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ERGONOMIC ANALYSIS OF WORKER POSTURES IN WASTE COLLECTION JOB

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ABSTRACT

Most environments are characterized with the problem of waste disposal and management. The effect of waste collection method on the musculoskeletal disorders (MSDs) has been a challenge. Efforts had been intensified to reduce MSDs of workers through various ergonomic studies. The objective of this work is to undertake an ergonomic analysis of workers' postures in waste collection job. Twenty five (15) employees of the parking and collection department of Lagos State Waste Management Authority (LAWMA) participated in the study. Their activities were video recorded while working and their postures was analyzed using Rapid Entire Body Assessment (REBA) sheet. Nordic questionnaire was also administered on the workers to obtain information on whether they experienced pain on any part of the body and the part of the body that the pain was experienced. The REBA action level classified postures into five levels as negligible risk, low risk, medium risk, high risk and very high risk of MSDs. Result showed that none of the workers were in the negligible risk, and low risk levels of MSDs. Further results showed that 6.66% were at medium risk; 26.7% were at high risk and 66.7% were at very high risk for the workers in the waste industry. The questionnaire revealed that 52% of the workers in both waste companies had pain in their neck and lower back during the last 12 months with the lower back being the most painful part in the body; 69.6% of them had wrist/hand pain; 65.2% had upper back pain which was the most painful part in the body during the last 7 days. It can be concluded that workers in waste collection job are subjected to MSDs as a result of the postures adopted while working.

1. INTRODUCTION

Waste is any unwanted or discarded material which may be in solid, liquid, or gaseous form and which are of no use to the person discharging it Barro and Douglas (1993). "Waste" is a relative term and it is subjected to individual perception of any particular material or product. Some waste products could be raw material for the production of other valuable products as is the case with plastics recycling, metal fabrication e.t.c. So it is clear that one man's waste is another man's treasure.

Wastes are categorized as follows:

(a) The source of waste generation, which are:

- Domestic waste
- Industrial / Agricultural waste
- Mining and Exploration, and

- Natural waste process

(b) The state of waste generation, which are

- Solid state
- Liquid state
- Gaseous state

In the pre- industrial era, nature often takes care of waste generated by the people. Disposal of solid waste is therefore through one or a combination of the following methods:

(a) Open dumps
(b) Burning
(c) Disposal in storm water

2. LITERATURE REVIEW

2.1. Ergonomic

Ergonomics as defined by the Board of Certification for Professional Ergonomist (BCPE) as a body of knowledge about human abilities, human limitation and human characteristics that is relevant to design.

Ergonomic design is the application of body knowledge to the design of tools machine systems, task jobs and environments for safe, comfortable and effective human use (BCPE, 1993).

Injuries could affect the performance of the worker, and they occur due to handling of heavy load, or awkward postures in managing the waste.

The most common category of injury is waist pain, back bone pains, shoulder pains usually from the lifting up and down of waste in the workplace (BCPE, 1993). These injuries occur to the young and inexperienced worker which is at risk to their health. Posture during work has been implicated in the various pains in the body experienced by workers. It is therefore essential to conduct an ergonomic analysis for the posture of the waste management workers to establish whether their posture may lead to MSDs.

During the past decade, research in ergonomics had led to heightened interest in technology of work and base in biomechanics of the human body. These researches focused on the development of principle in the work place Chou and Hsiao (2005) believed that this research area in ergonomics that deal with the measurement of the body dimension and certain physical characteristics in the body system.

Ergonomics is defined as the study of the relation between man and his occupation, equipment and his environment and particularly the application of anatomical and psychological knowledge to the problems arising thereof. It becomes how to reduce unnecessary stress and resulting injury to person engage in a certain activity or operating certain equipment.

Wilson (1995) defined ergonomics as "the practice of designing products so that the user can perform the required operation / service and supportive tasks with a minimum of stress and a maximum efficiency" they introduce the concept of system management in ergonomics programmes. The scope of human factor problem and effort occupied with the system mission requirement, determination of where to use human within the system and also to organize how to accomplish human factors research and application task were defined by them.

Wogalter and Rogers (1997) of North Carolina State University, Georgia Institute of Technology respectively – proved that human factor / ergonomics is the scientific discipline that attempts to find the best way to design products, equipment and system so that people are maximally productive, satisfied and safe. They stressed other terms that are used to describe the field such as engineering psychology and applied experimental psychology. Whatever the name, human factor / ergonomics is the science that bring together psychology and engineering design and professionally play the role of mediator between divergent interest advocating for human point of view in the design of products, equipment and system by championing design that make maximal use of the magnificent abilities that people possess and limiting the use of task where people could make errors.

According to Rogers *et al.* (2003) ergonomics is the interaction between the operator and task demand and is concerned with trying to reduce unnecessary stress and resulting injury to persons engage in a certain activity or operating certain equipment; the term ergonomics originated as a European term. Ergonomic traditionally focused on how work affects people; it may involve studies of physiological response to physically demanding work, environmental stressor such a heat, noise and illumination, the performance of complete psychomotor tasks, and activities involving elements of visual monitoring (Rogers *et al.*, 2003). The emphasis in ergonomics has been on ways to reduce fatigue by designing tasks within people work capabilities. The goal of an ergonomics work programme is to achieve the optimal match between person doing work and the overall work environment.

