections (hole coverings), crawling boards/planks, and strong roofing materials. Secondary protection measures would include travel restraint systems (safety belt), fall arrest systems (safety harness), and fall containment systems (safety nets). Vivek *et al*. (2003) [26] proposed interventions including the introduction of a safety management system and the use of Personal Protective Equipment (PPE). Realization of the necessary accident prevention measures requires a top-down approach, starting with management.

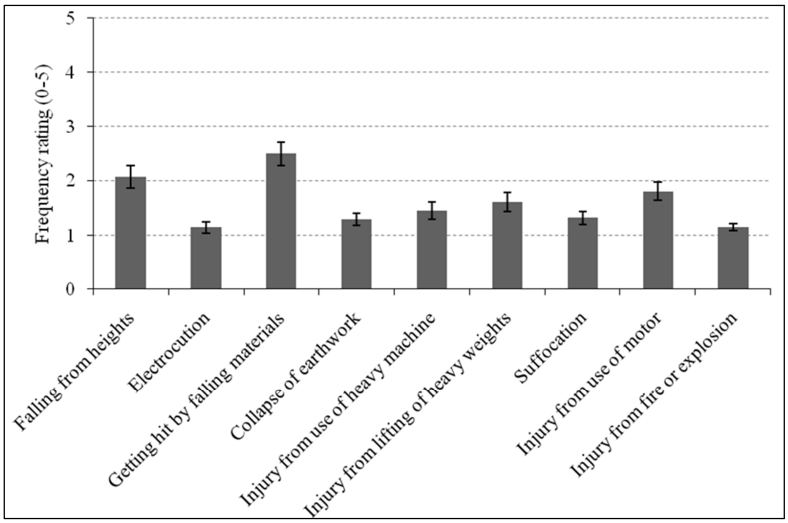

Figure 2. *Frequency rating of construction site accidents in for the period 2010 – 2014.*

Secondary data obtained from DOSH in this study indicates that the body parts that are frequently injured after construction site accidents are the hands (41.4%), the head (30.8%), legs (25.3%) and the chest (2.5%). To reduce such accidents, safety measures on site should be improved. Hinze *et al*. (2005) [12] suggested that construction site injuries can be prevented by providing adequate protective support equipment (14%) to workers; proper training (13%); and provision of warning signs /working audible alarm (11%).

This study concludes that falling from heights and being hit by falling objects contribute about 65% of all construction site accidents in Nairobi County (Figure 2). The study also established that the hand (41.4%), head (30.8%) and Leg (25.3%) are the most vulnerable parts of the body during accidents. Therefore, construction companies need to provide workers with the necessary Personal Protective Equipment (PPE), which include safety belts, retaining belts, safety ropes, and safety harness and catch nets to prevent being hit by falling materials and falling from heights.

3.2. Occurrence of Construction Accidents in Nairobi County

Field data indicated that for the period 2010 to 2013, the most frequent accidents (11-20 accidents in 4 years per site) were minor, requiring less than 1 day off duty (Figure 3). Data from DOSH indicates that for the same period, the total number of minor accidents in the county was 21. In a typical construction site during that period, an average of about 2 accidents requiring over 4 days off duty occurred. According to DOSH, the county experienced 180 accidents requiring over 4 days off duty and 32 fatalities (Table 1).

Data from DOSH established that most of the construction site accidents occurred in Kasarani, Embakasi, Westlands and Kibera divisions (Table 1). Kasarani Division had the highest number of reported accidents while Kibera Division had the highest number of fatal accidents. Kasarani is located furthest from DOSH offices suggesting that it may be the least monitored by DOSH officers considering Nairobi covers an area of 684 square kilometres [27]. Inadequate staffing compared with increased workload has continued to affect the occupational safety monitoring [28]. In addition to DOSH officers lacking the necessary means of transport for their work, during the 2010-11 financial year DOSH had only 36% of its staff employed [28]. This has contributed towards the inability of the Directorate to provide services.

