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An investigation of construction accidents in Rwanda: perspectives from Kigali

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The International Labour Organization suggests that measuring accident statistics is the first step in reducing accident numbers. However, many developing countries, especially in sub-Saharan Africa, including Rwanda, do not record accident statistics. In response to this, a questionnaire survey of 130 construction workers was undertaken in Kigali, the capital of the Republic of Rwanda, to raise awareness of construction accidents within the country. The survey generated information about 482 non-fatal and six fatal/serious accidents from 23 construction sites. This information enabled the determination of the primary causes and frequencies of accidents. Analysis at individual respondent level revealed that accident rate varied with nature of work for some accident causes and the average employee accident rate was high. Analysis at construction site level revealed that accident rates for some accident causes varied with certain construction site characteristics. It is anticipated that the outcomes of this study will support further research regarding occupational safety in Rwanda.

Notation

CRAR	composite respondent accident rate for all non-fatal accidents
CSARPE	composite site accident rate per employee for all non-fatal accidents
MCRAR	mean composite respondent accident rate for all non-fatal accidents
MRAR	mean respondent accident rate
RAR	respondent accident rate
SARPE	site accident rate per employee

1. Introduction

1.1 Background to Rwanda

The Central African country of Rwanda has suffered a turbulent history, being beset by decades of ethnic violence, culminating in the genocide of 1994. Since this period of great unrest however, the country has made remarkable progress in rebuilding its economy, with an annual gross domestic product (GDP) growth rate of 7–8% consistently seen since 2003 (CIA, 2011). Extensive large-scale infrastructure plans such as the 'Vision 2020' master plan have been revealed by the Republic of Rwanda Ministry of Finance and Economic Planning (2002). The management of health and safety (H&S) is particularly important for countries in a state of rapid development as construction accidents commonly increase with industrialisation (Hämäläinen *et al*., 2005; ILO, 2003).

1.2 The importance of good H&S management

Accidents 'represent a substantial ongoing cost to employers, workers and society' (Haslam *et al*., 2004: p. 4). These costs may be due to absenteeism, reduced productivity, reputational damage, compensatory claims or numerous other damages, accounting for an estimated GDP loss in excess of 4% (ILO, 2003). Awareness of this has resulted in the emergence of 'zero tolerance' policies in many industrialised nations. Mitigating the prevalence of accidents has benefits that extend far beyond reduced injury and compensation levels as international competitiveness has been linked to favourable H&S records (Hämäläinen *et al*., 2005; ILO, 2003).

1.3 Research problem

Many countries in sub-Saharan Africa do not record occupational accident statistics (Hämäläinen *et al*., 2005). This was found to be true in the case of Rwanda when the major organisations most likely to possess accident data were approached. The National Institute of Statistics Rwanda 'do not collect data' (on) occupational accidents and injuries within the construction industry (Karusisi D: personal communication by e-mail to first author, 2 May 2011). This lack of information was corroborated when Sion McGeever, a growth and infrastructure advisor working in Rwanda for the United Kingdom's Department for International Development, concluded that no official accident statistics were available for Rwanda (McGeever S 2011: personal communication by e-mail to first author, 19 April 2011). Furthermore, a detailed search of the World Health Organization's Global Health Observatory revealed no occupational injury statistics for Rwanda. Likewise, no relevant information was discovered after searching Labordoc, the database kept by the International Labour Organization (ILO). Due to the absence of literature, the ILO offered the assistance of a library information services employee for the purposes of this investigation. This effort yielded five documents thought to be relevant to the topic of construction accidents in Rwanda: République Rwandaise Ministère du Plan (1983), Schilderman (1987), Martens (1990), Mazimpaka *et al.* (1991) and Delanghe (2004). Following review, it became apparent that none of the documents provided information regarding construction accidents.

All the above lent strong support to the conclusion that construction accident statistics for Rwanda do not exist in the public domain. Yet, it is crucial that such information is available, as accident statistics, albeit bluntly, are the best method of communicating the importance of H&S (ILO, 2003). Accident statistics will allow for informed H&S management practices to be developed, preventing accident frequencies from escalating as the country makes significant advancements towards industrialisation.

