



Assessment of Occupational Hazards and Their Impacts in the *Jua Kali* Sector: A Case Study of Nakuru Town, Kenya

Langat N. Kipkurui^{1*}, Bernard W. Ikuu², R. Ongeri³

¹*Institute of Energy and Environmental Technology, Jomo Kenyatta University of Agriculture & Technology P.O Box 62000-00200 Nairobi –Kenya*

²*Department of Mechatronic Engineering, Jomo Kenyatta University of Agriculture & Technology P.O Box 62000-00200 Nairobi –Kenya*

³*Department of Physics, Jomo Kenyatta University of Agriculture & Technology P.O Box 62000-00200 Nairobi –Kenya*

**Corresponding Author - Email: langatnoah@gmail.com*

Abstract: In many developing countries the conditions under which most of the workers in informal enterprises operate are precarious and unsafe. Many workplaces in the informal sector have some inherent hazards. Multiple exposures to different hazards are mainly due to poor housekeeping and congestion in the workplaces. Occupational hazards lead to negative health and economic consequences on workers and on other persons in the proximity of the working area. In this study occupational hazards and their associated impacts on metal workers in Nakuru town is assessed. Data was collected by a combination of questionnaires, observation and measurements at various Jua kali workplaces. The study is carried out through surveys and observations in workplaces. The study shows that cutting, impacts and crushing are the most common mechanical hazards while welding fumes, paints and solvents are the main chemical hazards in many Jua kali establishments. The use of uninsulated cables or cables with worn-out insulations was seen to be the leading electrical hazard. In regard to work related illnesses, fatigue, periodic headaches and lower back pain were seen to be the most frequent. Occupational injuries in this sector include cuts, punctures and hearing impairments. As relates to economic impacts, it was established that many workers have occasioned property damage as result of workplace incidences. The study shows that the micro and small enterprises in this informal sector are burdened with a wide variety of hazards which are related to their activities. The results of the study showed that majority of Jua kali artisans have little knowledge and training in occupational safety and health. From this study it is seen that there is need for interventions such as trainings to improve health and safety awareness and welfare among Jua kali workers.

Keywords: Exposure, hazards, informal sector, Jua kali, occupational safety and health

1. Introduction

All over the world, workers in the informal sector are not adequately protected by health and safety legislations, consequently, they suffer higher rates of accidents and fatal injuries than workers in the formal industries [1]. Occupational injuries in developing countries are a major

concern. International Labour Organization (ILO) estimates that 250 million occupational injuries, 160 million work related diseases and 2 million deaths occur each year resulting in loss of roughly 4% of Gross Domestic Product (GDP) due to workers` compensation, loss of workdays, interruption of production, retraining and medical expenses [2].



In Kenya, the *Jua kali* sector has continued to play an important role in employment creation. According to the Economic Survey published by Kenya's Central Bureau of Statistics, employment within the sector increased from 12.6 million persons in 2015 to 13.3 million persons in 2016, accounting for 83.1% of total employment [3]. The sector contributes 34% of the GDP, employs as much as 75% of the labour, provides goods and services, promotes creativity and innovation, and enhances entrepreneurial culture. Reference [4] reports that the explosive growth of the informal sector has brought with it more hazards including biological, mechanical, chemical and psychological hazards. Reference [5] explains that excessive number of people and products in the workplace exposes workers to multiple hazards. In many small workshops, housekeeping is poor; tools and materials are usually out of reach and working postures that causes strain are common. There are a number of reasons for the poor occupational safety situations in informal sector, such as unhealthy and unsafe working environments, undesirable sanitary facilities, lack of, or inadequate safety equipments, and unsafe manufacturing methods [6]. While unsafe working environments cause most workplace injuries, human factors such as age, education, experience, level of intoxication and smoking are some of the inherent factors. A study conducted by [7] on health risks related to chemicals used in informal sector in Dar es Salaam indicated that workers dealing with metal work and manufacturing metal products are mostly exposed to soldering and paint fumes, lead and degreasing solvents such as sulphuric acid, ethanol and benzene. Wood workers are normally exposed to wood dust containing chemicals used to preserve the wood from insects and solvents used to soften varnish and glue in furniture making. Workers in garages are always exposed to welding fumes and sometimes to paint fumes/solvents if they happen to weld a surface with traces of paint or degreasing solvents. Reference [4] studied safety practices in *Jua kali* and reported that many *Jua kali* enterprises use obsolete production methods and raw materials of inferior quality. They also observed that in many *Jua kali* enterprises, there are several different activities taking place at the same time. As a result, workers are exposed to excessive noise far beyond the recommended maximum noise level of 90 dB(A) for an eight-hour working day.

