TITLE PAGE

INVESTIGATION OF THE ENVIRONMENTAL HAZARDS OF RUNNING CABLES AND CONDUCTORS (BOTH NEPA AND TELEPHONE) IN THE OPEN AIR.

BY

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93/3722

A PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF ENGINEERING (B. ENG.) DEGREE IN THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING, SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE.

MARCH, 2000.

DECLARATION

I hereby declare that this project work is the result of my own handiwork and has not been submitted by anybody anywhere. It was conducted under the supervision of Engineer A. O. ADULOJU(Senior Lecturer in the department of Electrical & Computer Engineering ,F.U.T, Minna.)

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93/3722

05/04/2000
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DEDICATION

This project work is humbly dedicated to the Almighty Allah and to my beloved parents, Late Mallam Yusuf A. Afolayan and Late Madam Yusuf A. Mopelola, who up to the point of their death, believed that education with Godliness is the only key to emancipation.

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More often, than not too, its major power stations and sub-stations are strategically located at remote towns and villages nation-wide; it has so developed its network of generation, transmission, distribution and marketing that today it stands as a colossus in this great country's special initiative towards socio-economic industrialization.

Hand-in-hand with these positive strides is the clear manifestation of the Authority's overall interest in pushing the frontiers of sports development to the highest height.

In the same vein, the Federal Government of Nigeria also created the Nigerian Telecommunications (NITEL) plc. in 1985 as a result of the creation of the Ministry of Communications, which was formerly under the Nigerian Post and Services (P. &T.) together with the Nigerian Postal and Service Telegraph (NIPOST).

Prime consideration of a power station is the production of electrical energy while that of communication is the generation of tone (current) signals. Though both are invisible and intangible, they have their influence and splendoured effects on our private and public lives. They are, however, the turning wheels of the nation's socio-economic development.

1.4 PROJECT OUTLINE.

The project is divided into four broad chapters. Chapter one is the introductory part which deals with the effects of cable network in the open air.The aims and objectives of this research work as well as the various methods employed in carrying out this research and the review of the literature. Chapter two deals with the generation, distribution and transmission of current electricity, NEPA and NITEL cabling systems, and the major causes of the environmental hazards of running cables in the open air. In chapter three, the advantages and disadvantages of both overhead and underground cables in comparism , the discussion of the results, the effects of cables on technology, the significant of the study, the limitation of the study and the reliability of overhead and underground cabling systems and their maintainability. Finally, in chapter four, the general Conclusions, Recommendations and References were drawn

CERTIFICATION

This is to certify that this project titled "**The Investigation of The Environmental Hazards of Running Cables and Conductors (BOTH NEPA & TELEPHONE) in The Open Air**" was carried out by YUSUF M. A. under the supervision of Engineer A. O. ADULOJU 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 & Computer Engineering.

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External Examiner

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Signature & Date

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ACKNOWLEDGEMENTS

I am indeed grateful to the wonderful Allah Almighty for making me what I am today. My sincere gratitude goes to my parents for their love and support.

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In fact, it has been a rewarding experience working with such a hospitable, kind and very hardworking Engineer.

My appreciation also goes to the honorable H.O.D., Engineer (DR.) Y.A. Adediran for his kindness.

'When kindness cannot be returned, it should be appreciated and passed on to others' (-Dele Giwa, 1984). This is the reason why when I looked back at this junction of my life, I could do but nothing than to express my sincere gratitude to Messrs. Yusuf R. Adebayo and Usamot F. Omoniyi whom Allah has used tremendously in this my University education. Really, I am indeed grateful. May the merciful Allah continually grant them a resounding success in all their life endeavours.

A river that forget its source shall surely dry. My utmost thanks and appreciation to my beloved and ever caring family for they have been a garland to grace my head and a chain to adorn my neck.

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This vote of thanks will be incomplete if I do not recognize the deemed moral and financial support of my sister, Late (Mrs.) A. Areo. May God give her an eternal rest and grant the entire family the fortitude to bear the irreparable loss.

Acknowledgement is greatly expressed to my fiancée, Miss.K.A.Afolabi, my friends: Messrs. Salami R.A., Yusuf K.O., Adebisi T.A., Lawal M. Bisi and other colleagues too numerous to mention

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minimum the electromagnetic and mechanical effects on the cables, the rate of electrocution and hence to beautify our environment.

1.2 METHODOLOGY

The set of methods used in this project work include oral sampling of individual opinions, the use of Questionnaires and the tabulation of the results obtained, and lastly, personal research through the use of relevant textbooks and other related journals to supplement the overall findings. This methodology is therefore limited to the afore-mentioned methods.

1.3 LITERATURE REVIEW

An attempt was firstly made in the early twenties to combine the advantages of high voltage alternate current (a.c.) turbo-generation and that of high voltage direct current (d.c.) transmission by Calvery and High field with the 'transverter'. This idea was based on the connection of number of transformers using brush-gears that is rotating synchronously at high speed. Hewitt's Mercury vapour rectifier (1901), the grid control (1928) provided the basis for controlled rectification and inversion.

Experiments were carried out in America with thyrations and in Europe with Mercury pool devices (1940). Also, in Soviet Union, and experimental single anode valve was constructed during the Second World War whilst an intensive research was conducted in Sweden by Allmana Suenska Elektriska Aktie bologet (ASEA) (1940).

In Germany, the secretarial for Aviation encouraged the development of high voltage direct current (d. c.) technology during the war based on the fact that underground transmission was less vulnerable to air raids. An experimental transmission system of 15 MW at 100KV was built between the chaloten-burg and Moabit districts of Berlin. This was intended to be a prototype for a 60 MW, 400KV system of about 110KM; part of which was built by the end of the war.

An underground system was brought into operation between Moscow and Kashwa, transmitting 30MW at 200KV over 112KM. Nonetheless, Sweden had pioneered the development of the modern high voltage direct-current (d.c.) transmission technology.

Also installed at 20MW, 100KV direct-current (d.c.) over 96KM was the Sweden-Scotland link (1954). The Britain-France (English channel) submarine link was constructed at 169MW, + 100KV direct –current (d.c.) at 64KM (1961).

The first overhead transmission linking Volgograd Donbass (1962-1965) with 720MW at + 400KV, 900A over 470KM was constructed. The New Zealand link (1965) which was partly overhead (570KM) and partly submarine (40KM) alternate-current (a.c.) of 600MW at + 250KV direct-current (d.c.) from North to South was also laid. The Kontiskan of 250MW, 250KV direct-current (d.c.) (1965) Interconnecting Sweden and Denmark partly overhead and partly submarine were installed.

Besides, Sakuma interconnect or (1965) to interchange up to 300MW at + 125KV in either direction between 50HZ to 60HZ power systems in Japan in the case of alternate-current (a.c.) network disturbances or lack of energy in either system was constructed. There is no practical alternative to the alternate-current (a.c.) to direct-current (d.c) and back to alternate-current (a.c.) converting station. The Sardiania – Italy (mainland) (1967)of 200MW at 200KV direct-current (d.c) over 121KM was constructed. The Pacific direct-current (d.c.) inter-tie (1970) runs in parallel with two other alternate-current (a.c) circuits at 500KV, 50HZ over 1372KM overhead transmission was installed.

However, three-terminal Kingsworth-Beddington Willesden direct-current (d.c.) scheme of 640MW, + 266KV was constructed in United Kingdom to reinforce the existing alternate-current (a.c) in areas of high load density without increasing the short circuit level (1974). It has distances of 59KM and 82KM for each respective links. The more obvious application (875KM) of nominal capacity of about 1620MW± 450KV to be expanded to its ultimate capacity of about 6500MW in Nelson River Bipole (1973-1977) was constructed. The first stage of this scheme used the highest power mercury-arc valves ever developed at 100KV and 1800A.

Due to the intervention of transformer, the advocates of alternate-current (a.c) prevails and steady development of local electricity generating station commenced with each larger town or load center operating its own station.

