

IMPACT OF BEHAVIOUR-BASED SAFETY IN ACCIDENT PREVENTION IN THE BONNY NLNG CONSTRUCTION PROJECT, NIGERIA

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Abstract

The paper focuses on the impact of behaviour-based safety (BBS) in accident prevention in the Bonny NLNG construction project. It defines BBS as an accident preventive programme designed to change employees' behaviours from "at risk" to "safe" behaviours using both positive and negative reinforcements. The objective of the research is to ascertain the degree of relationship between behaviour-based safety programme and the reduction of employees' at-risk behaviours/accident in the Bonny NLNG construction project. Thus, the research question addressed the degree of relationship between behaviour-based safety programme and the reduction of employees' at-risk behaviours/accident in the Bonny NLNG construction project. The research assumes that majority of work related accidents are caused by the unsafe actions of workers which can be decreased through modification of worker behaviors. A research questionnaire administered on 384 randomly selected employees of the ten construction companies involved in the Bonny NLNG construction project was used in generating the primary data for the study. The primary data generated were presented using tables, analyzed using percentages while the hypotheses were tested using correlation co-efficient. The results indicated that there is a significant relationship between behaviour-based safety programme and the reduction of employees' at-risk behaviours/accident in the Bonny NLNG construction project. The research concludes that the implementation of behaviour-based safety programme in the Bonny NLNG construction project has contributed significantly in accident prevention through the reduction of employees' at-risk behaviours. It therefore recommends among others: a continuous review of employees' behaviour reinforcement techniques, training and re-training of workers on safe work procedures, emphasis on employees' incident reporting/investigation, increase in safety supervision and continuous review of corporate safety policy and management system in line with industrial best practice.

30 **Keywords: Behaviour-based safety, At-risk behaviour, Behaviour reinforcement, Accident**
31 **prevention.**

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33 **1.1 Introduction**

34 The idea of executing a liquefied natural gas project was first conceived by the Nigerian
35 government in 1966, sequel to a request for natural gas supply by the European Union to
36 augment its supply shortfall. But the absence of a steady and stable natural gas market coupled
37 with other socio-economic and political factors delayed the early take-off of the
38 project. The discovery of a large and stable natural gas market, in the Pacific Rim and the
39 Atlantic Basin, in the late 80's by the Nigerian National Petroleum Corporation (NNPC),
40 rekindled the interest of the Federal Government in the liquefied natural gas (LNG) project. The
41 need to diversify the mono-product economic base of the nation and harness its vast natural gas
42 resources and reduce gas flaring led to the incorporation of the Nigeria Liquefied Natural
43 Gas (NLNG) company in May 17, 1989 (NLNG, 2004). The NLNG is jointly owned by the
44 Nigerian National Petroleum Corporation (49%), Shell Gas BV (25.6%), Totalfinaelf (15%) and
45 Eni International BV (10.4%). Its mission is to liquefy and export natural gas from the onshore
46 concession areas of the Eastern part of the Niger Delta, where about 50% of Nigeria's proven
47 and probable natural gas reserves are located. Nigeria's gas potentials are estimated at about
48 140 trillion standard cubic feet, about 27 billion barrels crude oil equivalent (Shell, 2001).

49 In order to realize the company's objective, the shareholders in November 1995, took a final
50 investment decision to build a \$3.8 billion Liquefied Natural Gas plant in Forcados, Bonny
51 Island, Rivers State (NLNG, 2001). In December 1995, a consortium of engineering firms
52 comprising Technip, Snamprogetti, M.V. Kellogg and Japan Gas Corporation (TSKJ) was
53 awarded a Turnkey Engineering, Procurement, Installation and Construction (EPIC) contract,
54 for the construction of the plant, the gas transmission system and the residential area. TSKJ as
55 an engineering design consortium engaged the services of construction firms (Julius Berger
56 Nigeria PLC, Daewoo Engineering and Electrical Construction Company, Fougere Nigeria
57 Limited, Cimimontubi Nigeria, DBN Nigeria Limited, Spibat Nigeria Limited, Bouygues

Nigeria Limited, Chicago Bridge and Iron Company Limited, Dumez Nigeria Limited and Etco Nigeria Limited).

