INVESTIGATION

OF

THE RATE AND CAUSES OF ELECTRIC SHOCK ACCIDENTS

(ABUJA, KADUNA AND MINNA AS A CASE STUDY).

BY

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93/3704

A PROJECT SUBMITTED

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR

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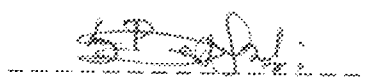
MARCH 2000

DECLARATION.

I hereby declare that the project work is an original concept wholly investigated by me, and submitted to the Department of Electrical and Computer Engineering, Federal University of Technology, Minna in partial fulfillment of the requirements for the award of the degree of Bachelor of Engineering.



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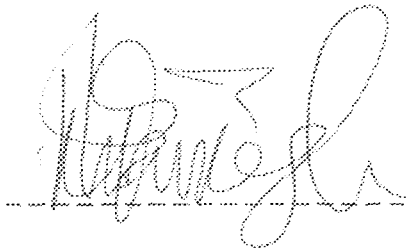
CERTIFICATION.

This is to certify that this project titled "Investigation of the Rate and Causes of Electric Shock Accidents (Abuja, Kaduna and Minna as a Case Study), was carried out by Sule B. N. (93/3704), under the supervision of Mr. Pinne K. K. and submitted to Electrical and Computer Engineering Department, Federal University of Technology, Minna in partial fulfillment of the requirements for the award of Bachelor of Engineering (B. Eng) degree in Electrical and Computer Engineering.



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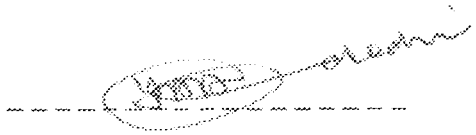

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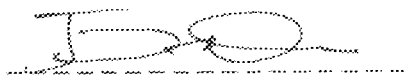

11/4/2009

Dr. J. O. Oni

EXTERNAL EXAMINER

DATE

DEDICATION.

To God, for life, strength, hope and my parents.

To my parents Mr. and Mrs. J. A. SULE for everything else.

ACKNOWLEDGEMENT.

Foremost, I owe gratitude to God, for making me, and giving me the strength to complete this phase of my life, and for everybody He made to be with me.

Special and sincere gratitude goes to my parents, Mr. and Mrs. J. A. Sule, for their immense contribution to my life. They did not abandon me when things got bad. The ever sounding advice from my mum, care and love she showed. The ever supportive finances and words of courage and hope with love from my dad have always been the bedrock on which I stand.

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I cannot close without mentioning the wonderful people God put in my way to help me during the good and the worst time during my course of study, Mr. & Mrs. F. S. Gana and family, Brother Dipo Ajayi and Aunty Lola, you stand out among the crowd. I have to mention specially here, Lanre Sunday Ajayi. I can not quantify the show of love, financially and every other way you have shown me.

To my family, my brothers and sisters, Kayode Sule, Ahmed Sule, Ayo Sule, Daniel Sule, Victoria Sule and Fatima Sule, you are all wonderful.

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To Helen Yisa, Adeoti, Ramat, Bimbo, Esse, Thomas Barna, Bose, Buchi and everyone else who added to my life, I say thanks. To those who stayed with me in my darkest hours, thanks for keeping the faith; and to those who left me, thanks for making a man out of me.

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ABSTRACT.

This project investigates the rate and causes of electric shock accidents and compares them with the effect they have on society. It shows the causes of accidents, the frequency at which they occur and compares such data on the positive and negative change in the society.

It justifies a general knowledge of electricity, its leakage, which causes shock, the reasons behind this, and the affected subjects. It is done with the comparison of graphs to prove stated points and assumption, deduce information and to generate new data on the topic of investigation.

TABLE OF CONTENTS.

CHAPTER ONE

GENERAL INTRODUCTION

INTRODUCTION:

Accidents have remained within the system of every growing society even before the advent of the civilised world. Accidents can not be avoided, occurring in different environments and circumstances. The modern society has thus evolved into one that has put into cognisance, with its development, the effects of accidents on it.

Electric shock accident can be treated as a subject on its own. This investigation therefore looks into electric shock accidents to determine the causes and the frequency of occurrence of same and its effect on society. In achieving the goal, the various forms of electric shock accidents will be considered, the probability of its occurrence and a comprehensive comparison will be undertaken to ascertain as close as possible the causes and rate with random sampling taking, also taken into effect the failure probability.

