

# Assessment of the Cost Impacts of Health and Safety Practices on Construction Projects in Abuja, Nigeria

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Forecasting the costs of a construction project usually fails to include the cost of health and safety of the construction workers, and the construction process itself contains a series of crafty activities which require time and costs for smooth execution. Thus, the research aimed at assessing the cost impact of health and safety practices on construction projects. The study adopted quantitative technique. The research population constituted the professionals in the construction industry who are directly involved on construction sites. A total of 181 structured questionnaires were administered to the sampled participants (23 project managers, 43 consultants, 48 contractors and 67 safety officer) within Abuja, using the stratified random sampling method, from which a total 170 was retrieved, representing 93.9% response rate. The collected data were analysed by using the descriptive methods (Relative Importance Index, frequencies, percentages and ranking method). The research found that struck by falling objects; slip, trip and falling from heights; collapse of cranes; death; and respiratory deformation, are the major health and safety risks that have major effects on project cost. The research also found that the provision of health and safety programs on construction sites contributes between 3–5% of the project costs. It was also revealed that the percentage cost of accidents to the overall cost of construction projects is less than 1%, with an average percentage contribution of 0.218%. Based on these findings, it can be concluded that the costs of health and safety programs and practices are significant in increasing the costs of building projects. It was recommended that health and safety practices and programs should always be given priority at the initial project estimating stage of a project, as they constitute a reasonable percentage of project cost.

**Keywords:** Accidents, Construction projects, Cost impacts, Health and safety, Risks

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## Introduction

The cost of constructing every new project is needed at its very begging, but forecasting this cost usually fails to include the cost of Health and Safety (H&S) of the construction workers (Idoro, 2011). The construction process itself contains a series of crafty activities which require time and costs for smooth execution. The great challenges posed by poor H&S practices in project executions are liable to raise the total cost of construction projects and it has been a great problem for contractors and their clients (Dimuna, 2011).

Construction projects in Nigeria are faced with a lot of problems among which is

additional costs usually incur on projects (Arditi & Yasamis, 2007). Parts of these claims can be potentially linked to cost incurred on H&S practices in the construction industry (Okoye & Okolie, 2014). Awodele and Ayoola (2015) declared that the absence of the H&S regulations and bye laws on construction projects in Nigeria may be one of the major causes of the high cost of construction projects. The expanding rate of site accidents has raised the cognisance of development of H&S, in this manner, including it as a major aspect of the venture budgetary arrangement. According to Rosli-Ahmad (2008), good H&S programs would

definitely assist in minimising the costs of construction. Furthermore, Bakri *et al.* (2006) recommended that it is essential to look for a new means of improving the reflection of the construction industry by getting rid of the additional costs out of the project budget, as the provision of safe and healthy workplace is one of the most helpful ways for cutting down the expenditure of the construction project. Accidents do not only result to hindrance in operations and works delivered, but have also earned additional expenses (Bakri *et al.*, 2006).

Research on H&S practices in construction projects is not a new field of knowledge and expertise. Many studies have been conducted by many authors in this field, including: improving safety performance in construction projects in Libya, Saudi Arabia, Gaza Strip and Ghana (Adnan *et al.*, 2009; Ibrahim, 2015; Evans, 2016); safety practices of construction industry (Ashly, 2015; Tan & Nadeer, 2014); causes and effect of accidents on construction sites (Kadiriet *al.*, 2014); safety concepts, value and cost in construction projects (Sarireh & Tarawneh, 2014); and effects of H&S management on project sites (Grace & Cornelius, 2014). However, not much research has been conducted on assessing the cost impact of health and safety practices on construction projects in Nigeria. This research will create awareness and provides guidance on the efficient planning and management of costs of H&S by project professionals. Azhar and-Farouqui (2008) noted that the trend of additional costs and extension of project time is a global phenomenon, which portion of it could be potentially linked to the problems of health and safety practices (health and safety risks and so forth) observed during the project execution by the construction industry. In order to minimize the effects of these problems, this research is conducted to assess the cost influence of H&S practices on construction projects, with a view to proffering solutions that would serve as means for successful construction project delivery within the estimated budget. The specific objectives include: to identify the most common H&S risks encountered on sites; to determine the effect of the identified

risks on project costs; to determine the costs incurred in the provision of health and safety programs on sites; and, to determine the percentage ratio of cost of accidents to the overall costs of construction projects.