Table 1. *DOSH data on accidents in Nairobi County for the period 2010-2014.*

Division	Severity of accident (days off duty)					
	Less than 3 (Minor)	4-10	11 - 20	Over 20	Fatal	Total
Kasarani	6	24	10	16	2	58
Embakasi	4	12	6	15	5	42
Westlands	5	12	7	14	3	41
Kibera	2	5	8	7	10	32
Nairobi Central	0	5	5	8	3	21
Makadara	3	3	1	5	2	14
Pumwani	1	1	2	7	2	13
Dagoreti	0	3	1	3	5	12
Total	21	65	40	75	32	237

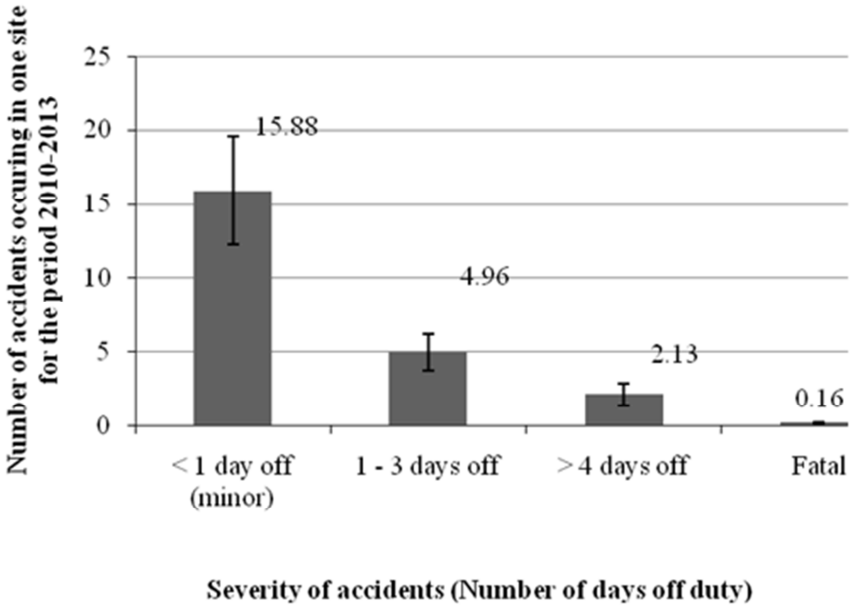

Figure 3. *DOSH data on construction site accidents during the period 2010-2013.*

3.3. Factors Contributing to Construction Accidents

Using data obtained from NCA1, NCA2, NCA3 and NCA4 contractors within Nairobi County, the study established that the ten most significant factors affecting safety in construction sites (Table 2) included (1) reluctance to invest in safety; (2) lack of training in safety management; (3) safety regulations not enforced; (4) workers not being safety conscious; (5) lack of strict operational procedures; (6) lack of personal protective equipment; (7) lack of organizational commitment to safety; (8) reckless operation of machines; (9) shortage of safety personnel on site; and (10) ignoring of safety regulations.

Table 2. *Rating of factors that contribute to construction accidents, on a scale of 0-5.*

Factor	Mean	Factor	Mean
Reluctance to invest in safety	4.1 ± 0.2	Lack of experienced project managers	3.29 ± 0.3
Lack of training	4.07 ± 0.2	Lack of certified skilled labour	3.22 ± 0.2
Safety regulations not enforced	3.98 ± 0.2	Low level of education of workers	3 ± 0.2
Workers not safety conscious	3.83 ± 0.2	Poor maintenance of equipment	2.98 ± 0.2
Top leaders not being safety aware	3.71 ± 0.2	lack of first aid measures	2.93 ± 0.2
Lack of personal protective equipment	3.66 ± 0.2	Lack of teamwork spirit	2.9 ± 0.2
Lack of organizational commitment	3.51 ± 0.2	Inadequate safety technology	2.8 ± 0.2
Reckless operation of machines	3.49 ± 0.2	Poor information flow	2.66 ± 0.2
Shortage of safety personnel on site	3.34 ± 0.2	Fatigue	2.34 ± 0.2
Ignoring of safety regulations	3.29 ± 0.2	No safety management manuals	2.15 ± 0.2
Lack of technical guidance	3.29 ± 0.2	Careless materials transportation	2.1 ± 0.2
		Unprotected material during storage	1.83 ± 0.2

