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# Assessment of construction sites' accident: strategies for sustainable construction

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**Abstract.** Diverse causes of accidents abound on construction sites and these have negative impacts on the construction process. These negative impacts are enormous, leading to non-sustainable construction. However, achieving sustainable construction requires reduction in the occurrence rate of accidents. The aim of this study is to investigate the occurrence rate of accident types on construction site. Accident types were majorly categorised into four namely, earth moving machinery, electrocution, construction fall, and others. From the positivist research paradigm and adopting cross-sectional survey research design, questionnaires were used to elicit information from personnel on construction sites. The mean of the occurrence rate of accidents was calculated. Findings show that construction site fall has high occurrence rate while earth moving machinery, electrocution and others have moderate rate of occurrence. The study concludes that the most frequently occurring type of accidents on construction site is construction fall.

Keywords: Accident, construction site, sustainable construction

## 1. Introduction

A sustainable construction is one in which construction activities, which have negative impacts, are minimised and positive impacts maximised for achieving balance between environmental, economic and social performance [1]. The idea of sustainable construction is to minimise negative impacts, hence sustainable construction is one in which the occurrence rate of accidents is minimised to achieve environmental, economic and social performance. Accident is an undesirable event yet it occurs on construction sites with consequences that can be described as negative impacts. Such consequences are fatal, major injury, minor injury, severe injury, damage, disabilities, deaths, increase in construction projects cost and time [2, 3, 4]. Further consequences include negative impacts on the economy, employers, employees and families [5]. Other negative impacts include demotivation of workers or reduced morale, conflict with owners and loss of productivity [6].

The diverse negative impacts of accidents negate the principle of sustainable construction; it is thus pertinent to examine the occurrence rate of accidents on construction site for proper understanding of this menace that impede sustainable construction. Previous studies on accidents focused on diverse areas. Wang [7] studied construction statistics with focus on types of accident, kind of work and location of accidents without considering the occurrence rate of accident based on it types. Jo [5] investigated the types of accident and the occurrence of accident but did not consider the occurrence rate based on types of accident. Gonzalez [8] studied the type of injury, part of body affected, agent in accident, accident mechanism and causes of accidents. Again, the occurrence rate of accident types was not investigated. Similarly, Yimaz [9] investigated type of accidents, affected body part and dangerous behaviours of workers that causes accident, but the occurrence rate of accident types was not considered.



There seems to be a gap in research on the categorisation of the types of accident and occurrence rate of accident types in literature. This study aims at minimizing accidents on construction sites by investigating the occurrence rate of accident types. The objectives of the study are; to identify the types of accident on construction sites and to investigate the frequency of occurrence of the accident types on construction site.

Achieving sustainable construction through minimizing negative impacts of accidents is important in construction industry. Knowledge of the occurrence rate of accident types will provide information for establishing strategies to minimise accident rate on construction sites. In addition, knowledge of the occurrence rate of accidents will also create awareness among construction workers and aid policy makers in formulating policy in construction industry; hence avoidance of such acts and behaviours that lead to accidents which in turn leads to sustainable construction.

## 2. Literature Review

### 2.1. Sustainable Construction

Sustainable construction coined from the two words ‘sustainable’ and ‘construction’ is a complex concept with different scope and meaning [10]. A clear definition of sustainable construction is important so as to adopt it into diverse areas of construction especially construction accident. Kamar [1] defined sustainable construction as ‘construction activities whose negative impacts are minimised and positive impacts maximised so as to achieve a balance in terms of environmental, economic and social performance’. This definition explains the fact that the occurrence of accidents during construction activities are negative impacts, thus achieving balance in terms of environmental, economic and social performance emphasises reduction in negative impacts such as accident and increase in positive impacts.

Sustainable construction aims at achieving a balance between social, economic and environmental dimensions of construction [11]. The social dimension focuses on issues relating to health and safety, involvement of stakeholders, equality and diversity in workplace and creating employment opportunity [11]. Sustainable construction also considers safety, security, environment and health in construction [12]. Achieving sustainable construction from social dimension implies minimising the occurrence rate of accidents on construction site.