## Literature Review

### Common health and safety risks on construction sites

The construction industry's accident fatality rate stands at more than double those of the other sectors average (Guha & Biswas, 2013). Minor accidents in construction are almost incalculable, where construction sites are health and safety nightmare, and almost every conceivable hazard exists within this constantly changing work environment (Guha & Biswas, 2013). Various researchers have divided health and safety hazards into two categories, namely: the physical injury hazards and the ill-health hazards (Davies & Tomasin, 2006; Murie, 2007; HSE, 2008). Hazard of physical injury include death consequences. Hazard of ill-health can only be notified after a long period and shall cause sickness or death after a certain period of time (Murie, 2007). Idoro (2008) recommended the following common hazards on construction sites irrespective of the physical injury: antagonism, aggression and maltreatment of workers, working at heights, dusts, moving objects, slips, outing and falls, noise, vibration and arm disorder, movement of materials, combustion, collapse, airborne strands and materials, electricity, and chemical substance.

Murie (2007) noted that building activities usually involve the uses of substances that contain toxic chemicals like adhesives, paints, varnishes and pesticides which can cause various health challenges (eye irritation, faintness, headaches, dizziness, and sleepiness) to site workers. At the sites, employees are exposed to these substances through ingestions, inhalation and direct contact (Murie, 2007). Among other health problems that exposure to these chemical substances can cause are like cancer, reproductive disorder, kidney, liver and skin (Hughes & Ferrett, 2011). Also, these toxic solvents, lead to defects in human reproduction (Murie, 2007).

### **Health and safety programs on construction sites**

With respect to Occupational Health and Safety (OHS), the program comprises of direction in danger acknowledgment and control measures, learning safe work honours and appropriate utilization of personal protective gear, and obtaining information about crisis strategies and preventive activities. The program likewise furnishes workers with approach to get included data about potential perils and their control; they could pick up aptitudes to expect a more dynamic part in actualizing danger control programs or to impact authoritative changes that would improve the work-site insurance (Idoro, 2008). The author further noted that site workers needed to be given serious H&S training involving fire safety and medical aid, before engaged in any work at the site. Add to this training, is the specialist training that focuses only on employee specific duty. On carrying out the duty, there should be training in case there is change in the risks. The common health and safety programs on construction site could include the following: acquiring new H&S equipment, personal protective equipment, first aid kits, fire safety measures, employment and training of H&S personnel, safety policy, H&S risk assessment, warning signs and so forth (Tan & Nadeer, 2014; Evans 2016; Ibrahim, 2015).

### **Health and safety performance on construction project cost**

The reduction in accidents rates and construction related H&S costs do not give off an impression of being the contributing factors for powerful H&S administration. Many conditions have shown to be of more motivational factors to encourage better H&S culture in the building industry. These conditions lead to reduction of risk claims; prompt handling of legal right; implementation of insurance rules; proper control of client and the customer desires; meeting of target set by the government; adoption of moral settings; gaining of confidence of the employee; and good maintenance and enrollment. Therefore, H&S failure is well known to affect the cost of project execution (Haefeli *et al.*, 2005).

On these bases, Guha and Biswas (2013) concluded that the assumption of H&S cannot be overemphasized, and that there is need for a logical verdict for H&S to maintain the cost related to severe health problems in developing nations like Nigeria. This is basically unsustainable due financial implication, particularly when the cost of accident is low comparable to the economy. Many industries were seen to already possess zeal to enhance H&S continuously, such that the need for further motivation seems to be important. Conversely, a series of conditions were noted as being the major controls for this adjustment, this includes: amount spent on interventions, the expenses incurred due to H&S failures; decreases in premiums of the insurance firms; decrease in exposure of legal claims and unacceptable drift in the rate of incidents.