Considering the fact that Nigeria and indeed the global village called the civilised earth is increasingly advancing in technology a number of hazardous conditions are being looked into to provide a safer condition. Thus, it has become necessary to find solution, to electric shock accidents. To achieve this it would be necessary to have knowledge of the causes of such accidents, the frequency, intensity and invariably the environment of concentration. This necessitates the conduction of this investigation, which would provide foundation knowledge to the provision of solution to electric shock accidents.

1.1 NEED FOR THE INVESTIGATION.

It is quite imperative for every nation to have a clear and comprehensive data and statistical information on the electric shock accident cases within its border. This is necessary in governmental planning and will govern decisions taken on accidents. According to Afolabi, (1998). " We must know how much trouble our 'electrical transmission causes if we are to effect any significant cure for it".

This investigation will provide a data and information insight

i. for the establishment prediction of electric shock accidents rate in the country,

ii. for planning and preparations of lectures and seminars on safety and precautions in the electrical field,

iii. for the process of planning electrical installations,

iv. for guidance in preparations of safety regulations,

v. that will help to rectify and reduce mortality and casualty rate resulting from electric shock accidents,

vi. that will guide in determining what aspects of the society needs orientation on type of safety and precautionary measures,

vii. which will enhance plans in providing alternate measures to situations, which are highly accident prone.

1.1.1 AIMS AND OBJECTIVES.

The Aims and Objectives of this investigation is

i. to ascertain true cause and true rate of electric shock accidents,

ii. to establish an avenue to compare causes and rate to advancement in the society,

iii. to help provide a reference database for the planning of legislature on electrical shocks accidents,

iv. to help provide database in the determination of what aspect of electrical environmental needs to be looked into.

1.2 METHODOLOGY.

In carrying out any investigation, it is necessary that research be done extensively to gather information already available about the proposed topic of investigation. Libraries and data information centres including administrative department of companies, hold a large volume document for reference and inductive purposes.

There are two types of information gathered for the purpose of investigation. The first is already available data from libraries and data information centers and the other being information obtained from individuals and bodies by the use of questionnaire.

i. Data Collection.

Data collection is of the utmost importance in carrying out an investigation as it provides a lead into and a background for the actualization of the investigation. In the course of this particular investigation, data was collected in two forms. The static type, being the already existing information, was retrieved from libraries. Information related to electric shocks accidents was gathered by the use of questionnaire, which targeted the related sections of society. Hospitals that receive cases, employer and employees of electrically related institutions and domestic residents, which are consumers of electricity and this, exposed to the shock.

ii. Analysis of Data

The data received and collected has to be screened to detect anomalies in it. The issue of outdated information or present unlikeness due to improvement in technology and electrical layout system has to be considered, while in case of volatile data the issue of authenticity comes in. Probability of occurrence and exaggerated information has to be carefully determined before being used as selected and approved data.

1.2.1 QUESTIONNAIRE.

The questionnaire used for information gathering in this investigation is of three types: the hospitals/medical type, the industrial type, and the personal/individual type. The basic difference between all three is the target audience and the form of approach to information demand.

1.2.2. CONSIDERATION OF QUESTIONNAIRE

The questionnaire is interactive and personalized and involves two sections in all the three types. The first is to be able to determine authenticity and have record of source of information while the second deals strictly with the collection of necessary data and needed information. The questionnaire is short, precise and does not bother about unnecessary information.

All three types of questionnaire were used to gather information in all three cities used as case study and equal numbers were used to have a distinct and equal probability determination.

1.2.3 LIMITATIONS OF INVESTIGATION.

The process of information and data collection and processing was not without shortcomings. The first of such is access to information centres and access to the data in information centres. Available data, where reached, is limited as they contain very little information on accident rates. Most information on the subject is restricted to causes and prevention.

The larger part of the investigation depended then on information recovered from questionnaires. It is also important that not all shock accidents are reported in hospitals, causing a shortage in data.

The investigation could not be conducted in every state due to financial reasons and the case centers are not an adequate representation of the nation.

1.3 LITERATURE REVIEW.

1.3.1 SCOPE OF INVESTIGATION.

All investigations undertaken in the course of this project have limitations on its expanded borderline. They do no exceed the Nigerian border. only three cities were used as a case study. This, it is expected, will cover a wide range in the sectors expected to be investigated in a project.

