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Workplace layout and the occupational safety of employees' in the calabar free trade zone, Nigeria

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Abstract
This study was focused on the relationship between workplace layout and occupational safety of employees. The purpose of this study was to examine the relationship between workplace design or layout and occupational safety of employees. A population of 300 workers drawn from 5 stratified and selected firms, representing the largest in term of employees and output in the Calabar Free Trade Zone, (CFTZ) Nigeria, constituted the population of the study. A sample of 169, which was representative of the various cadres of workers, was carved from the population with the aid of Krejcie Morgan table. Data was gathered with questionnaire from 169 respondents and hypotheses tested with Pearson product-moment correlation analysis at 0.05 level of significance and 118 degree of freedom. Findings indicated that most workers were dissatisfied with their workplace physical design, such as;the circulation of gangways/walkways, the articulation and functional relationships between spaces, ventilation and the unavailability of fire-fighting equipment, emergency exit doors and proper constructed gangways. Furthermore, findings also revealed that some of the consequences of unsafe and unhealthy work environment include; stress, industrial accidents and the development of chronic diseases, which affects employees physical and mental fitness, as well as, their occupational safety generally. Thus findings emanating from this study is a clarion call for the overhauling and redesigning of workplaces in the CFTZ and industrial space at large. It is also a wake-up call to government regulatory agencies, such as Federal Ministry of Labour and Productivity and Standard Organization of Nigeria (SON) to ensure strict adherence to workplace standards. It was recommended that organizations should provide work environments that are supportive of occupational safety and which guarantees the health and welfare of their workers.

Keywords: layout, occupational, safety, employees and workplace

Introduction

1. Background of the study

Governments the world over, in realization-of the very vital position adequate office layout plays in work performance, provides strict legal/regulatory frameworks and provisions. The legal provision specifies the physical conditions of office or factory pertaining to the health, occupation/safety and welfare of employees. (Hameed & Anyod, 2019) [9]. In addition, the need to ensure occupational safety and work effectiveness of employees and minimize distance travelled between one work unit and the other has necessitated the need for optimum layout of production facility (Nwekpa, 2018) [15].

Design in the context of usage herein is concerned with the planning and physical structuring of office or factory buildings to facilitate the flow of work and to achieve effectiveness in work performance without compromising the health of workers. Uzee (1999) defined layout as the physical configuration of departments, workstations and equipment. Furthermore, according to Moore, as cited by Nwekpa (2018: 93) [15] "Facility layout is a plan of optimum arrangement of a company's physical resources including personal operating equipment, storage space, material handling services along with the design of best structure to contain all these facilities." Office design can also be referred to as office layout; hence these two words would be interchangeably be applied hereinafter.

In Nigeria for example, the Factories Act of 2004 [8] which is meant to regulate and ensure the occupational safety and Health of the Nigerian worker, provides a number of benchmarks in designing office or factory buildings, summarized as follows:

1. An office building should provide exit doors for escape during emergencies.
2. The design should provide adequate lighting
3. It should provide solid construction of factory floors, stairs and passages/gangways
4. The provision of first aid Box/medical facilities to stabilize emergency situation.
5. Provide fire extinguisher and other fire-fighting equipment
6. Adequate doors and windows to ensure that work rooms have proper ventilation
7. The adequate number of persons in a room to avoid congestion

Apart from the provisions of the Factory's Act of 2004; there are other technical standards to be taken into cognizance in designing an office/factory building as noted by Stallworth and Heiner (2009), they include the following:

1. **The Floor Space Design:** The office space should be designed to facilitate free flow of work and employees from one section to another with ease.

2. **Provision of Gangways:** Walking paths should be provided in the layout of office in a manner that movement of staff or customers do not distract or impede the smooth flow of work.

3. **Work Space:** The design should provide enough work space for staff.

4. **Arrangements of Furniture/Equipment:** Desk, tables and chairs should be well arrangement and equipment properly fitted in positions that do not hinder the flow of work and staff.

Occupational safety and health (OSH) is defined by international labour organization (2011) as a discipline dealing with the prevention of work related injuries and diseases including the protection and the promotion of the health of workers.

