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Investigating Risk Assessment and Underlying Root-Causes of Accidents in a Power Services Company in Port Harcourt

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Abstract:- In this study, investigation on risk assessment and underlying root causes of accident was conducted in a power services company within the Port Harcourt metropolis of Rivers State, Nigeria. Both primary and secondary data were used. Primary data was obtained with the aid of a structured questionnaire on the responses on fifty-four persons consisting of office, maintenance and field workers. Descriptive statistics (i.e. mean and frequency distribution) was used in analysing the data. Results show that employees were exposed to workplace hazards such as physical (noise/heat); chemical (vapour/fumes) and ergonomic (stress/sprain). The Human Factor Accident Classification System (HFACS) was able to identify human error as a major cause of accident it the workplace. Unsafe acts of workers (57.8 %), preconditions for unsafe acts (76.7 %), unsafe supervision (69.4 %) and organizational influence (62.3%) were rated by the responded.

Keywords:- *Risk assessment, human error, unsafe acts, accidents, root causes.*

I. INTRODUCTION

Humans inherently make mistakes; therefore, it is not surprising that it has been implicated in a variety of occupational accidents (Shappell and Wiegmann, 2001). It has already been posited that it is the culprit behind 90 % of the entirety of work place accidents. It follows the fact that humans govern and accomplish all the processes which are essential in mitigating risks related to accidents. Humans also influence other humans in the procedures. Making errors directly related to the process itself is not the only way in which humans cause accidents as they likewise create loop holes in management systems structuring and implementation i.e. we make errors in authorities, accountabilities, procedures, feedback, proof documents and continual improvement provisions (Bridges and Tew, 2010). Industrial hygiene and safety as well as occupational health concern the work environment and work methods to eliminate the causes of health problems and occupational safety hazards that originate from human-related factors (Moraru and Băbuţ, 2000). Committing blunders is inevitable. The limelight of managing blunders is hinged on diminishing the probability of occurrence these blunders and on impeding the sequel if peradventure any error does occur (Moraru and Băbuţ, 2010). Placing emphasis on reducing human error may help reduce the costs induced by undesired workplace occurrences (Bell and Holroyd, 2009).

Searching for human errors in the workplace can be viewed in two main ways. They include;

A. *Person Approach*

The person approach lays emphasis on the various components of unsafe acts (slips, lapses, fumbles, blunders, and safety rules breaking) in which humans are usually involved (Burggraaf and Groeneweg, 2016). In the person approach, the errors culminating in an accident is faulted on human deficiencies, to mention a few such as forgetfulness, lacking concentration, motivation defect, acting without a second thought, wilfully acting wrongly, and acting dangerously. In its basic existence, the linking solution providing measures are focused on shrinking undesired fluctuations in the behaviours of individuals. Despite being a reasonably acceptable approach, the person approach displays a significant low as it detaches unsafe acts from systems integration by putting its torch only on individual induced errors (Drupsteen-Sint, 2014). Consequently, two key components relating to human errors tend to be treated with levity:

- The people who stand out are the people who make the most impactful mistakes. Error is not a destiny of a misshaped few.
- Mishaps run in a recurrent loop rather than occurring at random. There is a direct relationship between errors and their provoking circumstances even though those who are involved may be completely different.

B. *System Approach*

In contrast to the persons approach, the systems approach gives room to accommodate human blunders knowing well that they can still occur in the so called perfect workplaces. Errors are viewed as being sequel instead of aetiologies, rooting from a little of human characteristics (López-Arquillos and Rubio-Romero, 2016). These are composed of looping error dangers in workplaces and the procedures which they spring up from.

The fundamental theorem of the systems approach is to change the workers working circumstances rather than his or her inherent error prone nature.

The lime light is on what defence walls were broken rather than the culprit of the blunder.

