



Industrial Ergonomics of Manufacturing Industries in South West Nigeria

Ogundola Ilesanmi Peter ^{a*}

^a *Department of Vocational and Technical Education, Faculty of Education, Ekiti State University, Ado-Ekiti, Nigeria.*

Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/JERR/2023/v25i4904

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/99896>

Original Research Article

Received: 03/04/2023

Accepted: 05/06/2023

Published: 22/06/2023

ABSTRACT

The study was designed to appraise the industrial ergonomics of manufacturing industry in south west Nigeria. The study adopted a survey research design the population for the study were foreman, fitter machinists and plant operator who are employee in the manufacturing industry in south west, Nigeria. Four research questions guided the study. The instrument used for data collection was tagged manufacturing industrial ergonomics (MIE) questionnaire. The trial test for determining the coefficient of internal consistency of MIE items with the use of the croubach alpha yielded a coefficient of 0.79. Mean and Standard Deviation (SD) was adopted in answering the research questions raised. The study indicated that the machines, instrument and equipment in use meet ergonomics requirement of employees, most controls in use meets standardized safety requirements. It was however observed that work environment needs improvement among other discoveries. Recommendations were made on modality to improve the ergonomics of the work place.

Keywords: Ergonomics; manufacturing industry; Southwest Nigeria; employees.

**Corresponding author: Email: peterdolas@yahoo.com;*

1. INTRODUCTION

Since the inception of humans, they have successfully or otherwise attempted to create tools and equipment which satisfactorily serve human purposes and to control more adequately the environment within which people work. The increased rate of technological development of recent decades as well as the sharp increase in the population of Nigerians have all resulted into increase demands for industrially manufactured products. This has thus created the need to look at ways of increasing or improving the production of goods and services.

Manufacturing industries according to Bizfluent [1] are those that engage in the transformation of goods, materials or substances into new products. Insee (n.d) also described manufacturing industries as industries involved in transforming goods, and also those that are concerned with the repair and installation of industrial equipment and subcontracting operations for third parties. On this same vein Ajala, Okanlawon & Adunni [2]. Also viewed "manufacturing industries as places where machines and equipment are put together to process raw materials into finished products. Thus, the objective is to enhance the production of goods in large quantities depending on the needs of individuals and the society".

Different types of manufacturing companies exist with each having unique areas of specialization such as fabrication, textile production, furniture production, chemical production, and food and beverages production among others in southwest Nigeria. The region comprises of six states which includes Ekiti, Ondo, Osun, Oyo, Ogun and Lagos States respectively. The region has the highest concentration of manufacturing industries in Nigeria, with Ogun and Lagos States topping the charts [3]. The dwindling numbers of manufacturing industries in Nigeria is a contributory factor to the massive importation of finished goods into the country. The few manufacturing industries still existing are groaning under low productivity due to industrial accidents, work-related stresses, musculoskeletal disorders and other negative factors [4].

Musculoskeletal disorders (MSD) are injuries or disorders of the muscles, nerves, tendons, joints, cartilage, and spinal discs [5] MSD are associated with high costs to employers, this might be in form of absenteeism by employee,

lost productivity, increased health care, disability, and worker's compensation costs. Examples of MSDs according to Middlesworth [6] includes, Back pain, Carpal tunnel syndrome, Hernia, Sprains, strains, and tears.

In Nigeria, many studies have attested to the fact that very high numbers of factory or industrial workers are experiencing varying degree of MSDs related illnesses Saidu, Utti, Jaiyesimi, Rufa'i, Hbib, Maduagwu, Onuwe & Jajere [7], Okafor, Ezeukwu, Igwe (2015) Njaka, Yusoff, Anua, Kueh, Edeogu [8], Mbada, Abegunrin, Egwu, Fatoye, Moda, Falade, Fatoye [9]. This phenomenon might be a contributory factors to the high cost of operating industries in Nigeria and may also contribute to the massive migration of manufacturing industries from Nigeria to neighbouring countries [10,11].

To be able to boost productivity, there is need to access the industrial ergonomic of the existing manufacturing industries in order to identify areas of improvement needs if any as well as note such areas for consideration in subsequent industrial designs. The current interest in industrial ergonomics is borne out of the fact that technological developments have focused attention on the need to consider humans in such development.

University of North Carolina [12] described Ergonomics as a scientific discipline concerned with the understanding of interactions among humans and other elements of system and the profession that applies theory, principles, data and methods to design in order to optimize human wellbeing and overall system performance. On this same vein, LihgtGuide [13] defined Ergonomics is an applied science concerned with designing and arranging things people use so that the people and things interact most efficiently and safely. Ergonomics seeks to change things people use and the environment in which they are used to better match the capabilities, limitations and needs of the people. The basic goal of ergonomics is injury prevention and enhanced productivity. Accordingly, Middlesworth [14] identified three broad domains of ergonomics to include cognitive, organizational and physical ergonomics.

