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RATE OF ERGONOMICS HAZARD CONTROL MEASURES INCORPORATION INTO SMALL-SCALE INDUSTRIES IN SOUTHWEST NIGERIA

Abstract: *This study assessed the level of ergonomics inclusions into small-scale industries (SSI) in Southwest Nigeria. The objective was to find out the type of ergonomics control measures (ECM) put in place to enhance occupational and health safety of workers. Machine hazard and safety checklists were used to carry out assessment of hazards control level of different machineries in 121 SSI. By observation, scores were assigned by research personnel team (RPT) to safety levels under engineering, administrative and personal protective measures of all operational machines and the workplace designs. Questionnaire was completed among 345 workers to measure occupation hazard (past or present) among the workers and various ECM adopted by the administrators and/or the workers to prevent injuries. SPSS version 16.0, was used to analyze the recorded data. 50.2% of all SSI were rated poor (insufficient HCM). Sandcrete block industry (SCBI) had the worse percentage (90.4%). 19.2% used engineering, 18.3% engaged personal protective while 10.2% used administrative measures. However, 1.6% used the combined measures. The mean of the rated SSI with poor ECM programme by RPT are significantly not different from that reported by SSI employees ($t(24) = -0.563$, $p = 0.579$). SCBI workers had the highest percentage (17.2%) of the reported work related injuries followed by printing press (17%), welding and/or metal cutting workshops (16.7%). The study concluded that ECM inclusion into SSI operations is very low and this may have lead to the high reported ergonomics hazards among the group of workers.*

Key words: Ergonomics, hazard, small-scale, industry, control, measures.

INTRODUCTION

Ergonomics is the study of how a workplace, the equipment used and the work environment itself can best be designed for comfort, efficiency, safety and productivity. The goal of ergonomics program in industry is to adapt the workplace to a specific worker, dependent on the job description, required tasks, and physical makeup of the employee performing those tasks. Ergonomics consideration in design helps to prevent ergonomics hazards which are physical factors within the environment that harms the musculoskeletal system. Ergonomics hazards in workplace include themes such as repetitive movement, manual handling, workplace/job/task design, uncomfortable workstation and poor body positioning (Nancy et al., 2016; NIOSH, 2016).

Hundreds of millions of people throughout the world work under circumstances that foster ill health and/or are unsafe. It is estimated that yearly over 1.1 million people worldwide die of occupational injuries. In developing countries, Nigeria inclusive, the risk of having work-related injury is 10 to 20 times higher than that of developed counties. Majority of the workforce is employed in Small Scale Industries (SSI) that do not meet the minimum standards and guidelines set by the World Health Organization and the International Labor Organization (ILO) for occupational health, safety and social protection (Tadesse and Kumie, 2007) and are generally under-served in terms of occupational safety and health (OSH) expertise with very little attention in terms of either research or support for hazard preventive initiatives (Danièle and Jean-Pierre, 2003). Hence higher incidence rates of injury have been reported in SSI as compared to larger establishments. The risk for different forms of injuries is persistently elevated among the workers (Hasle and Limborg, 2006; Eakin, et al., 2010; U.S. Department of Labor, Bureau of Labor Statistics, 2011).

In a study conducted among SSI workers in Tanzania, it was reported that there was a high level of self-reported occupational health problems because of low use of personal protective equipment by the workers

(Rongo et al., 2004). A similar report was presented by Waju and Yohannes (2015) in Ethiopia, where a high prevalence of work related injuries, was reported as a result of sociodemographic, socioeconomic, personal work behavior and the poor working environment. Ezenwa, (2001) reported the outcome of a study of mortality among Nigerian factories over a 10 year period 16.9% of the total death were associated with power-driven machinery. Wood and wood products industry (small scale firm) were mentioned among the mostly affected. In a study to measure the pattern of occupational accidents, injuries, accident causal factors and intervention in Nigerian factories over an 11-year period (2002-2012), Ogechukwu and Kosi (2014) reported a significant increase in case of fatality rate compared with the last study of Ezenwa (2001) and that 90% of hazards were due to lack of training.