To ensure a safe work environment with zero accident/incident rates for the construction workforce, a safety management system with emphasis on changing workers at-risk behaviours (behaviour- based safety) was incorporated into the project design and construction contract document in accordance with the provisions of the Mineral Oils (Safety) Regulations (1997). The phrase "behavior-based safety" (BBS) was coined by Dr. E. Scott Geller of Safety Performance Solutions (SPS) in 1979. It is an accident preventive programme designed to change employees behaviours from "at risk" to "safe" behaviours using both positive and negative reinforcements. Its focus is on modifying the behavior of workers in order to prevent occupational injuries and illnesses since 88% of all industrial accidents/incidents are primarily caused by workers at-risk behaviours/unsafe acts (Heinrich, 1941). The researcher adopts a management/employee partnership approach to behaviour-based safety which emphasizes the collective efforts of both management and workers in the identification and elimination of at-risk behaviours in the workplace. The research only covered the NLNG trains 4, 5 and 6 projects with emphasis on site supervisors, foremen and workmen who are directly involved in construction activities.

1.2 Statement of the Problem

Since inception in 1996, the NLNG construction project with an average workforce of 9,566 persons records an average of 1 fatality, 10 medical treatment cases, 15 first aid cases, 20 near-misses and 50 unsafe acts per annum which is quite infinitesimal considering the magnitude of the workforce and the global construction industry accident statistics (NLNG, 2012). The occurrence of accidents in construction sites usually leads to site closure for accident investigation, loss of man/machine hours, loss of output, high labour turnover, loss of corporate reputation, payment of medical expenses of the injured and payment of compensation/insurance claims for the dead/injured. Economic development activities are usually hampered in a country with high rate of construction accidents; since productivity/national output will be low, inflation and rate of unemployment will be high while there will be an increase in social vices. Since accidents originate from the unsafe acts of people, they can be prevented through the

identification and elimination unsafe acts via a management/employees driven
behaviour- based safety programme that is deeply rooted in antecedents- behaviour-
consequence model especially in the Bonny NLNG construction project.

1.3 Research Objectives

The objectives of the research are as follows:

1. To ascertain whether there is any significant relationship between effective implementation of
behaviour-based safety and reduction of at-risk behaviours in the Bonny NLNG construction
project.
2. To find out whether there is any significant relationship between effective implementation of
behaviour-based safety and accident reduction in the Bonny NLNG construction project.

1.4 Research Questions

The identified gap of ineffectiveness in previous behaviour-based approaches to safety, which
were either management or employee driven, propelled the development of the
management/employees partnership approach to behaviour-based safety in the construction
industry thus prompting the following research questions:

1. Does any significant relationship exist between effective implementation of behaviour-based
safety and reduction of at-risk behaviours in the Bonny NLNG construction project?
2. Does any significant relationship exist between effective implementation of behaviour-
based safety and accident reduction in the Bonny NLNG construction project?

1.5 Research Hypotheses

In view of the above research questions, the following null hypotheses were formulated:

111 **H₀**: There is no significant relationship between effective implementation of behaviour-
112 based safety and reduction of at-risk behaviours in the Bonny NLNG construction
113 project.

114 **H₀**: There is no significant relationship between effective implementation of behaviour-based safety
115 and accident reduction in the Bonny NLNG construction project.

116 **2.1 Literature Review**

117 Historically, organizations have focused on improving safety by addressing the work environment
118 surrounding employees, providing hazard-free facilities, providing better tools and equipment
119 without achieving any appreciable reduction in the rate of accidents. They have come to realize
120 (or be reminded) that (1) people are not perfect and will make mistakes despite their best
121 intentions and working in the best of surroundings, and (2) the work culture often allows or
122 encourages at-risk behaviors to be performed. Thus, behaviour-based safety has become a popular
123 way of managing the people side of safety since it revolves around what motivates and reinforces
124 people's behaviour.

125 Behaviour-based safety has many advocates and critics. Advocates have seen or experienced
126 the effects of a well-designed process on incident rates (Cooper, 2003). Conversely, critics do not
127 believe it truly involves workers in the overall safety process (Howe, 1998), while some critics
128 believe the concept has run its course (Naso, 2002). The promotion of operant theory (Skinner,
129 1953) within the behavioral safety field (Geller, 1996; McSween, 2002; Krause, 1997) has led
130 many to believe that the antecedent-behavior-consequence model focuses almost exclusively on the
131 psychology of safety especially in the construction industry. In reality, like other safety
132 management programmes, behaviour-based safety requires the concerted effort of both management
133 and employees to produce desired results.

