INVESTIGATION OF WORK RELATED HEALTH HAZARDS PREVALENT AMONG METAL FABRICATION WORKERS IN NIGERIA

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ABSTRACT

The consideration of facility engineering principles in the design of sustainable workstations in manufacturing industries remains inadequate with the increasing intensity of observed misfit between facility arrangement and human demand for comfort, safety and effective operation of work system. Associated with these inadequacies are the problems resulting from improper workplace design, ill structured jobs, chaotic workplace, adverse environment, poor human-machine system design and inappropriate management programmes. This study investigates the work related health hazards among fabrication workers in Nigeria. Participatory Ergonomic Intervention Approach (PEIA) and analytical method were employed to drive the investigation towards achieving a safe, productive and ergonomic workstation which provides significant shift in the existing paradigm in metal fabrication industry. Poor work posture such as bending, twisting, over reaching, kneeling, under hazardous environment of heat, noise, smoke, dust and optical radiation were identified as hindrances to effective operation. Likewise, health related issues as pains on the neck, back, wrist, knee, elbow, shoulder, wrist, as well as leg muscle cramp assumed significant prevalence accounting for 29% of the workforce. The study therefore suggests the development of standard anthropometric dimensions for the construction of assembly workstation for metal fabrication industry. Such workstation is capable of boosting workers' morale, reduced Work Related Musculoskeletal Disorder (WRMD) and enhanced productivity with the support of enforced legislative instrumentality.

Keywords: WRHH, facility engineering, work place, productive system, anthropometry.

INTRODUCTION

The occupational health and safety of workers in manufacturing industry are directly related to their productivity and general performance which in turns become the concern of the management of the system. The paradox that is noticed in many production and manufacturing Industries where human resources form a larger percentage of the input resources is the unexplainable negligence and lack of serious commitment of fund to workers' well-being. However, the existence of adequate enforcement of rule, regulation and legislations helped significantly to reduce the rate of attrition of worker due to accident and

other work related risk factors in industries. The story is quite different in developing countries such as Liberia, Cameron, Togo and Nigeria where sweatshop is still in practice due to high rate of unemployment (Fapohunda, 2012). In many manufacturing industries casual worker were poorly paid far more than the permanent staff members thus taking advantage of the large number of jobless adults in the society. Some company work with organized human resources agency who assist in the recruitment workers from the public.

History has it that before the advent of modern technology (i.e. industrial revolution) worker working postures were dictated by equipment configurations, a wrong approach of "Fitting the Man to the Task" which was transformed by a new paradigm proposed by Grandjean (1988). Many painful afflictions of musculoskeletal system known as Cumulative Trauma Disorders (CTDs) or Occupation Overuse Syndrome (OOS) are associated with poor working postures by workers (Clark, 2002). These work related problems are caused and aggravated sometimes by the repeated forceful exertions connected with awkward work postures of the upper extremities dictated by poor workstation/workplace design and implementation (Armstrong *et al*, 1986).

Among the causal factors of work related challenge experienced in some factory systems is poor workplace design where there is mismatch between the workspace, environment, and equipment design and human ergonomic requirements. Most industrial workstations are designed primarily to ensure that the expected product quantity and quality is attainable. Little consideration is given to the physical and biomechanical traits of the user population (Kroemer *et al* 1994). There is therefore the mismatch between anthropometrical and biomechanical data of the users and workstation design dimensions/parameters; making the workstation to function with less efficiency (Deros & Khadem, 2011).