According to Occupational Safety and Health Administration (OSHA) (2000), recognizing ergonomics risk factors in a workplace is an essential first step in correcting hazards and improving workers' protection. OSH professionals believed that reducing physical stress in the workplace could eliminate up to half of the ergonomics hazards that affect workers in almost every industry. Among the hazards, mechanical-related claims for contusions/open wounds and fractures/dislocations were common (Safety Institute of Australia, 2012). Three types of mechanical components can therefore lead to hazards: point of operation, power-transmission apparatus and other moving parts such as reciprocating moving parts of the machine (OSHA, 2007).

Hazards should be recognized and preventive measures implemented at the planning and organizing stages of the work (CCOHS, 2001). According to Ohio Center for Occupational Safety & Health (OCOSH) (2008), the order of precedence and effectiveness of hazard control measures (HCM) are: engineering controls (elimination/minimization of the hazard by designing the facility, to remove the hazard, enclosure of the hazard, isolation of the hazard with guards); administrative controls (written operating procedures, safe work practices, exposure time limitations, signs, and warnings, training) and; Personal Protective Equipment (PPE) (use of respirators, hearing protection, protective clothing, safety glasses). The most effective control measures are engineering controls that physically change a machine or work environment to prevent employee exposure to the hazard. If this is not feasible other measures can be adopted.

Appraising the level of ergonomics hazards control measures put in place among SSI operations in Southwest Nigeria was the focus of this present study. The objectives were to find out the type(s) and /or effect(s) of the level of the adopted ergonomics hazards control measures on the group of workers

MATERIALS AND METHODS

Machinery Hazard Check

The machine hazard checklist reported by Gorge Manson University (2011) and that of machine safety checklist highlighted by Industrial Accident Prevention Association (IAPA) (2008) were modified and used to carry out workplace inspections and assessment of hazards level of all machineries in 121 SSI in Lagos and Abeokuta, the South Western Nigeria. The various trade group accessed included; 6 bottle making factory (BMF); 12 water factories (WF); 13 welding and/or metal cutting workshops (WW); 7 machine shops (MS); 8 feed mill factory (FMF); 11 wood working workshops (WWW); 13 printing press shop (PPS) and; 12 sand crete block making factories (SCBI). According to the Ministry of Business, Innovation and Employment (2013), physical inspections is one way by which hazards associated with machinery can be identified. This is by inspecting the machinery and assess where someone could get injured or be caught in the machinery. Therefore observation method was used and scores (below 1 = poorly or not provided, 1-3 = available but not enough, above 3 to 5 = adequately provided) were assigned by RPT to measure the safety conditions attached to operating each of the machines and the workplace design. Methods at which workers performed their tasks were critically followed. Among condition checked included; machine guarding, mechanical hazards, operator controls, supervision, use of protective equipment and clothing among others.

Semi-Structure Interviews

Questionnaire were completed among 345 workers through interviews to measure subjective injury and /or occupation hazard (past or present) by written response, using the modified version of questionnaire developed from the job demand-control-social support model detailed by Karasek and Theorell (1990) to assess HCM adopted by each trade group under engineering, administrative and personal protective. Workers were asked to allocate scores as stated above. All potential volunteers agreed, and consents were taken in written form after they were informed that their participation in the study was voluntary. The purpose of the study and the confidentiality of the information provided were emphasized. The interview however lasted approximately 15 minutes for each subject.

Data Analysis

Descriptive statistical procedure, using SPSS version 16.0, was used to analyse the recorded data. Independent sample t-test was used to analyze the significance of unrelated groups' means (means of allocated scores by PRT and that assigned by the interviewed SSI workers) at $p < 0.05$. According to Pagano (2004), the independent samples t-test appraises whether the means for two independent groups are significantly different from each other. The independent sample t-test is probably the single most widely used test in statistics (Matthew, 2004).