134 Since its inception and application in the mid- 1970s, behaviour-based safety, has undergone a series
135 of evolutionary changes. The first approach, popular in the early 1970s to mid-1980s, was largely
136 a supervisory top-down-driven process, based on operant theory (Skinner, 1953). In this
137 approach, supervisors observed their workers' behaviour, gave feedback and provided some form
138 of positive or negative reinforcement. It is important to note that behaviour change did not last
139 once reinforcers were removed. Though this concept is simple and cheap to implement, it

attracted legitimate criticisms that has since been hard to dispel (Howe, 1998). Perhaps as a reaction to those criticisms, employee-led approach emerged in the early '80s. In this approach, employees developed the overall process, conducted peer-to-peer or workgroup-based observations and provided feedback. However, the demerit of this approach is the exclusion of management, thus leading to the common perception that behaviour-based safety focused solely on employee behavior (Hopkins, 2006). This led, in the 1990s, to the cultural approach based on the concept of management and employee partnership. In this approach, employees monitor the behaviour of all members of a workgroup or work area while managers regularly monitor their own safety-related leadership behaviors. Everyone involved receives regular feedback while some also received tangible reinforcers or incentives (Chandler & Huntebrinker, 2003).

Surveys of behaviour-based safety users show that all three approaches are widely used around the world (Cooper, 2008). Each has tried to address the most efficient way to design the process to produce positive results in a cost-effective manner. Sulzer-Azaroff and Austin (2000) stated that the effectiveness of the various approaches is often dictated by the purpose of implementation. They cited variations in observation, frequency and mechanisms of feedback, priorities, support structures and roles of key personnel as factors that account for the choice of each approach.

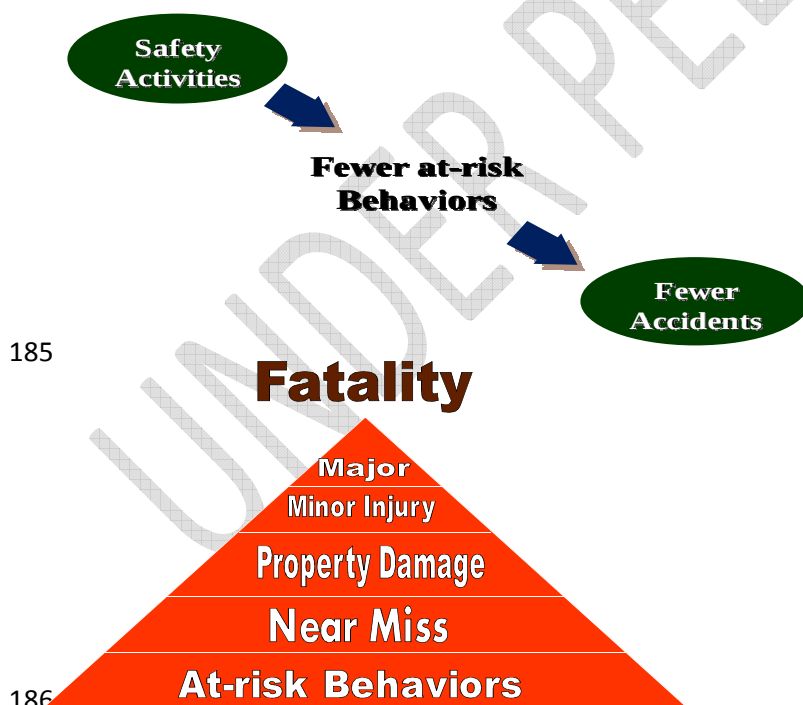
2.1.2 Conceptual Framework

The phrase "behavior-based safety" (BBS) was coined by Dr. E. Scott Geller of Safety Performance Solutions (SPS) in 1979. It originated from the work of Herbert William Heinrich in the 1930s, who reviewed thousands of accident reports completed by supervisors of Traveler's Insurance Company and concluded that roughly 90% of all accidents, illnesses and injuries in the workplace are directly attributable to "man-failures", or the unsafe actions of workers. This conclusion became the foundation of what BBS has come to be today. BBS addresses the fact that there are additional reasons for injuries in the workplace: environment, equipment, procedures and attitudes. Behavioral Science Technology (BST), pioneers in applying BBS processes, expanded on this work and identified the "working interface", as the point where exposure to injury occurs.