The National Electric Power Authority (N.E. P .A.) Was established by the Federal Government of Nigeria Decree No 24 of 1st April, 1972 consequent upon the amalgamation of the Electricity Corporation of Nigeria (E. C. N.) and Niger Dams Authority (N. D. A.). With that provision, the basic functions of the Authority cover the generation, transmission, distribution and marketing of electricity at an economical rate throughout the federation and even beyond, and, therefore, charge customers minimally for their consumption.

More often, than not too, its major power stations and sub-stations are strategically located at remote towns and villages nation-wide; it has so developed its network of generation, transmission, distribution and marketing that today it stands as a colossus in this great country's special initiative towards socio-economic industrialization.

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CHAPTER TWO

OVERHEAD CABLE HAZARDS.

2.0 INTRODUCTION:

The cable network of the National Electric Power Authority (N.E.P.A) and that of the Nigerian Telecommunication (NITEL) plc. have been subjected to severe attacks by vandals in recent times. The usefulness of the copper content of the cable in the making of jewelries and revinding of electrical machines cum loud speakers may have been the major attraction to the vandals. Though, this is not the only source of hazards but the incidents of cable theft had become so rampant that the multi-million Naira investments in both electricity and telephone cable networks became seriously threatened. Sudden loss of electrical and telephone services at strategic places equally threatened economic activities and national security to both lives and properties.

2.1 GENERATION, TRANSMISSION, AND DISTRIBUTION NETWORK.

Basically, electricity is generated by either Hydro or Thermal methods here in Nigeria. This is done through the eight major power stations located strategically nation-wide. The three hydro and six thermal power stations have a total installed capacity of 5,920 mega-watts (MW). The hydro (water) power station is cheaper to run but, even then, it is more expensive to build. Thermal power stations, on the other hand, depend on high pour fuel oil, steam, gas coal, e.t.c., for their operation. The cost of mining a thermal station is, therefore, much higher than its equivalent capacity of hydro power plant. The generation voltage is normally 16 kilovolts (KV).

The energy for telephony is generated by a constant direct -current (d.c.) supply at the main exchange (control room) with a capacity of about 50 volts.

The power generated is transported to the required various load centres all over the country for utilization at 330 Kilovolts (KV) and (or) 132 kilovolts to ensure minimum loss during the transmission process since power is transmitted over a long distance. The power stations, Distribution, and sub-stations are carefully inter-linked by a transmission

Network popularly known as the National Grid (N.G). Thus the generated electricity is contributed into a pool at the National Control Centre, N.C.C.,Osogbo, in Osun State for even re-distribution across the federation.

In the telephone network, individual lines were jumpered at the exchange side and cable pairs were laid from the exchange to cabinets erected at strategic locations in the town. Transmission lines were put in place by the authorities. The subscribers telephone sets' designed with in-built transmitter and receiver and the generated tone-signals are then linked via the distribution points and cable network which are overheads, for economic consideration, to the customers.

The consumers step down high voltages to very smaller ones for consumption. Power is, therefore, stepped-down from 330 Kilovolts (KV) to 132KV to33KV and 11KV for industrial consumers, and further down to 415 volts and 230volts for domestic consumption. The voltage at which a customer takes supply and how the supply is metered indicates the consumption charge

2.1.1 OVERHEAD CABLE NETWORKS.

Electrical energy and tone-signals must be transported from their producers to the customers. The cheapest method of conveying them is by overhead lines particularly where light load are concerned. For low and medium voltage services, overhead line poles used are of wooden or reinforced concrete. They are generally 8 metres in length with some 7metres out of the ground. The regulations that govern the election of poles must be observed for efficient and hazard free transmission network. Electricity poles should be on one side of the way whilst the telephone poles and water pipes on the other. In Nigeria, this regulation is not given much consideration hitherto. The butt of the poles should rest on a few inches of concrete or a hard core and be well rammed –in. However, in loose ground, cross-braces are very necessary below the ground level to present a larger area to the yielding soil.

The use of conductors is employed to carry the generated energy and signals to the appropriate consumers. Those mostly used include Aluminum, Al or copper, Cu. They possess high electrical conductivity, good mechanical properties and high resistance to corrosion. Conductors must have a breaking load of at least 560 Kilograms (KG) except those on a service to the consumers. They may be bare or insulated. All wooden support other than the hard wood or oak cross- arms must be impregnated with creosote.

Insulators generally reduce the loss of power being transmitted and avoid earthing of the voltage to the ground in overhead power cable that depends on air for its insulation. It makes use of glass or porcelain insulators at the supports.

Frequency and voltage at the major quantities used the power utility and communication respectively. Alternating current (a.c.) and direct current (d.c.) are the only forms of electrical energy in use generally. It is very economical to transmit large amount of alternating current power over long distances by the use of high voltages. The high voltage (h.v.) is of the order of 11KV to 230KV, 230KV to 7 65KV and voltages above 765KV are termed ultra-high voltage (U.H.V.) whilst 120V to 415V is considered as low- voltage (L.V.). The voltage used for transmitting electricity worldwide depends on the distance to be covered by the transmission cable network and ranges from 660KV through 132KV.

Investigation rev ealed that as at 1997, 500km of 330KV lines, 6000km of 132KV lines and 55,143 KM of 415volts lines and over 27,216 towers were constructed and firmly erected. A frequency of 50HZ is enhanced in Nigeria while in United state of America, for example,60HZ is used for her operations.

Length of poles, clearances required above ground, the availability of right-ways, policies and regulations from the government are some of the factors that dictates the planning and design of overhead cables. If these factors and many others are observed they can reduce the cable hazards to a greater extent.

2.1.2 DEFINITION OF TERMS USED:

(1) CABLE:

A cable is defined as a length of a single insulated conductor (solid or stranded) or two or more such conductors each provided with its own insulation which are laid up together.

(2) WIRE:

Any conductor which is composed of a conducting material, and is uniform in diameter and circular in cross-section, is called a wire.

(3). CONDUCTOR:

A substance which offers a low resistance to the flow of electric current is called a conductor. Examples of conductors are Copper, Aluminum, Eureka, Tungsten, and so on.

(3) INSULATORS:

A substance which (at a particular voltage) does not allow the flow of electrons, current ,through it is called an insulator. For example, some of the good insulators are mica, rubber, polyvinyl chloride (PVC), e.t.c.

(4) CORONA:

Corona phenomenon is defined as a self-sustained electric discharge in which the field intensified ionization is localized only over a portion of the distance between the electrodes.

(5) TELEPHONY: This is the method and process of sending sound and receiving message by telephoning.

(6) SIGNAL: signal is defined as the electric impulse in radio, television, sound or television image transmitted or received.

2.2 HAZARDS CAUSED TO THE ENVIRONMENT BY OVERHEAD CABLES.

This section deals with the overhead cable hazards done to the entire environment. These hazards are mainly due to both natural and unnatural effects and some of them include burning of houses and properties, constant loss of service, cable congestion , effects of broken poles, electrocutions, radio interference, total blackout, et-cetera, et-cetera.

For economic consideration, vast majority of power and telephone cables were laid in the open air. Many people ignored the side effect of these aerial networks and built their houses underneath due to the scarcity of land and hence violating the right-of-way. In big cities like Lagos and Kano where there is urban congestation, buildings were usually erected under high tension lines or very close to the power lines. Some of those involved in this act are ignorant of their effects and future implications while many do not consider it so dangerous to their lives and properties. Any of the transmission lines that falls on the roof of their houses will cause an extremely great havoc which may and may not be repaired. In case of power transmission lines lives and properties may be lost due to fire outbreak or (and) electrocution. However a reclosure of the circuit breaker might be tried, as a protection would be required to reduce the effects to the barest minimum.

Danger between a 330KV and the fallen wire on the ground could ocurr when a re-closure of the circuit breaker is tried. These could be fire outbreak all over the places very close to the affected area, since most electricity lines are usually protected these protection then activates and remove voltage supply from the line. The protective device commonly used is the circuit breaker (C.B.).