Kantowitz (1983) defined the scope of ergonomics control in designing products as follows: "that a product must be safe while in contact with man; a product must not produce harmful effect in man over a longer time; a product must be physically comfortable and should provide mental satisfaction. He further stated that for the above criteria to be met, a human factor engineer does not only play advisory and consultation roles but also provides data for the designer and participates in examination and appraisal of a finished product. In ensuring that system is safe, the man component must be physically fit. He stressed that the goal of ergonomics is to guide the application of technology towards benefiting humanity.

He proved that the purpose of designing a work system is to come up with a suitable man – machine combination, material, energy and resources to accomplish relevant tasks during designing process; and that the parameters that relates to man are regards as constant. The designer can at will restructure if need be. However, re-designing man seems to be an impossible, thus the man component is regarded as the most critical in work system design that brings about the subject ergonomics.

Galer (2001) defines ergonomic as "an area of study and application developed which is devoted to the problem of fit (between user and machine or tool)" Ergonomics measure human characteristic and human function, and establish the way the human body and the human mind work. The result of scientific work in the Human species is applied by ergonomists in the solution of practical problems in the design and manufacture of product and systems.

Ryan (1989) described ergonomics as traditionally focused on the how work affect people, while emphasis in (human factor engineering) is on design of system that reduce the potential for system operation errors and prevent injury. Ergonomics may involve studies of physiological response to physically demanding work; environment stressor such as heat, noise and illumination; the performance of complex psychomotor tasks; and activity involving element of visual – monitoring. Bergqvist *et al.* (1995) the emphasis in ergonomics has been on ways to reduce fatigue by designing tasks within people's work capabilities. The goal of ergonomics work program is to achieve the optimal match between person doing work and the overall work environment respectively.

Scott and Lambe (2006) noted that the potential for musculoskeletal discomfort or injury can be related to the amount of time spent in a particular position. They investigated the working posture in a manual collection of eggs by using OWAS.

Hoy *et al.* (2004) conducted postural analyses by using OWAS and Rapid Upper Limb Assessment RULA techniques. OWAS seeks to identify postures, which put the body in positions where force exertions can be dangerous, in applying the technique.

Scott and Lambe (2006) emphasized the process on how to reduce work related risk factors that contribute to MSDs.

In waste management operations, the two primary types of tasks on which to focus are manual handling tasks and repetitive tasks. Since numerous tasks are done at a plant, it is important to identify the tasks that hold high priority; that is, those that should have risk factors to reduce the potential for MSDs. Salminen *et al.* (1992) a qualitative screening approach assists in selecting the tasks that need further attention and possible risk reduction. The screening approach categorizes tasks into high-, medium-, and low-priority groups based on relative risk.

3. MATERIALS AND METHODS

3.1. General Design

This research work was carried out in a waste management industry in Lagos State, Nigeria. This is one of the pioneer waste industry in this country with several other waste industries in various States. All worker working in packing areas were included in the study. The waste management industry selected are in Lagos State, Nigeria.

For the purposes of achieving the study objective highlighted in the introductory chapter, a combination of different techniques are employed to sufficiently illustrate or evaluate the relevance of ergonomic analysis of workers postures in waste management workplace. The following techniques was used in the course of this analysis

i. Use of Nordic questionnaire Source: Kuorinka *et al.* (1989)
ii. Rapid Entire body Assessment (REBA) Source: Hignette and Mc Atamney (2000)

3.3. REBA Worksheet

In the application of the REBA worksheet, critical tasks of a job are considered for each task assessment of the posture factor was done by assigning a score to each worker. The data sheet figure provides a format for the process. Areas on the data sheet with a light grey background namely Group A which consist of neck, trunk, and, legs; Group B consists of the wrist, lower arms and upper arms. Score for the Group A (Trunk, Neck and Legs) postures and the Group B (Upper Arms, Lower Arms and Wrists) postures for left and right are obtained for the each worker, there is a posture scoring scale plus adjustment notes additional considerations. Then scores for the Load/Force and Coupling factors are obtained. Score A is the sum of the Table A score and the Load/Force score. Score B is the sum of Table B score and the coupling score for each hand. Score C is obtained from Table C, by entering Score A and Score B. the REBA Score is the sum of Score C and the Activity Score from Table C. The degree of risk is found in the REBA Decision Table.

3.4. Posture Data Collection Using Digital Camera / Video Recorder

Working postures are recorded by means of digital camera and video recorder. The observation are always made between 1 second and 60 seconds interval between observations, because it is often too hard for the observer to use shorter interval (Kivi and Mattila, 1998). Observer should maintain the recording distance around 3.5m space from the worker to ensure a full view of body segment (Karwowski and Marras, 2003).

The advantage of using video recorder is that the observer has much to look at during the observation posture. Besides, the video recorder can also easily and effectively be used in recalling the actual work situation.