Abuja, owing to its location, population and extensive and diversified working community, is selected as one case centre. Being able to provide data from a community using high voltage sources as an industrial centre, Kaduna is also chosen. Minna is also a case centre to complement a young growing community of majority of domestic consumers.

Although volatile data is narrowed down to the case centres, it is to be noted that static data types were collected widely from around the country. The accumulation of data was not restricted to electrical establishments alone but to every aspect of the society.

1.3.2 CRITERIA FOR ACCEPTABILITY OF ELECTRIC SHOCK ACCIDENT.

For electric shock accidents to be said to have occurred, the victim must first have come in contact with an exposed voltage source and current flows through him. It has been estimated that about 0.003A of current is sufficient to give a tingling sensation and between 10 to 15 milliamperes will cause the tightening of muscle, causing difficulty in releasing objects gripped at that moment. Between 25 to 30 milliamperes, tightening may extend to the thoracic muscles and at about 50 mA fibrillation of the heart occurs which may lead to death.

Thus, even if not dangerous at 0.003 A, it becomes dangerous from above 10 mA. Medically, shocks from this point on can be considered as effective shocks.

1.3.3 ACCIDENT RECORD IN NIGERIA

For a long time, due to a lot of factors and loss, record keeping has not been encouraged adequately. Although, vital in formulation and investigation of situation involvement, the public sector has had a low record base.

The private sector establishments hold the greater part of records. Victims of electric shock accidents though, hardly report cases that do not cause physical or obvious

mental damage. Most medical centres in turn manage a poor record system, which have been destroyed gently.

Summarily it can be said that very little records of accidents are kept in Nigeria, although, it is known that we have a high accident rate.

1.3.4 TYPES OF ELECTRIC SHOCK ACCIDENTS.

i. Industrial Electric Shock Accident: This is the type of accident that can also be referred to as an occupational hazard. Accidents in this category can be linked with power workers and people in establishments that with high voltage sources and lines on almost daily bases. Causes here can hardly be attributed to ignorance but rather negligence, violation of rules and/or unavoidable circumstances.

ii. Domestic Electric Shock Accident: This involves accidents in residential and living quarters. They can be attributed to a wide range of faults in electrical fittings and appliances and can be said to be caused by ignorance and illiteracy. Most accidents here are in low and medium voltage sources.

iii. General Electric Shock Accidents: this is a combination of the other sectors, which are non-industrial and domestic. It involves open-air accidents; automobile accidents with electrical installations and those caused by environmental factors. The causes can be attributed to carelessness, violation of basic rules, ignorance and the environment. High, medium and low voltages are involved here.

1.3.5 CLASSIFICATION OF ELECTRIC SHOCK ACCIDENTS.

- Societal Electric Shock Accident: This is the relationship between the frequency of accidents and the total number of people exposed. The relationship is plotted as a cumulative frequency distribution curve. The degree of accident is specified. It however does not show the distribution of accidents in the society.

- Individual Electric Shock Accidents: The frequency at which an individual specified by location suffers an accident. The location, nature of injury and source of accidents are quoted. It is used to provide a geographical representation or picture of the geographic electric shock accident distribution.
- Overall Electric Shock Accidents: This is a combination of both the societal and individual electric shock accidents. It describes the workable distribution of where electric accidents are possible.

1.3.6 DATA REQUIREMENT.

In every investigation, it is necessary to obtain data that will guide the investigation. It is important to give avenue of a foundation to base every finding and working on.

There are two types of data.

i. Static Data: Already existing information, retrievable from libraries, data storage centres and files. It is an accurate data type.

ii. Volatile Data: Data gathered from the society by the use of questionnaire and verbal questioning, retrievable from individual and organizations. It has a chance of inaccuracy.

Classification of Data.

The data collected can be classified based on the form and particular information. This investigation considers three types; i. Medical, ii. Establishment, iii. Domestic.

1.3.7 COMPARISON OF ELECTRIC SHOCK ACCIDENTS.

To design a reasonable working paper for the prevention and installation of precautionary measure against electric shock accidents in the society, data on the distribution of electric shock accidents, its concentration, its scope, frequency of

occurrence and type is necessary. Magnitude is a function of literary level (in terms of awareness) in the society and working class.