Occupational safety and health standards refers to the measures that are required to ensure the safety and welfare of workers at the workplace or factories. An employer is required to protect the health and safety of employees at workplace in accordance with the provisions of Factories Act 2004 and Labour Legislations (Laws of the Federation of Nigeria 2004) [8].

In specificity, it is the duty of the employer to ensure cleanliness in the factory, provide first aid/medical services in case of accidents and also avoid overcoming in workplaces. Furthermore, it is the duty of the employer to provide good ventilation lighting and proper designed drainage of floors, gangway and walkways to reduce chance of slipping and accidents (LFN, 2004). It is also an essential stipulation by legislation for factories to be fitted with fire extinguishers and exit doors for emergency situations and fire accidents. Legislation also should place a burden of care on the employer to ensure machines and work equipment are properly installed and kept in safe condition in a manner that does not pose a threat to the safety and health of employees in accordance with statutory provisions.

The Calabar free trade zone which is hereinafter referred to as (CFTZ), is located in Cross River State capital. The CFTZ is an industrial hub, consisting of companies and firms engaged in manufacturing, trading and oil and gas related activities. These companies benefit from special taxation rules and duty free imports and exports.

The CFTZ was created by an act of legislature in 1992 among nine (9) other free trade zones in Nigeria. It started operations however in 1999 upon full completion and commissioned by the Federal Government of Nigeria in 2001. It is pertinent to note here that the entire infrastructure of the CFTZ was built by the Federal Ministry of Trade and Investment, which includes, the building now used as factories and offices by the companies occupying the CFTZ.

2. Statement of the problem

Many Nigerian industries operate in work environments whose physical layout do not ensure employees safety and welfare in accordance with statutory provisions of the Factory's. Act of 2004 (LFN, 2004). Apart from the Factories Act provisions, there are other standards in terms of appropriate layout that are not also put in place by many Nigerian industries. These standards which are lacking, include proper construction of walkways/Gangways to avoid slipping, spacious and well ventilated workplaces, properly fitted work stations, appropriate lighting, availability of emergency exit doors and fire-fighting equipment. In specificity, the Calabar Free Trade Zones infrastructures was constructed by the Federal Government, without taking into cognizance the specific needs of the firms in terms of layout or design. Thus the companies occupying CFTZ only leased or bought over the factory spaces it uses for production. It is important to note here that some of these companies did not make structural adjustment to fit their specific layout requirement and these result in carryout production in work environment that do not agree with the Factory Act of 2004 (LFN, 2004) and other layout standards that should ensures employees occupational safety and health.

A pilot study conducted by the researcher in the study area, indicates that at least five industrial accidents occur every month in each of the companies being studied. To corroborate the foregoing assertion, in December 2020 the present Minister of Industry, Trade and Investment, Adeniyi Adebayo visited the CFTZ and conducted an inspection tour of facilities at the zone and he observed the abysmal non-compliance with statutory provision by most factories in the CFTZ and further noted that high incidence of industrial accident was occasioned by these lack of properly designed workplaces (Mofi review, 2021). The researcher also share's similar view with the minister, haven recently made a visit to this industrial hub

3. Objectives of the study

The main objective of this study is to establish how workplace layout could affect the occupational safety of employees in CFTZ. The following are the specific objectives for this study:

1. To investigate the relationship between the pattern of gangways/walkways in workplace and the occupational safety of employees in CFTZ.
2. To determine the relationship between the availability of emergency exit door in workplace and the occupational safety of employee in CFTZ
3. To determine the relationship between the state of ventilation of workplace and the occupational safety of employees in the CFTZ.
4. To determine the relationship between the provision of fire-fighting equipment/emergence exit doors in workplace and the occupational safety of employees in the CFTZ.

4. Research questions

1. To what extent does the pattern of gangways/walkways in workplace relate with the occupational safety of employees in the CFTZ?
2. To what extent does the availability of emergency exit door in workplace relate with the occupational safety of employees in CFTZ?
3. How far does the state of ventilation of workplace relate with the occupational safety of employee in the CFTZ?
4. To what extent does the provision of fire-fighting equipment/emergency exit doors inworkplace relate with the occupational safety of employees in the CFTZ?