### 2.2 Types of Accident

An accident is described as unpleasant events that result in fatality, injury of the person involved and damage to property [2]. Different authors identified different types of accident on construction site. Such accident types include fall from height, fall from same level, fall from roofs, ladders and scaffold [5, 7, 13], struck by objects or falling object, hit by object [4, 7, 14, 15], electrocution or electric shock [5, 15, 16]; cut or caught in between [4, 5, 7], fire explosion [17] and others [7, 13].

Al-Tabtabal [17] discovered that the three major types of accident are falling from height, falling objects and tools while Adekunle [13], concluded that falls are the most common home building fatality. In addition, the four major types of accident are falls, contact with objects and equipment, exposure to harmful substance or environment and transportation accidents. Lee [15] identified falls, hit by objects and machinery and equipment error as the most common types of accident on construction site. In contrast, Bhole [14] found falls from height, slips, trips or falls on same level and handling, lifting or carrying as the three major types of accidents.

Previous authors [13, 14, 15, 16, 17] identified the different types of accident; however the types of accident were not categorised into major groups for easy identification and understanding. Based on the accident types identified in previous literature, this study categorises the types of accidents into four, namely earth moving machinery, electrocution, construction site fall and others.

## 3. Research Method

A cross-sectional survey design which investigates a phenomenon at a specific time from more than one respondent was adopted [18]. This is because it was required that data should be collected at a point in time and a representative sample taken from the population be used to generalise the findings.

Furthermore a cross-sectional survey research design was adopted because there is a need to determine the prevalence of accidents on construction sites [18]. Questionnaires were used in eliciting information from the respondents. The respondents of this study are construction professionals or workers namely, architects, builders, quantity surveyors, civil engineers, mechanical engineers and electrical engineers who have on one or more occasion be involved in an accident or witness an accident on construction sites. The study adopts a purposive sampling technique. A purposive sampling technique is a nonprobability sampling technique in which the researcher chooses the samples of the study based on their knowledge of the information and their willingness to share the information [19]. Purposive sampling technique was adopted in the selection of the samples because there is no list of professionals working on construction site in the study area [Lagos state] and because the study requires specific group of persons who have knowledge of construction site accidents to give the required information. One hundred and twenty questionnaires were distributed and one hundred returned questionnaires were valid and used for analysis representing 95% response rate.

### 3.1 *Measures of variables*

Types of accident was conceptualised as four latent variables namely; earth moving machinery, electrocution, construction site fall and others. All the observable variables that were used to measure all the four latent variables are shown in Table 1. The first latent variable ‘earth moving machinery’ was measured with 8 observable variables such as fall from machine, starting of vehicle when in gear. The second latent variable ‘electrocution’ was measured with 3 observable variables. Examples are, stepping on expose electric, electric shock, etc. The third variable addresses construction fall and it was measured with 5 observable variables. For example, fall from roof, fall from scaffold, etc. The fourth variable classified as ‘others’ was measured with 7 observable variables such as welding accident, fire and explosions, etc.

To identify the types of accident on construction sites, the types of accident were categorised into four. Respondents were asked to choose the types of accident on construction site. A two-point rating scale was used; Yes [1], No [2] respectively. Percentage of the respondents that answered “yes” was thus calculated.

To determine the rate of occurrence of accident types, respondents were asked to rate the frequency of occurrence of each accident type using 1.00-1.49 for very low level; 1.50-2.49 for low level; 2.50-3.49 for moderate level; 3.50-4.49 for High level and 4.50-5.00 for very high level. Mean score was then used to calculate the rate of occurrence of accidents on construction site.