3.4. Specialization of Workers as a Factor Affecting Accidents

Based on the number of workers injured under different specialization, this study established that the probability of injury affecting unskilled workers, masons, machine operators and carpenters was 35.4%, 21.5%, 16.9% and 11.8%, respectively (Table 3). Another study by Cattledge *et al*. (2013) [15] also found that unskilled workers were the most vulnerable group of workers in construction sites. Since unskilled workers have tasks everywhere, they tend to be exposed to every type of accident. The accidents that affect masons and carpenters include falling from heights and being hit by falling objects. Site supervisors and drivers, with 6.8% and 2.1% chance of being injured, respectively, are the least exposed to accidents.

Table 3. *Probability of workers getting an injury in a construction site.*

Skill type	Unskilled workers	Masons	Machine operators	Carpenters	Supervisors	Driver-mechanics	Others
Probability of injury (%)	35.4	21.5	16.9	11.8	6.8	2.1	6.7

Although the contribution of supervision was not measured in this study, it has been established elsewhere that competent supervision contributes a lot towards reduced incidents of accidents Lubega *et al.* (2000) [8]. According to research done in China [5], Portugal [9] and Thailand [10] the occurrence of construction accidents depends a lot on the safety measures in place as well as the prevailing safety awareness.

3.5. Month of the Year and Time of the Day

Kenya's financial year starts in July and ends in June. From Figure 4, it's apparent that most of construction site accidents occur towards the end of the financial year. Some 10.5% and 15.2% of the reported accidents occurred in the months of June and July, respectively. During this period, it appears that workers have to deal with multiple activities, creating a situation where workers and site supervisors are overworked, leading to accidents.

To avoid rushing to complete the projects in June, It's recommended that clients could help by not specifying completion dates in May so that there will be no need to rush to complete the work in June. Experts in US recommend that safety meeting before starting work is effective and is highly recommended [29].

In Nairobi on a typical day, construction work takes place from 8am to 6 pm and breaks are taken at around 10 am and 1 pm. In Singapore, most fatal accidents occur around 9.30-11.30 am and 2.30-3.00 pm [29] while in the USA similar results show that construction accidents occur between 10.00 am-11.00 am in the morning and 2.00 pm-3.00 pm [12]. It's established that most accidents occur around just before the workers take lunch break and it has been called lunch time effect [12, 29]. From the study, the least likely time for an accident to occur is over lunch break (3.4% chance) while most accidents occurred between 10.00 am - 1.00 pm (37.6%) and 3.00 - 5.00 pm (26.1%) (Table 4). Research undertaken in Iran in 2015 showed that 44.97% of accidents occurred between 9am and 1pm [30] which is a similar trend to Nairobi County, Kenya.