Cognitive ergonomics emphasizes the ability of the mind to process information and interact with data. It emphasizes on how well the use of a product matches the cognitive capabilities of users. It concerned itself with intellectual

processes as they affect interactions among humans. [14] On the other hand, Organizational ergonomics emphasizes teamwork, smooth communication, job shifts, work satisfaction and cordial relation among company staff in order to increasing a company's yield, output or performance [15].

The Physical ergonomic is all about the safety and comfort of the individual in the work place. It focuses on building better working place with jobs designed to match abilities of people resulting in better working experience. It is an approach or solution to deal with a number of work-related musculoskeletal disorders. Accordingly, Middlesworth [14] assert that the ergonomics is very much focused on workplace ergonomics which is the science of designing the workplace, keeping in mind the capabilities and limitations of the worker. Workplace ergonomics attempts to reduce strain, fatigue and injuries by improving product design and workspace arrangements (Brain and Spine, 2018). The benefit of workplace ergonomics according to The Swedish Work Environment Authority [16] includes but not limited to reduced risk of work related injuries and illness, Higher productivity, Improved health, Improved mental insight, Better product quality, Decreased pain, Happy employee, Improved employee engagement and Better safety culture.

Ergonomics Factors that may contribute positively or inhibit the well-being of the employees may include but not limited to Instrument display, Machine Control, Work Environment and Layout of workplace factors.

The display system is often just the action of the machine on its local environment. The design of the displays of a machine can either facilitate interaction or increase task difficulty and the probability of error. "Most dynamic displays are either quantitative or qualitative in nature. Quantitative displays are used to give the state of the system with precision. Typical examples are temperature gauges and car speedometers. Quantitative displays may be either analog, such as an automobile speedometer, or digital, such as a car odometer. Qualitative displays are used to determine the "quality" of the system without knowing the exact value" [17].

"Controls are the basic operation of the machine on its local environment as controlled by the human". [18] Thus, Human interface with machines depends on the provision of suitable

controls that are to be acted on by the operators (employees). They are important source of feedback during execution of control actions. Common type of hand controls according to Bridger, [18] includes toggle switches, rotary switches, push buttons, knobs, levers, wheels and sticks. Common foot controls are also pedals and push buttons.

In designing a controls system for a workstation or workplace, stress of having to attend to several things at once most especially when workload becomes excessive may be confusing. This may lead to accident if there are too many signals or cues or control tasks requiring attention. For these reasons, it is important to place the primary controls and displays where they will most readily be seen and used, and where it can easily be read, understand, and operate [17].

Heath (2002) describe working environment as the sum of the interrelationships that exists within the employees and the environment in which they work. Thus, Working environment encompasses physical factors as they affect health of employees such as noise, vibration, lighting, temperature, ventilation, humidity, airflow, tools arrangement etc. it also include chemicals or toxic substances such as gases, radiation, vapours and paints risks to which employees are exposed to in the workplace. An attractive and supportive working environment provide conditions that enable employees to perform excellently, while workplace environment factors with negative indices will result in preventable but fatal accident, sicknesses, discomfort on the employees and reduction in employees' productivity [19].

Focusing on well-designed workplace layout eliminates distractions and spur employees to stay focused on accomplishing their goals. A well-planned workspace can make it easier for people to complete tasks more quickly and effectively, work together more collaboratively and creatively, and have a positive effect on their health, wellbeing, and engagement.

Feeling stuck in a cramped workspace can cause employees to shut down or get up more often to visit the restroom or coffee station. The sharing of a worktable with a colleague could result in the wasting of precious time searching for what they need. For many employees, a disorganised, chaotic workspace makes it more difficult, time-consuming, unsafe and prone to accident. Improperly designed workspace,

worktable and equipment can lead to musculoskeletal disorders related illness, fatigue and frustration of the employees. It may also result into irreparable injury, poor productivity and product quality.

The aims of ergonomics is to analyse all these factors and identify the conditions needed to create accord between employees and their jobs, this is in order to increase morale and their productivity.

An ergonomically well designed workspace and equipment will definitely lead to less body slumping, meandering stress and tension that can lead to work-related musculoskeletal complications and pain as a long time effect [16].

Bearing in mind the enormous influence workplace ergonomics has on the efficiency and productivity of employees, most especially in the production industry, the factors that may affect the interaction between humans, workspace and machines that will increase the chances of manufacturing industry maximally enjoying the benefit of ergonomics is the focus of this study. The article thus assess ergonomics as applied to instrument display design, machine control, layout of workplace and work environment as they affect productivity and comfort of employees in the manufacturing industry in Southwest, Nigeria.

2. LITERATURE REVIEW

Ajala, [20] conducted “a study aimed at analysing the influence of workplace environment on workers welfare and productivity in government parastatals of Ondo state, Nigeria. The findings of the study revealed that, workplace features such as sufficient light, absence of noise, proper ventilation, layout arrangement and good communication network at workplace have effect on worker’s welfare, healthy, morale, efficiency, and productivity. The study recommended that industrial social workers should advocate with management to create a conducive workplace environment and good communication network that will attract, keep, and motivate its workforce for healthy living and improved productivity and guarantee employees, enthusiastic employers and sustenance of the organization”.