RESULTS

Description of Samples' Responses and Questionnaire Return Rate

Three hundred and forty five (95.8%) of the total three hundred and sixty (360) workers who participated in the study from 121, SSI completed the questionnaire. Among others, job title assessed included 93 operators (27%), 112 artisans (32.5%) and 130 factory workers (37.7%). All subjects have spent not less than two (2) years on their current job with an average age of 32 years. The demographics of the workers are presented in Table 1.

Table 1. *Statistic of the demographic information of workers in 121 small scale industries*

Descriptions	Age	Work hours	Years of Working Experience
Mean	32	8.7	5.5
Mode	29	10	7.0
Std. Deviation	5.2	0.5	0.63

Source: Fieldwork

From figure 1, the Sand crete block industry (SCBI) has the highest percentage (90.4%) of poor availability of engineering control measures, 87.4% of WW also mentioned in this category. 65.3% of all PPS were also affected. About 40% of the total BMF and WF however had some level of adequate engineering control measures in place.

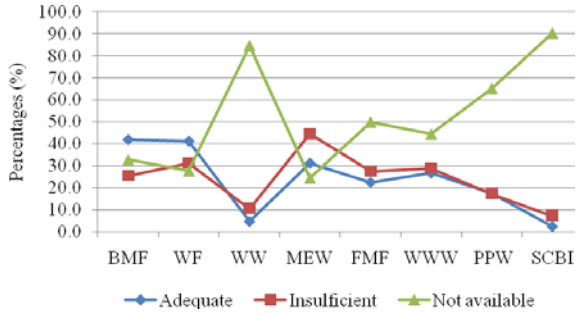

Figure 1. *Level of engineering measure adopted by the small scale industries*

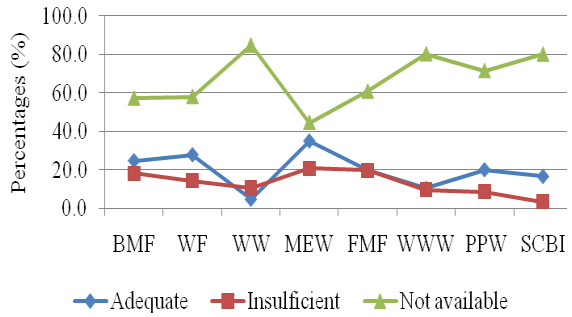

Figure 2. *Level of administrative measure adopted by the small scale industries*

Almost all the SSI studied lacked good administrative measures capable of minimizing hazards connected with the tasks. From Figure 2, WW had the highest percentages (84.7%) of non-availability of administrative measures followed by WWW (80.2%), SCBI (80%). 34.9% of all MS studied however could be considered adequate in terms of administrative provisions for safety. 27.8% and 24.7% of WF and BMF respectively also had some administrative provisions level.

From Figure 3, 94% of the SCBI and 77.3% of BMF, had no provision in place for personal protective equipments for their workers. Others included 53.2%, 52.8%, 50.0% of PPS, WWW and MS respectively. Among the categories of those who adequately provided for PPE, 47.1% of WW, 50.0% of FMF, 36.1 of water factories studied were noted.

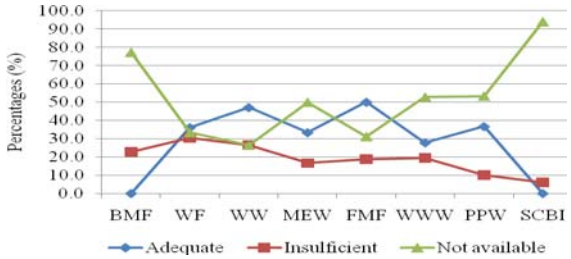

Figure 3. *Level of personal protective measure adopted by the smalls scale industries*

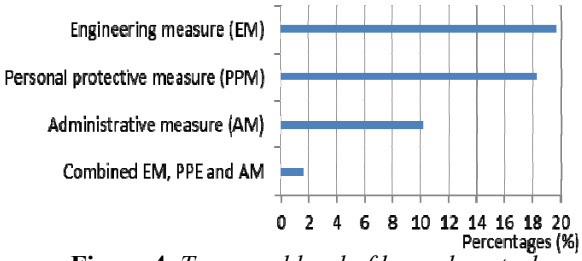

Figure 4. *Types and level of hazard control measures adopted by the Small-Scale*

Among the SSI who used one measure or the other to minimize occupational hazards, Figure 4 compared the types and level in place. 19.7% used engineering measures, 18.3% used personal protective equipment and 10.2% engaged the use of administrative measures. However 1.6% adopted the use of all the measures (engineering, administrative and personal protective).