It is commonly believed that the cost of H&S is compulsory and useful to production cost. Also, alleged gains of complying is far below the expense incur on legislation. This last observation is the common beliefs among the representatives of medium size firms. Most participatory industries had not clearly established savings of cost due to H&S interference. According to Haefeli *et al.* (2005) both direct and indirect H&S performance cost includes; cost of providing of safety programs; training and re-training costs; designing and planning costs; and costs of implementation.

### **Research Methodology**

The quantitative method is employed in this research. The research population constituted the personnel in the construction industry, who are directly involved on construction sites in Abuja, Nigeria. Abuja as a case area is selected because it is one of the cities in Nigeria, where local and international construction companies are mostly engaged. It is one of the metropolitan cities of Nigeria that has the highest population of built environment professionals and has a lot of ongoing construction projects.

In order to guarantee equal representation for each of the identified groups/strata in the population, stratified random sampling

method was adopted. The respondents were first categorised into different strata before they were selected and randomly sampled accordingly.

The sample frame included: 33 project managers, 71 consultants (26 Architects, 23 Quantity surveyors and 22 Builders), 41 contractor, and 65 health and safety officers in the construction industry, making up a total of 210 respondents. This value (210) was subjected to Krejci and Morgan (1970) formula for determining the minimum sample size value in the population. The value was reduced to a minimum of 136 at 95% confidence level and at 5% limit of

error; showing that 136 is the minimum number of questionnaires that can be administered within the population.

Table 1 shows that a total of 181 questionnaires were administered among various construction professionals across different construction sites and a correspondent total of 170 questionnaires were retrieved with all fully answered. This represents a response rate of 93.9 %. The sampled size shows a response rate of 20 project managers (11.76 %), 41 consultants (24.12 %), 46 contractors (27.06 %), and 63 safety officers (37.06 %).

**Table 1: Response Rate**

Research population	Administered questionnaire	Response/returned rate	Percentage(%) of response
Project manager	23	20	11.76
Consultants	43	41	24.12
Contractors	48	46	27.06
Safety officers	67	63	37.06
<b>Total</b>	<b>181</b>	<b>170</b>	<b>100%</b>

Source: Field survey, 2017.

The questionnaire developed for this study comprised questions with closed-ended questions and provided a set of answers from which the respondent were chosen.

In order to collect archival data (project records) on costs of accidents and costs of construction projects for this research, a total of 33 construction sites were identified and visited within Abuja. However, data collected from 14 of the visited projects were found valid for analysis in this research. For anonymity reasons, the names of the visited projects were represented with letters (A, B, C and so forth).

The data collected were used to determine the percentage contributions of the costs of accidents to the overall costs of building. The data were also analyzed by using the simple percentile method. The percentage average was calculated to determine the percentage cost of accident to the overall cost of the project.

The data collected through structured questionnaire were carefully analysed in relation to the stated objectives. The data were analysed by using descriptive statistical method (Relative Importance

Index, Percentile and Ranking Method) which were found in the Statistical Package for Social Science (SPSS) version 22. The analysed data were presented in the form of tables. The use of the Relative Importance Index assisted the researcher in establishing the significance of the lists of H&S risks encountered on sites, as well as the effects of the H&S risks on the cost of projects.

The Relative Importance Index (RII) is given by the formula:

$$RII = \frac{\sum fx}{\sum f} \times \frac{1}{k} \dots \dots \dots (1)$$

Where  $\sum fx$  = is the total weight given to each attributes by the respondents;  $\sum f$  = is the total number or respondents in the sample; and  $k$  = is the highest weight on the Likert scale.

It is meaningful to know that the nearer the value of the Relative Importance Index of the identified factor is at 1 or 100%, the more significant it is and hence, a greater impact on the rest of the variables.