This investigation will take into cognisance the relationship between all types of electric shock accidents, the distribution in terms of population and the frequency based on literacy level. This covers both rate and causes.

1.3.8 RATE AND CAUSE ANALYSIS.

To effectively analyse the rate and causes of accidents, it is necessary to look at each subject individually before any combination analysis is done.

(a) Cause –Consequence Analysis.

This shows the relationship between initial causes of accident and its subsequent relative consequence. The consequence is a general situation. Cause analysis deals with comparison of various situations that lead to accidents and the determination of a singular factor that is exclusive.

(b) Rate Analysis.

This shows the relationship between the frequency of occurrence of accidents and the subject under investigation. Subject in this case varies from individuals to a community, a related company or a selected environment. The sample space, which is invariably the subject area, is plotted against the frequency to be able to compare the rate. An average or general collection will result in an optimum. A maximum which can be used for external comparison.

1.4 PROJECT OUTLINE.

Chapter One of this investigation introduces the reader to a brief explanation and idea of what the subject is about. The aims and objectives, the methodology and literature review talks of method applied in the process of information gathering, of types of

information and what they represent. It gives a detailed information of what the project is based on.

Chapter Two shows the distribution of the data collected, its tabulation, and general description. It simplifies data and prepares it for onward processing.

The result of the investigation and discussion comes up in Chapter Three; here, the data is logically worked out to produce visible result translated into causes and rate and the effect of this result is discussed.

The Chapter Four of this project rounds up the entire work, and eventually suggest ways of improving.

CHAPTER TWO.

GENERAL ATTITUDE OF RESPONDENTS.

Data representation by the use of questionnaire involves the preparation of such data, distribution of it and recollection. The distribution involves going from home to home and office to office. In doing this, it becomes imperative to meet with people of different characters, the intended respondents.

In the course of this investigation, respondents were very co-operative, receiving and returning questionnaire and adhering to written and verbal instructions. Though, it must be put into record that not every part was smooth. A few negligible percentage of respondents actually filled the questionnaire for fun, this as much can be detected from the language and data type. Such questionnaires were selected and eliminated, to minimize error margin.

A few verbal instructions were put to every receiving respondent.

i. Restrict data to the last 20 years. This is necessary to have a sample space.

ii. To state separately if cases discussed has been reported to the hospital and to what hospital. This is to be able to avoid the duality of cases, so as not to have false overshoot in figures.

iii. A definition of what constitutes the electric shock accident was given to avoid respondent guessing.

In general, there was an air of co-operation especially within the industrial and medical sector, seemingly because they understood the importance of the investigation more than the respondents in the domestic sector did.

2.2 ANALYSIS OF QUESTIONNAIRE FOR ABUJA.

Table 2.2.1: Distribution of Questionnaire.

Description of Sectors	Domestic	Industrial	Medical	Total
Number of Distributed Questionnaire	150	12	15	177
Percentage of Dist. Questionnaire	84.70	6.80	8.50	100

Table 2.2.2 Casualty Returns.

Description	Domestic	Industrial	Medical	Total
Number of Casualty	68	3	28	99

DOMESTIC ACCIDENTS

Table 2.2.3 Domestic accidents in the last 20 years.

1980 - 1984	1985 - 1989	1990 - 1994	1995 - 1999
18	32	12	6

Table 2.2.4 Causes of Domestic Accident.

Illiteracy /Ignorance	23
Auto Accident	--
Error During Work	5
Others	16
Don't Know	24

Table 2.2.5 Degree of Injury Obtained.

Death	Burns	Stunning
3	--	65

INDUSTRIAL ACCIDENTS.

Table 2.2.6 Distribution of Degree of Injury.

Death	Burn	Stunning
2	--	1

MEDICAL ACCIDENTS

Table 2.2.7 Distribution of Degree of Injury.

Death	Burn	Stunning
5	3	20

2.3 ANALYSIS OF QUESTIONNAIRE FOR KADUNA.

Table 2.2.1 Distribution of Questionnaire.

Description of Sectors	Domestic	Industrial	Medical	Total
Number of Distributed Questionnaire	150	20	15	185
Percentage of Dist. Questionnaire	81.10	10.80	8.10	100

Table 2.3.2 Casualty Returns.

