Electrical Safety Management in the Kenya Informal Sector: A Case of Eldoret *Jua Kali* Sector

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ABSTRACT

The *jua kali* sector in Kenya is involved in the manufacture of many items and, like the formal manufacturing sector, uses electricity. Normally electricity is supplied to consumers depending on the consumer's maximum expected load demand. However, some consumers overload their supply lines and neglect electrical safety rules. A research aimed at developing a comprehensive electrical safety programme for Eldoret *jua kali* sector was undertaken. It was found that the majority of *jua kali* operators do not adhere to electrical safety regulations and requirements. Moreover, they also lacked the appropriate tools and equipment for electrical services and many operated from temporary shelters.

Keywords: Electricity, safety, informal, Kenya

1. INTRODUCTION

Development of sources of energy to accomplish useful work is the key to industrial progress which is essential to the continued improvement in the standard of living of people everywhere in the world (Stevenson, 1982). Electricity has proved to be the most convenient source of energy and it is now becoming very popular in domestic, industrial, agricultural and commercial sectors of Kenya's economy (KIE, 1994). This is because it is easy to generate, distribute, and control, and when properly installed, is safe for anyone to use (Lansley, 1989).

The Government of Kenya is currently advocating the informal sector, also known as *jua kali* ('hot sun' in Kiswahili – since most of them are in the open), as an alternative employer due to limited employment opportunities the formal sector (Republic of Kenya, 1994; King, 1996). The *jua kali* sector is involved in the manufacture of a wide range of items that include: farm implements, household utensils, office furniture, electrical appliances and specialised machine parts. The sector therefore uses electricity for processes like lighting, drilling, cutting, grinding, welding and soldering.

The fact that most *jua kali* operators work in the open or operate in temporary premises makes provision of electricity safely a difficult undertaking. It has also been observed that illegal power extensions, without regard to safety, are common in the *jua kali* sector. Thus *jua kali*

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operators are more vulnerable to the potential dangers of electricity, which include electric shock, electric fires, electric explosions and electric burns. Existing literature on electric safety does not adequately cover the *jua kali* sector and this research was undertaken to fill the void.

The objectives of this research were therefore:

- To conduct a critical analysis of existing electrical safety standards and regulations in Kenya.
- To provide an overview of electrical safety concepts, risks and impacts.
- To conduct a survey of typical electrical safety issues in Eldoret *jua kali* sector
- To develop electrical safety management measures for the Eldoret *jua kali* sector.

The hypotheses to be tested were:

1. There is no significant difference between the electrical safety regulations and requirements observed in *jua kali* workshops/premises and those established by both the Ministry of Labour and Kenya Bureau of Standards.
2. There is no significant difference between the electronic tools used by the *jua kali* operators and those recommended for electronic services.
3. There is no significant difference between the electrical tools and equipment used by *jua kali* operators and those recommended for electrical services.

2. METHODOLOGY

The survey method of data collection was used in the study. Data were collected through questionnaires designed by the researcher, interviews and participatory observation. The questionnaires had self-administered questions and Kuder-Richardson formula was used to calculate the reliability coefficient of the questionnaires. Owners/employees of some of the workshops/premises were interviewed and open-ended questions were used to enable the researcher collect more information in greater depth.

The research object was the Eldoret *jua kali* association premises and operation area and all the 300 registered *jua kali* workshops/premises in Eldoret municipality formed the population for the study. Questionnaires were administered to 80 of them who offered electrical and electronic services. This sample was chosen by systematic random sampling method. Out of the 80, 25 were chosen for interviews and 53 for participatory observation.

Answers to the questionnaire were analysed using descriptive methods. The chi-square formula was used as the general framework for evaluating whether there was significant difference between (i) the electrical tools and equipment used by *jua kali* operators and those expected of an electrician in the formal sector; (ii) the electronic tools and equipment used by *jua kali* operators and those expected of an electronic engineer in the formal sector; (iii) the safety regulations in *jua kali* and those recommended by the Ministry of Labour and Kenya Bureau of Standards.