Behaviour-based safety is an accident preventive programme designed to change employees behaviours from "at risk" to "safe" behaviours using both positive and negative reinforcements.

169 It focuses on what people do, analyzes why they do it, and then applies a research-supported
170 intervention strategy to improve what people do. It is not based on assumptions, personal feelings
171 or common knowledge but on scientific knowledge. It is also an excellent tool for collecting data
172 on the quality of a company's safety management system and an effective step in creating a truly
173 proactive safety culture where loss prevention is a core value. It is easy to understand but often
174 hard to implement and sustain.

175 At-risk behaviours are said to both directly and indirectly contribute to 90% of all workplace accidents
176 and incidents (Holnagel, 1993). Given the prominence of at-risk behaviours in the accident
177 pyramid/preventive process shown in figures 1 and 2 below, it is not surprising that
178 safety improvements focused on individual behaviours have acquired popularity in the evaluation of
179 organizational safety performance (Cox and Cox, 1996). However, the implementation and
180 sustainability of such programmes have been variable and many successful programmes that have
181 reportedly improved health and safety performance have seemingly lost momentum (HSE,
182 2002). It is important to note that the concept of behaviour change is intimately tied up with issues
183 of motivation, attitudes, beliefs, learning and trust that are influenced by the organizational safety
184 culture.



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Figure 2. Accident Preventive Process Figure 1. Accident Pyramid

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189 For any behaviour-based safety programme to achieve a change in behaviour, there is need for a
190 change in the company policy, procedures and organizational system and support from all
191 employees, from the CEO to the shop floor staff. An ideal BBS programme should consist of the
192 following steps: •Identify unsafe behaviors (obtained from injury and near-hit incident
193 records), •Develop appropriate observation checklists (which feature behaviours implicated in
194 injuries), •Educate everyone (tell and sell to all and train observers, facilitators and champions),
195 •Assess ongoing safety behaviour by conducting behavioural observations and provide limitless
196 feedback-verbal, graphical and written on results.

197 **2.1.3 Theoretical Framework**

198 The goal of behaviour-based safety is to change the behaviour of employees from “at risk”
199 behaviours to “safe” behaviours. A common phenomenon of this research and previous
200 behaviour-based research findings is that human errors (at-risk behaviours/unsafe acts) are
201 fundamental to the occurrence of accidents. This research is based on Boyce & Roman, 2002
202 theory that frequencies of illness and injury can be decreased through modification of worker
203 behaviours and that such modification is accomplished by focusing management attention on
204 unsafe acts committed by workers. The study assumes a causal relationship between at-risk
205 behaviours and the occurrence of workplace accidents and that the latter can be prevented
206 through the manipulation of the former using the Antecedent-Behaviour-Consequence (ABC)
207 model. The ABC model propounded by B.F. Skinner (1953) assumes that all behaviours are a
208 result of antecedents and consequences. Antecedents serve as triggers to observable behaviours
209 while consequences either enforce or discourage repetition of the behaviours.

210 **2.1.4 Behaviour-Based Safety Process**

211 The basic process of a behaviour-based safety programme consists of identifying observable
212 safe behaviors and its antecedents (activators) that encourage/discourage these safe
213 behaviours and encourage/remove them upstream in the process. Consequences (reinforcements)
214 that are positive, immediate and certain (rewards) will keep employees working safely while
215 negative consequences which are immediate and certain (punishment) discourage unsafe
216 behaviors. The goal for management is to set up a system to control the antecedents and
217 consequences so that workers will increase their safe behaviors. The assumption being that by

setting up a system of well-planned antecedents and consequences you can control the unsafe behaviors of employees thus accidents and injuries will be reduced.

Furthermore, behaviorists believe that consequences are the driving force to changing people's behaviour. The tools of positive and negative reinforcements are what are needed to make people behave in the prescribed manner. Consequences are those events that occur as a result of behaviour. Positive reinforcement rewards a person for behaving in a certain way while negative reinforcement provides unwanted or unpleasant consequences. The assumption is that punishment decreases the probability that a behaviour will be repeated. Some behaviorists believe that negative reinforcement prompts only a minimal level of compliance while others, believe that positive reinforcement encourages employees to exceed the minimum.