This research is aim at investigating risk assessment and underlying root causes of accident by utilizing the human factors analysis and classification system (HFACS) framework as an error analysis and classification tool within a power services company in Rivers State, Nigeria.

II. RESEARCH METHODOLOGY

A. Research Design

A cross sectional survey research design which is a form of quasi-experimental design was adopted; cross sectional survey can be likened to taking a snap shot of a situation at a time and analyzing it. It entails collecting data from a population of interest or a representative subset to make inferences at a specific point in time (Baridam, 2001). From the submission of Umoh, Amah, and Wokocha, (2014), the choice is informed by realising that the elements under study and their supposed outcome will not be controlled by the researcher. Thus, this research design was considered appropriate for this study.

B. Study Area

The study area for the research is a power services company within the Port Harcourt metropolis of Rivers State, Nigeria. Port Harcourt is the capital and largest city of Rivers State, Nigeria. It lies along the Bonny River and is in the Niger Delta. As of 2016, the Port Harcourt urban area has an estimated population of 1,865,000 inhabitants, up from 1,382,592 as of 2006. Figure 3.1 is a map of Nigeria showing Rivers State.

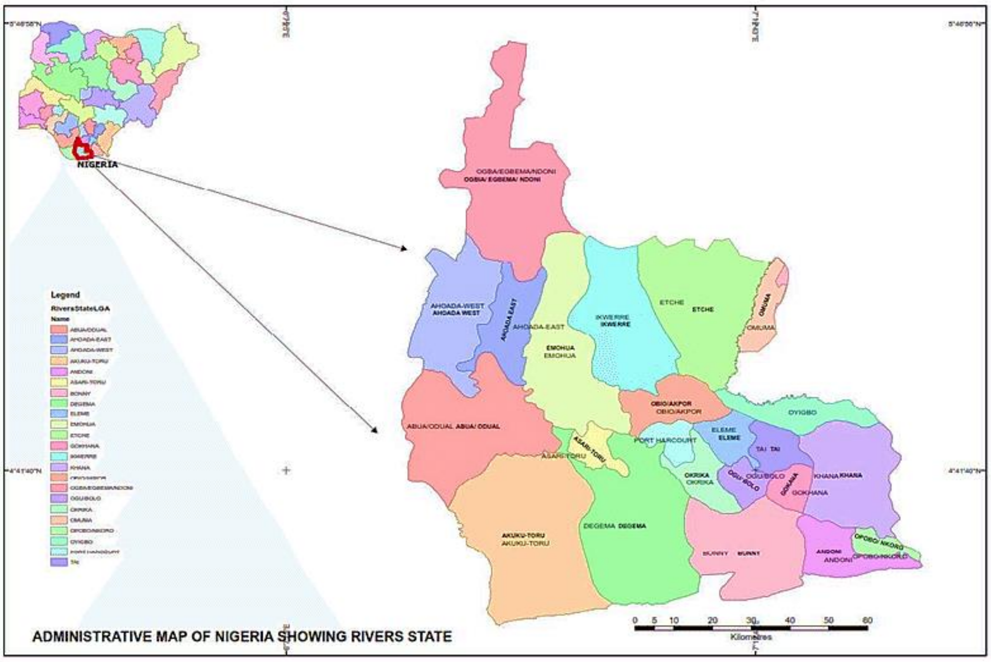

Fig. 1: is a map of Nigeria showing Rivers State

C. Population of Study

From preliminary investigations and personal interviews, a total of seventy-three (73) persons were earmarked for the population space. It is from this population size the sample population was obtained based on the Taro Yamane formula as applied by Agyekum (2012) and given in Equation 3.1.

$$N = \frac{N}{1+Ne^2} \qquad (3.1)$$

Where N = Population size (73)

n = sample size

e = Level of significance usually taken as 5 % (0.05)

a) Samples Size Determination

Based on the provisions of Equation 3.1 above, the sample size for this study was determined as follows: $N = \frac{73}{1+73(0.05^2)}$

$$= \frac{73}{1+0.1825}$$

$$= \frac{73}{1.1825} = 61.73$$

In other to account for those that will not return their as well improperly filled questionnaires, an attrition value of 5 % was further applied to the computed sample population. Thus, the eventual sample size becomes:

61.72 x 5/100 = 64.82 ≈ 65 persons.