3. LITERATURE REVIEW

A review of literature was done to show the nature and characteristics of electric power supply systems including installation and testing within the premises of the consumers. It was noticed, however, that premises such as those used by most *jua kali* operators in Kenya are not covered by standard literature on electrical installation though one finds reference to 'temporary installations', which have an expected maximum period of service of three months only after which they must be completely overhauled.

'Temporary installations' are usually under the continuous monitoring of a qualified electrician who has the legal responsibility to ensure the safety of the installation, which includes its construction, maintenance, and extension. The question that comes up in the context of the *jua kali* sector in Kenya is whether the *jua kali* electricians are aware of all the safety requirements of such 'temporary installations'. This is because the *jua kali* workshops/premises in Kenya commonly break the safety regulations of 'temporary installations'.

Electricity is a serious source of potential danger. Electrical hazards, unlike many mechanical hazards, are not usually obvious; a live conductor does not differ in appearance from a dead conductor, and the lack of earthing of a metal enclosure may exist unnoticed until it is too late when the metal work is touched and found to be dangerously live.

The major dangers of electricity are:

- Electric shock which occurs when the human body becomes part of an electric circuit; the effect depends on the magnitude of the current, duration of the shock, moistness of the skin, and the age and health of the victim.
- Electric fires which occur when a conductor is overheated and ignites other materials.
- Electric burns which are caused by an arc containing molten metal and are generally more dangerous (and more painful) than normal burns.
- Explosions that occur when a flammable substance is ignited by an electric spark or by an electric appliance with a surface temperature high enough to ignite any vapour or dust present.

The only supplier of grid electricity in Kenya is Kenya Power and Lighting Company (KPLC). KPLC has certain conditions which a consumer must satisfy before grid electricity is supplied to the premises. The Ministry of Labour and Kenya Bureau of Standards have also come up with electrical safety requirements and regulations which apply to the generation, transformation, conversion, switching, controlling, regulating, distribution and use of electrical energy in any factory and any premises (Kenya Bureau of Standards, 1996).

4. RESULTS AND DISCUSSION

Table 1 shows that all the operators had some level of literacy with the majority having secondary education as their highest level. This indicates that many secondary school leavers who fail to further their education end up in the *jua kali* sector.

Table 1: Highest education level of operators

	No.	%
Primary	24	36.9
Secondary	38	58.5
University	3	4.6
Total	65	100

Table 2 shows that most of the operators underwent on-the-job training. This was attributed to the high cost of training in formal colleges. Many also claimed that what was learnt in the colleges was mainly theoretical and was never useful in *jua kali* world, which requires practical skills and innovation.

Table 2: Highest professional qualifications of operators

	No.	%
On-the-job training	37	56.9
Trade test	8	12.3
Artisan certificate	6	9.2
Craft certificate	5	7.7
Diploma	7	10.8
Degree	2	3.1
Total	65	100

Table 3 shows that a majority of jua kali workshops/premises were temporary. This was because they (jua kali operators) rent these premises and thus could not build permanent structures. It was, however, noticed that the majority of the permanent workshops belonged to those offering electronic services.

Table 3: Status of workshops

	No.	%
Permanent	10	15.4
Temporary	55	84.6
Total	65	100

Table 4 shows that a majority of electrical installations were temporary. This was because the workshops were temporary and poorly constructed in most cases. Moreover, most of the operators did not have authorised power supply and therefore it was just a matter of temporarily tapping power from one neighbour to another. This meant that most of them used pvc sheathed cables (Table 5). It is also possible that most of them were incompetent in handling electrical circuits.

Table 4: Electrical installations in workshops

	No.	%
Permanent	16	24.6
Temporary	49	75.4
Total	65	100

Table 5: Type of wiring systems

	No.	%
p.v.c conduit	15	23.1
p.v.c. sheathed	34	52.3
p.v.c. trunking	16	24.6
Total	65	100

Table 6 shows that the majority of the temporary installations were serviced once a year. This is much less than the once in three months recommended for such installations.