## Results and Discussion

### Common health and safety risks on construction sites and their effects on project costs

Table 2 shows that the top ranked H&S risks encountered on construction sites by the majority of the respondents were: slips, trips and falling from a height; stepping on objects; muscular disorders; equipment, machinery, tools and transport; fractures; and cuts, because they had RII values of between 0.80-0.91. These findings corroborate some of the assertions of Idoro (2008); and Hughes and Ferret (2011) that slips, trips and falling from heights are the common workshop risk and they add to over a third of all key injuries. The study carried out by Lipscomb *et al.* (2008) also showed that slips, account for 18% of all injuries and 25% of workers' reparation payments.

However, H&S risk factors such as: ear defect due noise, dizziness, and damage to the central nervous system, were given less attention by the respondents, with RII values of 0.40.

Moreover, Table 2 also shows the effect of each of the encountered risks on project costs. The major risks factors that have effects on construction costs are: struck by falling objects; slip, trip and falling from a height; the collapse of a crane; death; and respiratory deformation. These factors were deemed to have high effects on the cost of health and safety by the respondents, because they fall between RII values of 0.96 and 0.90 respectively.

Operative being struck by falling object has the highest effect among the risks encountered on construction sites. This is probably, because it results in death. According to Health and Safety Executive (HSE) (2008), slips and trips are the distinct major frequent cause of injuries which account for most of all the work injuries. It also costs construction industry in the UK hundreds of millions of pounds a year in

finishing projects (HSE, 2008). Also, Lipscomb *et al.* (2008) concluded that slips, account for 18% of all injuries and 25% of workers' reparation payments.

Conversely, the H&S risks that have less effect on project cost are: eye irritation; dermatitis and dizziness, respectively. They are considered to have less effect because they have least RII values.

Table 3 further shows the aggregated effects of the identified H&S risks encountered on cost of projects in this research work. The result shows that a total of 90% of the respondents agreed that the health and safety risks have effect at various degrees on the cost of a construction project. 57.65% of the respondents accepted that the identified H&S risks have a 'moderate effect' on the cost of projects, while 21.76 % agreed that the risks have a 'high effect' on the project costs. These findings corroborates the conclusions of Okoye and Okolie (2014) that parts of additional cost problems incur on projects could be potentially linked to cost of H&S practices in the construction industry.

### Common health and safety programs for construction project

The results of the common H&S programs available at construction sites were presented in Table 4. From the results, acquiring new equipment was ranked first with an RII value of 0.82, followed by Personal protective equipment (0.81), and followed by First aid kits (0.78) respectively. This was followed by warning signs, employment and training and fire safety measures also appear to be important programs at construction sites. These findings corroborate the results of Tan and Nadeer (2014); Evans (2016); and Ibrahim (2015).

**Table 2: Common construction health and safety risks and their effects on project costs**

Sn	H&S Risks	RII	Rank	Effects of risks on project costs	RII	Rank
1	Slips, trips and falls from a height	0.91	1	Very high	0.95	2
2	Stepping on objects	0.90	2	High	0.87	6
3	Muscular disorders	0.87	3	High	0.87	6
4	Equipment, machinery, tools and transport breakdown/accident	0.80	4	High	0.80	8
5	Fractures	0.80	4	Low	0.73	15
6	General body pain	0.80	4	High	0.76	14
7	Cuts	0.80	4	High	0.80	8
8	Amputation	0.75	8	High	0.80	8
9	Struck by falling objects	0.73	9	Highest	0.96	1
10	Eye irritations	0.73	9	Very Low	0.60	20
11	Faintness	0.73	9	High	0.80	8
12	Back injuries	0.73	9	Low	0.73	15
13	Slipped discs	0.70	13	Low	0.70	17
14	Collapse of crane	0.68	14	Very high	0.92	3
15	Respiratory deformation	0.67	15	High	0.90	5
16	Expose to hazardous substances	0.60	16	High	0.80	8
17	Body burns	0.60	16	Very low	0.60	20
18	Asthma	0.60	16	Very low	0.60	20
19	Back overs	0.60	16	Very low	0.60	20
20	Trench	0.60	16	Very low	0.60	20
21	Deaths	0.60	16	Very high	0.92	3
22	Paralysis	0.60	16	High	0.80	8
23	Traumatic brain injuries	0.60	16	Very low	0.60	20
24	Explosions	0.50	24	Very low	0.67	18
25	Dermatitis	0.50	24	Very low	0.50	28
26	Post-traumatic stress disorder	0.50	24	Very low	0.67	18
27	Chemical body burns	0.47	27	Very low	0.60	20
28	Dizziness	0.40	30	Very low	0.40	30
29	Ear defect due noise	0.40	30	Very low	0.60	20
30	Damage to the central nervous system	0.40	30	Very low	0.40	30

