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Effect of Safety Management System on Production Efficiency in Construction Sites in Niger Delta, Nigeria

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Abstract
Construction industry has long been considered as a risky industry. The purpose of this study was to investigate the effect of safety management system on production efficiency in construction sites in Niger Delta, Nigeria. The data utilized in this study are based on a proportionate stratified sampling of construction workers representing the selected companies for this study. Out of the 236 copies of self-administered questionnaire distributed, 213 were used for the study, representing a response rate of 90.25%. Data were analyzed by using descriptive and inferential statistics and presented in tables and figures. Findings from the study show that the three most practiced elements of safety management system are adequate provision of PPEs with mean of 4.12, establishment of safety policy statement with mean of 3.19 and response system for attending to safety incidence with mean of 3.01. The relationship between safety management system implementation and production efficiency was found to be positive though not significant (r = 0.2924). The study suggests that improvement in safety management system will help increase productivity in construction workplaces.

Keywords: *Safety management system, Production efficiency, Construction site, Niger Delta*

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1. Introduction

A system describes an orderly arrangement of interwoven activities and procedures that implement and facilitate performance of a key activity in an organization (Baek *et al*., 2008). Management system represents a framework of processes, policies and procedures used by organization to achieve a predefined purpose and objectives (Geller, 2001). When the undertaking is reasoned to be risks, the term "safety management system" comes into play. In brief, safety management system (SMS) is a systematic approach intended to reduce incidents/accidents rate of occurrence for the goal of improving safety (Ghobakhloo, 2018). In detail, SMS is a series of defined structure, inputs, process that work in harmony in providing an atmosphere of improved safety in the workplace (HSE, 2004). The SMS goes beyond reactive safety management, which is useful when dealing with unusual events or technical failures, to identifying hazards before they occur and taking possible steps in reducing incident occurrence.

Assessment of occupational hazards and assurance of occupational safety at a construction site is extremely an important question to be analyzed. It has been estimated that most occupational fatality or injury occurs at construction site. Also, in comparison to other areas of economic activities, many more violations of regulatory enactments on health and safety are registered in the construction sector.

Construction industry has long been considered as a risky industry (Yiu et al., 2019). Globally, more than 2.78 million people die in occupational accidents and work-related diseases every year (Yiu et al., 2019). There are very specific potential hazards in this industry including working at high altitude, working with power transmission equipment, continuous work change, employing contract workers instead of permanent employees, the presence of several uncoordinated contractors in a construction site and inappropriate working conditions in terms of exposure to various harmful factors such as noise, vibration, aerosols, manual handling, etc. (Carter and Smith, 2006; Pinto et al., 2011; Tam et al., 2001). The accident rate is considered to be a common metric for benchmarking the construction safety performance.

About 350 million workers currently work in this industry around the world (Biswas et al., 2017). While in developed countries approximately 6 - 10% of the workers are employed in the construction industry, about 20 - 40% of deaths are attributed to this industry (Raheem and Hinze, 2014). The International Labour Organization (ILO) estimates that approximately 6000 workers die each day world-wide and 337 million people are victims of work-related accidents or illnesses arising from occupational injuries (Marras et al., 2000). In Nigeria, the construction industry loses at least 5% of its workforce annually to injuries and fatalities, while the influx of new blood has reduced by 17% compared to that of 1970s (Oh and Sol, 2008). In general, accidents at construction sites could be qualified as defects of the health and safety management system, which occur due to a number of aspects, including technical, technological, organizational and other types of factors (Dessler, 2008). Such multiple criteria aspects of risk and safety in construction or reconstruction works have been analyzed (Kibe, 2016).

Accidents cause human suffering and economic losses. Computation of the true costs of injuries reveals that compromising safety results in increased costs and decreased profits (Hinze 2000). After understanding "incurring the cost of injuries versus investing in safety" (Hinze 2000), it becomes apparent why such slogans as "Safety Pays; Injuries Cost" and "It Pays to Be Safe" make part of the culture of companies that are truly committed to the well-being of their employees. The International Labour Organization (ILO-OSH, 2001) guidelines summarized occupational safety and health as "decent work" which is safe work, and consider that it is a positive factor for productivity and economic growth.