Table 6: Servicing of the 49 temporary installations

	No.	%
Never	8	12.3
Once a year	33	50.8
Twice a year	15	23.1
Three times a year	5	7.7
Four times a year	4	6.2
Total	65	100

Table 7 shows that a majority of the workshops/premises had been in existence for less than 5 years. The fact that they rent their premises and lack market for their products means that they may not be able to pay rent promptly and are sent away from time to time by the plot owners. This causes instability in their business and lack of trust by potential customers.

Table 7: Age of business

	No.	%
Under 5 years	39	60
Over 5 years	26	40
Total	65	100

Table 8 shows that a majority of the workshops/premises employed less than 5 employees. This is because the workshops/premises are usually small and deal with a few items at a time.

Table 8: Number of technical employees

	No.	%
Less than 5	58	89.2
More than 5	7	10.8
Total	65	100

Table 9 shows that the majority of employees are males. This is because the nature of the working environment in the sector – long hours in scorching sun, lack of tools and equipment, lack of amenities – may not be liked by women. Moreover, most girls do not like technical work (Okaka, 2001).

Table 9: Employees by gender

	No.	%
Male	122	92.4
Female	10	7.6
Total	132	100

Table 10 shows that most of the workshops are situated within town. This could be because this is where most of the clients are found and also town is where most of the raw materials are found. Those located in the outskirts of town are established in densely populated areas like Langas and Huruma.

Table 10: Location of the workshops/premises

	No.	%
Within Eldoret town	48	73.8
In outskirts of town	17	26.2
Total	65	100

Table 11 shows that the majority of the workshops offered electrical services, which included: battery charging, arc-welding, electrical wiring and repair of electrical appliances. The arc-welders were dealing mainly with the welding of door and window frames, metal chairs and tables, and car parts.

Table 11: Specialisation of workshops/premises

	No.	%
Electrical services	47	73.4
Electronic services	18	26.6
Total	65	100

Table 12 shows the significance of the various electrical safety requirements and regulations as practised by the Eldoret *jua kali*. From this Table, it can be said that, at 5% level of significance, there is a significant difference between the electrical safety management in the *jua kali* premises and that recommended by the Ministry of Labour and Kenya Bureau of Standards.

Table 12: Chi-square analysis of electrical safety management in Eldoret *jua kali* sector

	Significance
Cables secured at plugs	0.074
Cables not frayed	0.000
Cables with mechanical protection	0.000
Use of earthed metal work	0.000
Circuit not over-fused	0.000
Good or unbroken earth connection	0.004
Sound electrical joints	0.000
Authorised additions to final circuits	0.039
Protected/earthed socket outlets	0.039
No use of two-pin adapter where earthing is required	0.001
No bell wire used to carry mains voltage	0.891
Use of sound welding machine	0.011
Use of unbroken connectors e.g. plugs	0.009
No signs of heating at socket outlets contacts	0.039
Correct cable size for lighting circuit	0.891
Correct cable size for heating circuit	0.002
Correct cable size for power circuit	0.039
Correct cable size for sockets	0.009
Presence of protective goggles	0.680
Presence of face shield	0.028
Presence of fire extinguisher	0.000
Presence of hand gloves	0.000
Use of sound battery charger	0.008

Table 13 shows the significance of use of the recommended tools and equipment by jua kali operators offering electronic services. From the Table, it can be said that at 5% level of significance, except for CRO, signal generator and signal tracer, there is no significant difference between the electronic tools and equipment used by jua kali operators and those recommended for such services.