Table 1 shows the number and total percentages of all the studied SSI that were rated high in the provision for HCM in the three categories of engineering, administrative and personal protective. In all the 12 hazard controls descriptions assessed. "Machine vibration control" was the highest (28.9%) followed by "provision of machine guard" (27.3%), while "eliminating manual lifting of objects" control was the least percentage (1.6%) of all the controls.

Table 2. *Description of result of the assessed 121 small scale industries who provided for the three categories of hazard control measures.*

	BMF n=11	WF n=18	WW n=17	MS n=9	FMF n=8	WWW n=18	PPS n=15	SCBI n=25	Total n=121	%
Engineering										
Provision of machine guard	8	5	3	4	2	5	4	2	33	27.3
Emergency stops painted red	3	5	0	2	1	4	0	0	15	12.4
Warning labels clearly stated	3	4	0	1	1	4	1	1	15	12.4
Noise minimized	2	12	0	2	2	5	6	0	29	24.0
Vibration minimized	7	11	1	5	3	6	2	0	35	28.9
Heat reduced	2	7	0	3	5	0	2	0	19	15.7
Administrative										
Standardized rest time	1	4	0	4	1	1	1	0	12	9.9
Machine oil loss or spillage regulated	3	2	0	1	1	5	1	4	17	14.1
Manual lifting eliminated	0	0	0	2	0	0	0	0	2	1.6
Frequent training of operators/staff	1	3	7	3	2	1	2	0	29	15.7
Firefighting equipment	3	1	0	0	0	0	0	0	4	3.3
Personal										
Right posture at work	0	7	5	5	5	4	5	0	31	21.6
Personal protective equipment	0	6	4	1	3	0	0	0	14	11.6
Total	33	67	20	33	26	35	24	7		
Percentage	25	31	9.8	30.6	27.1	16.2	13.3	2.3		

BMF= Bottle making factory, WF= Water factory, WW= Welding workshops, MS=machine shops, FMF= Feed mill factory, WWW= wood working workshop, PPW= Printing press shops, SCBI= sand crete block industry, n* = Total number studied, %= Percentage of the available hazard control measures

Among all the sectors, WF had the highest percentage (31%) among those who provided for HCM, followed by MS (30.6%), FMF (27.1%) and BMF (25%). The least of the sector been SCBI (2.3%).

Prevalence of work-related injuries among workers

Two hundred and ten (85.7%) out of the 245 workers complained suffered from one injury or the other on their job titles. From Figure 4, 128 representing 52.2% had suffered from musculoskeletal disorders (MSDs) in one parts of their body. This was followed by 79 (32.2%) workers who reported cuts and/or bruises and 77 (31.4%) workers were ones entangled with machine rotating parts. 50 of them, representing 20.4% were drawned into in-running machine nips. Other notable reported injuries included; burnt (17.6%), foot pain (15.5%), skin disorders (11.8%) among others

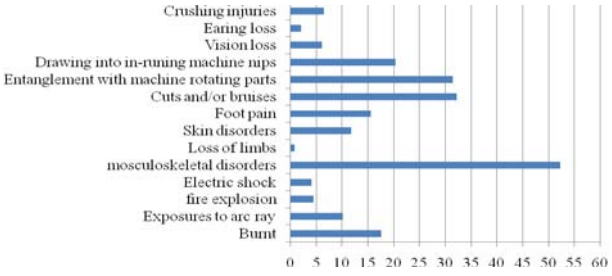

Figure 5. *Workers' reported work-related injuries type and percentages in all the small-scale industries*

Among the total reported cases of injuries in all the categories, SCBI had the highest of 91 responses representing 17.2% of the total responses. This was

loosely followed by PPS (17%), WW (16.7%), WWW (13.8%) and BMF (12.7%).