Description	Domestic	Industrial	Medical	Total
Number of Casualty	90	4	67	161

DOMESTIC ACCIDENTS

Table 2.3.3 Domestic Accidents in the Last 20 Years.

1980 - 1984	1985 - 1989	1990 - 1994	1995 - 1999
24	42	9	15

Table 2.3.4 Causes of Accident Distribution.

Illiteracy /Ignorance	29
Auto Accident	--
Error During Work	7
Others	4
Don't Know	50

Table 2.3.5 Degree of Injury Obtained

Death	Burns	Stunning
5	2	83

INDUSTRIAL ACCIDENTS

Table 2.3.6 Distribution of Degree of Injury.

Death	Burn	Stunning
2	1	1

MEDICAL ACCIDENTS

Table 2.3.7 Distribution of Degree of Injury.

Death	Burn	Stunning
6	3	58

2.4 ANALYSIS OF QUESTIONNAIRE FOR MINNA.

Table 2.4.1 Distribution of Questionnaire.

Description of Sectors	Domestic	Industrial	Medical	Total
Number of Distributed Questionnaire	150	8	10	168
Percentage of Dist. Questionnaire	89.30	4.80	5.90	100

Table 2.4.2 Casualty Returns.

Description	Domestic	Industrial	Medical	Total
Number of Casualty	51	1	21	73

DOMESTIC ACCIDENTS

Table 2.4.3 Domestic Accidents in the Last 20 years.

1980 - 1984	1985 - 1989	1990 - 1994	1995 - 1999
21	7	18	5

Table 2.4.4 Causes of Accident Distribution.

Illiteracy /Ignorance	8
Auto Accident	1
Error During Work	3
Others	2
Don't Know	3

Table 2.4.5 Distribution of Degree of Injury.

Death	Burns	Stunning
1	--	50

INDUSTRIAL ACCIDENTS

Table 2.4.6 Distribution of Degree of Injury

Death	Industrial	Stunning
--	--	1

MEDICAL ACCIDENTS

Table 2.4.7 Distribution of Degree of Injury

Death	Burn	Stunning
2	1	18

2.5 COMPARATIVE ANALYSIS OF ELECTRIC SHOCK ACCIDENTS IN ALL SELECTED CITIES.

Table 2.5.1 Distribution of Questionnaire.

	Medical	Industrial	Domestic	Total
Abuja	15	12	150	177
Kaduna	15	20	150	185
Minna	10	8	150	168
Total	40	40	450	530

Table 2.5.1 shows the distribution of questionnaires in all three cities.

Table 2.5.2 Distribution of Accident Record.

	Medical	Industrial	Domestic	Total
Abuja	28	3	68	99
Kaduna	67	4	90	161
Minna	21	1	51	73
Total	116	8	209	333

Table 2.5.2 shows the distribution as recorded.

Table 2.5.3 Distribution of Accidents in 20 Years.

Representation in Years	Range	Total no. of Accidents in the Domestic Sector
1995 - 1999	5 years	26
1990 - 1994	5 years	39
1985 - 1989	5 years	81
1980 - 1984	5 years	63

Table 2.5.4 Total Distribution of Causes of Accident in All Three Cities.

Cause of Accident	Abuja	Kaduna	Minna	Total
Illiteracy /Ignorance	23	29	8	60
Auto Accident	--	--	1	1
Error During Work	5	7	3	15
Others	16	4	2	22
Don't Know	24	50	37	111

CHAPTER THREE.

RESULTS AND DISCUSSION.