A study into health impact of occupational risks in the informal sector in Zimbabwe documented that annual rates of injury and illness in the informal sector were 131 injuries per 1,000 workers and 116 illnesses per 1,000 workers and that 19% of injuries resulted in some form of

permanent disability [8]. A study conducted in Dar es Salaam Tanzania, to assess chemical exposure and health problems among the small-scale industries workers reported that more than 70% of workers surveyed suffered from skin burn, red eyes, headaches and chest/throat pains. Painters reported headaches when in contact with paint and thinner and when working in direct sunlight, while woodworkers reported mainly respiratory and eye problems [7]. According to 2017 Human Development Index (HDI) Kenya's rate of unemployment stands at 39.1% [9].

Studies by many countries and the ILO have shown that costs of work-related illnesses and injuries range between 1.8%–6% of GDP [10]. Some economic cost of workplace injuries and illnesses are readily apparent. These include medical cost, lost time at work and administration of programs for those injured. Others however are difficult to quantify: loss of life, changes in future work activity and earnings of the injured, impacts on the household of the injured or ill workers diminishing quality of life [11]. Currently, there is little data and information available in literature on economic impacts of occupational hazards in Kenya, especially in informal sector

The purpose of this study was to assess the health and economic impacts of occupational hazards in *Jua kali* sector in Nakuru town, Kenya. The town is the fourth largest urban centre in Kenya.

2. Materials and Methods

This study used a survey research design, Survey research design seeks to obtain information that discloses the existing phenomena [17]. In this study, the existing phenomena were occupational hazards (independent variables) and health and economic impacts (dependent variables) in the *Jua-kali* sector.

Data was collected from *Jua kali* metal workers in Nakuru town, who were randomly selected. Quantitative and qualitative data were collected by the use of questionnaires and an observation schedule. The respondents were issued with the questionnaires were requested to filled it in and hand back. The respondents who could not read and write were guided by the researchers in filling in questionnaires through a face-to-face interview. The observation schedule was used to collect more information on occupational hazards present at the workplaces as the workers continued with their normal routines. The noise levels at the workplaces were measured using sound level meter (SLM). In the sound measurement, the SLM was placed at two metres from the noise source. This was to establish the noise level



perceived by other workers within the same workplace. Average noise levels were obtained for similar activities in workplaces that were sampled.

Total A-Weighted sound pressure levels for different activities at workplaces was then calculated for different sources as:

$$L_{pt} = 10 \log_{10} \left[\sum_{i=1}^n \log^{-1} (L_{pi}/10) \right] \quad (1)$$

where L_{pt} is the total noise level for all the noise sources when all are in simultaneous operations, n is the number of noise sources in workplaces sampled, and L_{pi} is sound level for a given noise event.

The study was conducted and data received from 230 respondents of which 84.1 were male, and 15.9% female. Among the respondents, 42.5% were metal fitters, 32.7% were welders and 24.8% were painters.

The data collected was organized, tabulated and analyzed using descriptive and inferential statistics.

3. Results and Discussion

3.1. Education level of respondents

The respondents were of different levels of education. levels of education as seen in Table 1.

As can be seen in Table 1, majority of the workers had attained at least primary level of education. About 10% of the respondents had no formal education, while about 15% had attained tertiary education.

Table 1: Level of Education of *Jua kali* workers

Highest education level	Number	Percentage
Tertiary college	31	14.5%
Secondary	77	36%
Primary	84	39.2%
No education	12	10.3%
Total	214	100

3.2. Analysis of Occupational Hazards

3.2.1. Mechanical hazards

The study sought to establish which mechanical hazards are at workplace. Fig. 1 shows the various mechanical hazards and their frequency of occurrence. It can be seen in this figure that the most frequent hazards are cutting and impact at 20% and 17% respectively, while the least common is entanglement (8%).