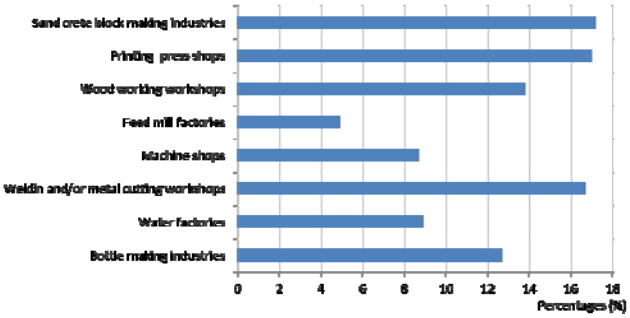

Figure 6. *Percentage reported work-related injuries among workers in each studied sector*

Statistic test

The result of independent-samples t-test which appraised whether means of the number of SSI rated low (insufficient or no hazard control measure programme) by RPT are significantly different from mean of that reported by Small Scale Industry Employees (SSIE) found that RPT report had statistically significantly lower number of SSI (mean=59.15, SEM=3.0) compared to that of SSIE (mean= 61.62, SEM = 3.2), with $t(24) = -0.563$, $p = 0.579$. With "Sig. (2-tailed)" value greater than 0.05, the groups' means are significantly not different. With 95% confidence interval for the difference, 6.56 and -

11.48 were recorded for upper and lower boundary respectively with standard error difference of 4.37. Hence, the SSI rated low by RPT were also confirmed same by the SSIE.

DISCUSSION

As noted across the entire SSI studied, there was generally a very low percentage (20.1%) of engineering measures adopted. Operators of the machines are liable to different types of machine hazards. As observed, most of the machines used were not provided with guards, there were little or no enclosures for noisy equipment most especially welding workshops, block making factories and others that used generating plants to power their machines. According to Health and Safety Executive (2004), most accidents at all types of machine happen to operators when: loading/unloading components, removing swarf, taking measurements and making adjustments. Lack of adequate guards on machines may form parts of the reasons why the reported mechanical-related injuries such as entanglement with machine rotating parts cuts and/or bruises were very high (85.7 %) and rated second worse to MSDs among all the reported injuries. There were no labels showing hazardous areas of machine neither was any emergency stops of the machines painted red. Workers/operators using the machines are exposed to hazards which may lead to amputations of fingers and hands.

Exposure time limitations, relevant and standardized trainings were inadequate and there were no enforcement of safe work practices. Whereas, as part of the administrative measures, equipping workers, especially operators, with safety kits suitable for the hazards of the jobs and training to understand function of all controls on the machine is vital to minimizing hazards (OSHA, 1999). The eight normal working hours recommended by ILO (2005) was not followed by the various SSI administrators. Most of the workers spent more than 10 hours working per day (from 8:00am to 6:00pm) without clear designated time for rest. This was noted common among all the trades, most especially, with bottle making industries, welding and/or cutting workshops, block making factories and water factories. Therefore leading to weak safety score mark allocation to administrative measures in the industries.

Some of the workers, most especially operators in bottle making industries, wood working workshops, printing press shops and block making factories, opined that using PPE has capacity to reduce their work efficiency, hence underused the available PPE provided by the administrators. This is similar to the findings of Paramasivam et al (2007). Protective clothing was not commonly used. All the workers worked with their own style of dressings some of which were loosed. A larger percentage of workers in welding workshop (56%) used hands, instead of safety glasses, to cover their faces from impact, dust and radiation hazards. This might have contributed to the high prevalence of cuts, brushes and burnt injuries reported by the workers. Though it was very difficult for workers to hear one another 2 m away talking in a normal voice in some of the trade groups like, welding shops, sand crete block industry and wood working factories, the use of hearing protectors were not common among the workers. This was similar to the report of Lusk et al. (1998) and Daniell et al. (2006) that consideration of noise controls was low and that hearing protectors are under-used in noisy industries. There seems to be a very wide gap in knowledge among the various administrators and workers as regards when to use hear protector to minimize hearing loss.