Another noteworthy study was that conducted by Alzahrani [21] on the relationship between workplace ergonomics (Temperature, furniture arrangement, facilities, lighting, noise, equipment) and academic staff performance in

Umm Al-Qura University (UQU) at Makkah. The sample of the study consisted of 154 academic staff at the College of Education in UQU. The descriptive relational approach was used to detect the level of workplace ergonomics satisfaction and employee’s performance. The study revealed that the workplace ergonomics satisfaction level was medium and that the performance level of academic staff at the College of Education in UQU, regarding the workplace ergonomics was high.

The study conducted by Kitila [22] on effects of physical workplace environment on Micro and Small Enterprises workers performance and productivity in Tanzania was another noteworthy study. The study used non-probability sampling techniques to collect data. The study revealed that the components of physical workplace environments affects workers performance and productivity of MSE’s in Dar es Salaam. Office layout and space, quality air and ventilation and lightning also have greater contribution toward increasing MSE’s workers performance and productivity.

On a related note, Obamiro & Kumolu-Johnson [23] carried out a study to examine the relationship that exists between physical workplace setting and job satisfaction of employee. Survey research design was adopted in the study. Pearson Product Moment Correlation (PPMC) and Simple Regression analysis were adopted to test the relationship among variables. The findings indicated that the physical workplace setting correlate with job satisfaction while work system significantly affects employees’ effectiveness.

Olawumi & Gbareygehe [24] also carried out a survey study on the Influence of Office Layout on Academic Staff Performance in Covenant University, Ota. The objectives of the study were to investigate staff perception of office layout, examine factors influencing staff performance in an office, and establish the nature of the relationship between office layout and staff performance. Questionnaires were randomly administered to academic staff at the university, the study revealed that office layout has a significant impact on performance. The study later recommended, among other things, that the Management of the institution should improve on office layout in order to enhance performance.

Ajala and Okanlawon [2] also conducted a study titled Environmental Ergonomics as Correlate of Job Performance of Employees in Selected

Workplaces in Lagos, Nigeria. The research looked into the correlation between environmental ergonomics and office employees. The descriptive survey research design of *ex-post facto type* was adopted for the study. Three hundred (300) respondents took part in the research. Environmental Ergonomics and Job Performance Questionnaire (EEAJPQ) was used for data collection. The findings showed that there was a positive significant correlation between room temperature, indoor air quality, illumination, noise, furniture/tools and job performance.

Another recent study conducted by Chukwuma [25] titled Physical Work Environment (Ergonomics) and Workers' Productivity in Selected Small and Medium Scale Enterprises in Umuahia, Abia State, Nigeria has the purpose of empirically examining the relationship between physical work environment and worker's productivity of small and medium scale enterprises. A structured questionnaire that highlighted some of the factors related to influence of the workplace on employee productivity was administered to one hundred and twenty (116) workers randomly selected from a population of One Hundred (100) SMEs in Umuahia Abia state. The data was analyzed using descriptive and inferential statistics. The results of the study reveal that there was a statistically significant correlation between physical environment and social interaction of the workplace and productivity of small-scale enterprises. The study recommends that if possible, changes should be included into the design and layout to adjust the location to suit different types of personnel. Firms should consider employee health while locating machines, as this reduces the risk of injury and lowers the workers' error rate among other recommendations.

In a related vein Saidu, Utti, Jaiyesimi, Rufa'i, Maduagwu, Onuwe & Jajere [7] conducted a study on the Prevalence of Musculoskeletal Injuries among Factory Workers in Kano. Metropolis, Nigeria. Five hundred questionnaires were distributed to respondents recruited from tannery, steel rolling, textile and agrochemical factories at the 3 industrial estates of the metropolis. The study uncovered that a substantial percentage of factory workers had sustained MSIs. Body ache/discomfort and that low back region was the most common injury sustained among the subjects surveyed. This thus indicated that the industry ergonomically need to be redesigned and updated.

2.1 Conceptual Framework

Based on the literature review, the relationship between ergonomics and industrial Workplace ergonomic compliance can be conceptualized and depicted in Fig. 1.

2.2 Purpose of the Study

The main purpose of the study was to analyse the industrial ergonomics of manufacturing industries in south west Nigeria. Specifically, the study sought to

- i. Determine if the various instrument display use are designed and installed in conformity with the principles of ergonomics.
- ii. Investigate the conformability of various controls used in the industries to the prescribe standards requirement
- iii. Access the conformity of the Design of the workshop to ergonomic principles
- iv. Determine whether the arrangement of the work place environment reduces accidents and work-related stresses.