Thus, a total of 65 questionnaires were distributed to the subjects.

D. Source of Data

In this study, both primary and secondary data were utilized. Primary data was acquired through site visitation/survey, personal interviews and questionnaire administration. Secondary data were gotten from published documents such as articles, journals, bulletins, annual reports, newspapers, amongst others.

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a) Research Instrument

A well-structured questionnaire was developed for collecting data from employees who have been be identified and categorised into the sample space. The questionnaire consists of three sections (A- C).

- **Section A** is meant to extract social-demographic information from the subject. This include gender, age bracket, educational qualification, workplace department, job category, workplace cadre, time on the job (years), total years of experience
- **Section B** is designed for workplace risk assessment which includes physical hazards (noise, heat, etc.), chemical hazards (vapours, gases, etc.) and ergonomic hazards (stress and sprain).
- **Section C** attempts to examine the underlying and root causes of accidents in the workplace by applying the principles in HFACS. This section captures
  - unsafe acts of workers
  - preconditions for unsafe acts
  - unsafe supervision
  - Organisational influence.

b) Method of Questionnaire Distribution

Questionnaires were distributed to the subjects via personal distribution for those that on ground, while distribution was done via emails for those that was not physically available as at the time of carrying out this research.

E. Sampling Techniques

Sampling techniques provide a range of methods that enables the researcher to reduce the amount of data the researcher needs to collect by considering only data from a subgroup rather than all possible cases (Saunders, Lewis, and Thornhill, 1997). Thus, the convenience random sampling was adopted in this study. This implies that all categories of persons, be it junior or senior staff, contract staff, top, mid or low management personnel, office, maintenance and field workers were sampled.

F. Method of Data Analysis

Descriptive statistics including mean and frequency distribution and percentage were performed. Tables and charts were also used to present the data from this study. This will enable the data to be presented clearly from where meaningful deductions could be made. Data analysis and plots were performed with the aid of two software packages. These are (i) the Statistical Package of Social Sciences (SPSS) version 20 and MS-Excel 2016.

III. RESULTS AND DISCUSSION

No of questionnaire distributed	No. of questionnaire retrieved	No. of questionnaire properly filled and used in this study
65	58 (89.2 %)	54 (83.1 %)

Table 1: Questionnaire distribution and retrieval

From Table 1 above, a total of 65 questionnaires were distributed to personnel of the industry under study. Of these 65 questionnaires only 58 copies representing 89.2 % were retrieved whilst only 54 copies representing 83.1 % were properly filled and as such were used in this study.

A. Social-demographic Information

Demographic information is a collection of different subcategories or group of data from a sample population in other to underscore the distribution pattern of the population. It also gives an insight into what it sot be expected or the nature of response from the sample population (Table.2).

Variable	Category	Frequency	Proportion (%)
Gender	Male	52	96.3
	Female	2	3.7
Age bracket (years)	20 – 29	3	5.6
	30 – 39	28	51.9
	40 – 49	19	35.2
	50 – 59	4	7.4
Educational qualification	SSCE	6	11.1
	OND/NCE	9	16.7
	HND/BSc	29	53.7
	PGD/MSc	10	18.5
Marital status	Single	13	24.1
	Married	38	70.4
	Divorced	3	5.6
Department	Operations	24	44.4
	EHS	13	24.1
	Others	17	31.5
Employment status	Field	45	83.3
	Staff	4	7.4
	Permanent	5	9.3
Job Title	Contract Performance manager	1	1.9