1.4 Research aim

The aim of this investigation was to discover the primary causes and frequencies of construction accidents in Kigali, while identifying whether certain predetermined characteristic variables affected the accidents sustained.

1.5 Limitations

The data collected during this investigation were generated from construction sites within the City of Kigali and are believed to be representative of the study region. However, there is a need for care when applying the findings of this investigation to the entire nation of Rwanda as the extent to which the data collected represent the country as a whole is largely unknown.

2. Research method

A questionnaire survey was conducted on construction sites within Kigali in January 2011. Due to the size of the survey population concerned and high costs associated with an enumeration, a sample was taken from the parent population of active construction projects within the city. Assistance in gathering primary data was enlisted from a number of postgraduate engineering students (hereinafter referred to as 'data collectors') from Kigali Institute of Science and Technology (KIST). The data collectors were recommended by the Dean of the School of Civil Engineering at KIST for their commitment to academic research and further study.

In general there are two methods of undertaking a survey: questionnaires and interviews. For the purposes of this study, questionnaires were chosen as the more suitable option. Interviews were rejected due to the possibility of conscious or subconscious biases being introduced by the data collectors, which would have had an unquantifiable effect on data. Questionnaires were favoured due to their structured format, reducing the risk of verbal communication error to which interviewer-administered interviews are susceptible. Closed-ended questions (dichotomous, numerical and multiple choice) were preferred, allowing responses to be deciphered without the potential error-inducing process of back-translation. The data collectors administered the questionnaires in person to workers on construction sites; this approach enabled suitable survey sites to be identified. Due to low literacy rates being foreseeable within the sample population, it was considered necessary for the data collectors to be present while respondents were completing the questionnaire to offer guidance and prevent misunderstanding. Clear instructions were given to the data collectors to ensure they were appropriately knowledgeable of the survey instrument to prevent experimenter bias when providing advice.

The questionnaire was designed in English; however, it was crucial that the survey was capable of being 'conducted in any language that is spoken by a significant number of people in the survey population to avoid the danger of disfranchisement' (Brace, 2008: p. 109). With the official languages of Rwanda being Kinyarwanda, English and French, the questionnaire was translated into French and Kinyarwanda and offered in all three languages. Professional translators were employed to ensure the etiquette and nuances of each language were conveyed correctly. The accuracy of the translation was verified by back-translation of questions into English using different translators, which resulted in the original questions being expressed. As the questionnaire was pre-tested in English, to British cultural norms, all three language versions were pilot-tested in Rwanda. This process led to the conclusion that the data collection instrument worked correctly and the instructions for data collectors were clear.

The questionnaire consisted of sections A, B and C. Section A was completed by the data collectors, whereas sections B and

C were completed by the respondent. Section A was completed once for each construction site and the following data were sought from site management.

(*a*) Construction industry sector (civil engineering or building).
(*b*) Type of client (public or private).
(*c*) Site workforce size (number of people on site).
(*d*) Project cost (Rwandan francs (RWF)).
(*e*) Project duration (months).
(*f*) Employment of H&S supervisor (yes/no).
(*g*) Age of company (years).
(*h*) Size of construction company (total number of employees).
(*i*) Experience of fatal/serious* accidents (yes/no). (*Serious accidents were defined as where employees had been left rendered incapable of continuing to work due to injuries sustained.)

Despite the necessity for back-translation, some open-ended questions were necessary to gain a complete understanding of accidents, for example discovering details regarding fatal/serious accidents.

Section B captured data regarding each respondent. The length of time each respondent had spent working at the construction site was recorded in either days or weeks. A list of 18 occupational categories within the construction industry developed from the Health and Safety Executive's HandS-On database (HSE, 2011) provided a framework for obtaining information regarding the type of work undertaken by each respondent.

Section C was designed to record the frequency with which respondents had experienced accidents arising from specified causes. Seventeen frequently reported construction accidents under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (HSE, 2011) provided a framework for this section. A series of open-ended questions were designed to elicit in-depth responses to discover accident causes not listed within the prompted accident causes.

It was anticipated that if the respondents suspected they were being investigated on a personal basis, they could misrepresent their answers, resulting in inaccurate data. To reduce the likelihood of this, the questionnaire was anonymous. This anonymity was reinforced in a cover letter introducing respondents to the research project.