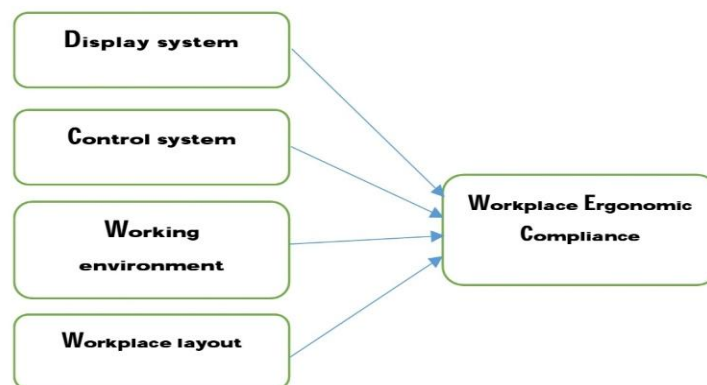


Fig. 1. Relationship between workplace ergonomic factors and ergonomic compliance

2.3 Research Questions

1. Are the various instruments display installed in the industries designed and installed in conformity with the principles of ergonomics?
2. To what extent does various controls used in the industries conform to standardized ergonomics requirement?
3. Do the workshop layout design of the industries conform to ergonomics principles
4. To what extent does the arrangement of the industrial work-place environments reduces accidents and work-related stresses.

3. METHODOLOGY

A descriptive Survey design was used for the study. The study was carried out in seven manufacturing industries in southwest Nigeria. These includes; (i). Pharmadeko PLC; Agbara Industrial Estate, Agbara, Ogun State. (ii). Unilever Nigeria PLC, (Agbara Factory); Agbara Industrial Estate, Agbara, Ogun State. (iii). Cadbury Nigeria PLC; Lateef Jakande Road, Ikeja, Lagos State. (iv). Golden Penny Flour Mill, Old Dock Yard road, Apapa, Lagos State (v). Nigerian Bottling Company (Coca-Cola) Ltd (NBC), Asejire-Plant, Ibadan (vi). Seven-up Bottling company, Ibadan). (vii) Saroafrika International Limited, (gossy warm spring Ltd.) Ikogosi Ekiti.

The population for this research study includes Foremen, Fitters, Machinists and Plant operators in manufacturing industries in Southwest, Nigeria.

Sample for the study consisted of four hundred (400) respondents purposively drawn from the population in the above mentioned industries. Thus between 50 and 60 respondents were sampled in each of the seven industries.

The instrument used for the collection of data for the study was a structured questionnaire titled Ergonomics of Manufacturing Industries (EMI). The EMI was a 5 point likert rating scale of Strongly Agree (SA); Agree (A); Undecided (U) and Strongly Disagree (SD) developed by the researcher. The questionnaire was divided into five sections, A to E. Section A sought information on personal data of the respondents. Section B sought information on ergonomics applied to instrument design. Section C sought information on ergonomics applied to machine and control. Section D

sought information on ergonomics applied to the layout of workplace and section E sought information on ergonomics applied to the work environments.

The questionnaire was validated by two mechanical engineers who are registered by the council for the regulation of engineering in Nigeria (COREN) that are not part of the study and one ergonomics expert from Ekiti State University. The comments and suggestions of the experts were incorporated in building up the final draft of the instrument. The instrument was trial-tested on 15 equivalent manufacturing workers in Osogbo, Osun State, an Industry not involved in the main study. The result was used to determine the reliability of the instrument using Cronbach Alpha techniques. A reliability index of 0.79 was estimated. This value was considered high enough, thus indicating that the instrument was adequate and reliable for the study. The questionnaires were administered to the respondents with the help of six research assistants. The questionnaires were retrieved from the respondents a week after being given to them by the research assistants. Three hundred and ninety (390) copies out of the 420 copies were returned. This represent a 93% retrieval.

The research questions were answered using mean and standard deviation. A questionnaire items with mean rating of 3.50 and above on the five- point scale was accepted and thus indicated that the respondents agreed with the item on the questionnaire while a mean of 3.49 and below indicated that the respondents disagreed with the item on the questionnaire. The 3.50 cut off point were derived from the sum of nominal values assigned to the scaling items responded to by the respondents divided by number of respondents (N) that responded to the items.

4. RESULTS

The result of the research questions are as presented in Table 1.

The Table 1 shows that all the items were agreed to by the respondents. This thus indicated that the installed instruments' display in the sampled industries conformed to ergonomics principles.

Data presented on Table 2 shows that the respondents were in agreement with all the items as to the conformity of the design of machine controls to ergonomics principles. Thus, controls used on the equipment in the industries in southwest Nigeria are ergonomically attuned.