**Table 3: Effect of the identified H&S risks on cost of project**

Effects	Frequency	Percentage	Cumulative Percentage
High effects	37	21.76	21.76
Moderate effects	98	57.65	79.41
Low effects	18	10.59	<b>90.00</b>
No effect	13	7.65	97.65
No idea	4	2.35	100
<b>Total</b>	<b>170</b>	<b>100</b>	

**Table 4: Common health and safety programs for a project**

Sn	Common H&S Programs	RII	Rank
1	Acquiring new equipment	0.82	1
2	Personal protective equipment	0.81	2
3	First aid kits	0.78	3
4	Fire safety measures	0.75	4
5	Employment and training	0.72	5
6	Safety policy	0.55	6
7	Provision of information	0.55	6
8	Control measures	0.47	8
9	Risk assessment	0.40	10
10	Warning signs	0.30	10

**Costs incur in provisions of health and safety programs on construction sites**

Table 5 shows the response of all the construction site professionals concerning the percentage contribution of the cost of provision of health and safety programs on the project cost. 62.94% of the respondents comprising project managers, consultants, contractors and safety officers agreed that the cost of provision of health and safety programs is between 3 to 5% of the total project cost, thereby increases the cost of a construction project. This finding is below the percentage amount reported by Tang *et al.* (2004) who stated that the optimal safety investment on construction project was found to be about 6% of the project sum. Also, Mottiar (2014) concluded that the overall costs of accidents and ill health in the European Union is approximately 2%. Moreover, 7.65%, 16.47% and 12.94% of the building experts noted that provision of H&S programs on the sites contribute to the project cost by above 10%, 6 – 10%, and 0 – 2% respectively.

**Common accidents on construction sites**

The results of the peculiar accidents experienced on construction sites were presented in Table 5. From the results, spinal cord fracture, mere dislocation, head injury, and broken legs, were the common sort of accidents to workers on construction site, because they had RII values of between 0.97-0.90 respectively. Conversely, fallen crane, total collapse were identified as the common accidents to project on construction site.

**Table 5: Costs incur in provisions of health and safety programs on site**

Percentage costs of the H&S programs	Number of responses	Percentage (%) response
Above 10% of project cost	13	7.65
6 - 10% of project cost	28	16.47
3 - 5% of project cost	107	62.94
0 - 2% of project cost	22	12.94
<b>Total</b>	<b>170</b>	<b>100</b>

**Table 5: Common accident on construction sites**

Sn	Accidents	RII	Rank
<b>Accidents to workers</b>			
1	Spinal cord fracture	0.97	1
2	Mere dislocation	0.93	2
3	Head injury	0.91	3
4	Broken leg	0.90	4
5	Severe chest injury	0.89	5
6	Broken arm	0.73	6
7	Death/ fatality	0.72	7
<b>Accidents to project</b>			
8	Fallen crane not well positioned	0.93	1
9	Total collapse	0.84	2
10	Collapse of project part	0.83	4
11	Removal of a fixed roof	0.83	4