Small changes in workstation dimensions can have a considerable impact on workers' productivity and occupational health and safety. Physical dimensions of workstations that matches with the anthropometric and biomechanics of the user population are of major importance if efficiency; physical and mental wellbeing of the worker is to be achieved in the industry (Shikdar *et al.*, 2011; Grandjean, 1988; Konz, 1995; Das & Grady, 1983; Burri & Helander, 1991 and Das & Sengupta, 1996). Accident with its attendant costs (loss of production, hospital bills, replacement of damaged equipment, absenteeism and payment of idle workers) is often experienced in industries and at workstations designed without proper consideration for ergonomics (Das & Sengupta, 1996). Adebiyi *et al* (2009) opined that workers will produce maximally in an enduring environment that is safe and healthy. Accident does not just occur; they are caused by unsafe act and unsafe condition. The problems with unsafe condition include improper workstation design need to be properly addressed if metal fabrication industry is to stay in competitive market and survive. Workers can tolerate deficient craftsmanship, but they cannot tolerate deficient delivery of technology necessary for comfort and safety during the performance of their jobs Grandjean, 1988. It is common in industry that after knowing the extremity of problems caused due to the negligence of ergonomics, industries insist that workers should do the job in the same condition to increase productivity and profit. This attitude is not off course tolerated by the workers and thus becomes necessary to investigate the present working conditions, look for alternative ways and design new production tools and equipment that can enhance productivity in the fabrication industry. The need therefore arises to research into the prevailing situation at workstations in metal processing industry with the view to make amendments that ensures full capacity production and good health and safety of workers. The sustainability of workplace is often challenged by the deficit in its level of consideration of

users' characteristics. It therefore suggests that much efforts are still expected to be made in the area of research, design and construction of human work system. This study focused on the macro-ergonomic consideration of the facility arrangement of components of fabricator/operator's workstation in local metal fabrication shops Nigeria.

Metal Fabrication in Nigeria

The transformation of metals through the application of the availably manufacturing process date back to stone ages when bulk of the valuable work content are manual with the accompanying by risks of repetitive trauma disorders. Common manufacturing processes in practice among the local fabricators includes cutting, grinding, welding, shaping, bending, painting and forging (Ibhadode 2001). Obsolete machine tools and work tools with limiting capacity, capability and efficiency erratically located in a job shop setting characteristically depict the feature of many local fabrication shops. More often the operators of the workshops are semi-literate with lower level of technical knowledge and little or no knowledge about ergonomics. Additional knowledge was acquired through on the job experience and other trouble shooting exercises which often ends in more costs and injury. The quality of job outputs may be poor but performance is comparable with imported products which suggest the exceeding ingenuity and capability.

METHODOLOGY

A population of 155 subjects were involved in fabricating operations such as welding, setting, panel beating, machining, painting, forming, forging and black smelting in the nine companies visited and were interviewed on job experience and general assessment of workstation in their respective industries. This interaction addressed specific ergonomic risk factors. Research instrument used include structured questionnaire on demography, safety and ergonomics of engineering facilities, designed Participatory Ergonomic Intervention Approach (PEIA) tool as well as training kit for the employed enumerators.

Structured Questionnaire and Interview

Demographic information about respondents which include age, sex, academic qualification, year of work experience, religion affiliation, marital status and gender were considered. Oral interview on ergonomic and safety of workplace and other related issues were conducted.

Nordic Musculoskeletal Questionnaire

Assessment of safety and ergonomic issues were included in the questionnaire. A standard Nordic musculoskeletal questionnaire was adopted for the investigation on work related musculoskeletal disorder being experienced by the respondents. The question has time variate responds system which was developed to capture the level of work related musculoskeletal disorder among the responding fabricators. Noticeably among the selected body part for the investigation were head, neck, shoulder, elbow, wrist/hands, upper back, lower back, hip, thigh, buttock, knees, ankles and feet.

Participatory Ergonomic Intervention Approach Investigation (PEIA)

This investigation was carried out using PEIA tool which considered users' opinion in all matters relating to the effect of the existing nature of the job and the workplace. The

responses were found to have capacity of evolving a safe and sustainable design, modification and eventual reengineering of man-machine system design (Onawumi *et al*, 2012). Etiological data on the work related musculoskeletal disorder were obtained via personal interview structured questionnaire designed and handed over to five trained enumerators who ensured the credible conduct of the survey of the work system in the fabrication industry under study.

Training of enumerators

Five graduate students of mechanical engineering were trained as enumerators. They were given intensive training on some principles of ergonomics in relation to the use of the survey kit consist of:

- discomfort chart
- structured questionnaire
- data collection form
- method of interview and
- taking anthropometric measurements of workers using Vernier callipers, digital weighing scale, meter rule, writing board, pencil and anthropometric seat/chair.