### 3.2 *Demographic details of respondents*

43% of the respondents are builders by profession, 32% are civil engineers, 17% are architects, 15% are project managers while 2% and 1% are electrical and mechanical engineer respectively. This shows that respondents are professionally qualified to answer questions correctly. Furthermore, 35% are site managers, 28% are site supervisors, 16% occupy other positions such as human resource manager, 15% are project managers while 6% are safety manager. The diverse range of professionals’ positions on construction sites indicates that they are aware of construction site accidents. In terms of site experience, 44% of the respondents have experiences of 5 years and below while 42% have experiences between 6-10 years. 9% of the respondents have experience between 11-15 years, 2% have between 10-20 years and 1% has experiences above 20 years. A large percentage of the respondents have experience of 10 years and below, this suggests that most professionals working on construction sites are middle management staff, hence the reason for having large proportion of the respondents with experiences of 10 years and below. In addition, the diverse range of respondents’ site experiences shows that they have vast knowledge of construction site accidents.

## 4. Result and Discussion of Findings

### 4.1 Types of accident

The result in Table 1 shows that on average 90% of the respondents identified ‘other types’ as construction site accident, 89% identified construction site fall as construction site accident, 87% of the respondents identified electrocution as construction site accident, while 79% identified earth-moving machinery as construction site accident. Overall, large percentage of the respondents identified all the listed types of accident in Table 1 as construction sites accident. Previous studies [13, 17] also identified fall from height, fall from roof, and electrocution as type of construction sites accident. The result of this study differs slightly from [13, 16, and 17] in that the types of construction accident were categorised into groups for easy identification and understanding.

**Table 1:** Types of Construction Site Accident

S/N	Types of Accident on Construction Site	%	S/N	Types of Accident on Construction Site	%
	<b>Earth moving machinery</b>	<b>79</b>		<b>Construction site fall</b>	<b>89</b>
1	Person fall from machine	70	12	Fall from roof	88
2	Vehicle started when in gear	78	13	Fall from crane	78
3	Person hit by machine which was moving in a forward direction	79	14	Fall from scaffold	95
5	Person injured when conducting maintenance on the machine	85	15	Slips and fall	88
6	Struck by backhoes	85	16	Falling debris, materials or object	96
7	Machine cutting worker	85		<b>Other types</b>	<b>90</b>
8	Reversing excavators	71	17	Building Collapse	96
	<b>Electrocution</b>	<b>87</b>	18	Welding accident	89
9	Stepping on expose electric wire	90	19	Getting caught in-between objects or material	90
10	Electric shock	86	20	Fires and explosions	90
11	Power line contact	84	21	Trench collapses	92
			22	Gas explosion	88

### 4.2 Rate of occurrence of construction sites accident

The result in Table 2 shows that the frequency of occurrence of construction site accident is moderate except for construction site fall, which is high. This suggests that the rate at which falling from scaffold, falling of debris, materials or object on workers, fall from roof, fall from crane is high. The implication is that proper inspection of scaffold is not carried out before use. Furthermore, training of construction site workers on safety practices especially when working on height is not properly carried out on construction site. The result correlates with that of Jo [5] in which fall was identified as the dominant type of accident. In addition, the result differs from Lee [15] in which the three most occurring types of accident are fall, hit by objects, machinery and equipment. The difference lies in that fact that this study categorises accident types into major groups while Lee [15] did not categorise accident types. Individually, fall debris, materials or objects, slips and fall, and fall from scaffold were the three most occurring types of accidents. This differs from Adekunle [13] in that fall from roof, fall from ladder and fall from scaffold were identified as the types of accident with highest number of fatalities. The difference could be due to the scope of the study, while Adekunle’s [13] finding is based on accidents in home building; this study generally focuses on construction projects.

The second most occurring group of accident types is ‘others’. Others imply types of accident not mentioned. Previous studies also identified others as types of accident [5, 7, and 16]. Due to the fact

that different types of accident occur, it may be difficult to classify them; as such they are categorised as others. In contrast to Jo [5] in which other types of accident was the least dominant type of accident, this study discovered that other types was the second most occurring types of accident. Furthermore, the study identified building collapse and trench collapse as the most occurring types of accident under the main category of 'others'. Although, Jo [5] did not consider the subtypes of other types of accidents, collapse was found to be the 6<sup>th</sup> dominant types of accident. The difference could be as a result of the study area; the implication is that building collapse occurs more in Lagos state compare to Korea.