5. Research hypotheses

The following null hypothesis were formulated for the study

Ho_1: There is no significant relationship between the pattern of gangways/walkways and work the occupational safety of employees in CFTZ

Ho_2: There are no significant relationship between the availability of emergency exit and the occupational safety of employees in the CFTZ.

Ho_3: There is no significant relationship between workplace ventilation and the occupational safety of employees in CFTZ.

H04: There is no significant relationship between the provision of fire-fighting equipment and occupational safety of employee in the CFTZ

6. Implications of the study

This study is a clarion call on chief executive officers and top management of industries in Nigeria and indeed to all employers of labour to the very important, but neglected impact workplaces layout have on the occupational safety of their employees. Findings emanating from this study occasions for a total over-hauling and re-designing of many factories and workplace in the CFTZ and the Nigeria industrial space generally The wake-up call is also directed to regulatory agencies, saddled with the statutory responsibility of enforcing the Factory Act of 2004, which is the ministry of labour and productivity and Standard Organization of Nigeria (SON) is by this study offered suggestion on how to enforce compliance of industrialist in tandem with the provision of the Factory Act and other necessary legislation and bench marks.

This study also offers academics/researchers meaningful and insightful information on the very important subject matter of employee safety/health as well as the environment they perform their duties.

Literature Review

1. Conceptual Review

This involved the review and description of relevant concepts relating to the subject-matter under study. Here a linkage between variables presented in the objective of study is created

1.1 Workplace layout

Layout in the context of usage herein is concerned with the planning and physical structuring of office or factory buildings to facilitate the flow of work and to achieve effectiveness in work performance without compromising the health of workers. Uzee (1999*)* defined layout as the physical configuration of departments, workstations and equipment. Furthermore, according to Moore, as cited by Nwekpa (2018: 93) [15] "Facility layout is a plan of optimum arrangement of a company's physical resources including personal operating equipment, storage space, material handling services along with the design of best structure to contain all these facilities."Office design can also be referred to as office layout; hence these two words would be interchangeably be applied hereinafter.

1.2 Types of Layouts/Designs

There are various types of layouts as submitted by Jameson (1990) and Nwekpa (2018) [15].

1. **Process Layout:** This is the arrangement of facilities in a manner that work centre or stations are grouped according to their functional types. Distribution warehouses, buildings and job shops often use process layout.

2. **Product Layout:** In a product layout, works stations and equipment are arranged in a line to facilitate specialized sequence of tasks. This is suitable when production involves the same sequence of operation from start to finish repeatedly.

3. **Fixed position layout:** In this type of layout, production takes place in a stationary position and most equipment, tools and workers are conveyed over.

4. **Combination layout:** This is an hybrid or mixed type of design. It is an amalgamation of the process layout and product layout.

5. **Group layout:** This type of layout is an approach that introduces flexibility and creativity into workplace design by allowing variations in production. This involve variation in production of products with different dimensions in types of size, colour and sequence of operations.

1.2.1 Walkways/Gangways

Walkways or gangways refers to passage way between offices or factories and work stations, it could also mean a temporal bridge for getting on and off a factory, manufacturing plant or building site, (Hameed and Amjab, 2019) [9]. As noted by Jameson (1990) most injuries that occurs on gangways result from slipping and falling which may cause fatal bodily injuries and even death in some cases. These vulnerability therefore imposes a statutory burden or responsibility on employers to provide or construct gangways/walkways fitted with non-skid surface to reduce slipperiness. Furthermore employers are also admonished to equip walkways/gangways with safety features, such as; handrails, bulwark, ladders, lifebuoys and safety net, (Jamessons, 1990).