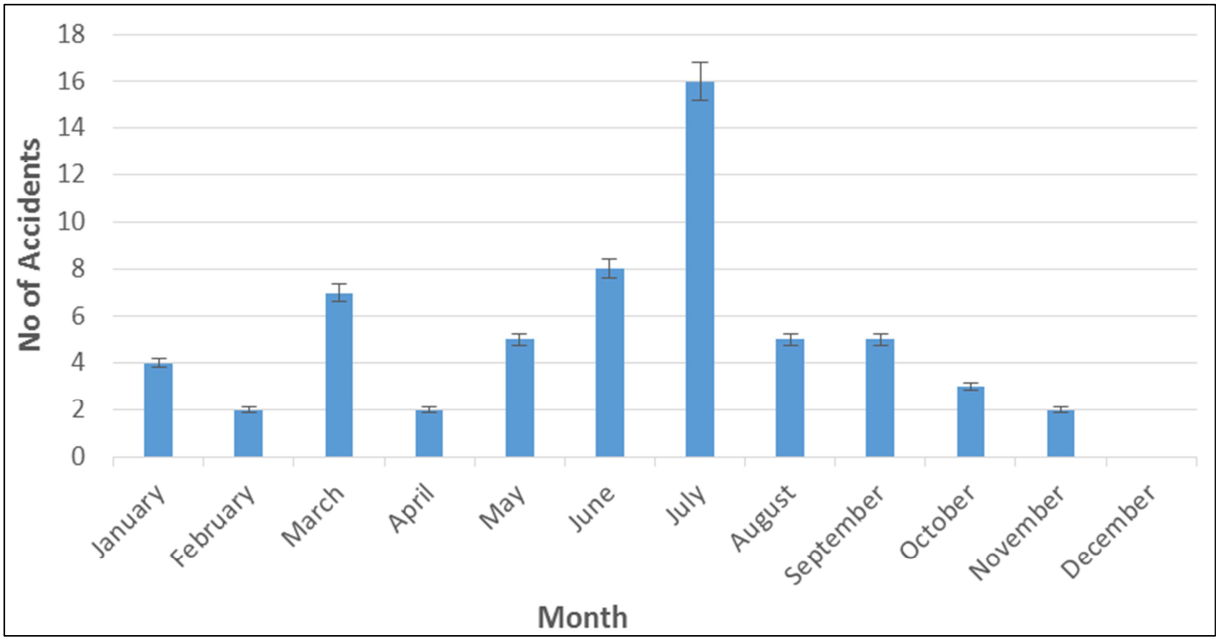

Figure 4. *Construction accident occurrence over different months of the year.*

Table 4. *Probability of accident occurrence in a typical hour of the day.*

Time of day	Morning					Break	Afternoon					
	before 8 am	8-9 am	9-10 am	10-11 am	11-12 pm	12-1 pm	1–2 pm	2–3 pm	3–4 pm	4-5 pm	5-6 pm	after 6 pm
Probability (%)	0.8	4.6	9.3	14.8	10.1	12.7	3.4	10.5	14.3	11.8	5.1	2.5

3.6. Gender, Age and Experience of Workers

Based on the 2010 to 2014 Nairobi County data, 97% of 237 affected construction workers were male. Also, about 72% of reported accidents affected workers in the age category 21-40 (Table 5). In Iran, between the years 2008 and 2012, 69% of occupational accidents occurred to workers below the age of 35 years [30]. In the USA, the highest fatality occurs among workers of ages 35-44 years [29]. This could be because this is the age group that is the most active in construction. High frequency of accidents has been reduced in the USA since, (1) workers are trained when they first hired; (2) workers receive training once a year; (3) workers receive training before being assigned to a job that requires new skills; and (4) workers are trained when deficiency is detected in their skills [29].

Table 5. *Distribution of injured workers by age.*

Age	Under 21	21 – 30	31 – 40	41 – 50	Over 50	Total
Probability of injury (%)	2.1	38.6	33.1	20.8	5.5	100

To reduce the frequency of accidents in Kenya, it is recommended that each construction site should have a competent safety officer to identify safety risks, check safety equipment and ensure training is provided to the workers with emphasis on the vulnerable age groups.

3.7. Safety Policy, Safety Budgets and Accident Occurrence Factors

Project managers have a safety responsibility to prepare project safety plan, identify potential hazards at the site, prepare a written safety plan and insist on reporting injuries, death and property damage as a result of accidents [30]. Perhaps because of lack of emphasis on health and safety training, 12% of the construction sites visited during this study, lacked a written safety policy. The absence of a policy document means that the most vulnerable group of workers has no protection and construction accidents.

The majority of surveyed contractors, some 61% of the studied population, managed projects valued at over KES 500 Million (5 Million US Dollars). However, 39% of the contractors had no specific budget for occupational health and safety (Figure 5). Another (24%) of the contractors had budgeted less than KES 0.5 Million (5,000 US Dollars) for health and safety. Only 4% of companies budgeted over KES 2 million (20,000 US dollars) per year.