Thus the core features of a BBS process are as follows:

- ❖ Observation of workers by workers.
- ❖ Provision of extensive training for observers.
- ❖ Development of a list of "critical worker behaviours" often with input from workers.
- ❖ Development of 'model safe behaviours' so that workers' behaviours are measured against their own standards – i.e. past behaviours.
- ❖ Substantial management commitment, including financial.
- ❖ Institution of reward systems e.g. bonuses or acknowledgement of efforts and results
- ❖ Promotion of BBS as a 'voluntary' participatory company-wide programme.
- ❖ Utilization of current participative and representative structures e.g. elected safety representatives, union delegates, and safety committees.

3.1 Research Methodology

The scope of the research is limited to the ten construction companies (Julius Berger Nigeria PLC, Daewoo Engineering and Electrical Construction Company, Fogerolle Nigeria Limited, Cimimontubi Nigeria, DBN Nigeria Limited, Spibat Nigeria Limited, Bouygues Nigeria Limited, Chicago Bridge and Iron Company Limited, Dumez Nigeria Limited and Etco Nigeria Limited) that are involved in the construction of NLNG trains 4, 5 and 6 projects with emphasis on site supervisors, foremen and workmen who are directly involved in construction activities.

249 An exploratory, cross-sectional survey was used in generating the primary data required for the
250 study. The population of study consists of 9,566 workers of three categories (280 supervisors, 830
251 foremen and 8,456 workmen) drawn from the ten construction companies involved in the
252 construction of NLNG trains 4, 5 and 6 projects.

253 A sample of 384 workers (11 supervisors, 33 foremen and 340 workmen) determined at 5%
254 level of significance for sample error, using Taro Yamane's (1964) formula, was selected using
255 stratified random sampling method for the purpose of questionnaire administration. The
256 questionnaire was designed to obtain a fair representation of the opinions of the three categories
257 of workers involved in the construction of NLNG trains 4, 5 and 6 projects using a five-point
258 Likert type scale. The questionnaire responses of the sample respondents were presented using
259 tables, analyzed and interpreted using simple percentages. A total of 384 copies of the
260 questionnaire were administered, out of which 2 were cancelled while 2 were also not returned
261 and 380 (99%) were used for analysis.

262 4.1 Results and Discussions

263 4.1.1 Distribution of Sample Respondents

264 The distribution of sample respondents among the three categories of workers in the ten
265 construction companies involved in the construction of NLNG trains 4, 5 and 6 projects is as
266 shown in table 1 below:

267 **Table 1: Distribution of Sample Respondents among NLNG Construction Companies**

S/N o	Name of Company	Sample Supervisors	Sample Foremen	Sample Workmen	Total Number of Sample Respondents
1.	Julius Berger Nigeria PLC	2	4	57	63
2.	Daewoo Engineering and Electrical Construction Company	1	4	50	55
3.	Fougerolle Nigeria Limited	1	4	35	40
4.	Cimimontubi Nigeria	1	3	30	34

	Limited				
5.	DBN Nigeria Limited	1	3	30	34
6.	Spibat Nigeria Limited	1	3	35	39
7.	Bouygues Nigeria Limited	1	3	21	25
8.	Chicago Bridge and Iron Company Limited	1	3	28	32
9.	Dumez Nigeria Limited	1	3	30	34
10.	Etco Nigeria Limited	1	3	20	24
	Total Number of Sample Respondents	11	33	336	380

Source: Field Survey, 2012.

4.1.2 Distribution of Responses on Research Questions

The sample responses of the three categories of workers (supervisors, foremen and workmen) of the ten construction companies involved in the execution of the NLNG project is as summarized in table 2 below:

Table 2: Summary of Sample Responses on Research Questions

S/ No	Research Questions	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total Responses
1.	To what extent do you agree that BBS is implemented in your company's execution of the NLNG project?	205	120	40	10	5	380
2.	To what extent do you agree that effective implementation of BBS has reduced at-risk behaviours among workers in your company?	220	110	30	10	10	380
3.	To what extent do you agree that	200	125	40	8	7	380

	effective implementation of BBS has reduced accident rate in your company?						
4.	To what extent do you agree that any significant relationship exists between effective implementation of BBS and the reduction of at- risk behaviours among workers in your company?	217	110	25	20	8	380
5.	To what extent do you agree that any significant relationship exists between effective implementation of BBS and accident reduction in your company?	210	100	40	20	10	380

Source: Field Survey, 2012.