3. Data collection and preparation

Due to the location of construction sites being largely unknown, a cluster sampling technique was utilised. A 71·5 km^2 area of central Kigali was divided into six zones. The six data collectors were each allocated a zone in which sampling must take place, along with an approximate quota of how many completed surveys to achieve. The survey region stretched from the Nyabugogo Mosque in the east of the city, to Kigali International Airport in the west. The northern boundary of the survey area was Avenue du lac Kivu and the southern boundary was Ecole Technique de Kicukiro. On completing the data collection exercise, the data were checked to verify that the survey had been administered as instructed.

It was necessary to compute accident rates for a common time period. A month was chosen as an appropriate time period. From the primary variables, derived variables representing accident rates per month at individual and site level were computed using Equations 1 to 4 below.

1. $$RAR = f/t$$

2. $$SARPE = \sum_{1}^{n} RAR/n$$

3. $$CRAR = F/t$$

4. $$CSARPE = \sum_{1}^{n} CRAR/n$$

where RAR is the respondent accident rate; $SARPE$ is the site accident rate per employee; $CRAR$ is the composite respondent accident rate for all non-fatal accidents; $CSARPE$ is the composite site accident rate per employee for all non-fatal accidents; f is the number of times respondent experienced an accident; n is a number of respondents at the site; t is the respondent's duration of employment at the construction site (months); F is the total number of non-fatal accidents experienced by respondents

4. Data analysis and discussion

The primary and derived variables enabled data analysis with two units of analysis: individual respondent and construction site.

4.1 Results with the unit of analysis as the individual respondent

The results here relate to frequencies associated with specific causes of accidents and also with the impact the type of work had on accident rates. For purposes of this paper, accidents were classified as either non-fatal or fatal/serious.

4.1.1 Frequencies and causes of accidents

In total 482 non-fatal accidents were reported by 130 respondents, with a cumulative working period of 780 man-months. To aid interpretation of the data, accidents per working month (APWM) were calculated for each accident cause by

Accident number	Accident cause	Frequency	APWM	Contribution to accidents: %
1	Contact with moving machinery	2	0·003	0·4
2	Hit by a moving, flying or falling object	27	0·035	5·6
3	Hit by a moving vehicle	2	0·003	0·4
4	Hit/stepped upon something fixed or stationary	89	0·114	18·5
5	Injured while handling, lifting or carrying	78	0·100	16·2
6	Slip, trip or fall on same level	116	0·149	24·1
7	High fall over 2 m	8	0·010	1·7
8	Low fall up to and including 2 m	20	0·026	4·1
9	Height of fall not known	11	0·014	2·3
10	Trapped by something collapsing or overturning	10	0·013	2·1
11	Falling into/getting trapped in water or something stopping you from breathing	2	0·003	0·4
12	Exposed to or contact with harmful substance	23	0·029	4·8
13	Exposed to fire	7	0·009	1·5
14	Exposed to an explosion	0	0·000	0·0
15	Contact with electricity or electrical discharge	17	0·022	3·5
16	Injured by an animal	6	0·008	1·2
17	Being physically assaulted by another person	64	0·082	13·3
	Totals	482	—	100·0

Table 1. Non-fatal accident frequencies by cause

dividing the total accidents reported by the number of man-months. APWM for all accident causes across all employees studied was found to be 0·6243. A summary of non-fatal accident causes and frequencies identified is presented in Table 1.

One fatality and five serious injuries were identified on four separate construction sites as shown in Table 2. All fatal/serious accidents involved falling from height, which is a leading cause of fatal construction accidents in many countries (Haslam, *et al*., 2004; Smith and Barss, 1991).

Case	Accident details
1	Two employees fell from scaffolding of unknown height; one was killed and the other seriously injured
2	One employee fell off a wall from 4 m, suffering serious injuries
3	One employee fell when manoeuvring on scaffolding while stripping formwork from a concrete slab and was seriously injured
4	Two employees fell due to improper scaffolding, with both suffering serious injuries

Table 2. Details of fatal and serious accidents

4.1.2 Variation of accident rate with nature of work

Due to low response rates for some of the 18 prompted occupational categories, responses were collapsed into four types of construction work: superstructure, substructure, services and finishes, with 51, 18, 38, 23 responses, respectively. This new variable was then taken as the independent variable for analysis at individual respondent level.