Table 13: Chi-square analysis of electronic tools and equipment

	Significance
Engineer's pliers with insulated handle	0.225
Soldering iron	0.090
Multimeter	0.469
CRO	0.008
Signal generator	0.002
Signal tracer	0.001
Microphone	0.225
Earphone	0.090
Long nose pliers	0.134
Phase tester	0.808
Precision screw drivers	0.046
De-soldering iron	0.225
Radio alignment tools	0.467
Variable DC power supply	0.225
Variable AC power supply	0.808

Table 14 shows the significance of use of the recommended tools and equipment by jua kali operators offering arc-welding services. From the Table, it can be said that at 5% level of significance, only five out of the twenty electrical tools and equipment had a significant value higher than 0.05. These were: engineer's square, files (assorted), hacksaw, screw drivers (assorted), and bench vice.

Table 14: Chi-square analysis of electrical tools and equipment used for arc-welding services

	Significance
Industrial-made arc welding machine	0.028
Face shield	0.009
Multimeter	0.002
Files (assorted)	0.683
Grinder	0.005
Engineer's square	0.317
Scriber	0.022
Hacksaw	0.549
Tin snips	0.028
Phase tester	0.000
Screw drivers (assorted)	0.162
Ordinary hammer	0.162
Soft-face hammer	0.022
Drilling machine	0.009
Drill bits (assorted)	0.041
Vice grip pliers	0.001
Drill sharpening gauge	0.000
Bench vice	0.317
Centre punch	0.028
Engineer's pliers	0.028

Table 15 shows the significance of use of the recommended tools and equipment by jua kali operators offering electrical wiring services. From the Table, it can be said that at 5% level of significance, only six out of the 21 were found to be significant. These were: screw drivers (assorted), side cutter, engineer's pliers, long nose pliers, ordinary hammer, and engineer's square.

Table 15: Chi-square analysis of electrical tools and equipment for electrical wiring services

	Significance
Screw drivers (assorted)	1.000
Megger	0.008
Phase tester	0.033
Bending spring	0.013
Multi-meter	0.033
Side cutter	0.166
Engineer's pliers	0.285
Spanners (assorted)	0.033
Ordinary hammer	1.000
Soft-face hammer	0.013
Engineer's square	0.593
Wire stripper	0.013
Cold chisel	0.008
Gimlet	0.008
Vice grip pliers	0.021
Portable drilling machine	0.008
Twist drill bits (assorted)	0.052
Long nose pliers	0.109
Drill-sharpening gauge	0.004
Draw wire	0.021
Centre punch	0.033

Table 16 shows the significance of use of the recommended tools and equipment by jua kali operators offering battery-charging services. From the Table, it can be said that at 5% level of significance, only two out of the 10 were found to be significant. These were: engineer's pliers and screw drivers (assorted).

Table 16: Chi-square analysis of tools and equipment for battery-charging services

	Significance
Industrial-made battery charger	0.012
Hydrometer gauge	0.000
Multi-meter	0.012
Phase tester	0.012
Screw drivers (assorted)	0.317
Spanners (assorted)	0.020
Engineer's pliers	1.000
Long nose pliers	0.012
Side cutter	0.020
Wire stripper	0.005

Table 17 shows the significance of use of the recommended tools and equipment by jua kali operators making/repairing electrical appliances. From the Table, it can be said that at 5% level of significance, only four out of the 14 were found to be significant. These were: screw drivers, ordinary hammer, engineer's pliers and long nose pliers.

Table 17: Chi-square analysis of electrical tools and equipment for electrical wiring services

	Significance
Multi-meter	0.012
Screw drivers (assorted)	0.819
Phase tester	0.018
Ordinary hammer	0.637
Soft-face hammer	0.005
Engineer's square	0.012
Side cutter	0.108
Wire stripper	0.005
Engineer's pliers	0.819
Soldering iron	0.018
Vice grip pliers	0.003
Long nose pliers	0.346
Rewinding machine	0.001
Oven	0.000

It is therefore clear from these results that the common tools and equipment that were being used by *jua kali* operators included: engineer's square, engineer's pliers, screw drivers, ordinary hammer, hacksaw and long nose pliers. Other important electrical tools and equipment were rarely found. These results therefore revealed that there is a significant difference between the electrical tools and equipment used by *jua kali* operators and those recommended for electrical services and has led to the rejection of the third null hypothesis.