1.2.2 Emergency exit door

Emergency exit doors on the other hand are exits paths made available as escape routs in case of fire outbreak or accidents. The installation in a workplace would restrict the spread of flames and smoke, thus it is important for such doors to be constructed with custom mode fire resistant doors such that the tight fit maximizes fire resistance, (Royston, 2019)

1.2.3 Ventilation

Ventilation can be defined as a process whereby fresh outdoor air is introduced to an indoor space to help the airborne contaminants that have built up over time (Lingard, 2020). When an office or factory space is not roomy or properly ventilated it results to the employees feeling hot and heavy air building up and draining them of energy, thereby impending their work output and health. Furthermore, as observed by Uzee (1999), poor ventilation is the catalyst for a variety of embient issues which negatively impact employee health. Without proper ventilation, humidity, carbon dioxide (C^{o2}), germs and indoor pollution sources build up

1.2.4 Firefighting equipment.

Firefighting equipment can simply be referred to as equipment required to ensure fire safety targeted at the safety of employees and the protection of the building. As observed by Lingard (2020) [12], the first step to be taken in any workplace is a fire risk assessment of the entire work environment such a fire assessment entails the process of identifying the potential fire hazard and identifying the employees at risk and then reducing or possibly eliminating potential risk and chances of eventual fire outbreak.

Firefighting equipment are made up of the following; Fire extinguishers, fire exit signs, fire alarm system, emergency lighting,

n, error detection, collection of spare and finally repairs and overhauling, (Tameson, 1999)

2. Empirical Review

Akindele (2014), conducted a study, titled factory design and safety with the main objective of determining impact of workplace design on employee performance and safety. Is adopted a survey design using expost-facto type with employees drawn from firm four randomly selected firms in Lagos, island in conducting a study on organizational layout and its effects. (2010 - 2015). The data for the study was analyzed using both descriptive and inferential statistics, while predictions were determined using analysis of variance (ANOVA). It was revealed that there was a significant relationship between workplace layout and employee performance and safety.

Olayinla and Temitope (2015) [16] conducted a study titled office design and occupational safety in Nigeria. The main objective of the study was to investigate the relationship between office design and safety of employees. Qualitative research method was used to examine the nexus between office design and occupational safety in Nigeria manufacturing industry. The study utilized data on variables which were believed to be related to factory layout. These variables included employee work effectiveness and occupational safety and health. The result showed that factory layout has a positive relationship with occupational safety and health. Furthermore, Uzee (2018) in a survey of 95 empirical studies conducted between 2000–2018 in Nigeria, titled analysis of workplace and safety in Nigeria. It was reported that, when treated as an independent variable, workplace layout is found to have a positive relationship with occupational safety and health in 42 studies (53%), no relationship in 19 studies (24%), a negative relationship in 4 studies (5%) and a market relationship in 15 studies (18%). In cases several, when the empirical literature assessed the limits between workplace layout and occupational health, the conclusion was that the evidence is positive.

Egan (2021) conducted a study titled factory design and employees safety/health, utilizing three medium scale companies as sample in a survey, the main objective of the study was to determine the relationship between factory physical design and the safety/health of employees. The data generated from sample was analyzed using pearson product-moment correlation analysis. Result revealed that there was a positive relation between factory design and employee safety and health.

3. Theoretical Framework

The Researcher consider the Accident Prevention Theory, propounded by Dr. William Haddon as the anchor theory for the study.

The Accident Prevention Theory is an energy release theory which identify and classifies preventable damage caused by accidents. The assumption of this theory is that, accidents are caused by the transfer of energy with such force that body injuries and property damage occur. Strategies can be designed to interrupt or suppress the chain of accidents causing events. Those strategies as postulated by Hadden revolve around the following cardinal codes/principles.

1. Control and prevention of buildup of energy that is inherently injurious
2. Creation of an environment that is not prone to injuries and buildup of negative energy
3. Production of counteractive measures to injuries buildup of energy.

An application of Accident Prevention Theory contextually would ensure that firms at the CFTZ would have to create work environment for its workers that would or prevent inhibit injurious building of energy that could eventually cause accidents in workplaces. Furthermore an adoption of the approach of this theory in CFTZ would culminate in an accident preventive and proactive environment rather than a corrective and reactive one. This accident preventive and proactive approach can be achieved by providing or redesigning workplace design in accordance with minimum benchmark of the Factories Act of 2014.

Methodology

1. Research design

The research design adopted for the study was stratified survey design. This was adopted to allow inferences to be made from sample and generalization drawn from the population that may have been too expensive and cumbersome to study wholly.