The variables *RAR* and *CRAR* (Equations 1 and 3) were taken as dependent variables. After computing these new variables, it was necessary to determine how the 18 dependent variables (17 *RAR* values and *CRAR*) were distributed. One-sample Kolmogorov–Smirnov tests (Kinnear and Gray, 2010) of goodness-of-fit provided evidence against the null hypothesis that the sample was drawn from a normal population. Therefore, the tests to determine the variation of accident rate with nature of work had to be non-parametric (Kinnear and Gray, 2010; Tutesigensi and Phung, 2011). This was achieved through standard Kruskal–Wallis tests followed by Mann Whitney *U* tests (Kinnear and Gray, 2010).

The Kruskal–Wallis test (Kinnear and Gray, 2010) was conducted to establish whether *RAR* was influenced by type of work. It was established that *RAR* was not influenced by type of work for the majority of cases; however, *RAR* was found to be influenced by the type of work for the following accident causes

(*a*) hitting/stepping upon something fixed or stationary
(*b*) injured while handling, lifting or carrying
(*c*) slips, trips and falls on the same level
(*d*) being physically assaulted by another person.

Furthermore, $CRAR$ was also found to vary with type of work.

The differences in RAR among the different types of work for the four accident causes above merited further investigation using the Mann–Whitney U test (Kinnear and Gray, 2010). The mean RAR per month ($MRAR$) for accidents involving 'hitting/stepping upon something fixed or stationary' for occupations involved with works on the superstructure was 0·2966 and identified as being significantly greater than the $MRAR$ of 0·0826 among people working on finishes: $U = 429{\cdot}000$; exact $p = 0{\cdot}025$ (two-tailed). The same test for people involved in superstructure works and those involved with services ($MRAR = 0{\cdot}0765$) for the same accident cause also showed significant differences: $U = 754{\cdot}000$; exact $p = 0{\cdot}028$ (two-tailed). The $MRAR$ for substructure was 0·1829 and not found to be significantly different from the $MRAR$ values of the other three areas of work.

Occupations involved with works on the superstructure ($MRAR = 0{\cdot}4085$) were found to have a higher $MRAR$ than those working on the substructure ($MRAR = 0{\cdot}1034$), services ($MRAR = 0{\cdot}2115$) and finishes ($MRAR = 0{\cdot}0565$) for accidents arising from 'injured while handling, lifting or carrying'. A series of Mann–Whitney U tests (Kinnear and Gray, 2010) discovered these differences to be significant ($U = 322{\cdot}500$, exact $p = 0{\cdot}034$ (two-tailed); $U = 416{\cdot}500$, exact $p = 0{\cdot}023$ (two-tailed); and $U = 738{\cdot}500$, exact $p = 0{\cdot}026$ (two-tailed), respectively). This suggests that those working on the superstructure of a construction project are more likely to be involved with accidents resulting from 'injured while handling, lifting or carrying' when compared with the other three areas of work studied.

Mann–Whitney U tests (Kinnear and Gray, 2010) discovered that people working on the superstructure ($MRAR = 1{\cdot}76$) were also significantly more likely to be involved with accidents arising from 'slips, trips and falls on the same level' than those working on the substructure ($MRAR = 0{\cdot}50$: $U = 331{\cdot}500$, exact $p = 0{\cdot}048$ (two-tailed)); finishes ($MRAR = 0{\cdot}39$: $U = 362{\cdot}500$, exact $p = 0{\cdot}002$ (two-tailed)) and services ($MRAR = 0{\cdot}21$: $U = 649{\cdot}000$, exact $p = 0{\cdot}02$ (two-tailed)).

The Mann–Whitney U test (Kinnear and Gray, 2010) was used to identify the relative occurrence of physical assault within different areas of work. The results revealed that those employed within the superstructure ($MRAR = 0{\cdot}2260$: $U = 696{\cdot}000$, exact $p = 0{\cdot}002$ (two-tailed)) and finishes ($MRAR = 0{\cdot}0300$: $U = 696{\cdot}000$, exact $p = 0{\cdot}002$ (two-tailed)) work areas were more susceptible to 'being physically assaulted by another person' than people working on services ($MRAR = 0{\cdot}0285$). Tests between employees working on the substructure ($MRAR = 0{\cdot}1204$) and the other work areas revealed no differences in experiencing 'being physically assaulted by another person'.