The trained enumerators were equipped with copies of questionnaire on the musculoskeletal problems experienced on the job using the existing workstation and general environmental condition in their respective industries with the support of work supervisor in the departments and units visited.

Work table and seat characteristics

The existing work table and seat at each of the workstation were assessed in relation to important ergonomic criteria which include (i) table and seat adjustability (ii) seat comfort (iii) ease of use (iv) body support (v) leg support and (vi) the percentage of the respondents in terms of acceptability and non-acceptability of the present operating conditions at the workstation.

RESULTS

The workplaces that were visited and details on the production system were shown in Table 1. Fabrication industries were observed to of small scale type with work force ranging between 5 and 45 workers. This cottage size explains why most of the fabrication shops are one-man business and run by individual sole proprietor. This workplace had some basic features in common which suggest the need for sampling of nine total of 155 workers/fabricators.

Demographic Analysis of the Study

Success rate of the survey which was 73.81% resulted in 155 question completed satisfactorily. The masculinity of fabrication occupation becomes vivid with 100 percent of the respondent being male (Table 2). This is suggestive because of the nature and the environment for carrying out metal fabrication work which place high demand on human physiological capacity. There is a local believe that metal fabrication is men's business. Similarly, noticeable is the dominance of youths in metal fabrication job with about all the respondent aged between 20 to 30 years. These young men were at the critical time of their

life when important decision about their future are being made and as result about 75% of them are still single.

The educational qualification distribution of the respondents unveiled the reason for the youth dominance with about 19 % having no formal education and a total of 73% with highest qualification of school leaving certificate. This testified to the assumption that crafts are exclusive reserved of drop outs from schools and now has become a challenge to the quality of work and products from such society which fail to support and ensure proper informal training of his youth engaging in cottage business. The religion affiliation of the respondents is highly informative with over 75% being Muslims. The possibly due to the uncompromising acceptance of formal education by Christian community and such placed the demand to train a child to the highest level of education they could afford. Categories of involvement of respondents varies from apprentice, industrial training students (IT students) or production helper (38.1%) learning the job to joining man or trained technical assistants (43.2%) who were engaged in technical aspect of the job as well as training others Technicians, technical director or owners of the business (15.5%). Casual workers were also represented in the fabrication business forming not more than four percent.

TABLE 1: Sampled workplaces and the number of respondents in each of the assembly workstation

S/N	Name	Product	Fabrication Technique	No of Fabricators
1.	Kam Wire Industries Nig. Ltd.,	Production of binding wires, nails, roofing sheets	Mass production, Special purpose equipment.	13
2.	Abiola Electrical Machinery Company Ltd	Fabrication of household and agricultural product processing equipment.	Job shop and Batch production, General purpose equipment	19
3.	S. Adetoro Technical Services Limited	Agricultural product processing equipment and household machines.	Job shop and Batch production, general purpose equipment	13
4.	LAWOD Metals Nig. Ltd.,	Metal doors, gates, agricultural products processing equipment.	Job shop and Batch production, general purpose equipment.	19
5.	Ola OluwaAina Wire Industry Nig. Ltd.,	Nails, binding wires, wire mesh.	Mass production, special purpose equipment	22
6.	Nigeria Machine Tools	Machines, tools, household equipment, spare parts.	Batch production, general and special purpose equipment.	41
7.	Ola Iya Metal Works	Metal doors, household furniture and agricultural products processing equipment.	Batch production, general purpose equipment	9
8.	FATECO Engineering Works	Household machines and equipment	Job shop, general purpose equipment	9
9.	ABU Construction Company	Metal tanks – cylindrical, ground and overhead	Batch production, welding and general purpose equipment	10
			Number of Respondents	155

TABLE 2: Demography results of the survey

	Status	Frequency	(%)
Gender	Male	155	100
	Female	0	0
Age	21 – 25yrs	130	83.9
	26 – 30yrs	25	16.1
	31 – 35yrs	Nil	Nil
	36 – 40yrs	Nil	Nil
Marital status	Single	115	74.2
	Married	40	25.8
Academic Qualification	Primary	65	41.9
	Secondary	48	31.0
	Tertiary	29	18.7
	None	13	8.4
Religion affiliation	Islam	119	76.8
	Christianity	29	18.7
	Others	7	4.5
Length of service	1 – 10yrs	92	59.4
	11 – 20yrs	27	17.4
	21 – 30yrs	36	23.2
	31 – 40yrs	Nil	Nil
Designation on employment	Production helper	59	38.1
	Technical assistant	67	43.2
	Technician	24	15.5
	Casual workers	5	3.2