Table 1. Mean and Standard Deviation ratings of responses of respondent on the conformity of installed instruments displays to ergonomics principles

S/N	N=390 ERGONOMICS APPLIED TO INSTRUMENT DISPLAY DESIGN	\bar{X}	SD	DECISION
1	The types of machine display used in my workplace are such that are not Susceptible to misinterpretation	3.61	1.38	Agree
2	External information are not always required to operate equipment or perform task on them	3.54	1.30	Agree
3	The various displays required for my task are arranged for optimum usage	3.82	1.20	Agree
4	The numbering displayed on the indicator or instruments are legible	3.72	1.27	Agree
5	The conventional codes are strictly adhered to in terms of lighting display on equipment in my workplace	3.55	1.35	Agree
6	Buzzers or other auditory/noise indicators are provided as warning displays	3.94	1.24	Agree
7	There is a clear difference between the dial and the background of the instruments I work with	3.93	1.23	Agree
8	The instruments I work with are so mounted to facilitate ease of reading	4.09	1.23	Agree
	Grand Mean	3.71		

Key: N=numbers of the respondents; \bar{X} = mean of the respondents; SD = standard deviation of the respondents

Table 2. Mean and standard deviation ratings of responses of respondent on the conformity of the design of machine control to ergonomics principles

S/N	N=390 ERGONOMICS APPLIED TO MACHINE AND CONTROL	\bar{X}	SD	DECISION
1	Where controls are used, the type of control device used on equipment I work with minimise fatigue and stress	4.00	1.15	Agree
2	Each control device is easily identifiable.	3.85	1.18	Agree
3	The controls on the equipment are well designed in terms of shape	3.97	1.21	Agree
4	The controls are designed properly in terms of size	4.09	1.23	Agree
5	The operation of each control on the machines agrees with the corresponding display	4.03	1.12	Agree
6	The conventional code is strictly adhered to in the design of the controls on the machines	3.80	1.18	Agree
7	The operation of the control device is in agreement with the human response tendency	3.99	1.25	Agree
8	The control device(s) is/are arranged conveniently and for reasonably optimum usage	3.53	1.27	Agree
9	The design of machine and control takes into account variation in dimensions	3.69	1.33	Agree
10	The gender of individual user are taken into consideration in the design of machine control	3.70	1.25	Agree
	Grand Mean	3.86		

Key: N=numbers of the respondents; \bar{X} = mean of the respondents; SD = standard deviation of the respondents

Table 3 indicates that the respondents are in agreement with all the items above except for item 5 that was rated 3.48. Thus indicating that the respondents disagree with statement.

Despite being in agreement with other items, the respondents still suffers from a kind of work-related stresses or musculo-skeletal disorders.

Table 3. Mean and standard deviation ratings of responses of respondent on the conformity of the workshop layout design to ergonomics principles

S/N	N=390 ERGONOMICS APPLIED TO LAYOUT OF WORKPLACE	\bar{X}	SD	DECISSION
1	The workplace is suitable for the range of individuals who may use the facility	3.50	1.32	Agree
2	The various components and other features of the facilities are arranged in satisfactory manner for ease of use	3.68	1.23	Agree
3	The arrangement of the facility do not compromise safety Standard	4.02	1.30	Agree
4	There is provision of appropriate tools/materials required for the specific job I do	3.74	1.34	Agree
5	work-related stresses or musculo-skeletal disorders (back,neck, hand, leg pains etc.) are rarely experienced by me after work	3.48	1.89	Disagree
6	The arrangement of my Workplace encourages safety and discourages factory industrial related accident.	3.98	1.23	Agree
7	Adjustment(s) made to my workplace after the initial design has improved my efficiency	3.80	1.18	Agree
8	There are provisions for lifting/carrying heavy objects in my workplace	3.71	1.25	Agree
9	My workplace is designed to allow for free movement of workers to exercise their body parts when need be	3.64	1.24	Agree
10	If given the opportunity to advice, I will not suggest any re-arrangement of my workplace for optimum productivity and efficiency	3.97	1.21	Agree
	Grand Mean	3.79		

Key: N=numbers of the respondents; \bar{X} = mean of the respondents; SD = standard deviation of the respondents

Table 4. Mean and Standard Deviation ratings of responses of respondent on the conformity of the factory working environment to ergonomics principles

S/N	N=390 ERGONOMICS APPLIED TO THE WORK ENVIRONMENT	\bar{X}	SD	DECISSION
1	The visibility of my workplace is satisfactory.	3.53	1.27	Agree
2	Glare is not a problem at my workplace	3.88	1.31	Agree
3	I do not need any additional personal lighting arrangement to the general lighting in my working environment	3.33	1.49	Disagree
4	My performance is not negatively affected by improper placement of work equipment	3.81	1.19	Agree
5	Intense and disturbing noise in my workplace Environment is firmly controlled	3.51	1.29	Agree
6	The colour of the work environment, including the Paintings and ornamental flowers are so pleasant to behold	2.98	1.45	Disagree
7	The temperature in my workplace is somehow kept at a tolerable level.	3.35	1.47	Disagree
8	My workplace is properly ventilated	3.53	1.27	Agree
9	My workplace environment is well illuminated	3.72	1.27	Agree
10	My workplace environment is constantly very clean and free of dust	3.32	1.47	Disagree
11	we are protected from the dangerous emissions in my workplace	3.20	1.23	Disagree
12	The quality of air around and in my workplace environment is very pleasant	3.34	1.46	Disagree
13	The environmental condition in my workplace does not pose a threat to my health and well-being as an individual	3.42	1.50	Disagree
	Grand Mean	3.20		