Table 2 shows that 205(54%) of the sample respondents strongly agreed that their company implements BBS in the execution of the NLNG project, 120(31%) respondents agreed, 40(11%) respondents were undecided, 10(3%) respondents disagreed while 5(1%) respondents strongly disagreed that their company implements BBS in the execution of the NLNG project. 220(57%) respondents strongly agreed that their company effective implementation of BBS has reduced at-risk behaviours among workers in their company, 110(29%) respondents agreed, 30(8%) respondents were undecided, 10(3%) respondents disagreed while 10(3%) respondents also strongly disagreed that their company effective implementation of BBS has reduced at- risk behaviours among workers in their company. 200(52%) respondents

strongly agreed that their company effective implementation of BBS has reduced accident rate in their company, 125(33%) respondents agreed, 40(11%) respondents were undecided, 8(2%) respondents disagreed while 7 (2%) respondents strongly disagreed that their company effective implementation of BBS has reduced accident rate in their company. 217(57%) respondents strongly agreed that there is a significant relationship between their effective implementation of BBS in their company and reduction of at-risk behaviours among workers in their company, 110(29%) respondents agreed, 25(7%) respondents were undecided, 20(5%) respondents disagreed while 8(2%) respondents strongly disagreed that there is any significant relationship between their effective implementation of BBS in their company and reduction of at-risk behaviours among workers in their company. 210(55%) respondents strongly agreed that there is any significant relationship between effective implementation of BBS in their company and reduction of accident in their company, 100(26%) respondents agreed, 40 (11%) respondents were undecided, 20(5%) respondents disagreed while 10(3%) respondents strongly disagreed that there is any significant relationship between their effective implementation of BBS in their company and reduction of accident in their company.

4.2 Test of the First Hypothesis

(i) H_0 : There is no significant relationship between effective implementation of behaviour-based safety and reduction of at-risk behaviours in the Bonny NLNG construction project.

(ii) H_1 : There is a significant relationship between effective implementation of behaviour-based safety and reduction of at-risk behaviours in the Bonny NLNG construction project.

(iii) $\alpha = 0.05$

(iv) Degree of freedom(df) = $n - 2 = 5 - 2 = 3$

(v) $r = \frac{n\sum XY - \sum X \sum Y}{\sqrt{n\sum X^2 - (\sum X)^2} \sqrt{n\sum Y^2 - (\sum Y)^2}}$

Table3: Calculation of Correlation Coefficient

Options	X Points	Y Responses	XY	X ²	Y ²
Strongly	5	217	1085	25	47089

AGREE					
Agree	4	110	440	16	12100
Undecided	3	25	75	9	625
Strongly Disagree	2	20	40	4	400
Disagree	1	8	8	1	64
Total	15	380	1648	55	60278

Source: Field Survey, 2012.

$$r = \frac{5(1648) - (15)(380)}{\sqrt{5(55) - (15)^2} \sqrt{5(60278) - (380)^2}} = 0.9066$$

The above result shows that there is a significant relationship between effective implementation of behaviour-based safety and the reduction of at-risk behaviours in the Bonny NLNG construction project. In order to justify our result, there is a further need for a confirmatory test. In doing so, a test of significance was employed using the student's t distribution.

$$\text{Test statistic} = t_{\text{cal}} = \frac{r}{\sqrt{\frac{1-r^2}{n-2}}}$$

$$t_{\text{cal}} = \frac{0.9066}{\sqrt{\frac{1-(0.9066)^2}{5-2}}} = 8.8180$$

$$t_{\text{tab}} \text{ (two tailed test)} = df.(n-2) = (5-2) = 3, \alpha = 0.05 = T_{\text{tab}} = 2.353$$

With $t_{\text{cal}} = 8.8180 > t_{\text{tab}} = 2.353$, the null hypothesis (H_0) was rejected while the alternative hypothesis (H_1) was accepted which means that there is a significant relationship between effective implementation of behaviour-based safety and reduction of at-risk behaviours in the Bonny NLNG construction project.

4.3 Test of the Second Hypothesis

(i)H₀: There is no significant relationship between effective implementation of behaviour-based safety and accident reduction in the Bonny NLNG construction project.

(ii)H₁: There is a significant relationship between effective implementation of behaviour-based safety and accident reduction in the Bonny NLNG construction project.