Ergonomic Evaluation of Sampled Fabricators

Welding operation is faced with a number of safety and ergonomic challenges because of the emissions (fume, heat and/or sparks) that occurs during the operation. Likewise, the dynamic posture required for welding job and the environmental factors could lead to varying musculoskeletal disorder which in turn causes low performance, increase frequency of accident and absenteeism from work by the fabricators. The cumulative nature of musculoskeletal disorder is observed with the increase percent of respondents who suffered the disorders as the time of exposure increase from 7 days to 12 months particularly at neck (5.2%, 9.0%) and shoulder (8.3%, 16.8%), in spite of repeated treatment of the work related disease as suggested by the 6.5% and 16.1% of the respondents respectively (Table 3). The response of the subjects on the experience of disorder on lower arm (elbow, wrist, and hand) is indicative of human body capacity to adjust and possibly adapt to certain work conditions and thus reducing the frequency of complaint of pains, stress and/or strain as noticed in the reduction of percentage of respondents who suffered disorder by 1.7% and 7.1% respectively as time changes (from 7 days to 12mouths)**.** The reason for absenteeism is significant for cases of disorder at the elbow by 26.5%. Welding operation as reported by the enumerator involve frequently standing, bending and squatting postures. Sitting was not found comfortable for welding job for the cases under study hence the work related deceases suffered by the subjects were more on the upper back than at the lower back. This is supported by the disorder complaint are (22.6%, 20.6%) and (9.0%, 9.0%) respectively in the last 7 days and 12 months. Other unidentified disorder causing absenteeism experienced by the respondents was 4.5%.

TABLE 3: Workers health complaints

Body Member	Work related diseases suffered by welder in the last Seven (7) days		Work related diseases suffered in the last twelve (12) months		Pain and strain syndrome: Cause of absenteeism in the last 12 months at work	
	N	%	N	%	N	%
Neck	8	5.2	14	9.0	10	6.5
Shoulder	13	8.4	26	16.8	25	16.1
Elbows	35	22.3	32	20.6	41	26.5
Wrist/hand	45	29.0	34	21.9	35	22.6
Upper back	35	22.6	32	20.6	27	17.4
Lower back	14	9.0	14	9.0	10	6.5
Others	5	3.2	3	1.9	7	4.5
Total	155	100.0	155	100.0	155	100.0

Environmental Hazard in the Workplace

Some work related environmentally induced hazard were unveiled through the survey which were characteristic of manufacturing processes employed and the state of the workplace. These according to the respondents include heat/smoke (40%), dust (31.6%), noise (20.4%) and Lighten (7.7%) as shown in Fig. 1. The major heat, noise and fume generating process is welding which is critical to activities carried out in any fabrication shop. In all the shops surveyed welding operations were carried out in the open space with the shop often located besides untarred road which compound the air pollution through dust from the roads. The welding type common to all the shops are gas welding and electric arc welding without welding booth in place. Also observed was the general apathy to use of protection gadgets/wears. Noise were produced by most of the machines used and welding, milling and turning machines leading in the noise pollution of the workshop environment. A nonchalant attitude to provision of light sources other than sunlight at work area was observed in 65% of the study areas as some opined that sunlight is enough source of light especially during day time thereby limiting working time to day times only.

Ergonomic Trauma Perception

Work related challenges observed by the respondents show work stress (22.6%) and dissatisfaction (22.6%) as predominant and neck pain (3.2%) being the least experienced trouble. Other in the list of trauma experienced by the subjects include Fatigue (16.8%), Back pain (18.7%) and Head ace (15.2%) (Fig. 2). Job dissatisfaction was found to have been influenced by lack of motivation, job insecurity and poor working condition most of which were kept secret to workmen for fear of being sacked. The prevalence of stress suggested that the identified work related hazard such as heat, smoke, noise, and dust had taken significant turn on the workmen and consequently on their productivity. The identified pains and aces were results of unsafe conditions to which the respondents were exposed. These trouble has the tendency of cumulating with time, workload and attitudinal abuses.