	Controls Tech/field adviser	1	1.9
	CPM	1	1.9
	EHS Leader	1	1.9
	EHS Manager	1	1.9
	EHS Specialist	6	11.1
	Field Engineer	12	22.2
	Generator specialist	1	1.9
	Instrument Technician	1	1.9
	Materials & Tooling Specialist	1	1.9
	Mechanical Supervisor	2	3.7
	Mill Wright	11	20.4
	Project manage	1	1.9
	Resource manager	1	1.9
	Senior machine	1	1.9
	Service Manage	1	1.9
	Shroud machinist	2	3.7
	Supervisor	6	11.1
	Nil	3	5.6
Segment	Aero	4	7.4
	Oil and Gas	9	16.7
	Power services	40	74.1
	Others	1	1.9
Years on the Job	Less than 1 year	7	13.0
	1 - 5 years	13	24.1
	6 - 10 years	15	27.8
	11 - 15 years	11	20.4
	15 years and above	8	14.8
Years of Experience	1 - 5 years	11	20.4
	6 - 10 years	5	9.3
	11 - 15 years	14	25.9
	15 years and above	24	44.4
Hours of work per week	30 – 40	2	3.7
	41 – 50	9	16.7
	50 and above	43	79.6

Table 2: Social-demographic Information (n = 54) *

*n =Sample size

Table 2 shows the demographic information from the sample population. In terms of gender, fifty-two persons, representing about 96.3 % are males and two persons (3.7 %) are females. The age bracket is centred on 30- 39 years which constitute about 51.9 % of the entire sample population.

In terms of educational qualification, HND/BSc holders were twenty-nine (29) in number consisting of about 53.7 % of the sample size. The married people were more in number, 38 (70.4 %) as the single (24.1 %) and divorced (5.6). None of the participants were separated or widowed. Employees in operations department dominated the sample population making up of 24 (44.4 %) persons as against those in EHS 13, (24.1 %). Those in the others categories were 17 (31.5 %) in number. With reference to the segment of the organization, four (4) persons (7.4 %) are in aero, another nine (9) persons (16.7 %) are in the oil and gas segment while those in power and services make up about 74.1 % (40 persons) of the entire respondents. The number of years of the respondents on the job is almost uniformly distributed between 1 - 5 years (24.1 %), 6 - 10 year (27.8 %) and 11 - 15 years (20.4 %). Employees with 15 years and above of experience dominated the respondents (44.4 %). This was followed by those with 11 - 15 years of experience (25.9 %). Finally, a large portion (43 persons) making up about 79.6 % of the respondents work over 50 hours on the average per week.

B. *Workplace Risk Assessment*

The response of the sample population on the assessment of workplace hazards is shown in Table 3. From Table 3, in the physical category of workplace risks assessment, the respondents are mostly exposed to noise (90.7 %). This is followed by heat (85.2 %), fire and explosion (55.6 %), non-ionizing radiation (13.0 %) and the least is ionizing radiation which makes up 9.5 % of the workplace hazards employees are exposed to. Gases were considered the most of chemical hazards (83.3 %) workers are exposed to. Next to this is vapours consisting 70.4 %, fumes (63.0 %) and smoke ranked the least with 59.3 %. In terms of ergonomic hazards workers are exposed to, about 92.6 % are exposed to strain/stress while some 70.4 % are exposed to sprain.

Workplace hazard	Category	Frequency	Proportion (%)	Mean (%)
Physical hazards	Noise	49	90.7	
	Heat	46	85.2	
	Fire and Explosion	30	55.6	50.7
	Non-ionizing radiation	7	13.0	
	Ionizing radiation	5	9.5	
Chemical hazards	Vapours	38	70.4	
	Gases	45	83.3	69.0
	Fumes	34	63.0	
	Smoke	32	59.3	
Ergonomic hazards	Strain/Stress	50	92.6	81.5
	Sprain	38	70.4	
			Overall mean	63.0

Table 3: Workplace Risk Assessment

C. Underlying and Root Causes of Accidents

a) Unsafe Acts of Workers

A total of forty-nine persons representing 90.7 % of the respondents believe unsafe acts of workers constitute a cause of accident in the workplace. Figure 3.1, Skill-based error (70.4 %) ranked highest as the main cause of accident due to unsafe acts of workers in the workplace. Next to this is decision error and perceptual violations which ranked equally at 59.3 % and routine violations 57.4 %. Exceptional violation (42.6 %) ranked least in this category (Table 4).