Key: N=numbers of the respondents; \bar{X} = mean of the respondents; SD = standard deviation of the respondents

Table 4 above shows that the respondents agreed with only six of the items this includes items 1, 2, 4, 5, 8, 9. They disagree with seven (7) of the items. The items are 3, 6, 7, 10, 11, 12 and 13. It has grand mean of 3.20. This is indicative of the fact that the respondents do not believe that their industries' work environment conform to ergonomics principles.

5. DISCUSSION AND CONCLUSION

The data presented in Table 1 provided answer to research question one, the finding revealed that the respondents (employees) agreed that the display systems of the instrument used in the industry complied with ergonomics principles. Thus, all the items were agreed to be present in their workplace. The implication of this finding is that the instruments display adopted in manufacturing industries in southwest Nigeria, do not pose risks due to accident or musculoskeletal disorders related illness to the users. This finding corroborated the assertion of Bridger [18] and Hendrick [17] who separately postulated that an ergonomically compliance display system will reduce the chances of the occurrence of accident and also drastically reduce musculoskeletal related illness. This finding is similar to that of Grozdanovic and Bijelic [26] who conducted a study on the Ergonomic design of display systems in control rooms of complex systems in Serbia and concluded that adequate design of display systems in control rooms has a significant impact on the efficiency and functionality of the operator's work i control centers.

Furthermore, the data presented in Table 2 provided answer to research question 2 on the conformity of the design of machine control to ergonomics principles in southwest Nigeria manufacturing industry. The Findings revealed that the respondents agreed to all the items which has a combined grand mean of 3.86. This is above the general cut off mean. This finding is in line with Kroemer [27] who concluded that if all necessary steps and precaution are taken in the design of controls, the operators shall be safe. It is also in agreement with Paul and Donald [28] deduction that Controls are a frequent source of system error and failure, especially when improperly placed, badly designed or wrongly used. A further explanation of this finding could be explained by a very important European legislation to assess whether or not machinery meets certain minimum requirements for health and safety passed for machinery safety

standards for controls and displays (EN 894) that was intended to prevent health and safety matters being used as a barrier to trade which includes requirements for designers to take ergonomic principles into account when considering how a machine will be used. [29]. Since most of the machines, tools and equipment used in the modern industries in southwest Nigeria are either Asian or EU manufactured, they are bound to comply with international standard and specification.

The data presented in Table 3 provided answer to research question three on ergonomics as applied to layout of industrial manufacturing workplace. The Findings revealed that the layout of the workplace conform to ergonomic principles. This is reflected in the agreement of all the questionnaire items by the respondents which all have their mean above the cut off mean and with a grand mean of 3.79. This findings corroborated the study of Obamiro & Kumolu-Johnson [23] who observed contentment in their respondents workspace and the study of Ajala and Okanlawon [20] who discovered a positive significant correlation between furniture, tools and equipment on one side and job performance of the employees.

This finding is not in agreement with the study of Njaka, Yusoff, Anua, Kueh and Edeogu [8] who discovered high prevalence of MSDs among quarry workers in Nigeria, with lower back pain being the most common type with exposure to vibration being among the identified causes.

On yet another contradictory study by Halim, Omar, Saman, Othman and Ali [30] on Ergonomics Risk Factors at Manufacturing Industry: A Prelude Study that was conducted in a metal stamping company of which the objective was to identify ergonomics risk factors present in the workplace and propose a solution to minimize the risk of occupational injuries. The study revealed that there was evident that workers were exposed to ergonomics risk factors associated with awkward working posture such as ergonomically unfriendly designed workstation. Perhaps the most plausible explanation for the differences in the findings of the present study and does identified above is that majority of the industries equipped with the state of the art machines and facilities. Again, the sampled industries are indoor related unlike the quarry and metal stamping industries that is outdoor oriented where manual tasks are often carried out.

This study is also not in line with the findings of Saidu *et al* [7] who discovered in hierarchical order that Low back complaints, limb injuries, shoulder complaints and hip injuries to be the highest prevalence of Musculoskeletal Injuries among Factory Workers in Kano Metropolis, Nigeria.

The data presented on table 4 as regard the work environment of the manufacturing industries meeting ergonomics standard provided answer to research question 4. The respondents disagree to majority of the items i.e. 3, 6, 7, 10, 11, 12 and 13 while they only agreed to items 1, 2, 4, 5, 8 and 9. Thus the grand mean of 3.20 is lower than the projected cut off mean. This study is in harmony with that of Bushiri [19] who discovered that flexibility of working environment and work noise distraction among other findings are major ergonomic problem identified in the her study.