Mann–Whitney U tests (Kinnear and Gray, 2010) also showed that the cumulative accident rate for people working on the superstructure ($MCRAR = 1{\cdot}90$) was significantly higher than for those working in finishes ($MCRAR = 0{\cdot}47$: $U = 418{\cdot}000$, exact $p = 0{\cdot}046$ (two-tailed)) and services ($MCRAR = 0{\cdot}71$: $U = 734{\cdot}500$, exact $p = 0{\cdot}047$ (two-tailed)). The mean of the cumulative monthly accident rate for people working on the substructure was 1·01 and tests between this and other work areas revealed no distinct differences.

4.2 Results with unit of analysis as the construction site

4.2.1 Sample characteristics

The nine variables in section A of the questionnaire (see Section 2) were considered as independent variables for construction sites. The civil engineering sector accounted for 20% of responses, whereas 80% were generated from building projects. A more even split was noted within the types of client, with 58% of construction projects being privately financed and 42% government financed. Site workforce size ranged from 15 to 428 people. Cost ranged from 14 000 000RWF [£14 578·78] (XE, 2011) to 8 000 000 000RWF [£8 330 729·98] (XE, 2011). Project durations ranged from one to 71 months. H&S supervisors were not employed on five sites. Company age varied from 1 year to 25 years, with a mean of 10·5 years. Company size varied considerably, ranging from an organisation employing seven staff to one firm recorded as employing 12 000 staff. Fatal/serious accidents were experienced on four sites.

The site variables of $SARPE$ and $CSARPE$ (see Equations 2 and 4) were taken as dependent variables. Table 3 shows the data regarding these variables. Tests to determine the variation of accident rate with site characteristics required an understanding of how the variables ($SARPE1$–$SARPE17$ and $CSARPE$) were distributed (Kinnear and Gray, 2010). One-sample Kolmogorov–Smirnov tests (Kinnear and Gray, 2010) of goodness-of-fit established that $SARPE4$ and $CSARPE$ were parametric, while the remaining variables were non-parametrically distributed. The subsequent tests used reflected the distribution.

4.2.2 Variation of accident rate with construction industry sector

Mann–Whitney U tests (Kinnear and Gray, 2010) on the non-parametric variables suggested differences in accident rates between the civil engineering and building sectors in two

Site	*SARPE**																	*CSARPE*
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
1	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·375	0·250	0·000	0·375	0·000	0·000	1·000
2	0·000	0·028	0·000	0·056	0·048	0·000	0·000	0·000	0·007	0·014	0·000	0·375	0·000	0·000	0·000	0·000	0·000	0·527
3	0·000	0·000	0·000	0·167	0·083	0·000	0·000	0·033	0·067	0·125	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·475
4	0·000	0·272	0·025	0·275	0·297	0·192	0·040	0·090	0·000	0·075	0·000	0·267	0·000	0·000	0·125	0·000	0·025	1·682
5	0·000	0·222	0·000	0·167	0·056	0·722	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	1·167
6	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·500	0·500
7	0·000	0·042	0·000	0·071	0·121	0·250	0·000	0·000	0·000	0·000	0·000	0·000	0·042	0·000	0·000	0·000	0·000	0·526
8	0·000	0·000	0·000	0·111	0·111	2·111	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	2·333
9	0·000	0·000	0·000	0·167	0·167	0·333	0·000	0·167	0·000	0·000	0·000	0·000	0·167	0·000	0·000	0·000	0·167	1·167
10	0·000	0·000	0·000	0·333	0·000	0·000	0·000	0·000	0·000	0·083	0·000	0·000	0·167	0·000	0·000	0·000	0·167	0·750
11	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000
12	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000
13	0·000	0·000	0·000	0·167	0·000	0·000	0·000	0·000	0·167	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000
14	0·025	0·150	0·013	0·075	0·025	0·088	0·000	0·050	0·000	0·038	0·000	0·013	0·000	0·000	0·038	0·000	0·000	0·525
15	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000
16	0·000	0·000	0·000	0·042	0·896	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·167	0·000	0·000	0·000	0·000	1·104
17	0·000	0·000	0·000	0·055	0·019	0·000	0·000	0·250	0·000	0·000	0·000	0·000	0·000	0·000	0·167	0·083	0·000	0·574
18	0·000	0·000	0·000	0·333	0·333	0·024	0·524	0·524	0·424	0·000	0·000	0·167	0·000	0·000	0·307	0·000	0·048	2·683
19	0·000	0·000	0·000	0·916	0·371	0·432	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·491	2·209
20	0·000	0·000	0·000	0·255	0·210	0·474	0·024	0·035	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·275	1·272
21	0·000	0·000	0·000	0·563	1·979	1·438	0·063	0·063	0·000	0·000	0·188	0·500	0·000	0·000	0·000	0·313	0·625	6·354
22	0·000	0·000	0·000	0·048	0·016	0·104	0·005	0·089	0·028	0·000	0·000	0·014	0·000	0·000	0·006	0·000	0·256	0·566
23	0·000	0·000	0·000	0·122	0·125	0·110	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·083	0·000	0·193	0·633