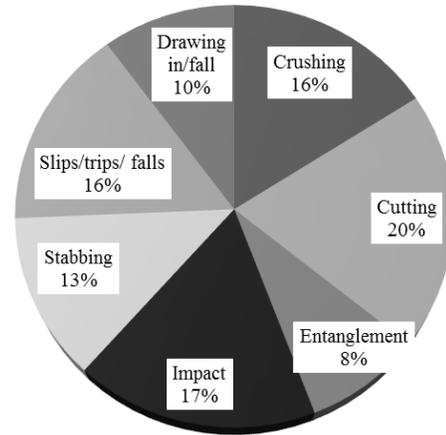


Fig. 1: Mechanical hazards

Mechanical hazards are mainly brought about by tools and equipments used at a workplace. Menya et al., [12] indicated that a significant number of mechanical hazards in Eldoret’s *Jua kali* sector are mainly attributed to use of bad procedures. The causes of injuries can be easily managed and contained if the workers are adequately sensitized on occupational safety and how to avoid various injuries at the workplace. For example, provision of information on the appropriate protective wear against each type of injury would greatly enhance their preparedness levels towards such injuries at the workplace.

3.2.2. Chemical hazards

In regard to exposure to chemical hazards, it was seen that 59.3% of respondents use chemicals in their place of work while 40.7% do not use chemicals. Some of the hazardous chemicals noted in their workplaces were categorized into acids, alkalis, solvents, dust, and fumes. Paints and solvents were the most common, found in 35% of the workplaces studied. Fumes, dust and acid/alkalis were in 30%, 28% and 7% of the workplaces, respectively. The chemicals can cause health problems when ingested, inhaled or upon contact with the skin.

4. Exposure to fumes at workplace

On the issue of exposure to fumes at workplace, the study revealed that majority of the workers (87.3%) were exposed to fumes. Out of these, 40.1% were exposed to welding fumes, 25.2% to exhaust fumes, 18% to paint vapours and 17.4% to adhesive vapours. These are shown graphically in Fig. 2.

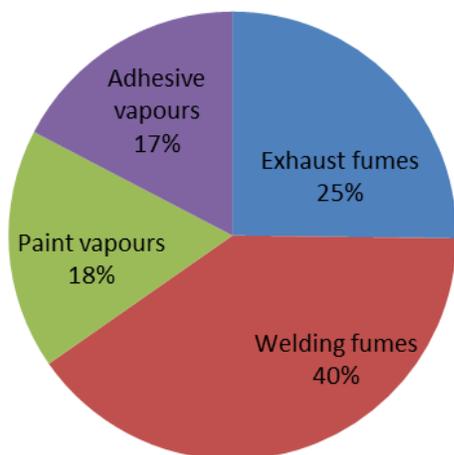


Fig. 2: Exposure to various fumes

Majority of workers in *Jua kali* are thus exposed to a range of hazardous chemicals through inhalation, ingestion or absorption via skin. It was observed that workers do not use of personal protective equipment such as nose/mouth masks, goggles, gloves and overalls. In addition, air circulation is inadequate due to poor ventilation in many workplaces. These findings are similar to those of [7] whose study on occupational exposures and health problems in small scale industries (SSI) in Tanzania indicated that workers were exposed to high levels of exhaust, paint and soldering fumes. Welders were exposed to welding fumes. Workers and employers in *Jua kali* sector were found to be aware of these chemicals health hazards but not on proactive measures to control these hazards.

5. Electrical hazards

In regards to electrical hazards, it was found out that 83.1% of the workplaces use either worn-out or un-insulated wires which is a major electrical hazard. Further, it was seen that some equipments are connected directly to power source without plugs and that even for those connected with plugs most of them are unearthed. The results of various connection methods used in the sector are shown in Table 2.

The use of uninsulated or cables with worn-out insulation cables was identified as one of the major electrical hazards in *Jua kali* sector.

Table 2: Equipment connection to the power source

Method of Power connection	Percentage (%)
Directly without plugs	30.8
Through earthed plugs	36.9
Through unearthed plugs	32.3
Total	100.0

From the observations, it was noted that majority of welders connected their equipments to the power source using cables with worn-out insulation therefore exposes themselves and other workers to risk of electrocutions. It was also noted that most of the workers had no formal training in electricity and many had been trained through apprenticeship.

6. Hazards emanating from poor housekeeping

The study in this part aimed at identifying the status of various workplace housekeeping aspects. Data was collected using 5-level Likert scale, with responses of strongly disagree (1), disagree, (2), Neutral (3), agree (4) and strongly agree (5). The mean for the responses for each aspect was computed. The findings are summarized in Table 3.