From interviews carried out in 25 *jua kali* workshops/premises, it emerged strongly that most operators lacked financial assistance which, they claimed, contributed greatly to their poor quality services. They never hesitated to blame the government for lack of commitment as far as the implementation of *jua kali* sector policies were concerned. They said promises for financial assistance were made to them by the Ministry concerned with *jua kali* but has not been implemented so far.

Lack of market for their products was another problem the operators faced. They also cited the Eldoret municipal council and KPLC personnel as harassing them in both the place of work and the electric power they used. The municipal council officers wanted them to pay levies for the premises they work in, yet the operators claimed that they pay money to individual owners of the plots in which they operate.

Application and supply of electrical power was mentioned as very expensive and hence the operators connected their supplies from their friends who had managed to get power through the right channel. Most operators also said that due to the temporary nature of their

workshops/premises they saw no need of proper electrical installations. They also cited the high cost of electrical accessories and materials as the other factor that made them not go for proper installations.

The operators also accused the technical training colleges for providing only theoretical knowledge to their students and no practical skills. They said that *jua kali* trained operators work faster and more accurately than the ones trained in formal institutions. However, it was found that personnel trained in formal institutions were more aware of the existence and proper use of the essential tools and equipment and safety procedure.

The operators offering electronic services that included servicing and repairing of radios, televisions, amplifiers, and video machines proved to be aware of the electrical safety requirements and regulations and in fact 95% of their workshops were permanent and had proper electrical installations. All those interviewed had professional qualifications and used proper tools and equipment.

It was noticed that the operators were never keen on electrical safety issues. They seemed not to be aware that they were exposed to dangers of electricity and if at all they were aware, then they did not care. Most of cables used to supply power to electrical appliances were frayed and some of them even used bread wrappers and other polythene materials to insulate conductors. It was also sad to note that the operators used any size of cable to extend power from one point to another.

5. CONCLUSIONS AND RECOMMENDATIONS

From the study, it can be concluded that:

1. There is a significant difference between the electrical safety regulations and requirements observed in *jua kali* workshops/premises and those established by both the Ministry of Labour and Kenya Bureau of Standards.
2. There is no significant difference between the electronic tools used by *jua kali* operators and those recommended for electronic services.
3. There is a significant difference between the electrical tools and equipment used by *jua kali* operators and those recommended for electrical services.

From the study, the following recommendations can be made:

1. The government should build permanent electrical workshops in areas designated for jua kali workshops/premises.
2. KPLC should provide power to *jua kali* sector at lower cost than formal sector.
3. *Jua kali* operators should periodically attend seminars on electrical safety.
4. The government should assist *jua kali* operators access loans.
5. More technical training colleges be put up and their curricula reviewed to be more practical.

6. REFERENCES

Kenya Bureau of Standards, 1996. Kenya standard specification for safety requirements for domestic and similar electrical appliances. Nairobi: KBS Centre.

KIE, 1994. Secondary electricity pupils' book one. Nairobi, Kenya: Kenya Literature Bureau
King, K. 1996. Jua kali in Kenya: Change and development in an informal economy. Nairobi: EAEP.
Lansley, T., 1989. Basic electrical installation work. London, UK: Bath Press.
Okaka, P.O. 2001. Technical and vocational education training in Kenya. Paper presented at Sub-regional workshop on promotion and reform of technical and vocational education and training in Africa, Kampala, Uganda.
Republic of Kenya, 1994. Jua kali sector policy, management and needs. Nairobi: Ministry of Research, Technology & Technical Training.
Stevenson, W.D. 1982. Elements of power systems analysis. Singapore: McGraw-Hill.

NOMENCLATURE

KPLC Kenya Power and Lighting Company
CRO Cathode Ray Oscilloscope
DC Direct Current
AC Alternating Current
KIE Kenya Institute of Education
EAEP East Africa Educational Publishers
KBS Kenya Bureau of Standards