A great care must be exercised when closing a circuit breaker to avoid a disaster. Investigation revealed that early this year at Kaduna state, an 11KV distribution line connected on the same pole as 415volts distribution line cable fell on the 415 volts line resulted in immediate power failure. The re-closure of the circuit breaker was carried out by the appropriate staff on duty and the 415 volts were then energized by the fallen 11Kilovolts power line. More than seven people were instantly electrocuted to death. Also in Niger state another 11KV line fell off the cross-arms of the power pole and the circuit breaker again was automatically opened. The conduction of the line on the ground was observed when a reclosure was tried and five goats and a number of other creatures were reportedly burnt beyond recognition.

A Fulani man in 1997 observed that his hen has laid eggs on the conductor of the 415V power line mounted on poles. He was electrocuted in attempting to pack the eggs and the hen due to ignorance. This occurred in kwara state. In 1998 an electrician was also electrocuted when he was reconnecting a dis-connected power line. Similarly, a bat was electrocuted in an attempt to rest on a 415 volts distribution lines. In the second quarter of this year a young man in his early twenties was electrocuted at Bida, Niger State, when he was plugging mangoes on a mango tree which has been electrified by a cable that fell on it unknowingly to the victim.

Broken poles might fall on the roads or (and) streets due to heavy rainstorms and winds. These fallen poles together with the cables they carry might be conducting if the relays at the control rooms are not functioning or because of residual voltages in the affected cables. Thus, the conducting medium has been one of the main sources of electrocution to the surrounding people and animals in general. Cyclists, motorists and passers-by were not left out. Apart from preventing them to carry out their daily activities, it is very detrimental to those that are unaware of the incident and therefore might accidentally step on the live cables resenlting in their sudden and untimely death.

More so, in December 1998 at Ilorin, Kwara State,a 33Kilovolts transmission line suddenly cut due to improper joining of the cables and (or) weak cables and dropped on a telecommunication's cabinet cum the other road adjacent to the cable. Although no casualty was recorded, investigation reveals that the cabinets as well as the exchange sides were seriously damage. Millions of Naira was lost to this disgruntled incidence.

Voltage surges usually occur when lightning and thunders and storms take place and then come in contact with the aerial cables. Over voltages build up and current surges would be induced into the cable circuitry simultaneously. These over currents and over voltages usually destroy the electronic systems connected in our residences and switched on permanently. Telephone cables could be damaged and the resulting affect the loss of service from the utility. This effect is very rampant due to high number of thunderstorms per year, which is generally put at 45,000.

Power and telephone cable networks might take the form of linear or radial in the open air. These methods of laying cable have caused the congestion of the cables in the environment and as a result the natural beauty of our environment is threatened over the years. However, these are still considered as the cheapest compare to the underground but it must quickly be added that they directly or indirectly encourage the vandals to perpetuate their illegal acts. Hence, the open air seems untidy and, at times, does not give free access to its users such as house builders and heavy trunk motorists who may like to transport large goods across the roads at a particular time.

In addition, broken high-tension lines may fall on to fire outbreak. Short circuits could also result from the sparking of distribution cables and improper twisting very often. These distribution cables and other high-tension cables dry bushes and then result could damage buildings and properties. Damage cables that are meant for distribution eventually result in the blackout due to power outage. The affected customers may not enjoy their electrical facilities for some days or months depending on the degree of the damage and some other factors.

Environmental pollution could also occur due to the burning of the aerial cable network or fire outbreak. Carbon (ii) oxide and carbon(iv)oxide were released into the atmosphere and these hazardous compounds are very dangerous to human lives when inhale in a very large quantities.

The odour of ozone (03) formed in the atmosphere due to the effects of corona on high voltage and extra high voltage is very harmful to the entire people's health. Whenever a conductor is energized above its corona threshold voltage, an audible noise that appear as a hissing sound would be heard. This sound is produced by the disturbances set up in the air in the vicinity of the discharge. Ozone plays an important role as a good absorber of gamma rays from the sun.

When an old man, so says an adage, keeps harping on a matter time and time again, it is either he enjoys discussing it or it is an issue that pains him to his bone marrow. Who enjoys talking about parasites living on his body, a vermin that is ready to suck life out of his victim? This is exactly the true picture between the NEPA and NITEL utilities and vandalisation. Enormous resources have been lost to the callous and nefarious act of vandalization which have since become a social problem in the country.

Electricity and telephone cable thefts have been so rampant that hardly a day could be passed without the vandals perpetrating their unpatriotic acts. For example, late in March 1989,the whole Afam-PortHarcourt 330 KV lines were vandalised causing a collapse of four giant tower tension lines. And so ,a curtain of darkness was drawn over the whole of state radio and Television stations and the entire communities. This incident led to the interruption of the agog and blissful preparations for the state visit of the president of Nigeria, General Ibrahim Babangida and the proposed visit had to be cancelled at the last minutes due to the blackout in the state.

Vandalization of 33KV overhead line along Madobi Road, Kano, in Dala District was also recorded. This caused an interruption of electricity supply to every nook and cronny of the district for over three months. Besides, the distribution network lines in Birnin Kebbi and Sokoto districts were also vandalized.

We cannot over-emphasize the importance of both electricity and telephone networks in powering the economic, social and technological development of our nation. The continuous vandalisation of overhead cable lines which tends to impede the productivity, stability, and distribution of electricity and signals in our country should therefore be viewed seriously and pay the desired attention to. Since 1991, Imala, Imeko and other adjoining towns and villages in Abeokuta district have been without power supply. No sooner had the electrification project of the area been completed than the vandals struck, carting away the cables, pot insulators, spindles and other materials then valued at about six million naira (N6M).

On the other hand, another instance of vandals-induced blackout occured in Osun state. At least eleven local Government areas were affected. This unpatriotic act took place in 1995.

In April 1997,about fifteen communities located in four Local Government Areas of Edo State were thrown into darkness after an onslaught of vandals had vandalized the Guiness Igweadolo 33KV lines making away with 800 metres of aluminuim conductors, 33KV pin insulators and other electrical materials valued at about N2million naira. Investigation revealed that the Ugbowo campus of the University of Benin and the University of Benin Teaching Hospital (U.B.T.H.) were also affected. There local Government Head-quarters. Iguobasuwa, Okada, and Fuga were some of the towns and villages affected by the vandalization.

Early 1998, in Ogun state, Olodo, Killa, Ilugun,all in Abeokuta District and about seven other villages along Abeokuta-Ibadan road were thrown into darkness when the Eruwa-Ibadan 33KV line servcing the area was vandalized. It was also revealed that, within the same year eleven 132KV double circoit towers were vandalized between Benin and Ughelli amounting to 66million naira (N66M). In the same vein, some 132KV line were lost to the vandals in July 1998 at Benue State. At least two states, Kogi and Benue, were among the affected states in the federation.

When vandals plan their heinous act, the thought of the possibility of luck running out on them and then being caught in the act or even coming to a sad end through electrocution is never put in mind. However, scores of vandals have been caught in the act alive and made to face the full wrath of the law. Some others were mobbed and had themselves "Vandalized" by the communities they had intended to inconvenience by their act . Security agents shot so many others while some were found maimed or dead after suffering electrocution from the equipment they wanted to vandalize. The list is inexhaustible.

Investigation also shows that at the Ikeja Exchange, some staff who were illegally tempering with pairs in the cabinet were caught with the aid of the Anti-Cable Theft Devicce. Also, a tree that fell on a cable in Kaduna causing short circuit was also detected in the exchange by the same device Although the telephone cables theft is not so rampant like that of the electricity due to their usage and economic value, yet they were not excluded in being vandalized. There are many voices against vandalization. The havoc wreaked by vandals and its attendants inconveniences have been eliciting reactions from individuals and groups of different live and status across the land. Thus the late Head of State, General Sanni Abacha, was not left out in the struggle. He noted that the nation's under-development was as a result of these vandals. All hands should therefore be on deck in securing these infrastructures to enhance the speedy development of the country.