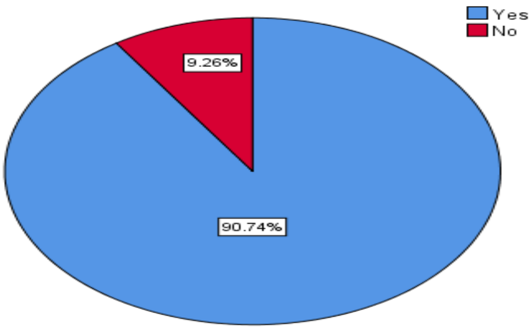

Fig. 2: Unsafe acts of workers as a cause of accident in the workplace

	Category	**Frequency**	**Proportion (%)**	**Mean (%)**
Unsafe acts of workers	Decision error	32	59.3	
	Skill-based	38	70.4	
	Perceptual	32	59.3	57.8
	Routine violations	31	57.4	
	Exceptional violation	23	42.6	
Preconditions for unsafe acts	Adverse mental states	48	88.9	
	Adverse physiological states	39	72.2	
	Physical and/or mental limitations	36	66.7	76.7
	Crew resource management	48	88.9	
	Personal readiness	36	66.7	
Unsafe supervision	Inadequate supervision	42	77.8	
	Planned inappropriate	34	63.0	
	Failure to correct problems	42	77.8	69.4
	Supervisory violations	32	59.3	
Organizational influence	Resource management	39	72.2	
	Organizational climate	26	48.1	62.3
	Operational processes	36	66.7	
		Overall mean		**66.9**

Table 4: Underlying and Root Causes of Accidents

b) Preconditions for unsafe acts

Figure 3.2 represents the opinions of the respondents as to if there are preconditions for unsafe acts of employees in the workplace. About 98.15 % agrees that there are certain preconditions for unsafe act of workers in the work environment, whilst about 1.85 % held a contrary opinion. From Table 4 of the preconditions that could lead to unsafe acts on worker in the workplace, adverse mental states and crew resource management ranked top (88.9 %). This is followed by adverse physiological states (72.2 %). Physical and/or mental limitations and personal readiness ranked least and equally with 66.7 %.

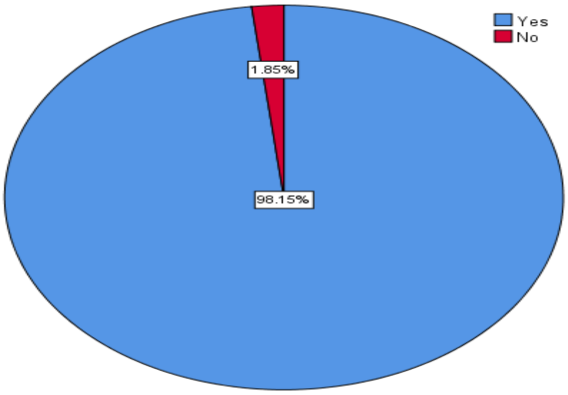

Fig. 3: Preconditions for unsafe acts of workers in the workplace

c) Unsafe supervision

Unsafe supervision has been established to lead to accidents in the workplace. In this study about 88.9 % of the respondent considered unsafe supervision as a cause of accident in the workplace (Figure 3.3). Inadequate supervision and failure to correct problems ranked top with about 77.8 % as the leading act of unsafe supervision in the workplace. Others are planned inappropriate operations (63.0 %) and supervisory violations (59.3 %).