### Percentage contributions of costs of accident to the overall costs of project

Table 6 shows that 67.62% of the respondents acknowledged that the percentage cost of accident to the overall cost of construction project are less than 1% of project costs. While 12.94% of the respondents believed that the percentage of the cost of accidents is between 1-2% of project costs. However, 7.65%, 7.08% and 4.71 % of the respondents agreed that percentage cost of accident to the overall cost of construction project are 2 – 5%, 5 - 10% and above 10% respectively.

expenses on accidents were analyzed in Table 6. It is clear from Table 6 that the percentage contributions of costs of accident to the overall costs of the project fall between a minimum of 0.083% and a maximum of 0.46% with an average percentage contribution of 0.218%. This result refutes some of the findings in the Table 5 which state that cost of accident contributes above 10% of project costs. Though, the results corroborate some of the findings that state that the contributions is less than 1% of project cost which is the majority (67.62%).

In order to confirm the results in Table 7, the archival data on the cost of the project and

**Table 6: Percentage of cost of accident to the overall cost of construction projects**

Percentage	Number of responses	Percentage (%) response
Above 10% of project costs	8	4.71
5-10% of project cost	12	7.08
2-5% of project cost	13	7.65
1-2% of project costs	22	12.94
Less than 1% of project cost	115	67.62
<b>Total</b>	<b>170</b>	<b>100</b>

Source: Field survey, 2017

**Table 7: Percentage cost of accident to the overall cost of projects (archival data)**

Sn	Project year	Name of projects	H&S and accident expenses	Cost of project	% Contribution of H&S cost to total project cost
1	2000	A	10,650,000.00	4,006,000,000.00	0.265851223
2	2003	B	9,231,000.00	6,300,000,000.00	0.14652381
3	2007	C	12,543,000.00	15,183,000,000.00	0.082612132
4	2006	D	5,120,000.00	3,600,000,000.00	0.142222222
5	2012	E	3,525,000.00	1,600,000,000.00	0.220312500
6	2015	F	3,115,000.00	1,800,000,000.00	0.173055556
7	2009	G	5,512,000.00	2,800,000,000.00	0.196857143
8	2006	H	2,264,000.00	1,350,000,000.00	0.167703704
9	2009	I	5,890,000.00	1,270,000,000.00	0.463779528
10	2005	J	2,450,000.00	956,000,000.00	0.256276151
11	2007	K	14,200,000.00	3,522,000,000.00	0.403180011
12	2012	L	7,300,000.00	4,520,000,000.00	0.161504425
13	2011	M	3,120,000.00	1,090,000,000.00	0.286238532
14	2009	N	9,735,000.00	11,230,000,000.00	0.086687444
			<b>General</b>	<b>average</b>	<b>=0.218057456</b>
			<b>Percentage</b>		

Source: Field survey, 2017

## Conclusion and Recommendations

Forecasting the cost of a construction project usually fails to include the cost of health and safety of the construction workers and the construction process itself contains a series of crafty activities which require time and costs for smooth execution. The research aims to assess the cost impact of health and safety practices on construction projects. The research found that slips, trips and falling from a height; stepping on objects; muscular disorders; equipment, machinery, tools and transportation failure; fractures; and cuts are the common H&S risks on a building site; and struck by falling objects; slip, trip and falling from a height; the collapse of a crane; death; and respiratory deformation are the major health and safety risks factors that have major effects on project cost, and most H&S risks contribute to increase in project costs. The important health and safety programs available at construction sites are: acquiring new equipment; personal protective equipment; first aid kits; warning signs; and employment and training on fire safety measures. Also, the research found that the provision of H&S programs on the site contribute 3–5% to the cost of the project. Based on these findings, it can be concluded that the cost of health and safety increases the cost of building projects. The study also concludes that the percentage costs of accident to the overall cost of construction project is less than 1% of project costs with an average percentage contribution of 0.218%.

Based on this conclusion, the research recommends that health and safety practices and programs should always be given priority in the initial project estimating stage of a project, as they constitutes a reasonable percentage of project cost. Construction professionals embarking on health and safety practices should constantly evaluate the costs of the major H&S risks as they have high effects on project cost.

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