2. Area of the study

There are about twenty-five [25] functional manufacturing Industries, for domestic export market, in Calabar Free Trade Zone, from which the 5 largest and oldest firms were selected, constituting an aggregate study population of about 300.

3. Population of the study

The population of this study is made up of all the employees of the [5] manufacturing firms studied in the Calabar Free Trade Zone numbering 300. This is a free trade and industrial zone located in the metropolitan city of Calabar. Calabar is the capital of Cross River State, which is one of the 36 states that constitute the Federal Republic of Nigeria.

4. Sample size determination

The study utilized a sample size of 169 determined by the aid of Krejcie Morgan Table, (1970). Questionnaires was administered on the respondents taking into cognizance various categories of staff, *viz*: top management staff, middle level and lower cadre staff

5. Sources of data

Primary data was utilized in conducting the study.

6. Instrument of data collection

A four-point questionnaire was used to gather data from respondents. Section A sought demography details of respondents and section B contained items that were to actually determine the relationship between workplace layout and occupational safety/health. The well-structured questionnaire was validated by experts in research and recommendations of colleagues. The questionnaire required the following relative responses. Strongly Agree (SA), Agree (A), strongly disagree (AD) and Disagree (D).

7. Validity and reliability of instrument

In order to determine the validity of the research instrument, the questionnaire was given to test and measured expert to critique the items. The face and content validity approaches were adopted. The expert and supervisor made their inputs respectively and correction were accordingly effected by the researcher before the approval of instrument by supervisor. Thereafter, a reliability analysis was done to ensure measurements are reliable for the study. A pilot test was conducted and feedback from the test led to further modification of the instrument was considered suitable for the research by my supervisor.

8. Method of data analysis.

Data were analyzed with Pearson product moment correlation analysis. A total of 169 copies of questionnaire were administered on respondents, out of which 120 (71%) were returned, while 49 (29%) were not returned. Data were analyzed and hypotheses tested and validated with the aid of Pearson product-moment
correlation analysis.
Given by:

$$r = \frac{n(\sum xy) - (Ex)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - ([\sum y)^2]}}$$

Where r = Pearson's correlation co-efficient
N = Sample size
$\sum XY$ = Sum of product of X and Y
$\sum X$ = Sum of X
$\sum Y$ = Sum of Y
$\sum X^2$ = sum of the square of X
$(\sum X^2)$ = squares of the sum of all Xs
$\sum Y^2$ = sum of square of Y
$(\sum Y)^2$ = squares of the sum of all Ys

Decision Rule

The obtained r must be greater than the critical r to be considered significant. In other words, if the calculated value is less than the critical table value, we do not reject the null hypothesis and if however otherwise, we reject the null and accept the alternative. The level of significance is 0.05 and degree of freedom of 118 (N-2).

1. Data collection/Analysis

Data which are collected with the aid of questionnaires are analyzed and presented on the basis of research questions and hypotheses formulated in chapter one.

2. Presentation of Results

Hypothesis 1: There is no significant relationship between the pattern of gangways/walkways and occupation safety/health. The analysis/test was done with the aid of Pearson product-moment correlation analysis and presented on table 1 below.

Table:1 Computation of responses on the relationship between pattern of gangways/walkway and occupation safety.

Variable	Σx Σy	Σx Σy^2	Σy	R
Pattern of Gangway/walkways	5920	20008970		
			4322402	0.81
Occupational Safety.	3008	607728		

Source: Field Survey (Questionnaire, 2021)
P< 0.05, df = 118, t = 1.98

The table above reveals a calculated r value of 0.81 which is less than the critical value of 1.98 at 0.05 level of significance with 118 degree of freedom. Therefore in accordance with decision rule, the null hypothesis is not rejected.

Hypothesis II: There is significant relationship between availability of emergency exit door and occupational safety.
Pearson product-moment correlation analysis was employed in testing the hypothesis and result is personated below.

Table 2: Computation of response on the relationship between emergency exit door and occupational safety.