3.1 RESULTS.

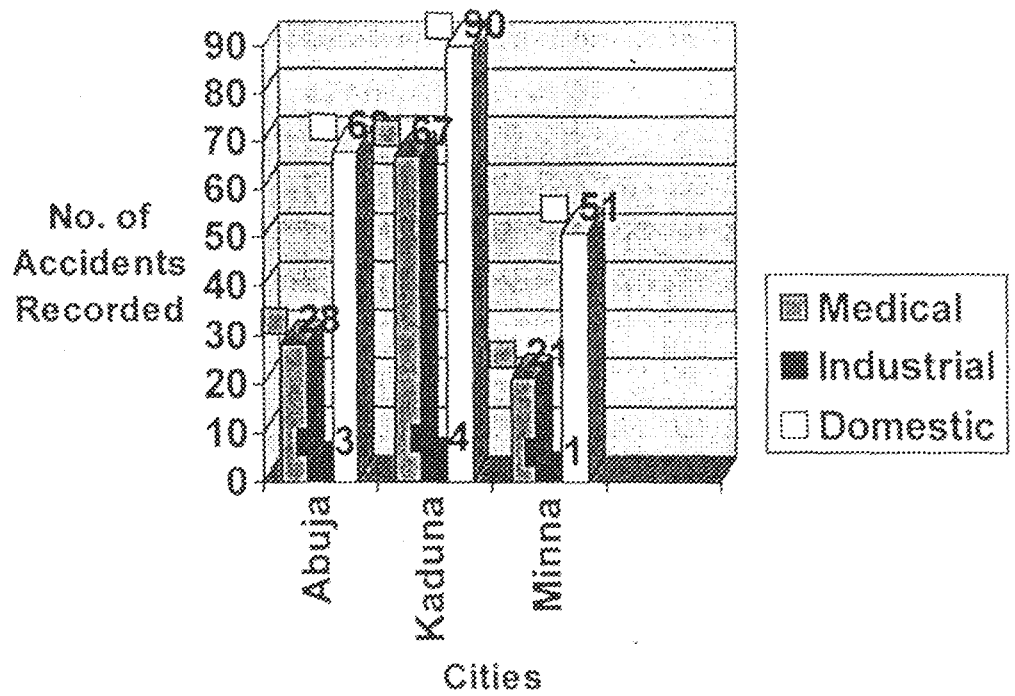

Fig. 3.1.1 Chart showing distribution of accidents in three cities.