According to Attar *et al*. (2012), production efficiency is usually regarded as labour productivity. This according to them could be attributed to the fact that construction projects are mostly Labour based with basic hand tools and equipment. According to the American Association of Cost Engineers, production efficiency is a relative measure of labour efficiency, either good or bad when compared to an established base or norm (Intergraph Cooperation, 2012). Production efficiency is the ratio of volume measure of output to a volume measure of input used (Organization for Economic Cooperation and Development, 2001). For construction companies, production efficiency is closely related to technical efficiency which pertains to the optimal combination of capital and labour to execute a project. However, a construction company can be efficient in productivity but inefficient in resource allocation or distribution.

The incorporation of occupational safety and health programmes/measures (positive safety culture, SMS) into investment in machines and technology (socio-technical investments) will result in better safety performance of employees (reduced rate of unsafe acts) and the company (reduced rate of fatalities). According to Mossink and De Greef (2002), when an effective SMS is implemented through management and employee commitment, it leads to adherence to safety rules and regulations in the operations of the organization, and hence, enhance safety performance. This in turn, reduces accidents, near-miss and fatalities. It further enhances the working condition, leading to improved efficiency and productivity among other benefits (Agwu and Olele, 2014).

The construction industry contributes to a large proportion of industrial injury and mortality. It is of high importance to evaluate the effectiveness of the SMS. In particular, it is necessary to compare the level of implementation of SMS and production efficiency of a construction project. Given that there is no comprehensive and complete information based on actual recorded data on the effect of safety management system on production in the construction industry in Nigeria, the purpose of this study was to identify the information gap on effect of safety management system on production in the construction industry in the Niger Delta.

2. Materials and methods

2.1 Research design

This cross-sectional study was conducted to investigate the prevalence and variation of work-related diseases and illnesses among construction workers in Niger Delta, Nigeria. Niger Delta consists of nine (9) States (Abia, Akwa-Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo and Rivers) with 185 LGA (UNDP, 2006). A total of 236 construction workers were selected from seven construction workplaces in northern, southern, eastern, western and central parts of the Niger Delta. The seven construction companies used in this study were represented as companies A, B, C, D, E, F and G due to ethical reasons.

2.2 Participants

The target participants for this research consisted of site managers, engineers, foremen, quantity surveyors, architects, building trade operatives such as bricklayers, carpenters and others who work in major building construction companies in the Niger Delta, Nigeria. A total of 236 workers with at least one year of work experience in the construction workplaces participated in the study.

2.3 Data collection and quality control

Data was collected using questionnaire containing questions about the level of implementation of safety management system, production efficiency and demographic characteristics of the study participants. The formal validity of the questions was confirmed by occupational health and safety experts. For this purpose, copies of questionnaire were sent to experts who gave their feedback regarding the necessary corrections. Questionnaire was computed and administered to 236 construction workers including the site managers, foremen, quantity surveyors, engineers, architects, building trade operatives. Confidentiality was maintained and informed consent was obtained.

During training of data collectors and supervisors, issues such as the data collection instrument, sampling technique, inclusion-exclusion criteria and recordkeeping were emphasized. The questionnaire was pre-tested on 20 respondents in order to identify potential problem areas, unanticipated interpretations and cultural objections to any of the questions. Based on the pre-test results, the questionnaire was adjusted contextually. Out of the 236 copies of questionnaire distributed, a total of 213 copies were deemed fit for use for the data analysis, representing a response rate of 90.25%.

2.4 Data analysis

Data analysis was performed using SPSS software version 22. Data gathered were presented via tables and charts and analyzed with descriptive and inferential statistics. Descriptive statistics comprised: frequencies, mean, percentages, standard deviation, ranks and relative importance index. Inferential statistics included the Pearson Product Moment Correlation (PPMC).