Another important factor is the Inductive Interference between Power and communication lines. It is a common practise to run communication lines along the same route as the power lines since the user of electrical energy is also the user of electrical communication system. The transmission lines transmit bulk power at relatively higher voltages.These lines give rise to electromagnetic and electrostatic fields of suffient magnitude which induce currents and voltages respectively in the neighbouring communication lines. The effects of extraneous currents and voltages on communication systems include interference with communication service. For example, the superposition of extraneous currents on the true speech currents in the communication wires, hazard to person and damage to apparatus due to the extraneous voltages.

In extreme cases, the effect of these fields may make it impossible to transmit any message faithfully and may raise the potential of the apparatus above the ground to such an extent as to render the handing of the telephone receiver extremely dangerous. It is to be noted that the larger the distance between the power conductors and the communication conductors, the smaller is the value of their mutual inductance.

2.3 ENVIROMENTAL HAZARDS ON OVERHEAD CABLE NETWORKS.

A number of environmental forces has influenced the hazards caused to the aerial cables networks directly or indirectly. These hazards would be enumerated in details in this section.

The de-regulation system of laying both power and telephone cables along the same routes and on the same poles usually affects the later to a greater extent due to their thickness, diameter insulation and the amount of currents (signals) they carry which is generally smaller than those of power cables. Thus, when power cables fall on communication cables their circuitry will be energized. The communication cables may therefore get burnt; the result is usually the replacement of the damaged cables by the affected subscriber(s).

More often, than not, bush burning is a practice common to hunter and farmers in the rural areas. Due to their carelessness and ignorance, power and telephone poles and (or) cables and other installations around that particular place may be burnt. Apart from the huge amount of money being wasted to the fire disaster, the ravaging of everything around the place could also lead to total blackout for the neighbourhood.

Close to bush burning in the rural areas is the incineration of refuse close to power and communication installations at public refuse dumps in our cities. For example, in 1992,a whole neighbourhood was thrown into darkness at the Kuto area of Abeokuta, Ogun State, when fire from a refuse depot caught up with an overhead power poles and burnt it up.

Severe damage is also caused by the reckless attitude of some motorists who drive at so high a speed losing control of their vehicles and thereby leaving the main road to hit communication and power poles. Most trailers and other heavy trucks usually load their vehicles so high to the sky that it become very difficult for them to pass under overhead lines without damaging the cables. In case of power lines, they have themselves to blame if the cables were not insulated while for telephone cables, the hazard that might be caused to them may be ignored by these drivers and forcefully drive-on leading to the destruction of the cables and (or) poles as the case may be.

In addition, the violent demonstrators or rioters cause a great deal of hazards to the overhead cables. Whenever there is power outage in their area, they occasionally take laws to their hands by resorting to violence and attack power and communication installations. This is usually the case when there is an important event of national interest being shown on the television, especially during soccer involving Nigeria.

The destruction of cables and poles often takes place as a result of de-forestation and lumbering processes. Investigations indicated that many lumberers accidentally destroy the transmission lines by allowing their cut- trees to fall on the cables.
These fallen cables are extremely dangerous to other people who might wish to pass across the place, the animals in the bush as well as the neighbourhood that the lines were meant for.

Dirt and salt also accumulate on the surface of the insulators produces a leakage path for currents to flour. This flow. This is one of the natural forces that affect the earial cables and it is due to flashover voltage as a result of environmental pollution. The ultimate result is the contamination of the insulator surfaces and hence reduces their performances considerably.

Heavy rainfall could be very disastrous to both cables and poles. Occasionally, it may only affect the cross arms which are also dangerous if they fall on the road. The effect of rainfall cannot be overlooked since the destruction is magnanimous each time it breaks the poles . Investigation shows that as a result of heavy rainfall cum wind, an 11KV power line and two communication poles were destroyed at Ibeto, Niger state. Heavy rainfall can also erode the top soil thereby weakening the strength of poles. The rotten of the poles by termites can lead to the weakening and falling of poles meant for distribution.

Erosion has played hazardous roles in the past on distribution line most especially in the Northern part of the country. It is usually due to the nature of soil. The insulators can be damaged in some cases and the continuous distribution of power and signals are disturbed in most cases. Some river-rine areas are so swampy that with time they fully become extended rivers. Poles erected very close too these places have the tendency of being swallowed by water and the mechanical destruction of the cables might result.

The effects of wind, movement of air relative to the underlying earths surfaces, have a vital ...tural phenomenon on aerial cables. Pressure gradient would tend to exert a force causing air move from low pressure to high pressure thereby inflict the cables. When pressure gradient is ...t up due to the variation of pressure with distance, its potential energy would increase. The ...eeper the pressure gradient, the greater would be the force exerted and hence the stronger the ...rface winds which destructs the overhead cables. The effect of ice loading in geographical ...eas where several mountains exist might be very hazardous to cables. The ice loading might ...as a greater diameter than that of the conductors and its weight tends to exert tension of the ...onductors surfaces thereby destructing the area cables.

The velocity of propagation of any disturbance in air is equal to the speed of light given as 3×10^8 metres per second .The velocity of surge propagation along a transmission line is usually expressed as:

$$V = 1/\sqrt{LC} \quad M/S.$$

Assume a zero ground resistivity, the inductance of a single phase of over head line conductor ,L is given by $2 \times 10^{-7} \ln(2h/r)$ heary per metre, and its equivalent capacitance, C is $5.56 \times 10^{-9}/ \ln(2h/r)$ farad per metre (F/M).

Where,

h = height of conductor above ground in metres, and

r = radius of conductor in metres .

Similarly, the surge velocity in aerial cables is given as :

$$V = 1/\sqrt{LC} = 3 \times 10^8/\sqrt{K} \quad M/S$$

Where,

K is the dielectric constant of the cable insulation.

Hence , surge attenuation and distortion in aerial cables are mainly due to losses in the energy of the waves.

Corona phenomenon is the ionization of air surrounding the power conductor . The potential between the conductors will be increased due to corona causing a corresponding increase in the gradient around the surface of the conductor as a result of free electrons that normally present in free space because of radio activity and cosmic rays. These electrons will move with certain velocity depending upon the field strength. The process of this ionization is thus cumulative and ultimately forms an electron avalanche. How ever, the alternating current (a.c.) corona viewed through a stroboscope was observed to have the same appearance as direct current (d.c.) corona, with a bluish or violet colour, a hissing noise and ozone gas formation. Tests conducted show that dry air at normal atmospheric pressure of 760mmHg and temperature $25^{o}C$ breaks down at 29.8 KV/cm (maximum) or at 21.1 KV/cm (r.m.s.) value.

Besides, it is desirable to avoid corona loss on power lines under fair weather conditions. Bad weather conditions such as rain sleet greatly increase the corona loss and also lower the critical voltage of the line. A typical distribution line may have a fair weather loss of 1KW per 3-phase mile and foul weather loss of 20KW per 3-phase mile. Thus, when corona is present, the effective capacitance of the conductors would be increased since the effective diameter of the conductor is increased. This effect increases the flow of charging current and consequently the distribution aerial cables might be destroyed.

Lightning discharges constitute a source of over-voltages in power and telecommunication lines. They produce electric and magnetic fields, which might be connected to the metal parts of towers, cable sheaths and other distribution installations. Lightning causes mechanical hazards because of its frequent rise and peak amplitude current being produced since it is a source of high electric field.

Due to its high current discharge of electrostatic accumulation between the cloud and earth, it usually affects the overhead cables because of over- voltage production.

Lightning strikes also cause a lot of damages to the power and communication systems. Lightening is the discharge of very high potential of electrical energy that has built up in the atmosphere at a high altitude usually between 1.5 Kilometers to 4 kilometers above the earth. This energy results in the polarization of the upper layer of the stormy cloud which contain positively charged particles and the lower layers take to negative charges while the central part retains charges while the central part retains the negative charges while the central part retains charges while the central part retains the combination of both positive and negative charges in a balanced state that makes it neutral. The pressure level rises to about 300KV /m or above as the potential builds up due to the rapid movements taking place between clouds.