Table 3: Housekeeping aspects

Aspect	Mean	Std. Deviation
The workplace is disorganized	4.237	.3176
There is lack of routine cleaning at workplace	3.874	.2597
There are loose cables or wires at a workplace	3.401	.4454
There is lack of provision of a designated waste bins/area at a workplace	3.398	.3860
There is lack of tool racks and equipment storage area at workplace	3.353	.2958
There are spills at workplace	3.258	.3630

It can be seen in this table that the means for all aspects assessed were above 3, which indicates general agreement that there is poor housekeeping in *Jua kali* workplaces. The response for the aspect ‘The workplace is disorganized’ had the highest mean of 4.23, followed by ‘There is no routine cleaning at workplace’ and ‘There are loose cables and wires at workplace’ with means of 3.87 and 3.4 respectively. These findings are similar to those of [14] who stated that many *Jua kali* enterprises operate in ramshackle structures that have poor housekeeping and lack waste disposal facilities. As previously mentioned *Jua kali* workplaces are normally overcrowded with



people, finished products and raw materials placed within confined working spaces.

7. Ergonomics and manual material handling hazards

In regards to ergonomics and material handling, the study found that 58.4% of workers carry loads manually, 32.7% use trolleys, 6.2% use Chain block and 2.7% use Electrical hoists. When asked of how heavy the loads they lift or carry at workplace 44.6% of workers lifted/carried loads ranging from 31 to 50 Kgs while only 7.8% of workers carried loads of above 81 Kgs. There is no legal maximum weight to lift at work, however there are guidelines which set out the recommended safe maximum weight for lifting at work [15]. Recommended maximum weight limit should be adjusted depending on how the load is being lifted, how close to the body the weight is held and how high or low the weight is lifted. The guidelines suggest that the maximum weight men should lift at work is 25Kg. This is for loads held close to the body at around waist height. As observed in many *Jua kali* workplaces, lifting activities are repetitive and involves twisting and bending. Lifting also takes place in confined spaces thus, not in line with set guidelines for recommended maximum weight of 25Kg. There is an increase risks of musculoskeletal disorders when manual handling is rampant. From the findings, majority of the respondents carry loads manually as compared to those who use mechanized means. Insufficient number of mechanized means of lifting and carrying in many *Jua kali* establishments is attributed to low economic strength of the sector.

8. Working posture

In regards to suitability of working 56% indicated that they were comfortable while 44% indicated that they were uncomfortable. However, these responses were highly subjective. Over 94.0% of the workers indicated they had suffered from muscle strain at workplace while 73.8% reported headaches, low back pain and neck pain. These illnesses could be attributed to use of excessive force and repetitive movements. In a study conducted by [16] amongst metal workers in Kamukunji, Kenya, 47% of workers squatted while working, 33.3% stood for long hours and 25% handled very heavy loads. These awkward working postures and heavy loads were linked to several cases of Musculoskeletal disorders (MSDS).

9. Exposure to excessive noise

Workplace noise levels were measured in various *Jua kali* sheds in Nakuru town. Table 4 shows noise levels from different activities conducted.

Most of the activities conducted in *Jua kali* workplaces generated noise levels above the maximum allowable limit of 90 dB(A) for an eight-hour work shift. The total noise level at source L_{p0} and total noise level at 2m from source L_{p2} were calculated using (1) and obtained as 120.86 dB(A) and 117.69 dB(A), respectively. Welding operation generated continuous noise level of 82 dB(A) at source and 72.9 dB(A) as perceived at 2 metres from source.

Table 4: Noise levels for various activities

Activity	Noise level in dB(A)	
	At Source	2m from Source
Panel Beating/Grinding	115.23	111.32
Panel Beating	114.6	110.6
Hammering	114.42	112.15
Hammering/cutting/Welding	114.21	112.07
Grinding	106.45	99.8
Cutting	101.05	94.17
Welding	82.1	72.9

This was the only activity whose average noise level was below maximum allowable limit of 90 dB(A) for eight-hour shift. These results are consistent with those of [16] who indicated that the noise levels in Kamukunji metal fabricating sheds ranged from 72.0 to 113 dB(A).

Various processes in *Jua kali* establishments are carried out at the same place at the same time. This lack of segregation and enclosure of noisy operations exposes workers to dangerous noise levels with likely serious health implications. Factories and other places of work legal notice No.5 of 2005 requires an occupier of a workplace to implement noise control and hearing conservation measures when noise level exceeds 85 dB(A).