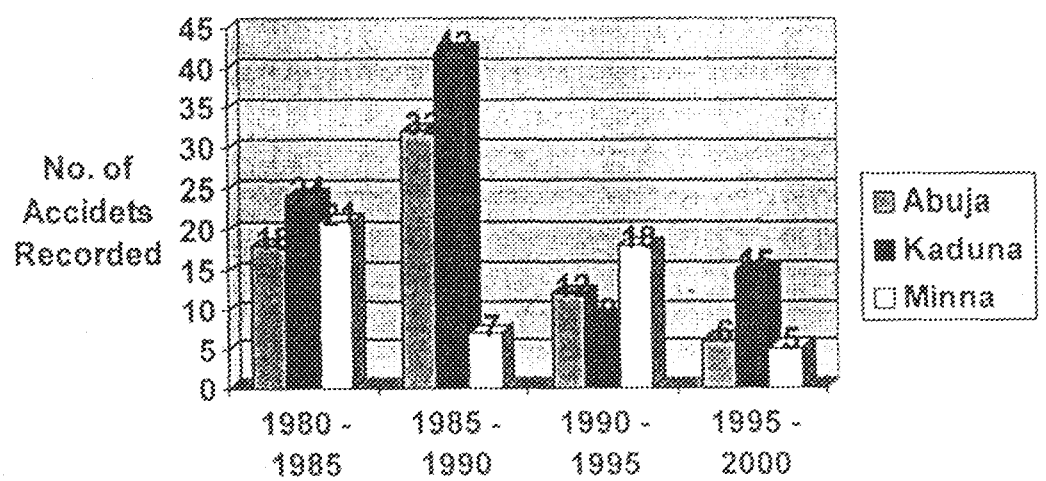

Fig. 3.1.2 Chart showing rate of accidents in all three cities

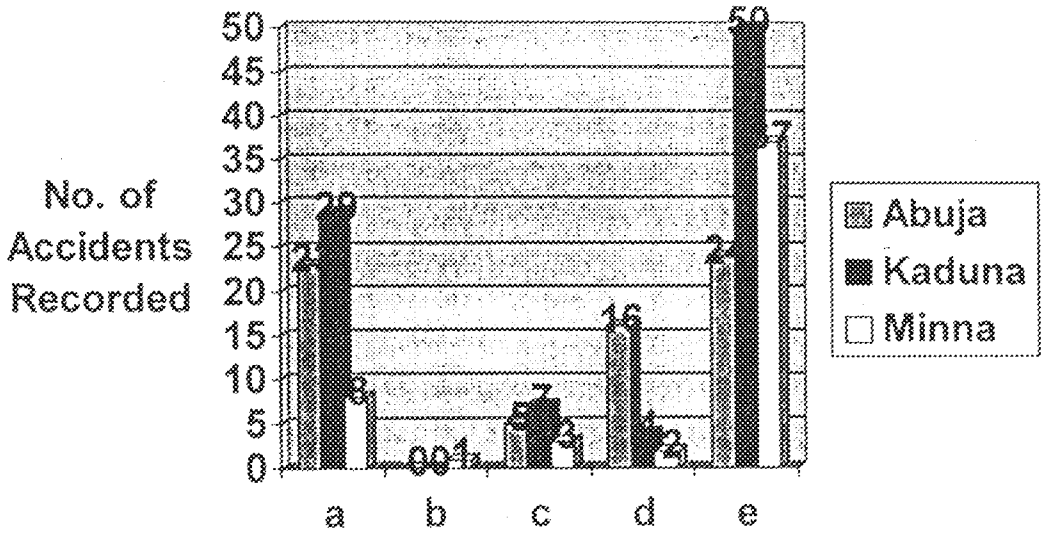

Fig. 3.1.3 Chart showing causes of accidents in all three cities.

Key:

a – Ignorance /illiteracy.

b – Auto accidents.

c – Error.

d – Others.

e – Don't Know.

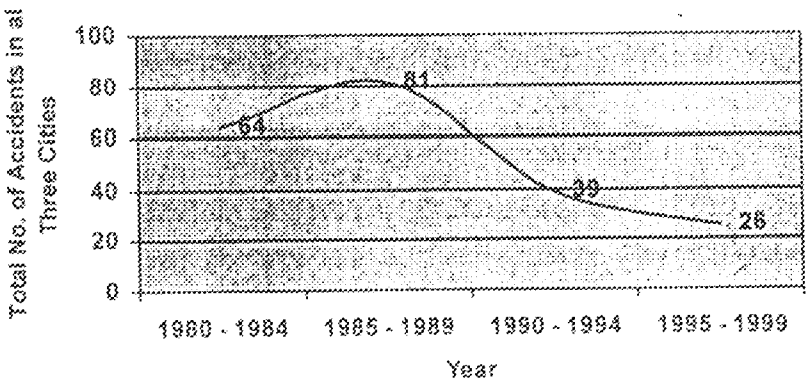

Table 3.1.4 Frequency Chart Showing Distribution of Accidents (per 5 years) in 20 years.

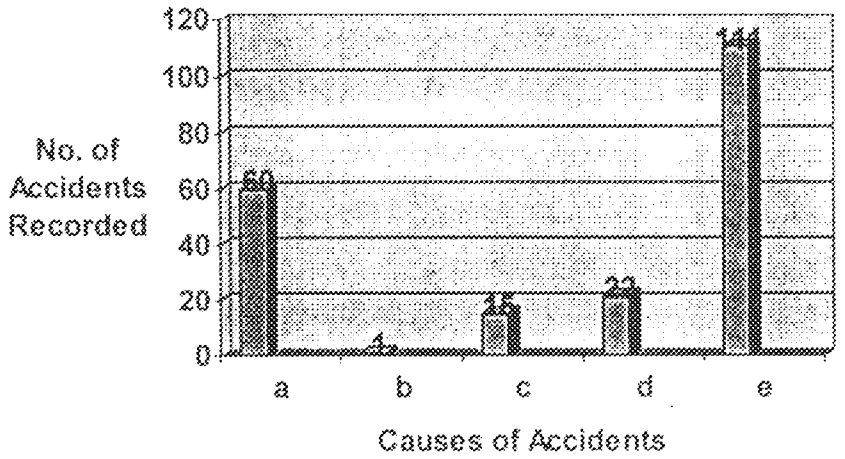

Fig 3.1.5 Chart showing total cause(s) of accidents.

Key:

a – Ignorance /illiteracy.

b – Auto accidents.

c – Error.

d – Others.

e – Don't Know

Total number of accidents in each sector in all three cities:

Medical Sector = 116

Industrial Sector = 8

Domestic Sector = 209

Total number of faults recorded for every case:

Ignorance /illiteracy = 60

Auto accidents = 1

Error during work = 15

Others = 22

Don't know = 111

Note: In all three cities, accidents in the industrial sector are wholly due to error.

3.2 DISCUSSION.

It can be noticed from Fig. 3.1.1 that the domestic sector records the highest number of accidents, taking into consideration that cases already reported to the medical centres have been eliminated. From the analysis, it should be noted that although a high number of accidents are reported to the medical centres, a lot is still held back. Generally, the industrial sectors in all three cities record very few accidents due to a very high prevention ethic.