The study also corroborated an earlier research by Kumari and Kaur [31] in their study titled Ergonomic assessment of the work environment of food processing enterprises where they observed that the light intensity in all sampled enterprises were less than the recommended value and that the workstation dimensions were also not in accordance with the recommended values.

The finding of the study is at variance to the study of Ajala and Okanlawon [20] who discovered a positive significant correlation between room temperature, indoor air quality, illumination, noise and job performance. This differences may probably be due to the fact that Ajala and Okanlawon study was not performed on industrial manufacturing employees but on office workers [32,33].

6. RECOMMENDATION

Based on the findings of this study, the following recommendations are made;

The Work environment need to be ergonomically regulated and adapted to employees in order to increase labour performance and productivity.

Employers should be watchful of all the workplace design elements such as colour, temperatures, noise, sanitary conditions and illumination that can hamper employees' productivity.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Definition of the Manufacturing Industry. Bizfluent; 2021.
Available:<https://bizfluent.com/facts-6853113-definition-manufacturing-industry.html>
2. Ajala EM, Okanlawon A, Adunni. Environmental ergonomics as correlate of job performance of employees in selected workplaces in Lagos, Nigeria. Research Gate; 2019.
Available:https://www.researchgate.net/publication/334480331_ENVIRONMENTAL_ERGONOMICS_AS_CORRELATE_OF_JOB_PERFORMANCE_OF_EMPLOYEES_IN_SELECTED_WORKPLACES_IN_LAGOS_NIGERIA
3. Ajayi DD. Recent trends and patterns in Nigeria's industrial development. Africa Development. 2007;32(2).
DOI: 10.4314/ad.v32i2.57184
4. Umeokafor NI. Realities of construction health and safety regulation in Nigeria, Ph.D Thesis, University of Greenwich; 2017.
Available:<https://gala.gre.ac.uk/id/eprint/23437/1/Nnedinma%20Ikenna%20Umeokafor%202017%20-%20redacted.pdf>
5. Centre for Disease Control and Prevention. Work-Related Musculoskeletal Disorders & Ergonomics | Workplace Health Strategies by Condition | Workplace Health Promotion; 2020.
Available:<https://www.cdc.gov/workplacehealthpromotion/health-strategies/musculoskeletal-disorders/index.html>
6. Middlesworth M. 5 proven benefits of ergonomics in the workplace. Ergo Plus; 2020.
Available:<https://ergo-plus.com/workplace-ergonomics-benefits/>
7. Saidu IA, Utti V, Jaiyesimi AO, Habib A, Rufa'i AA, Maduagwu SM, Onuwe HK, Jajere AM. Prevalence of musculoskeletal injuries among factory workers in Kano Metropolis, Nigeria. International Journal of Occupational Safety and Ergonomics. 2011b;17(1):99–102.
Available:<https://doi.org/10.1080/10803548.2011.11076874>