* The different *SARPE* variables are differentiated by numbers 1 to 17 and associated with accident causes as outlined in the first two columns of Table 1.

Table 3. Site accident rates

Variable	U	Exact p (two-tailed)	Building projects		Civil engineering projects	
			Mean	SD	Mean	SD
SARPE5	10·000	0·006	0·26878	0·477951	0·00380	0·008497
SARPE6	15·000	0·024	0·34878	0·569243	0·00000	0·000000

SD, standard deviation

Table 4. Variation of accident rate with construction industry sector

variables only, as shown in Table 4. The table also shows that building projects had higher accident rates than civil engineering projects for both *SARPE5* and *SARPE6*. Independent T-tests on the two parametric variables revealed no significant differences.

4.2.3 Variation of accident rate with type of client

Mann–Whitney U tests (Kinnear and Gray, 2010) on the non-parametric variables suggested no differences in accident rates between public and private clients. Likewise, independent T-tests on the two parametric variables also revealed no significant differences.

4.2.4 Variation of accident rate with site workforce size

Association between site workforce size and the 18 dependent variables was investigated using Pearson's coefficient, r. It was established that a large significant correlation existed between workforce size and *SARPE12*; ($r(23) = 0{\cdot}500$; $p < 0{\cdot}05$. $r^2 = 0{\cdot}25$). No other significant correlations were found.

4.2.5 Variation of accident rate with project cost

Association between project cost and the 18 dependent variables was investigated using Pearson's coefficient, r. No significant correlation was found.

4.2.6 Variation of accident rate with project duration

Association between project duration and the 18 dependent variables was investigated using Pearson's coefficient, r. It was established that significant correlation existed between workforce size and three variables only, as shown in Table 5.

Variable	Pearson's coefficient: r	r^2	p	Magnitude of association
SARPE2	0·489	0·2391	$<0{\cdot}05$	Large
SARPE3	0·682	0·4651	$<0{\cdot}01$	Large
SARPE8	0·441	0·1945	$<0{\cdot}05$	Large

Table 5. Variation of accident rate with project duration

4.2.7 Variation of accident rate with employment of H&S supervisor

Mann–Whitney U tests (Kinnear and Gray, 2010) on non-parametric variables revealed differences between sites which had an H&S supervisor and those that did not in five variables only, as shown in Table 6 below. The table also shows that sites with an H&S supervisor had lower accident rates on each of the five variables. This implies that sites without an H&S supervisor can be considered less safe. Independent T-tests on the two parametric variables revealed no significant differences.

4.2.8 Variation of accident rate with age of construction company

Association between age of the construction company and the 18 dependent variables was investigated using Pearson's coefficient, r. No significant correlation was found.