The direction of lightning discharge:

The direction of the discharge of lightning stroke is usually between two distant clouds of differently charged polarities up in the sky or in the final case between the charged cloud and the earth; the traveling lightning with its negative charges move in the direction of concentrated positive points of the other cloud or to the earth

Air discharges, discharges that emerge from the cloud but do not reach the ground, can run horizontally for many kilometers. Sometimes they re-enter the cloud base further on, in which case they are regarded as cloud-to-cloud discharges.

There are two stages of lightning namely:

(1) Leader; and

(2) Streamer,

(1) LEADER:

The leader is responsible for the pricking of the surrounding ionosphere and attracting their positive charges thereby making the attracting their positive charges thereby making the surroundings to conduct electricity through a series of trajectories that are downward bound. Thus the stage at which the charged electrical energy starts traveling downward marks the commencement of the leader. Each of the established leaders has a faint luminous length of between 30m to 75m while traveling at the speed of about 1.2x10 m/s.

(2) STREAMERS:

As the leader further approaches the earth, the intensity of the established electrical field rises to a height of tens of metres above the ground in several places. These upward bound discharges that are usually earth positive phenomena are known as STREAMERS

However, lightning causes devastation in the following ways:

(i) Through direct strikes to telephone communications person and systems;

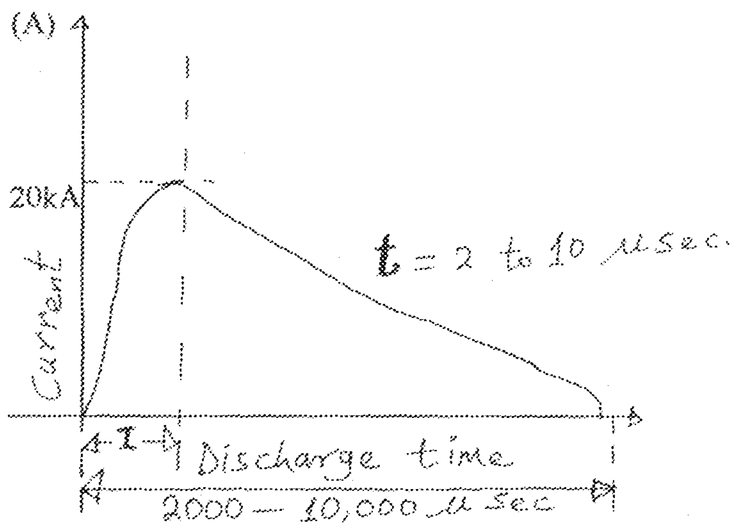
(ii) Side-flashes or flash-over;

(iii) Step and touch voltage.

(i) Direct strike:

The effect of direct hit on telecommunication infrastructure range from burnt components, falling parts, bent metal parts outright fire to explosions. That apart, direct lightning strike on person may result in paralysis, brain damaged, heart failure, burns or even instantaneous death.

The fast rise and large peak of amplitude current can produce severe mechanical effects. Lightning current magnitudes can range from around 3x10 to 200x10 amperes



A typical Current-amplitude characteristic is illustrated above.

(ii) Flash-over (side flash):

Serious damage could result if the danger of side flashing is not considered in overhears power and communication distribution cable networks. This is a very important factor when designing lightening protection systems.

If the current flowing down the lightning protector conductor path comes across a high impedance path during the time of the discharge and the nearby metal work offers lower impedance path to earth, then the discharge will flash over to the nearby metalwork provided the magnitude of the potential difference is sufficient to break down the dielectric gap.

Some of the reasons why flashovers could occur include:

(a) Faulty lightening protection system;

(b) Incorrect routing of conductors; and

(c) High impedance of lightning protection system

(iii) Step and Touch voltage

: In the event of a lightning stroke, a voltage gradient builds up in the soil, which is highest at the point where the lightning discharge enters the earth.

Touch potential is the voltage gradient between a people holding or leaning on an electrified object and the point of excite of the current from the person body.

The frequency of lightning strokes to Telecommunication towers depends on a number of factors such as:

(i) Number of thunderstorm days per year;

(ii) The height of the tower; and

(iii) The characteristics of the point where the tower is situated. Whether the tower is situated in a plain, on a mountain, a peak or half way down the slope.

Conclusively, lightning stroke effect on both power and communication networks in the open air has always proven to be disastrous, and without any foreseen benefit. No effort should be spared to protect the infrastructures at all times and to improve the quality of protection being offered to equipments and personnel.

Thunderstorms are very impressive atmospheric phenomena that give rise to thunder and lightning accompanied usually with heavy rain. These are natural meteorological conditions that constitute very hazardous effects to the power and communication networks connected aerially. They occur mainly in the lower troposphere. In mid-latitude, they can reach the height of about 15 kilometres and in the tropics some 20 kilometres. High air temperature, upward moving air currents and high air humidity are meteorological conditions that favour the development of thunderstorms.

Thunderstorms can be classified into three main categories namely: frontal thunderstorms, thunderstorms associated with tornadoes, and heat thunderstorm in homogenous air masses.

(A) Frontal thunderstorms:

They occur at cold and warm fronts or convergences which often have high drift speeds. They pre-dominate in temperate region areas of the world.

(B) Thunderstorms Associated with tornadoes:

The different climatic zones are due to the spherical shape of the earth and the consequential widely varying specific solar energy supply. Their main contrast lies in the differing temperature and humidity conditions, which are also the reason for the characteristic distribution of thunderstorms on earth.

(C) Heat thunderstorm in homogeneous air masses is especially violent in mountainous regions (orographic thunderstorms). In most cases their drifting is very low and predominates in tropical regions.

There are estimated 45,000 thunderstorms per-day the world over, the majority of which occur in tropical regions not only because of the high temperature but also of the larger land areas in these latitudes in comparison to the pole wards regions. Thunderstorms, therefore, have their origin in Cumulonimbus (cb) clouds. In these clouds, large-scale over-turnings take place, which tend to change the existing unstable state of this region into stable ones. The consequential severe process brings about electric discharges-the lightning and the accompanying noise thunder.

CHAPTER THREE

RESULTS AND DISCUSSION OF RESULTS

2.1 RESULT OF INVESTIGATIONS:

Questions were asked from the power and communication staff across the country for this investigation project. Different answers provided were noted and taken into consideration. Some questionnaires were also produced and distributed to people of high intellectuals that specialize in distribution cables and conductors and staff of both NEPA and NITEL PLC.

The results obtained were therefore discussed in the subsequent sections of this chapter.

Appendix 1, 2, and 3 contain other vital information obtained from NEPA and NITEL clearing sections.

A bar chart was plotted for each of the questions answered from the questionnaire. The number of people that responded to the questions in the questionnaire were represented on the vertical axis while the horizontal axis represents their individual options ticked in response to the questions. No answer was given to some questions. The highest bar on the bar-chart corresponds to the maximum number of people that responded to a particular question while the lowest bar to the fewest number of people that responded.

The scale used throughout the drawing of the bar-charts is i the ratio of 1 cm representing 5 people.

2.2 DISCUSSION OF RESULTS:

From the samples of questionnaires distributed, the following observations could however be drawn.

From graph 1, it was observed that the majority of people believed overhead cable and conductors are sources of public insecurity and hazards.

For graph 2, the total number of people that had seen the defect of running overhead cables are 88, while only 12 had not seen the defect at all.