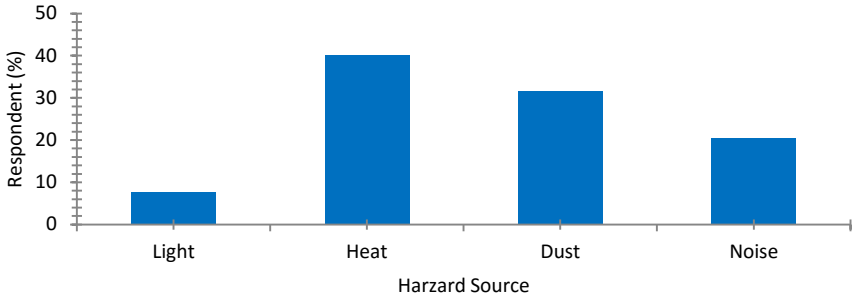

Figure 1: Work Related Environmentally Induced Hazard

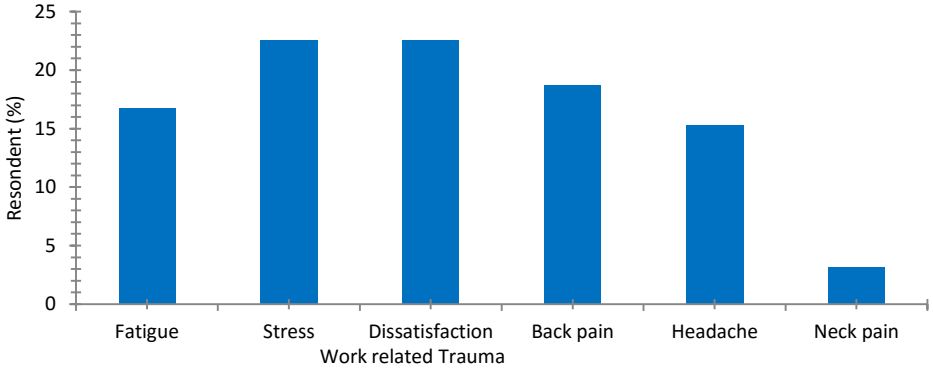

Figure 2: Perceived Work Related Trauma

System Concept of the Fabrication

The unproductive state of facilities in the sampled company was found to affect all workers with respect to safety challenges while the fabricator had in addition the traumatic musculoskeletal disorder being batted. The remedy however lies in the use of participatory intervention approach with holistic consideration of all factors influencing human and material flow within the system (Table 4). The man-machine System at the organization study suffers the lack of competent administrative to manage them and the poor attitude of workforce to safety and maintenance of work system. General lack of respect for the environment was evident in the poor house- keeping observed within and outside the work shop area.

TABLE 4: Occupational hazards identified and Suggested Remedies

Criteria	Complains/Symptoms	Suggested Action
Employee	Low back pains/back aches, upper body and neck pains, hand and wrist pain and discomfort, fatigue, stress and dissatisfaction	Reengineering of the seat and work table
Work and workplace design	Manual materials handling, hand tools, machines, workstation, vibration.	Work station redesign
Environment	heat, light, noise and dust;	Work system overview
Management	Training, motivation and OHS programs.	Organization policy and Supports

CONCLUSIONS

This study has exposed the defects in the workstation design of the studied industry and the need for redesign of the work system to enhance productivity, ensure safety and establish standard performance in the activities of the company. The chaotic feature and state of disused of engineering facility observed can be properly handled by appropriate organizational policy statement on maintenance, safety and ergonomics. The sustainability of a productive system is therefore hinged on ergonomic and safety criteria contents with cost effectiveness of its design and fabrication. Further study of the workstation users' peculiar anatomical characteristics resulting in development of anthropometric database is hereby suggested. There is also an urgent need for legislative control on manufacturers' activities as well as the environment where metal fabrications are carried out in order to mitigate the unwanted battery of associated occupational health hazard and other influences such activity have had on the ecosystem and human productivity.

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