Figure 3.1.2 shows, that Kaduna, followed by Abuja and Minna, records the highest number of casualties. This is probably attributed to the fact that they are in an order of technological advancement and have a higher population density. The basic representation of the graph is that within the last 10 years as compared to the last 10 to 20 years, there has been an appreciable drop in accident rates. The highest record being between the last 10 and 15 years and the lowest within the last 5 years.

The causes are represented in Fig. 3.1.3, ignoring the "Don't Know" figures, as it does not typify any particular function and the "Others" which could be a fragmentation of a number of causes. A high figure is seen for the ignorance /illiteracy, showing that a high percentage of faults is due to very little or no knowledge of electricity. Error during work also accounts for a reasonable percentage while auto accidents involving electrical installation are very little.

3.3 EFFECT OF ELECTRIC SHOCK ACCIDENTS

All events, including accidents, have effect on the society in which they happen. Electric shock accidents have both negative and positive effect, and representation on the society.

The accident itself is a negative action, which can maim or kill. Apart from death, which can result from it, it can render a person impotent or induce cancer. According to

Afolabi, (1998); "I understand it can even cause impotence and cancer" referring to electromagnetic wave.

This action increases mortality rate and indirectly affects labour and production. High accident rates reflect on the profitability of a business, a society, the economy of a nation, as cost of production would unavoidably be increased. In summary, the effect of electric shock accidents is as listed below.

i. Injury to worker.

ii. Loss of skilled labour through death or incapacitation.

iii. Loss of production time (man hours) due to temporary absence from duty as a result of hospitalisation.

iv. Loss of time and money spent in investigation of accidents.

v. Compensation claims.

vi. High cost of caring for families of injured or deceased persons or outfit.

vii. Poor public image of the organisation with staff or of production outfit.

There are no real positive effects derived from accidents except that, they create awareness and draw attention to neglected aspects. They make production outfits (of electrical appliances) improve on safety of products and make power generating authorities create awareness about the danger of electricity and invariably provide more protection against shocks in installations.

CHAPTER FOUR.

CONCLUSION AND RECOMMENDATION.

4.1 CONCLUSION.

Accidents are due largely to human error, which include unsafe acts and unsafe conditions or a combination of both. In recent years, as shown by this investigation, accident rate has greatly reduced. Corroborating this fact is Obilimo (1998). According to him, " it is heartening to note that the rate of electrical accidents is gradually going down".

To solve any problem a good base study of the causes and rate should be carried out. Organisations and government have it as a statutory responsibility to prevent accidents within its territory.

Electric shock accidents are hazards, and the management of such is essential. An identification of it, measurement, removal and substitution is paramount to make any society grow.

Thus, in this investigation, it has been established that most electric shock accidents are caused because of lack of knowledge on electric power and its installation and the handling procedures of appliance. Taking into cognisance that error too causes accidents and this happens mostly with skilled workers who understand the workings and principles of electricity. Carelessness too contributes. It is also established that there are high percentages of casualties on the consumers side than the workers (producers). Therefore, to greatly check this result with the effect it has on society, it is necessary for organisations and governments to look into various investigations on the topic and act.

4.2 RECOMMENDATION.

It must be noted that many preventive measures are already in place to avoid electric shock accidents, such as the provision of protective wears (gloves, goggles and boots), the fencing of electrical installation, the provision at consumer ends of

switchgears, breakers and insulators (which protect over-voltage and abnormal situations) and the training and persuasion of consumers, safety workshops for workers, laws and acts such as the 1987 Factories Decree.

Accidents can be prevented if all these are in place, and if, when accidents occur, the causes are recognised and appropriate counter measures adopted. Below is a list of recommendations, which from my findings I deem necessary to be considered.

1. Education, training and persuasion by NEPA workers to the grass roots (villages and illiterates) should be stepped up on electrical installations, appliances and electricity.
2. More workshops on safety should be carried out, and regularly too.
3. Warning signs on electrical installations should not only be in English but in the local dialect of the host communities.
4. Regular checks on locally built houses' electrical installations should be done to make sure there is compliance with regulations on wiring.
5. Electric appliances along the road should be well protected and guided against auto crash.

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