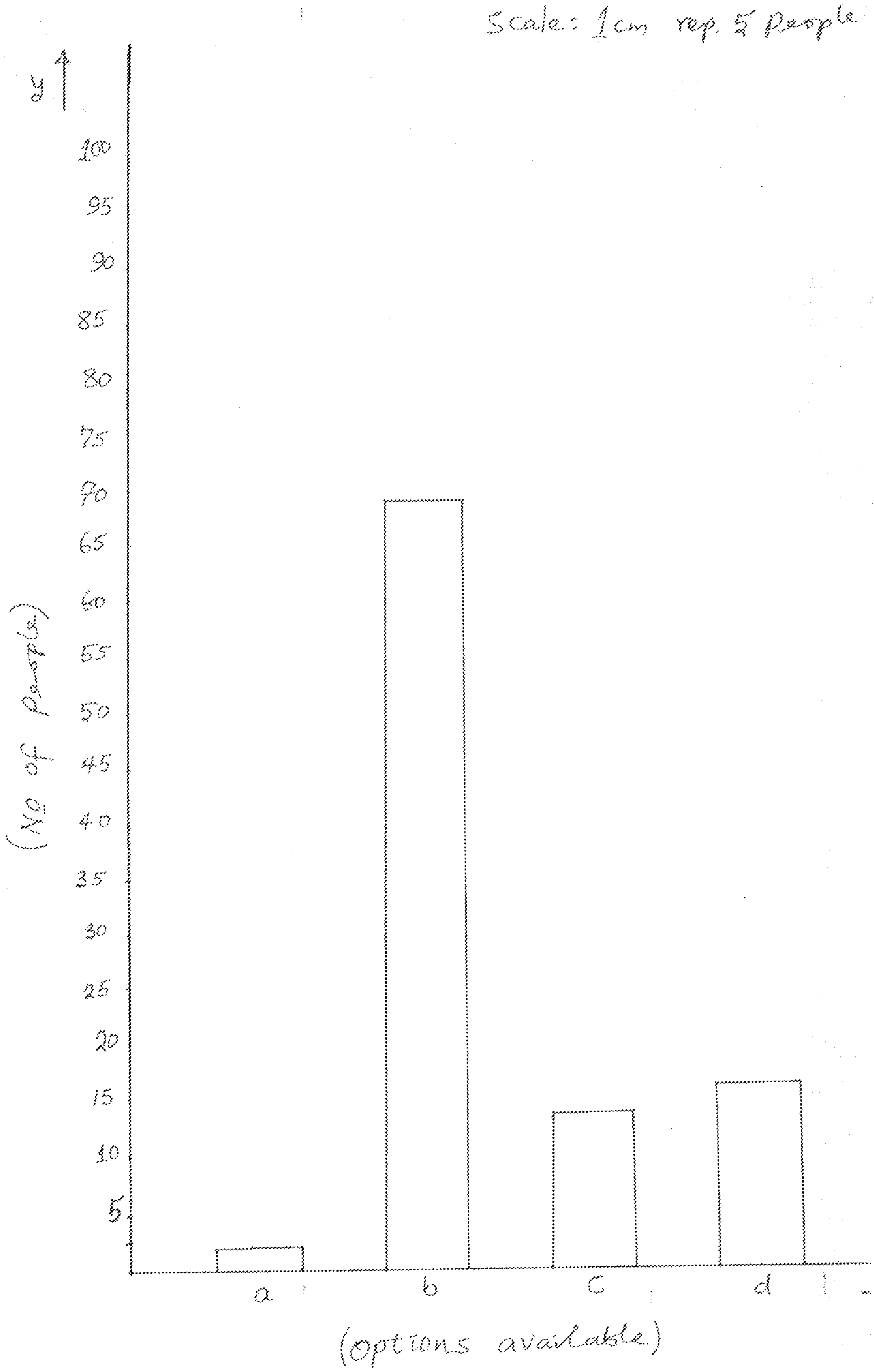
From graph 3, 38 people had seen accidents on poles, 35 people had witnessed a total blackout, 2 people had seen breakage of distribution cables that resulted to killing of the innocent passers-by, 8 people had witnessed loss of tone signals on telephones.

Also from graph 4, 27 people had accepted that the illegal connections line distribution and 62 believed that the power supply irregularities could be a demerit to the consumers.

Graph 5 recorded 12 people for bush burning, 40, for heavy winds, 20 for abnormal knocking of poles by motorists, 10 form intensive rainfall, 4 for intense sunshine and 48 for theft of cables that resulted to environmental hazards of cable.

Graph 6 has the highest value of 74 for those that believe there is an alternative method of running cables while 2 people had no idea on the topic. Probably it can be said these 2 people had never seen or heard of any other alternative to overhead cables lying.