3. Results and discussion

3.1 Demographic data of the respondents

Table 1 presents the demographic data of the respondents. As shown, 193 (90.61%) of the respondents were male while 20 (9.39%) were female. This shows that the construction companies have more male workers than female workers. 104 (48.83%) of the respondents had age ranging from 18 to 35 years while 109 (51.17%) had age of 36 years and above. 98 (46.01%) of the respondents were married while 115 (53.99%) were single. This is an indication that there were more single workers among the respondents than married workers. 40 (18.78%) of the respondents were project managers; 19 (8.92%) were quantity surveyors; 55 (25.82% were engineers; 13 (6.10%) were architects while 86 (40.38%) were building trade operatives. It can be deduced that building operatives were more in number than other personnel in the construction companies under study. A total of 65 respondents stated that the highest level of educational qualification they have is a WAEC certificate which accounted for about 30.5% of the total respondents, 111 respondents stated that they obtained a bachelor degree which accounted for about 52.1% of the total respondents while 37 respondents stated that they have obtained a degree higher than a bachelor degree.

3.2 Implementation level of safety management system across the construction companies

The result in Table 2 indicates that the three most practiced elements of safety management system are adequate provision of PPEs with mean and rank of 4.12 and 1st respectively, establishment of safety policy statement with mean and rank of 3.19 and 2nd respectively and response system for attending to safety incidence with mean and rank of 3.01 and 3rd respectively. This result shows that adequate provision of PPEs was often practiced by the construction companies under study. The result further shows that establishment of safety policy statement and response system for attending to safety incidence were moderately practiced among the construction companies.

Table 1: Demographic data of respondents

Variable	Categories	Frequency	Percentage
Gender	Male	193	90.61
	Female	20	9.39
Age	18-35	104	48.83
	36 and Above	109	51.17
Marital Status	Married	98	46.01
	Single	115	53.99
Workers	Project Managers	40	18.78
	Quantity Surveyors	19	8.92
	Engineers	55	25.82
	Architects	13	6.10
	Building Trade Operatives	86	40.38
Education	WAEC/Equivalent	65	30.52
	BSc/Equivalent	111	52.11
	Above BSc	37	17.37

Table 2: Level of implementation of safety management system (N=213)

S/N	Items	SA	A	D	SD	U	WM	Rank
1	Company has safety policy statement.	21 10%	75 35%	47 22%	15 7%	55 26%	2.96	2nd
2	Management engages in periodic safety audit.	24 11%	51 24%	62 29%	30 14%	46 22%	2.89	6th
3	There is adequate provision of PPEs by management.	103 48%	50 23%	18 8%	0 0%	42 20%	3.81	1st
4	A system for identifying hazards is in place.	26 12%	54 25%	53 25%	30 14%	50 23%	2.89	4th
5	There exists a system for assessing identified hazards	20 9%	55 26%	40 19%	36 17%	62 29%	2.69	5th
6	The company has an effective training system for enhancing safety practice.	15 7%	63 30%	45 21%	37 17%	53 25%	2.77	8th
7	Response system for attending to safety incidence is adequate.	21 10%	64 30%	49 23%	27 13%	52 24%	2.88	3rd
8	Adequate control measures are in place to address safety matters.	17 8%	42 20%	61 29%	34 16%	59 28%	2.64	9th
9	There is active collaboration between workers and management to enhance safety practice.	20 9%	54 25%	50 23%	34 16%	55 26%	2.77	7th
10	There is effective system in place for communication of safety related matters.	13 6%	55 26%	70 33%	32 15%	43 20%	2.83	9th

*(WM=Weighted Mean, SA=Strongly Agree; A=Agree; U=Undecided; D=Disagree; SD=Strongly Disagree)

3.3 Variation of production efficiency in construction companies

Table 3 shows the production efficiency of construction companies under the study area. As shown, company D has a grand mean-value of 3.50 for production efficiency. Company F has a grand mean value of 3.11. Company B has a grand mean value of 3.01. This depicts that three companies (D, F, B) have production efficiency within expectation. The result also shows that company D has the highest level of production efficiency while company C has the lowest level of production efficiency.