Arising from this study, exposures to ergonomics hazards is common among the workers with low level (1.6%) of combined machine, administrative and personal protective hazards control measures in practice. Workers in these trade groups may therefore suffer damages to: nerves, muscles and tendons; cuts and/or bruises, skin, muscle, or body part exposed to crushing, caught-between, cutting, tearing; hearing loss, inability to communicate impending dangers, among the workers. Measures to assist the small scale enterprises at providing relevant trainings to both administrators and workers on how to effectively combine productivity with hazard prevention planning and management, including ergonomics inclusions to daily plans becomes very necessary and urgent. This measure will enhance safety among the group of trades.

CONCLUSION

This study assessed the level of ergonomics inclusions, under engineering, administrative and personal protective measures, into small-scale organizations in Southwest Nigeria. It can be concluded from the study that the level of ergonomics formations in these sectors is very low and this may have lead to the high reported ergonomics hazards among the group of workers. Hence, courses to assist the small scale enterprises at providing relevant trainings to both administrators and workers, most especially, on how to effectively combine productivity with hazard prevention program becomes very necessary and urgent. This will reduce work-related hazards and enhance occupational safety among the group of workers.

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BIOGRAPHY

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STOPA UPOTREBE MERA ZA KONTROLU ERGONOMSKIH OPASNOSTI U MALIM INDUSTRIJSKIM PREDUZEĆIMA U JUGOZAPADNOJ NIGERIJI

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Rezime: *U ovoj studiji data je procena stepena upotrebe ergonomskih mera u malim industrijskim preduzećima u jugozapadnoj Nigeriji. Cilj rada je definisanje tipova ergonomskih kontrolnih mera za poboljšanje stanja bezbednosti i zdravlja na radu. Procena stepena opasnosti na mašinama i uređajima je izvršena uz pomoć čeklista za procenu stepena zaštite na mašinama u 121 malom industrijskom preduzeću. Članovi istraživačkog tima su izvršili procenu primene inženjerskih, administrativnih i ličnih mera zaštite za sve mašine u pogonu i sva radna mesta. Upitnik koji je popunilo 345 radnika je obuhvatao pitanja u vezi opasnosti na radnom mestu (prethodnom ili sadašnjem) i upotrebe ergonomskih mera od strane radnika i administrativnog osoblja u cilju prevencije povreda. Za analizu dobijenih podataka korišćen je program SPSS verzija 16.0. Od ukupnog broja malih industrijskih preduzeća, 50,2% nedovoljno primenjuje preventivne mere. Preduzeća koja se bave proizvodnjom betonskih elemenata beleže najmanji procenat primene preventivnih mera (90,4%). Inženjerske mere zaštite primenjuje 19.2% ispitanih, mere lične zaštite 18,3%, dok 10.2% koristi administrativne mere. Međutim, svega 1,6% beleži upotrebu kombinovanih mera. Srednja vrednost u malim industrijskim preduzećima kod kojih je zabeležena slaba primena mera za kontrolu opasnosti se ne razlikuje od vrednosti dobijenih anketiranjem zaposlenih ($t(24) = -0.563$, $p = 0.579$). Radnici u proizvodnji betonskih blokova su imali najveći procenat povreda (17,2%), nešto više od radnika u štamparijama (17%), i radionicama za zavarivanje i/ili sečenje metala (16,7%). Nakon sprovedenog istraživanja došlo se do zaključka da je upotreba kontrolnih mera u malim industrijskim preduzećima na veoma niskom nivou, čime veliki broj radnika može biti ugrežen.*

Ključne reči: Ergonomija, opasnost, mala preduzeća, industrija, kontrola, mere.