Graph 7 recorded 67 for the choice of underground cable laying, 18 for laying cables overhead with high insulating materials, 12 for eradication of using cables and only 3 for the choice of laying cables on very high poles. Hence it can be seen that the majority accept the idea off using underground cable networks for both power and communication.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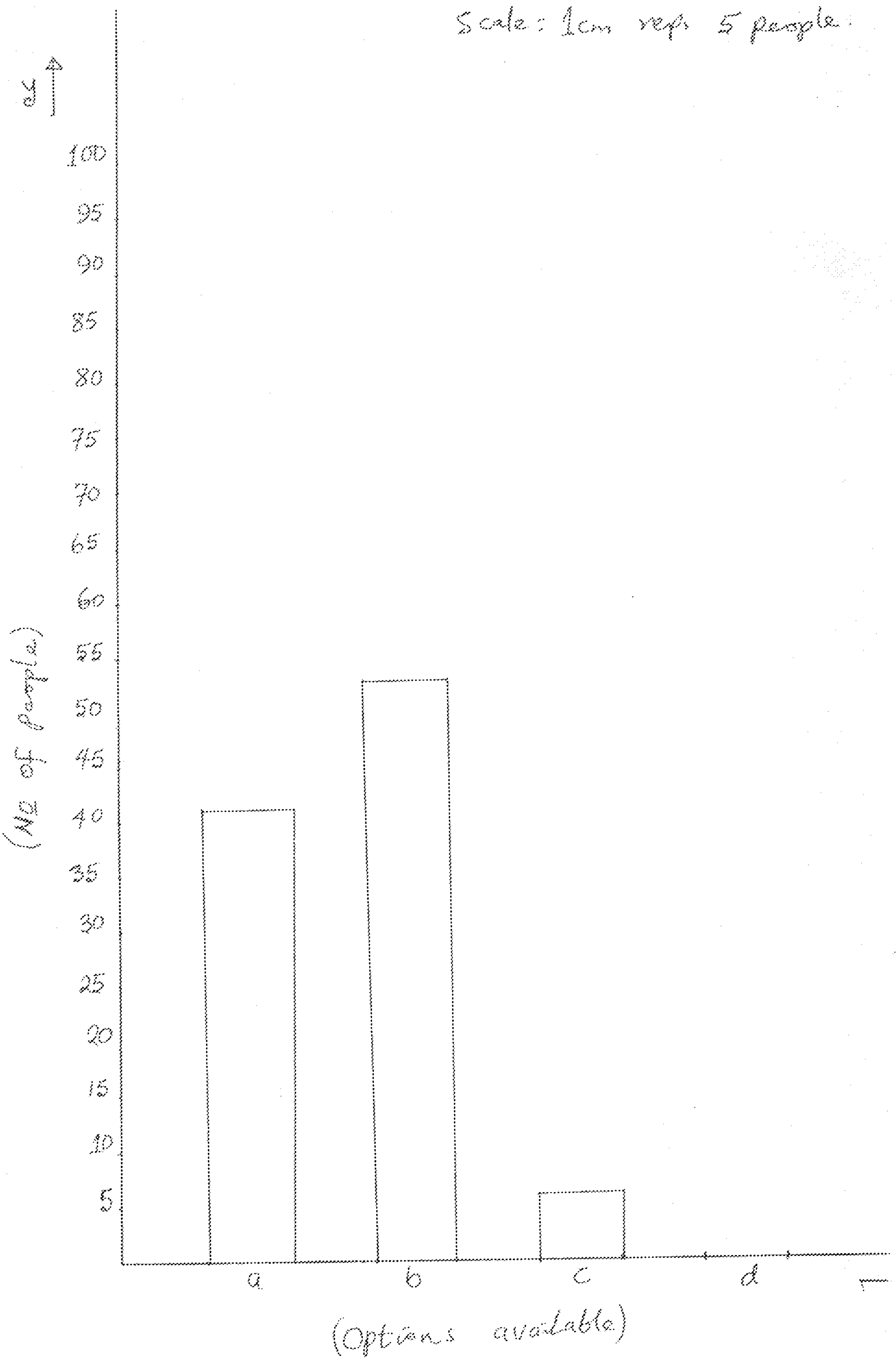