Variable	ΣX Σy	ΣX Σy²	ΣXy	R
Emergency Exit doors	66714	2108208		
			4722313	0.66
Occupational Safety.	3508	607728		

Source: Field survey (Questionnaire, 2021)
P < 0.05, Df = 118, T = 1.98

The table above shows a calculated r value of 0.66 which is less than the critical value of 1.98 at 0.05 level of significance with 118 degree of freedom. In accordance with decision rule, the null hypothesis is therefore not rejected.

Hypothesis 3: There is no significant relationship between workplace roominess/ventilation and occupational safety. The hypothesis was tested with the aid of Pearson product moment correlation analysis. The result is presented below.

Table 3: Computation of responses on the relationship between workplace roominess/ventilation and occupational safety/health.

Variable	ΣX Σy	Σx² Σy²	ΣXy	R
Workplace Ventilation	5288	1628400		
			3498290	0.99
Occupational Safety.	1890	490180		

Source: Field Survey (Questionnaire, 2021)
P<0.05, D = 118, T=1.98

The Table above shows a calculated r value of 0.99, which is less them critical value of 1.98 at 0.05 significance level and 118 degree of freedom. The null hypothesis, in line with decision rule the null hypothesis is therefore not rejected.

Hypothesis IV
There is no significant relationship between the provision of fire-fighting equipment/emergency exit doors and occupational safety/heath of employees in the CFTZ.

Table 4: Computation of responses on the relationship between the provision of fire-fighting equipment/emergency exit doors and occupational safety of employees in the CFTZ.

Variable	ΣX Σy	Σx² Σy²	ΣXy	R
Fire-fighting Equipment	6017	2002801		
			42332	0.06
Occupational Safety.	3207	596624		

Source: Field Survey (Questionnaire, 2021)

The table above shows a calculated value of 0.60 which is less than the critical value of 1.98 at 0.05 level of significant and 118 degree of freedom. In accordance with the decision rule therefore the null hypothesis is not rejected.

3. Discussion of findings
The sum of empirical finding emanating from the analysis revealed that most employees were dissatisfied with the patterns of gangways and walkways in their offices and factory hence hinders occupational safety.
Findings also indicate that a good number of employees and factory workers were not satisfied with the non-availability of emergency exit door in their workplace in case of accident or injuries. This does not support occupational safety. This finding is in accordance with the study of Jameson (1990) [10] and Uzee (1999) who both opined that an unpleasant work environment reduces employees physical safety and mental fitness.
Findings further revealed that the roominess and ventilation in most of the companies within the zone is poor, as expressed by their employees. These they emphasized, affects their respiratory system negatively. This also aptly agrees with Cole (2002) who discovered that an unspacious, crowded and stuffy work environment is a stressor and stress of course negatively impacts on work effectiveness.

Conclusion and recommendations
1. Conclusion
This study has indeed proved the position of the minister of trade and investment who aptly observed that lack of conducive workplace in CFTZ was the cause of occupational safety/health, as stipulated by Nigeria factories Act of 2004 [8]. Upon retirement, quite a good number of retirees develop strange diseases which they may have been acquired or developed over the years of working in an unconducive and unhealthy environment.
Wrongly design gangways/walkways are a source of industrial accidents and stress, both taking their toll on work effectiveness and safety of employees. Neither does an over-crowded, congested, and poorly ventilated office or factory enhance occupational safety. In conclusion, therefore, we can authoritatively state that for occupational safety to be achieved in the Nigerian industrial sector, issues bordering on the physical design and employee safety and welfare must be taken seriously and strict adherence to the Nigeria's Factories Act of 2004 [8] must be ensured.

2. Recommendations
1. The following recommendations are advanced: Industries and as well as regulatory agencies of government should ensure the proper construction of gangways/walkways that enhance the safety, health and work effectiveness of their employees.
2. Offices and factories should provide emergency exit door to help stabilize injured employees in a case of accident.
3. workplace should be constructed to provide roominess and ventilation to facilitate proper respiration in accordance with theFactories Act of 2004 [8].

4. fire-fighting equipment's, such as fire extinguishers and emergency exit doors should be made available to ensure occupational safety employee. In all case,

government regulatory agencies, such as Federal Ministry of Labour and Standard Organization of Nigeria (SON) should enforce ompliance with the provision of the Factories Act of 2004 [8].

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