Variable	U	Exact p (two-tailed)	Sites with H&S supervisor		Sites without H&S supervisor	
			Mean	SD	Mean	SD
SARPE2	1·000	0·011	0·01622	0·052634	0·21100	0·086267
SARPE3	0·000	0·005	0·00000	0·000000	0·01900	0·008485
SARPE10	4·000	0·042	0·01233	0·034276	0·05650	0·002616
SARPE12	5·000	0·047	0·05789	0·145156	0·14000	0·179605
SARPE15	5·00	0·047	0·03094	0·081092	0·08150	0·061518

Table 6. Variation of accident rate with employment of H&S supervisor

Variable	Pearson's coefficient: *r*	r^2	*p*	Magnitude of association
SARPE12	0·434	0·1884	$<0·05$	Large
SARPE13	0·593	0·3516	$<0·01$	Large
SARPE15	0·692	0·4789	$<0·01$	Large

Table 7. Variation of accident rate with size of construction company

4.2.9 Variation of accident rate with size of construction company

Association between size of the construction company and the 18 dependent variables was investigated using Pearson's coefficient, *r*. It was established that significant correlation existed between size of the construction company and three variables only, as shown in Table 7.

4.2.10 Variation of accident rate with experience of fatal/serious accidents

Mann–Whitney *U* tests (Kinnear and Gray, 2010) on non-parametric variables revealed differences between sites which had experienced fatal/serious accidents and those that had not on three variables only, as shown in Table 8 below. The table also shows that sites that had suffered fatal/serious accidents had higher non-fatal accident rates on each of the three variables. This suggests construction sites that had experienced fatal/serious accidents also had more non-fatal accidents. Independent T-tests on the two parametric variables revealed no significant differences.

5. Conclusion

Accident data were systematically and objectively collected and analysed – an approach that allowed accurate observations and contributed important new knowledge of construction accidents in Rwanda. Identifying the causes of construction accidents is the first significant step towards successful H&S management (ILO, 2003). Therefore, it is hoped that the findings of this study will be recognised by those engaged within the construction industry of Kigali and, if required, contribute to developing preventative measures and regulation to manage H&S across the country.

Accident causes identified during this study followed a similar trend to previous investigations of construction accidents, with falls from height and slips, trips and falls being major contributors to accident frequencies (Haslam *et al.*, 2004; HSE, 2011; Smith and Barss, 1991). Slips, trips and falls accounted for almost a quarter of all accidents and hence this is something that must be addressed in order to reduce accident rates. A basic recommendation, proven to reduce slips, trips and falls is to improve site cleanliness and implement good house-keeping (Gibb and Bust, 2006).

Physical assault was recorded on 10 of the 23 construction sites surveyed and hence it was considered a particularly prominent finding. Information was not obtained regarding the individuals/parties responsible for assault for reasons of maintaining anonymity and perhaps such enlightment of prolific accident causes would not have been possible if the study had not been designed to maintain anonymity, for fear of reprisal. Further investigation into the reasoning behind such high levels of physical assault is required and reducing levels of assault on construction sites may extend beyond construction regulations and into criminal law.

Data collected revealed that average monthly accident rates were high and also that different work areas are exposed to differing levels of risk. To reduce accident frequencies, H&S training should be offered to all employees; however, the training should be tailored to suit the unique hazards of specific work areas. Also, employees should not transfer between work areas unless they are suitably trained. From analysis at site level it was discovered that accident rate varied with construction industry sector, site workforce size, project duration, size of construction company and the experience of fatal/serious accidents for some accident causes. It was also determined that employing the use of an H&S manager had a positive effect on H&S performance.

Variable	*U*	Exact *p* (two-tailed)	Sites that had fatal/serious accident		Sites that did not have fatal/serious accident	
			Mean	SD	Mean	SD
SARPE2	13·500	0·013	0·11250	0·124690	0·01389	0·051305
SARPE3	19·000	0·024	0·00950	0·012014	0·00000	0·000000
SARPE10	16·500	0·021	0·03175	0·032827	0·10905	0·033530

Table 8. Variation of accident rate with experience of fatal/serious accidents

Through continuation of accurate accident monitoring, benchmark levels can be established, allowing for H&S performance to be measured, reflected upon and improved. By continually evaluating and monitoring accidents, the Rwandan construction industry can be made significantly safer, allowing organisations to increase productivity and perform at their most efficient. This will significantly contribute to improving the lives of the country's construction employees while boosting the nation's economy.

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