**Table 2:** Rate of Occurrence of Accidents on Construction Site

S/N	Occurrence Accident	Level of	1	2	3	4	5	TS	MS	SD	Remark
	<b>EARTH MOVING</b>										
<b>A</b>	<b>MACHINERY</b>		<b>8</b>	<b>18</b>	<b>43</b>	<b>24</b>	<b>7</b>	<b>100</b>	<b>3.04</b>	<b>0.59</b>	<b>Moderate</b>
1	Person fall from machine		19	16	39	16	10	100	2.82	1.21	
2	Vehicle started when in gear		6	14	56	18	6	100	3.04	0.90	
3	Person hit by machine which Person injured when		5	14	57	21	3	100	3.03	0.82	
4	conducting		0	8	47	30	15	100	3.52	0.85	
5	Struck by back hoes		4	26	39	28	3	100	3.00	0.91	
6	Machine cutting worker		1	11	39	39	10	100	3.46	0.86	
7	Reversing excavators		21	39	24	13	3	100	2.38	1.05	
<b>B</b>	<b>ELECTROCUTION</b>		<b>6</b>	<b>17</b>	<b>37</b>	<b>27</b>	<b>14</b>	<b>100</b>	<b>3.27</b>	<b>0.88</b>	<b>Moderate</b>
8	Stepping on expose electric wire		3	10	39	29	19	100	3.51	1.01	
9	Electric shock		4	18	35	28	15	100	3.32	1.06	
10	Power line contact		10	22	36	24	8	100	2.98	1.09	
	<b>CONSTRUCTION SITE</b>										
<b>C</b>	<b>FALL</b>		<b>2</b>	<b>10</b>	<b>24</b>	<b>45</b>	<b>19</b>	<b>100</b>	<b>3.70</b>	<b>0.73</b>	<b>High</b>
11	Fall from roof		3	11	37	38	11	100	3.43	0.94	
12	Fall from crane		1	12	24	51	12	100	3.61	0.89	
13	Fall from scaffold		2	10	24	46	18	100	3.68	0.95	
14	Slips and fall		4	6	22	44	24	100	3.78	1.01	
15	Falling debris, materials or object		0	10	13	45	32	100	3.99	0.93	
<b>D</b>	<b>OTHERS</b>		<b>2</b>	<b>16</b>	<b>36</b>	<b>33</b>	<b>14</b>	<b>100</b>	<b>3.43</b>	<b>0.63</b>	<b>Moderate</b>
16	Building Collapse		1	7	18	44	30	100	4	1	
17	Welding accident		2	26	37	23	12	100	3	1	
18	Getting caught in-between objects ....		3	11	35	41	10	100	3	1	
19	Fires and explosions		2	17	41	28	12	100	3	1	
20	Trench collapses		1	9	29	43	18	100	4	1	
21	Gas explosion		1	23	44	22	10	100	3	1	
22	Cutting Accident		1	16	45	29	9	100	3	1	

<sup>a</sup> MS= Mean Score, TS= Total Score

<sup>b</sup>1.00-1.49 for *very low level*; 1.50-2.49 for *low level*; 2.50-3.49 for *moderate level*; 3.50-4.49 for *High level* and 4.50-5.00 for *very high level*

## 5. Conclusion

Achieving sustainable construction through determining the occurrence rate of accidents on construction sites is important. The study examined the occurrence rate of accidents on construction sites. The result indicates that four major types of accident namely earth moving machinery, electrocution, construction site fall and other types of construction accident occur on construction sites. Thus, the study concludes that accidents can be majorly classified into four types on construction site. In addition, the study discovered that the occurrence rate of construction site fall is high while the occurrence rate of earth moving machinery, electrocution, and other types are moderate. The study therefore, concludes that the frequency of; fall from roof, fall from crane, fall from scaffold, slips and fall, falling debris, materials or object is high on construction sites. Construction workers should therefore take cognise of these types of accident when working on construction site so as to prevent the frequent occurrence. This can be achieved by placing the accident types on signboard on construction sites to serve as a means of awareness and training of workers on sites.

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