10. Exposure to physical injuries

On physical injuries at workplace 84% of the workers indicated that they have had accidents at workplace that have resulted in various forms of injuries. Only 11% of workers indicated that they had not sustained any form of injury at their workplace. The findings of these study are closely related to those of [12] whose study on occupational safety awareness amongst metal workers in Jinja, Uganda, showed that the most common work related injuries sustained were cut and burns accounting



for 73% of all injuries sustained, eye injuries and hearing impairments each at 6% and the least common were fractures at 0.6%. Injuries sustained could be attributed to manual handling since few *Jua kali* operatives can afford mechanized operations. Use of poorly maintained hand tools may also lead to physical injuries. Table 5 shows the distribution of work-related injuries at *Jua kali* workplaces.

Table 5: Work related injuries

Physical injury	Percent (%)
Cuts	20
Puncture	18
Abrasion	17
Bruise	15
Burn/Scald	10
Electric shock	9
Eye injury	5
Crushing	2.5
Heat strain	1.5
Amputation	1
Fracture	1
Total	100.0

11. Illnesses at workplace

In regards to illnesses at workplace, 92.1% of workers reported to have had work-related illnesses. Fig. 4 summarizes findings on nature and relative prevalence of work-related illnesses in the *Jua Kali* sector. Occupational stress was identified as the leading work-related illness at 20.1%. The *Jua kali* sector, being very demanding in terms of physical effort, subject workers to psychological stress and fatigue due to the much pressure put upon the workers to meet production demands. Awkward working postures and repetitive motions subject workers to recurring back pains. Excessive noise and heat exposure, poor air circulation and manual handling may also cause fatigue.

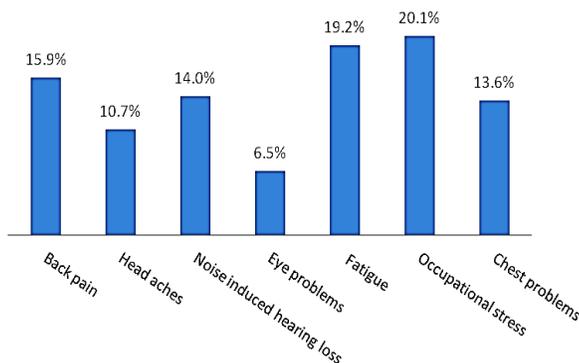


Fig. 4: Work related illnesses

12. Economic Impacts of Occupational Hazards

The study in this part aimed at identifying the extent at which occupational hazards in *Jua kali* sector affect economic livelihood of the workers. In the last 12 months, 83% of workers reported to have been involved in workplace accidents of which 84.6% had one occurrence while 15.4% had two or more of such occurrences where materials, products, tools and equipment were damaged.

In relation to lost time injuries, of 83% of workers who reported to have been involved in workplace accidents, 42% were absent from work for one to three days, 32% for four to six days and 9% for more than seven days. Only 17% of workers reported to have sustained injuries that did not result in lost time at work. According to Theuri [13], wages for workers in *Jua kali* sector are pegged directly on production and therefore, absence from work greatly impacts their daily earnings.

A five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) was used to assess economic impacts of injuries arising from workplace hazards. The arithmetic means and standard deviations for the responses as received were then computed to assess the significance of each of the aspects investigated. The findings of this study are presented in Table 6.

Table 6: Economic impacts of occupational Hazards

Aspects	Mean	Std. Dev
Reduction of income as a result of workplace injuries	4.66	.437
Reduction in working efficiency due to injury sustained.	4.06	.329
Incapacitation due to injuries sustained	2.55	.366
Change of occupation a result of injuries sustained.	2.10	.556
Injuries sustained affects future earnings	1.83	.581

From the means in Table 6, it can be deduced that injuries that the workers have sustained at workplace have resulted in significant reduction in the worker’s incomes (mean = 4.66 or (93.2%)) and also a reduction in their working efficiency (4.06 or (80.1%)). Thus, lack of safety at workplace has a very significant impact on the economic wellbeing of the *Jua kali* workers.

It can also be seen from the means that the injuries the workers have sustained have somehow incapacitated them (mean = 2.55 or 51%). However, the injuries have not significantly affected their future earnings (mean = 1.83 or 36.3%),



A regression analysis showed that mechanical hazards had the greatest impact on the health and economic wellbeing of *Jua kali* workers while poor housekeeping had the least impact. These findings are similar to those of Gikonyo [16], who reported that most injuries in Kamukunji informal sector are mainly as a result of mechanical hazards such as being struck by moving/falling objects, impacts and crushes.