3.5. Data Analysis Using REBA Methods

The REBA method involves the observation and collection of worker posture on neck, trunk, legs, and load combination for Posture Score A estimation in REBA Assessment sheet. Each posture of the REBA Assessment sheet has their own digit code in which numbers indicates the posture of each body parts. The same procedure is observed in Posture Score B estimation of the same REBA Assessment sheet, such that the upper arm, the lower arm, wrist, and coupling score will be added together to form the total estimation for Posture B. The grand score of Posture A and Posture B is used to find the final result Score C after looking in table C for final result the score of posture A, in row and of posture B, in column is observed and it gives the result final score C. This score is than added to the Activity score to get grand score in the REBA employee assessment worksheet.

This scores lies in Medium risk level, High risk level, Very High risk level which means the workstation has to be corrective action including further assessment is necessary now.

4. RESULTS

4.1. General Information of the Studies of the Companies

The companies selected for the study are located in Lagos Island metropolis of Lagos State and they are Lagos State waste management authority The number of the working hours/day at the companies was similar; the companies were equipped with similar truck, waste bin and basket of different capacity as shown in the plates.

The study has analyze the causes and effects of ergonomic risks at waste collector body while manually loading bundles of waste during and after work process. The intent was to make recommendations on how to lower the ergonomic risk factors involved with the process. The Rapid Entire Body Assessment (REBA) assessment techniques and Nordic questionnaire were use to detect ergonomics risk in the participants. While observing the participants, questions were asked about operation rates, and inputting the identified force and posture angles into the assessments worksheet.

Table-1. Summary Result of Part A for the workers Position

S/N	Neck	Trunk	Leg	Sub Score A from table A	Activity Score	Total Score A
1	3	5	4	9	3	12
2	2	4	3	7	0	7
3	3	3	4	8	1	9
4	3	3	3	7	0	7
5	3	4	3	8	3	11
6	2	5	3	8	3	11
7	2	3	4	7	2	9
8	3	5	3	9	1	10
9	3	2	3	6	0	6
10	3	3	4	8	1	9
11	2	4	4	8	1	9
12	3	1	4	6	2	8
13	3	2	3	6	2	8
14	2	5	3	8	3	11
15	3	4	4	9	0	9

Table-2. Summary Result of Part B for the workers Position

S/N	Upper Arm	Lower Arm	Wrist	Sub Score B from table B	Activity Score	Total Score B
1	3	1	2	4	2	6
2	2	1	2	2	0	2
3	1	1	1	1	3	4
4	2	1	3	3	2	5
5	4	2	2	6	0	6
6	5	2	3	8	1	9
7	3	1	2	4	0	4
8	3	1	1	3	1	4
9	2	1	2	2	0	2
10	2	1	3	3	0	3
11	4	2	3	7	1	8
12	3	2	2	5	3	8
13	3	1	1	3	2	5
14	3	2	2	5	0	5
15	4	2	3	7	3	10

Table-3. Final Result REBA Score for the workers

S/N	Total Score A	Total Score B	Score C from Table C	Activity Score	Final REBA Score
1	12	6	12	2	14
2	7	2	7	2	9
3	9	4	10	1	11
4	7	5	9	1	10
5	11	6	12	1	13
6	11	9	12	1	13
7	9	4	10	0	10
8	10	4	11	1	12
9	6	2	6	1	7
10	9	3	9	0	9
11	9	8	12	2	14
12	8	8	10	1	11
13	8	5	10	1	11
14	11	5	12	1	13
15	9	10	12	2	14

Table-4. Scoring and Description of Result for the workers

S/N	Final REBA Score	Description Scoring
1	14	Very high risk, implement change
2	9	High risk, investigate & implement change
3	11	Very high risk, implement change
4	10	High risk, investigate & implement change
5	13	Very high risk, implement change
6	13	Very high risk, implement change
7	10	High risk, investigate & implement change
8	12	Very high risk, implement change
9	7	Medium risk, further investigation, change soon
10	9	High risk, investigate & implement change
11	14	Very high risk, implement change
12	11	Very high risk, implement change
13	11	Very high risk, implement change
14	13	Very high risk, implement change
15	14	Very high risk, implement change

Note Description Scoring

1 = Negligible risk

2 or 3 = low risk, change may be needed

4 - 7 = Medium risk, further investigation, change soon

8 - 10 = High risk, investigate & implement change

11 + = Very high risk, implement Change

5. CONCLUSION

The environments are characterized with the problem of waste disposal and management. The effect of waste collection method on the musculoskeletal disorders (MSDs) are the mayor challenge. Which showed that good numbers of the workers were at very high risk levels of MSDs. It can be concluded that workers in waste collection job are subjected to MSDs as a result of the postures adopted while working.

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• The analysis of the working postures of data collection and proffered solution to reduce the musculoskeletal disorder (MDS)
S.O. Islamail, Proper arrangement analysis of the materials
• TO identify discomfort level for each body parts using (standardized nordic questionnaire (Karhu et al., 1997)
• TO suggest possible ways of reducing the discomfort associated with the waste collection job

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