3.4 Correlation between safety management system and production efficiency

The correlation between safety management system and production efficiency is shown in Table 4. The relationship between safety management system implementation and production efficiency shows that a positive relationship was between the two constructs. The more safety management system implementation put in place by the company, the more productive the company would be. The result showed that if company management provide adequate personal protective equipment and have a good safety policy at the workplace, workers will have a better sense of security when it comes to doing their jobs which will eventually lead to better productivity by the workers.

Table 3: Variation of production efficiency in construction companies

S/N	Elements of Production Efficiency	Mean values						
		A	B	C	D	E	F	G
1	The company delivers projects within specified time.	3.60	2.69	2.33	3.31	3.05	3.00	2.93
2	Labour force of the company is utilized optimally to achieve project goals.	2.90	3.12	2.33	3.60	2.87	3.03	2.86
3	Projects are completed utilizing materials at minimal cost without compromising quality.	2.85	3.10	2.80	3.77	2.82	2.88	2.89
4	Financial investment into projects yields optimal financial returns.	2.60	3.05	2.60	3.54	2.67	3.26	2.68
5	Workers perform as expected.	2.85	3.07	2.60	3.46	2.72	3.44	2.86
6	Wastages are reduced to the barest minimum to achieve optimum result.	3.05	2.90	2.47	3.40	2.95	2.88	2.86
7	Capital is used efficiently to accomplish projects.	2.70	3.02	2.73	3.40	2.62	3.00	3.18
8	Hours of work contribute greatly to the accomplishment of projects.	2.95	2.95	2.53	3.63	3.03	3.18	3.18
9	Utilization of available resources is maximized to achieve optimum output.	2.95	3.17	2.60	3.51	2.97	3.26	2.86
10	The company utilizes resources optimally to accomplish project for satisfaction of clients.	2.75	3.00	2.60	3.34	2.90	3.18	2.68
	Grand Mean	2.90	3.01	2.56	3.50	2.86	3.11	2.90

Table 4: Correlation between safety management system and production efficiency

Variables	Safety Management System	Production Efficiency
Safety Management System	1	0.2924
Production Efficiency	0.2924	1

4. Discussion

Result obtained shows that three most practiced elements of safety management system are adequate provision of PPEs, establishment of safety policy statement and response system for attending to safety incidence. This means that adequate provision of PPEs was often practiced by the construction companies under study. The result further shows that establishment of safety policy statement and response system for attending to safety incidence were moderately practiced amid the construction companies.

The result further showed that elements of safety management system such as putting a system for identifying hazards in place, putting a system for assessing identified hazards in place, engagement in periodic safety audit, active collaboration between workers and management to enhance safety practice, effective training system for enhancing safety practice, putting control measures to address safety matters in place and putting an effective system for communication of safety matters in place were practiced sometimes. This result implies that management of construction companies have some level of commitment to safety practice. A study by Olutuase (2014) lamented the poor implementation of safety management programmes in construction companies in Nigeria. This finding agrees with the findings of Kibe (2016) that Personal Protective Equipment were present in construction companies in Kenya, nevertheless, they were used minimally.

The result shows that three companies (D, F and B) had production efficiency within expectation. Then, four construction companies (A, G, E and C) have production efficiency slightly below expectation. The result further shows that company D has the highest production efficiency level while company C has the lowest level. This result clearly shows the level of variation in production efficiency amidst the construction companies. This variation may possibly be caused by some factors. According to Udo et al. (2016) findings, neglecting safety on construction sites could negatively impact productivity and performance. Similarly, safety practices, attitude of management and safety training were found as factors that could influence workers' productivity in manufacturing companies in Ghana (Esi, 2012). The causal relationship between safety management system implementation and production efficiency showed that there was positive relationship between the two variables but the relationship was not significant.

5. Conclusions

This study showed that adequate provision of PPEs, establishment of safety policy statement and response system for attending to safety incidence were the three most practiced elements of safety management system in construction companies in Niger Delta, Nigeria. Production efficiency varied significantly across the construction companies studied. Furthermore, there was positive relationship between the safety management system and production efficiency, but the relationship was not significant.

Conflict of interest

The author(s) declare no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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