13. Conclusions

This paper has assessed occupational hazards and their impacts in *Jua kali* sector in Nakuru town, Kenya. It was seen that the main mechanical hazards are cutting (20%) and impacts (17%). It was further seen that the main chemical hazards are exposure to welding fumes (40%), exhaust fumes (25%) and paint vapours (18%).

It was also seen that noise levels in most of the *Jua kali* workplaces are above 90 dB(A), which is above the maximum allowable levels by Directorate of Occupational Safety and Health Services (DOSHS).

Further, it was seen that occupational stress, fatigue, back pain and headaches are the most common work-related ailments experienced by the *Jua kali* workers. Occupational injuries mostly sustained are cuts, punctures, abrasion and bruises inflicted by tools, equipment and materials.

On the issue of economic impact of the hazards, it was seen that the most common factors are property damages, reduction in income and working efficiency of the injured workers, arising from accidents at workplace.

The following are recommendations arising from the results of the study. The recommendations can be taken up mainly by policy makers and implementation agencies.

1. A national policy for occupational safety and health should be developed to specifically address safety and health in the informal sector. One of the objectives of the policy should be to impart practical knowledge to informal sector workers on workplace hazards identification and control.
2. There should be regular training and awareness programs on safety and health for *Jua kali* sector.
3. *Jua kali* workplaces should be designed so as to incorporate various aspects of health and safety, including mechanisms for effective response to emergencies. We suggest a further study on this aspect.

4. It should be made mandatory that machines such as those used for grinding, trimming, etc, be fitted with guards.
5. Where process-induced noise is inevitable, mechanisms for isolation or shielding should be put in place and enforced.

References

- [1] Christer, H., Bodhi, P. (2000), Occupational Safety and Health in Developing Countries: National Institute for Working life.
- [2] ILO (2011). International labour introductory report. Global trends and challenges on Occupational safety and Health; Istanbul, Turkey
- [3] Kenya National Bureau of Statistics, Economic Survey 2017
- [4] Karanja I.W.M, Muchiri, F.K., Muruka, A. (April 2013) Safety and Health in the Informal Economy. *African Newsletter on Occupational Health and Safety*. Vol. 13 (1):4-6
- [5] Valentina F., (1999) ILO: Improvement of working conditions and environments in the informal sector through safety and health measures 36 (4), 1-17.
- [6] Mehdi J., Akbar R., Parvaneh Y., Bahare M.A., Faroborz B., Ahmadi S.F. and Zahra M (2016) Study of Occupational Health Services in Self-Employed Enterprises (Nano-scale Enterprises) In Shiraz, Iran.
- [7] Rongo, LMB. (2005). Health risks related to the chemicals in small scale industries in the informal sector. *East African public Health Journal*, 2, 1-13.
- [8] Loewenson, R. H. (1998) Health Impact of Occupational Risks in the Informal Sector in Zimbabwe. *International Journal Occupational Environmental Health*. 4(4):264-74.
- [9] UNDP (2017) Human Development Reports
- [10] Takala J, Pavi H, Kaija L.S, (2013), Global Estimates of Burden of Injury and Illnesses at Work in 2012
- [11] Weil, D. (2001). The Economic Consequences of Work Injury and Illness: National Occupational Research Agenda, Denver: National Institute for Occupational Safety and Health.
- [12] Menya, D., Too R, Rafael S.C (2012) Occupational Risk Factors in *Jua kali* Industry, Eldoret, Kenya. *African Newsletter on Occupational Health and Safety*. Vol 22 (2):46-50
- [13] Theuri, C.K. (2012) Small-scale Enterprises and Informal Sector in Kenya. *African Newsletter on Occupational Health and Safety*. Vol 22 (2):32-34
- [14] Waters, T.R., Putz-Anderson, V., Garg, A. and Fine, L.J. (1994) Applications Manual for the Revised NIOSH Lifting Equation. DHHS (NIOSH) Publication No. 94-110. U.S. Department of Health and Human Services, Cincinnati.
- [15] Kimani, M.J (2011) Evaluation of Occupational Noise exposure among workers in metal fabricating sector in Kamukunji, Nairobi, unpublished MSc thesis, Juja: Jomo Kenyatta University of Agriculture & Technology
- [16] Gikonyo, E.G (2008) The impacts of Occupational Hazards on the Health of Metal Workers in Kenya's *Jua Kali* Sector A Case Study of Kamukunji Metal Work Cluster in Nairobi, University of Nairobi Repository
- [17] Mugenda, O.M. and Mugenda A.G. (2003) Research methods, Quantitative and Qualitative Approaches, ACTS Press, Nairobi