(iii) $\alpha = 0.05$

(iv) Degree of freedom (df) = $n - 2 = 5 - 2 = 3$

$$(v) r = \frac{n\sum XY - \sum X \sum Y}{\sqrt{n\sum X^2 - (\sum X)^2} \sqrt{n\sum Y^2 - (\sum Y)^2}}$$

Table3: Calculation of Correlation Coefficient

Options	X Points	Y Responses	XY	X ²	Y ²
Strongly AGREE	5	210	1050	25	44100
Agree	4	100	400	16	10000
Undecided	3	40	120	9	1600
Strongly Disagree	2	20	40	4	400
Disagree	1	10	10	1	100
Total	15	380	1620	55	56200

Source: Field Survey, 2012.

$$r = \frac{5(1620) - (15)(380)}{\sqrt{5(55) - (15)^2} \sqrt{5(56200) - (380)^2}} = 0.9183$$

The above result shows that there is between a significant relationship between effective implementation of behaviour-based safety and accident reduction in the Bonny NLNG construction project. In order to justify our result, there is a further need for a confirmatory test. In doing so, a test of significance was employed using the student's t distribution.

$$\text{Test statistic} = t_{\text{cal}} = \frac{r}{\sqrt{1 - r^2}}$$

$$\sqrt{n - 2}$$

$$t_{\text{cal}} = \frac{0.9183}{\sqrt{1 - (0.9183)^2}} = 10.1486$$

$$t_{\text{cal}} = 0.9183$$

$$\frac{1 - (0.9183)^2}{\sqrt{1 - (0.9183)^2}} = 10.1486$$

$$\sqrt{5 - 2}$$

$$t_{\text{tab}} \text{ (two tailed test)} = df.(n-2) = (5-2) = 3, \alpha = 0.05 = T_{\text{tab}} = 2.353$$

With $t_{\text{cal}} = 10.1486 > t_{\text{tab}} = 2.353$, the null hypothesis (H_0) was rejected while the alternative hypothesis (H_1) was accepted which means that there was a significant relationship between effective implementation of behaviour-based safety and accident reduction in the Bonny NLNG construction project.

5.1 Conclusion

This paper has tried to address the impact of behaviour-based safety in accident prevention in the Bonny NLNG construction project. Concisely stated it assumes that roughly 90% of all accidents, illnesses and injuries in the workplace are directly attributable to "man-failures" or the unsafe actions of workers hence setting up a system of well-planned antecedents and consequences can control the unsafe behaviors of employees thus reducing accidents and injuries in the workplace. The main thrust of this paper is based on three principles:

- At-risk behaviours/unsafe acts are fundamental to the occurrence of accidents.
- All behaviours arise from a combination of antecedents and consequences.

Antecedents serve as triggers to observable behaviours while consequences either enforce or discourage repetition of such behaviours.

- A causal relationship exists between at-risk behaviours and the occurrence of workplace accidents and the latter can be prevented through the manipulation of the former using the Antecedent-Behaviour-Consequence (ABC) model.

5.2 Recommendations

Arising from the findings of this paper, it is suggested that all construction companies involved in the execution of the Bonny NLNG project should take the following measures to sustain the present safety record of reduced accident rate in their construction activities:

- A continuous review of employees/management behaviour reinforcement techniques to reduce at-risk behaviours in the workplace.
- Training and re-training of workers/management team on safe work procedures.

- Greater emphasis on incident reporting/investigation so as to identify immediate/root causes.
- Joint management/employees audit/supervision of work site for the purpose of hazard identification and control.
- Continuous review of corporate safety policy and management system in line with industrial best practice.
- Regular management/workers safety meetings to identify/control at-risk behaviours.
- Establishment of management/employees quality circles to identify and solve workplace safety challenges.
- Encouragement of workers to be their brother's keeper by observing and correcting each other's at-risk behaviours.
- Continuous commitment of management/workers to the elimination of at-risk behaviours in the workplace.
- Regular review of work procedures/method statements to identify and eliminate hazards or at-risk behaviours at source.
- Institution of regular inter-work group audits/safety walk-about to identify and nip on the bud unsafe acts/conditions in the workplace.
- Provision of extensive training for B-Safe observers.
- Development of a list of "critical worker behaviours" often with input from workers.
- Development of 'model safe behaviours' so that workers' behaviours are measured against their own standards – i.e. past behaviours.

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