8. Njaka S, Yusoff DM, Anua SM, Kueh YC, Edeogu C. Musculoskeletal disorders (MSDs) and their associated factors among quarry workers in Nigeria: A cross-sectional study. *Heliyon*. 2021;7(2):e06130. Available:<https://doi.org/10.1016/j.heliyon.2021.e06130>
9. Mbada CE, Abegunrin AF, Egwu MO, Fatoye CT, Moda H, Falade O, Fatoye F. Prevalence, pattern and risk factors for work-related musculoskeletal disorders among Nigerian plumbers. *Plos One*. 2022;17(10):e0273956. Available:<https://doi.org/10.1371/journal.pone.0273956>
10. Sunday.. As Nigerian coys move to Ghana. *Vanguard News*; 2009. Available:<https://www.vanguardngr.com/2009/08/as-nigerian-coys-move-to-ghana/>
11. My Engineers. Report: Why companies will continue to leave Nigeria for Ghana; 2018. Available:<https://www.myengineers.com.ng/2018/08/15/report-why-companies-will-continue-to-leave-nigeria-for-ghana/>
12. University of North Carolina. Ergonomics - Environment, Health and Safety. *Environment, Health and Safety*; 2023. Available:<https://ehs.unc.edu/topics/ergonomics/>
13. Light Guide. What is Ergonomics? 2021. Available:<https://www.lightguidesys.com/resource-center/blog/what-is-ergonomics/>
14. Middlesworth M. Ergonomics 101: The definition, domains, and applications of ergonomics. *Ergo Plus*; 2022. Available:<https://ergo-plus.com/ergonomics-definition-domains-applications/>
15. Youmatter. Ergonomics: Definition, Examples and Areas of Application; 2020. Available:<https://youmatter.world/en/definition/ergonomics-definition-examples/>
16. The Swedish Work Environment Authority. Ergonomics for the Prevention of Musculoskeletal Disorders, Anna Middelmann, Sweden; 2012. Available:<https://www.av.se/globalassets/filer/publikationer/foreskrifter/engelska/ergonomics-for-the-prevention-of-musculoskeletal-disorders-afs-2012-2.pdf>
17. Hendrick H. Ergonomic Design of Controls, Displays, and Workspace Arrangements to Reduce Human Error; 2002. Available:<https://www.semanticscholar.org/paper/ERGONOMIC-DESIGN-OF-CONTROLS%2C-DISPLAYS%2C-AND-TO-Hendrick/605568d7996a8a8df4bfcadd0c93a455ede4f06c#citing-papers>
18. Bridger RS. Introduction to Ergonomics, Taylor & Francis London; 2003. Available:<https://teknik.umri.ac.id/wp-content/uploads/2016/08/10.-Introduction-to-Ergonomics-Bridger-2nd-Edition.pdf>
19. Bushiri CP. The impact of working environment on employees' performance: The case of institute of finance management in Dar Es Salaam Region, Master Degree Dissertation, Open University of Tanzania; 2014. Available:<https://core.ac.uk/download/pdf/33424874.pdf>
20. Ajala, Emmanuel Majekodunmi. The influence of workplace environment on workers' welfare, performance and productivity. *The African Symposium*. 2012;12(1). Available:https://www.academia.edu/25858859/THE_INFLUENCE_OF_WORKPLACE_ENVIRONMENT_ON_WORKERS_WELFARE_PERFORMANCE_AND_PRODUCTIVITY
21. Alzahrani NA. Workplace ergonomics and academic staff performance in College of Education in Umm Al-Qura University in Makkah. *American Journal of Educational Research*. 2019;7(9):604–617. Available:<https://doi.org/10.12691/education-7-9-2>
22. Kitila TE. Effects of workplace environment on workers performance and productivity in tanzania a case of selected micro and small enterprises (Mse's) in Dar Es Salaam, MSc Thesis, Mzumbe University, Tanzania; 2017. Available:http://scholar.mzumbe.ac.tz/bitstream/handle/11192/2312/Msc-HRM_Edna%20Kitila_2017.pdf?sequence=1
23. Obamiro JK, Kumolu-Johnson BO. Work environment and employees' performance: Empirical evidence of Nigerian Beverage Firm. *AUDC*. 2019;15(3). Available:https://media.proquest.com/media/hms/PFT/1/qyaFC?_s=1VDQgy3V4vvaLyc%2FKtV11QAprvk%3D
24. Olawumi AO, Gbareygehe NV. Influence of office layout on academic staff performance in Covenant University, Ota. *Environmental Technology and Science Journal*. 2022;13(1):98–109. Available:<https://doi.org/10.4314/etsj.v13i1.8>

25. Chukwuma NN. Physical work environment and workers' productivity in selected small and medium scale enterprises in Umuahia, Abia State, Nigeria. South Asian Research Journal of Business and Management. 2022;4(3):82–89. Available: <https://doi.org/10.36346/sarjbm.2022.v04i03.001>
26. Grozdanovic M, Bijelic B. Ergonomic design of display systems in control rooms of complex systems in Serbia. Process Safety Progress; 2020. Available: <https://doi.org/10.1002/prs.12205>
27. Kroemer, Karl HE. Controls, indicators and panels, ILO encyclopaedia of occupational health and safety; 2011. Available: <https://www.iloencyclopaedia.org/part-iv-66769/ergonomics-52353/work-systems-design/item/635-controls-indicators-and-panels-2>
28. Paul Stager. Donald Hameluck. Ergonomics in air traffic control. Ergonomics; 1990;33:4. DOI: 10.1080/00140139008927156
29. Gray MA. Controls, displays and ergonomics standards - ensuring health and safety in machinery design. Proceedings of the Human Factors and Ergonomics Society . . . Annual Meeting; 2000. 44(35):6–441. Available: <https://doi.org/10.1177/154193120004403511>
30. Isa H, Abdul Rahman O, Saman AM, Othman I, Ali MA. Ergonomics risk factors at manufacturing industry: A prelude study, National Symposium on Advancements in Ergonomics and Safety (ERGOSYM 2009), 30 November - 2 December 2009, Kangar, Perlis; 2009. Available: <http://dspace.unimap.edu.my:80/dspace/handle/123456789/37418>
31. Kumari A, Kaur H. Ergonomic assessment of the work environment of food processing enterprises in Punjab. Pharma Innovation Journal. 2018;7(5). Available: <https://www.thepharmajournal.com/archives/2018/vol7issue5/Part1/7-5-67-206.pdf>
32. Opinion. Of Nigeria's dying factories and exodus to Ghana. Punch Newspapers; 2020. Available: <https://punchng.com/of-nigerias-dying-factories-and-exodus-to-ghana/>
33. Definition - Manufacturing industry | Insee. (n.d.). Available: <https://www.insee.fr/en/metadonnees/definition/c1934>

© 2023 Peter; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
<https://www.sdiarticle5.com/review-history/99896>