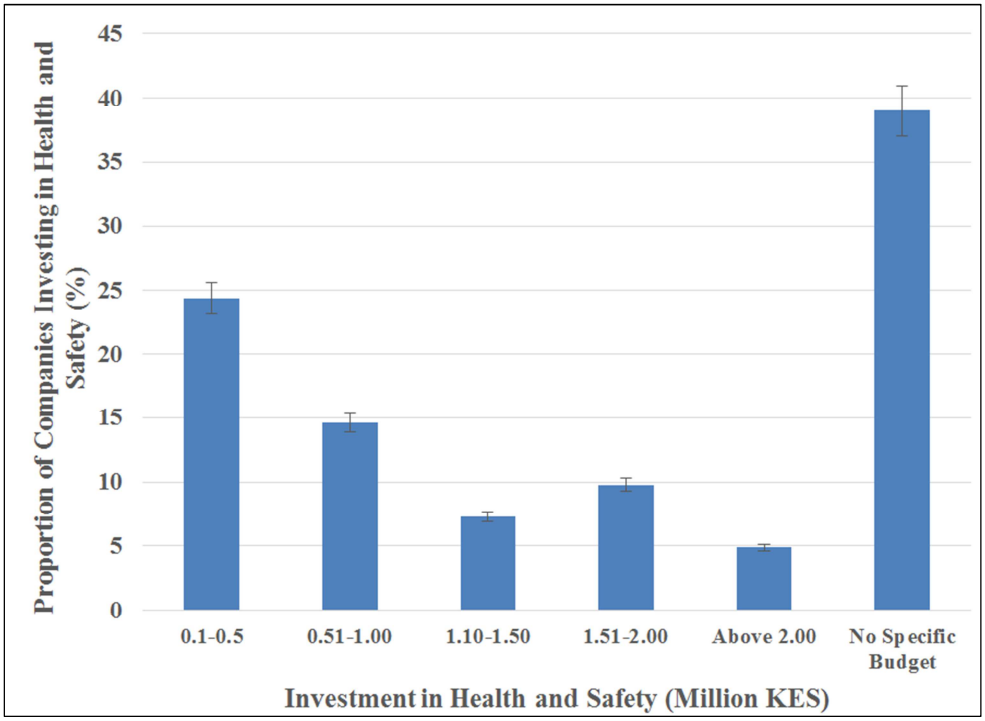

Figure 5. *Investment in health and safety.*

A similar study in Kuwaiti, reported that while various players including government, project owners, and contractors may be aware of the importance of safety in construction, they do not actively pursue effective ways to achieve safety goals [31]. The study associated this lack of commitment to safety with the fact that: (1) Most contractors do not consider safety costs in their tenders unless it's recognized by contract documents; (2) Many companies look for fast profit and sell their projects to subcontractors; (3) There is lack of official safety data and records of construction accidents at sites; (4) Dependency on labour that has no union or community to defend it's rights and secure the safety of workers; (5) Construction has a high labour turnover compared with other industries; (6) Many contractors are unaware of the effectiveness of safety prevention programs in reducing costs and increasing productivity; and (7) Safety is often considered to be a waste of money.

4. Conclusions and Recommendations

This study included a field study and analysis of secondary data from Kenya's Directorate of occupational safety and Health (DOSH) covering the period between 2010 and 2014. It is concluded that (1) falling from heights and being hit by falling objects are the most frequent construction site accidents; (2) perhaps due to inadequate training in safety and lack of experience, workers who are less than 40 years old tend to be the most prone to injuries and death in construction sites; and (3) about a third of construction site accidents occur during the busiest months of the year (June and July) and the busiest hours of the day (10-11 am, and 3-4 pm).

The law in Kenya requires every construction site to have safety officers to identify project risks. However, most construction firms in Nairobi have no safety policy and allocate less than 1% of project budget to health and safety, resulting in an inadequately funded safety programs. Enhanced investment in Occupational Safety and Health (OSH) and deliberate occupational safety training are recommended to benefit construction workers.

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