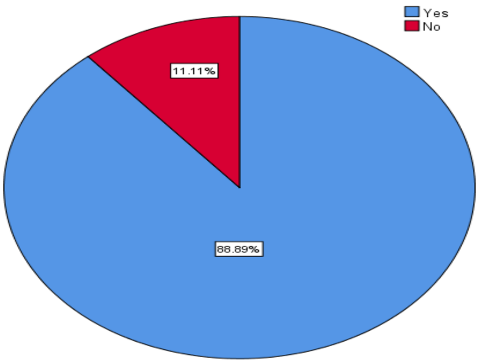

Fig. 4: Unsafe supervision as a cause of accident in the workplace

d) Organizational influence

About 81.5 % of the respondent believed fallible decisions of senior management can directly affect supervisory practices, as well as the conditions and actions of operators (Figure 3.4). Unfortunately, these organizational influences are often undetected or are not reported by even the best-intentioned accident investigators. Ranking on top of this is resource management (72.2 %), which is followed by operational processes (66.7%).Organizational climate ranked the least with 48.1 % (Table 4).

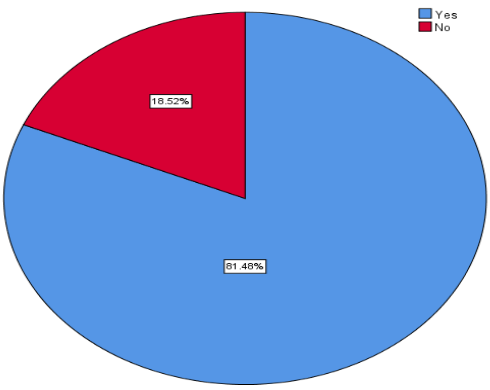

Fig. 5: Organizational influence as a cause of accident in the workplace

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Various workplaces around world experienced high in the number of occupation-based accidents over a few decades ago. Though its cause is of multiple origins, human factor occupies a large chunk of it. According to AlKhldi, Pathirage, and Kulatunga, (2017), human error constitutes the largest contributor of over 70 % of all accidents in the Oil and Gas industry. This agrees with the findings of this work where 57.8 - 76.7 % of accident in the workplace with an overall mean of 69.9 % has been attributed to human error. The expenses of the so-called accidents are strikingly high to individuals, their place of work and the society at large because the Oil sector operates on differential range of chemicals and processes (Moura *et al.*, 2015).

Abdelhamid and Everett (2000) in a paper presentation which utilized accident root causes tracing model (ARCTM) that strengthens how accidents in construction industry were investigated through a session of questions and answers which assisted to solve puzzle of recognizing very root cause of occupation-based accident. The accident scenarios studied thoroughly with use of ARCTM reveal that the events analysis – if they pre-existed or are generating unsafe situations (conditions or acts), and the reaction of employees or effect it had on them – is a brainy way to trend in other to correctly unravel very root cause of accidents that occur on construction areas. Coupled to finding out very root cause(s) behind accidents, provision of answers or areas of consideration in the prevention of repeated accidents. This recent study further fosters a study by Abdelhamid and Everett were very specific root causes of occupation-based accidents have been demystified by those who participated in research.

IV. CONCLUSION

The occurrence of accident in workplace cannot be overlooked even with the establishment of very stringent measures to forestall its occurrence. This is because humans have an inbuilt default nature of making mistakes. Furthermore, materials and equipment can fail at any time.

The notwithstanding, relevance of a well-defined and properly implemented accident prevention and reporting policy and programmes in workplace cannot be over emphasized. This is because even though we cannot entirely halt accidents from occurring, their awful impacts in work place can be greatly streamlined.

Furthermore, proper orientation, training and retraining of personnel in goes long way towards diminishing happenings and negative impacts of accident in the workplace.

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