Graph No 1.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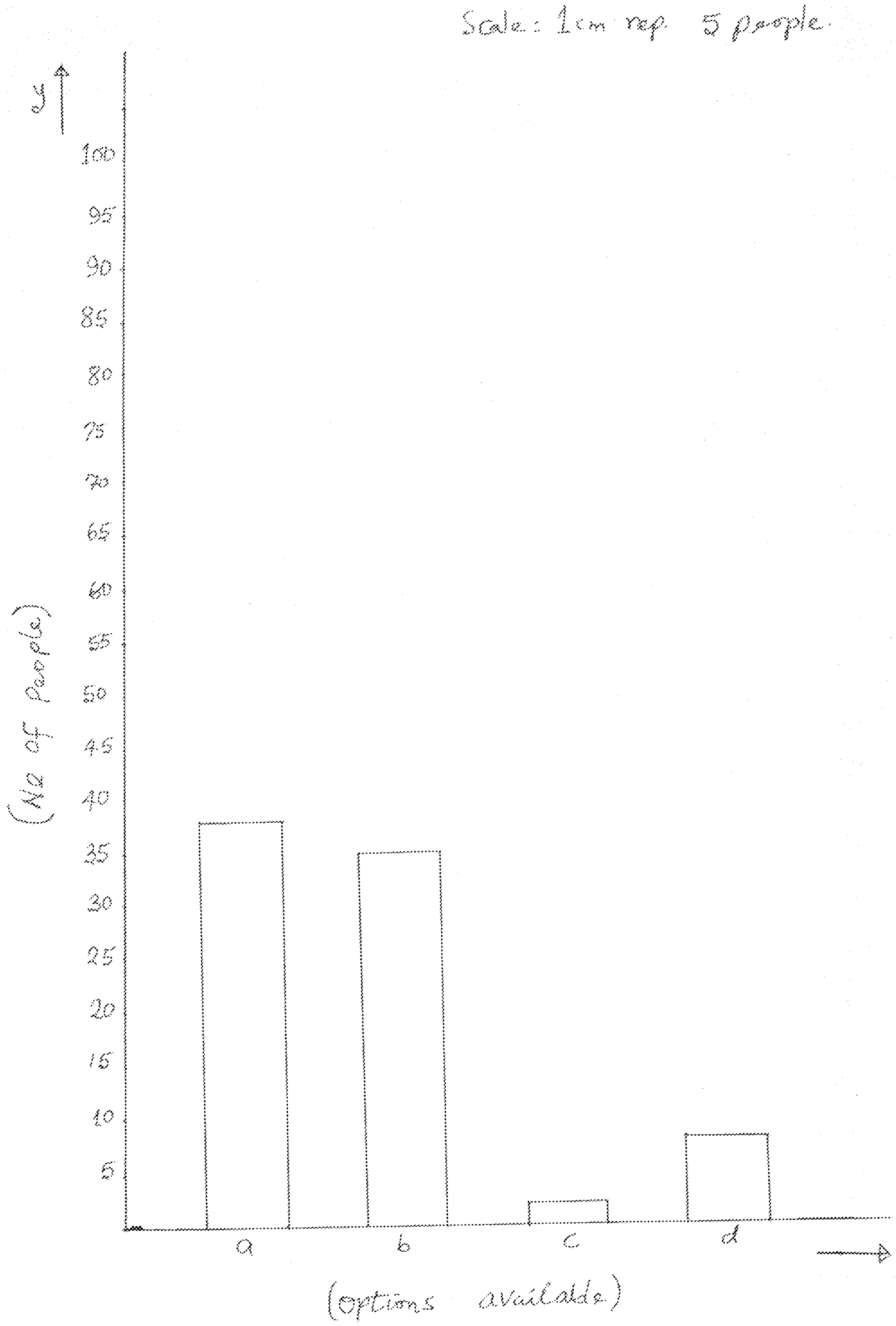
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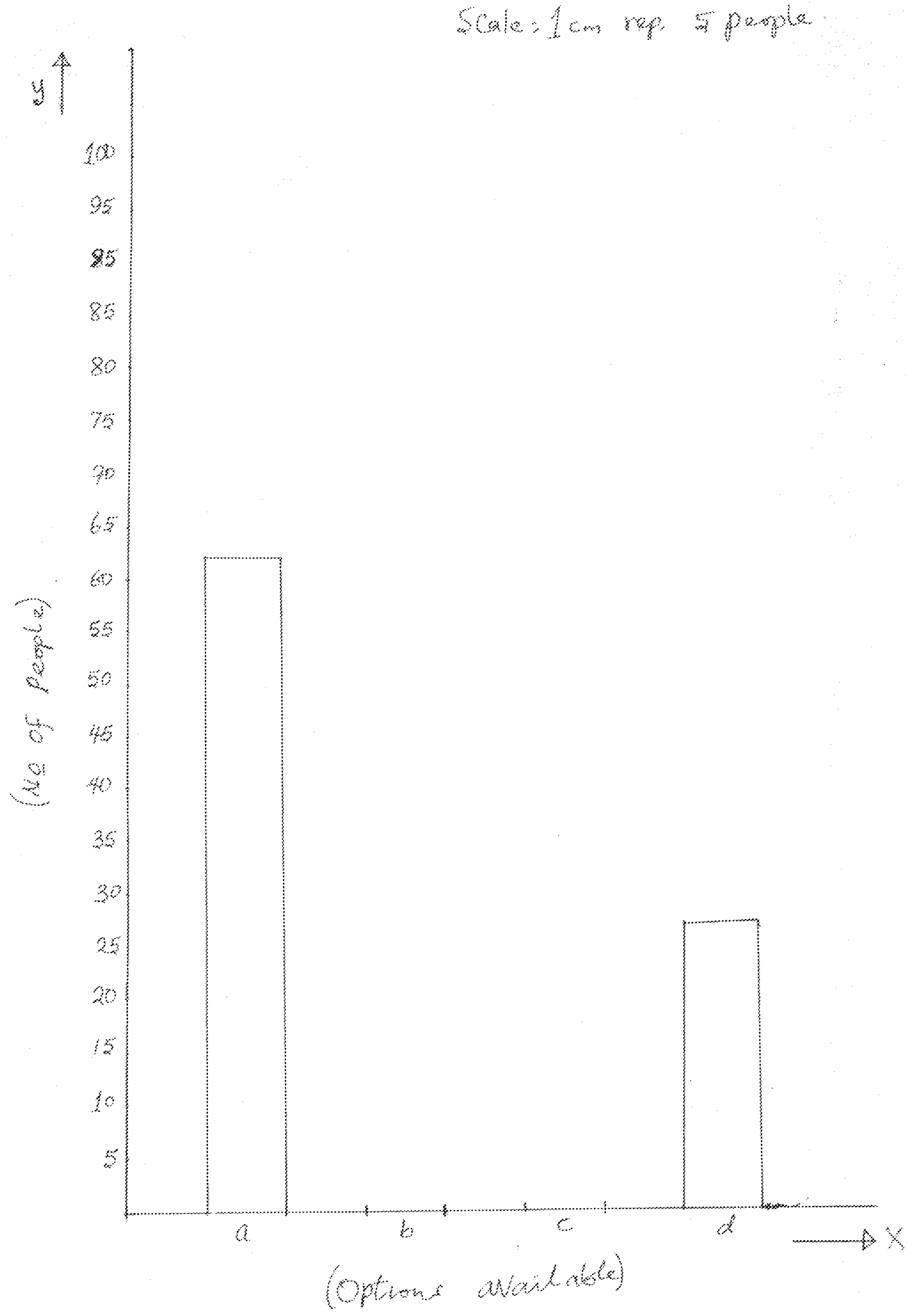
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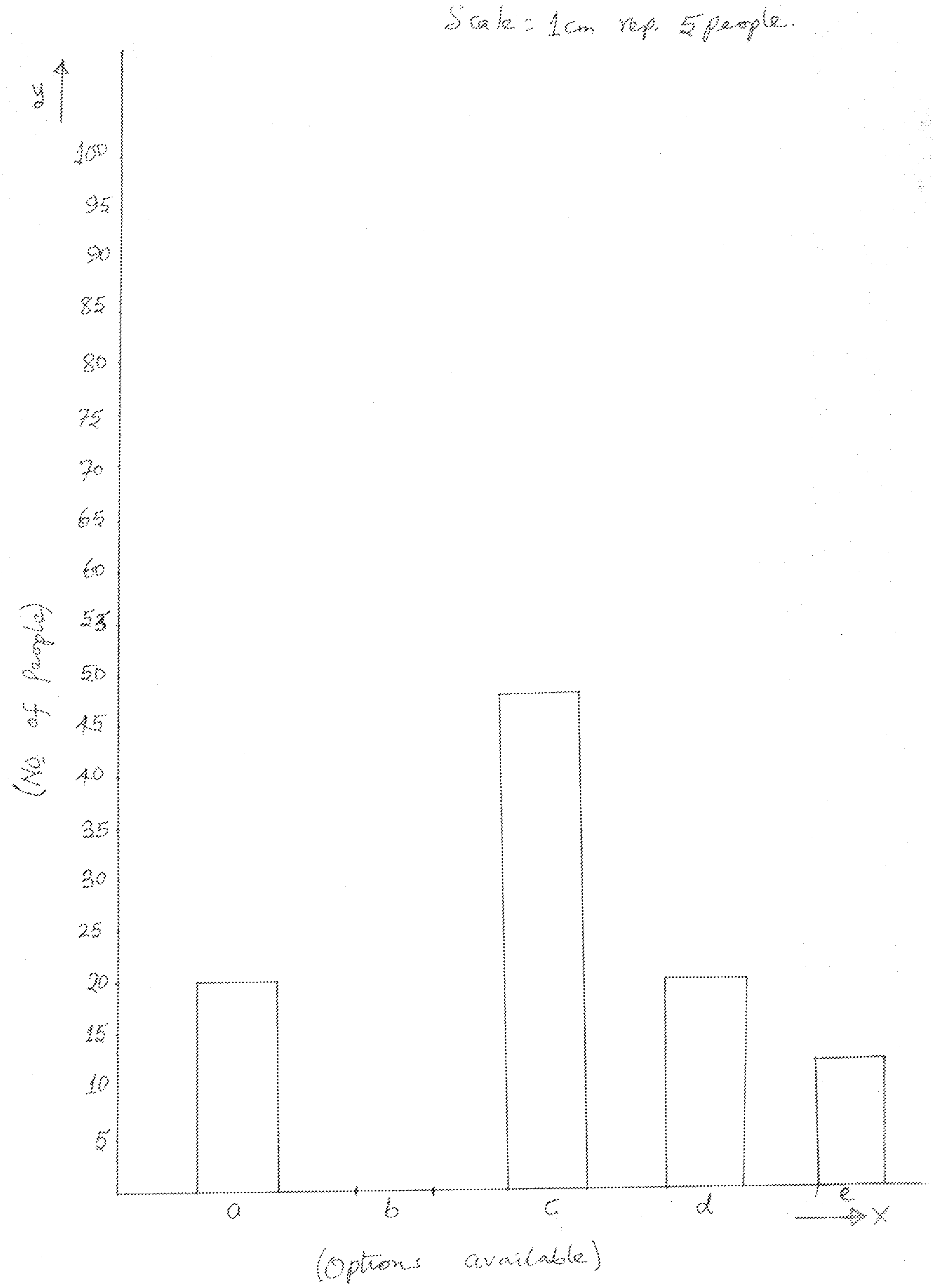
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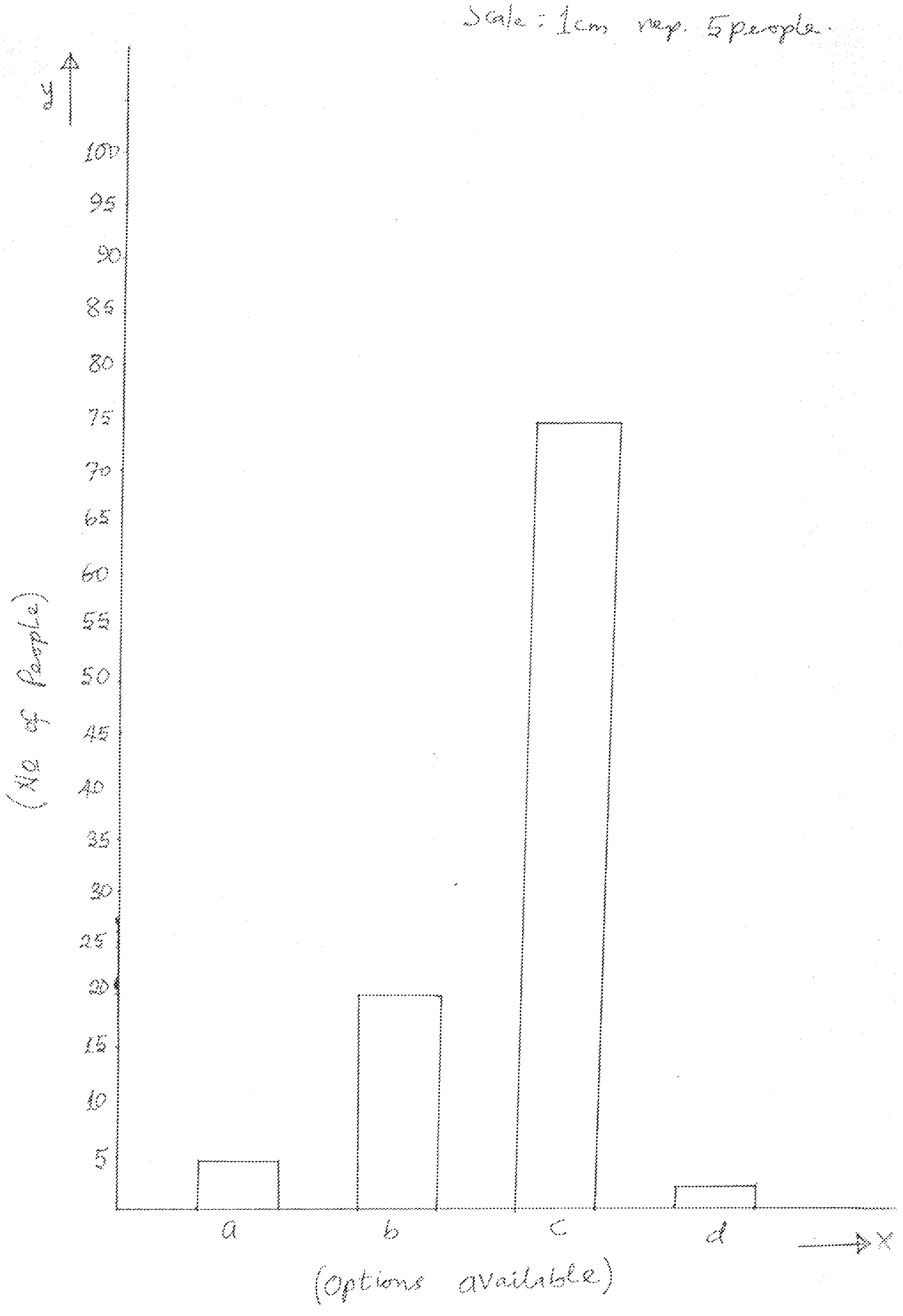
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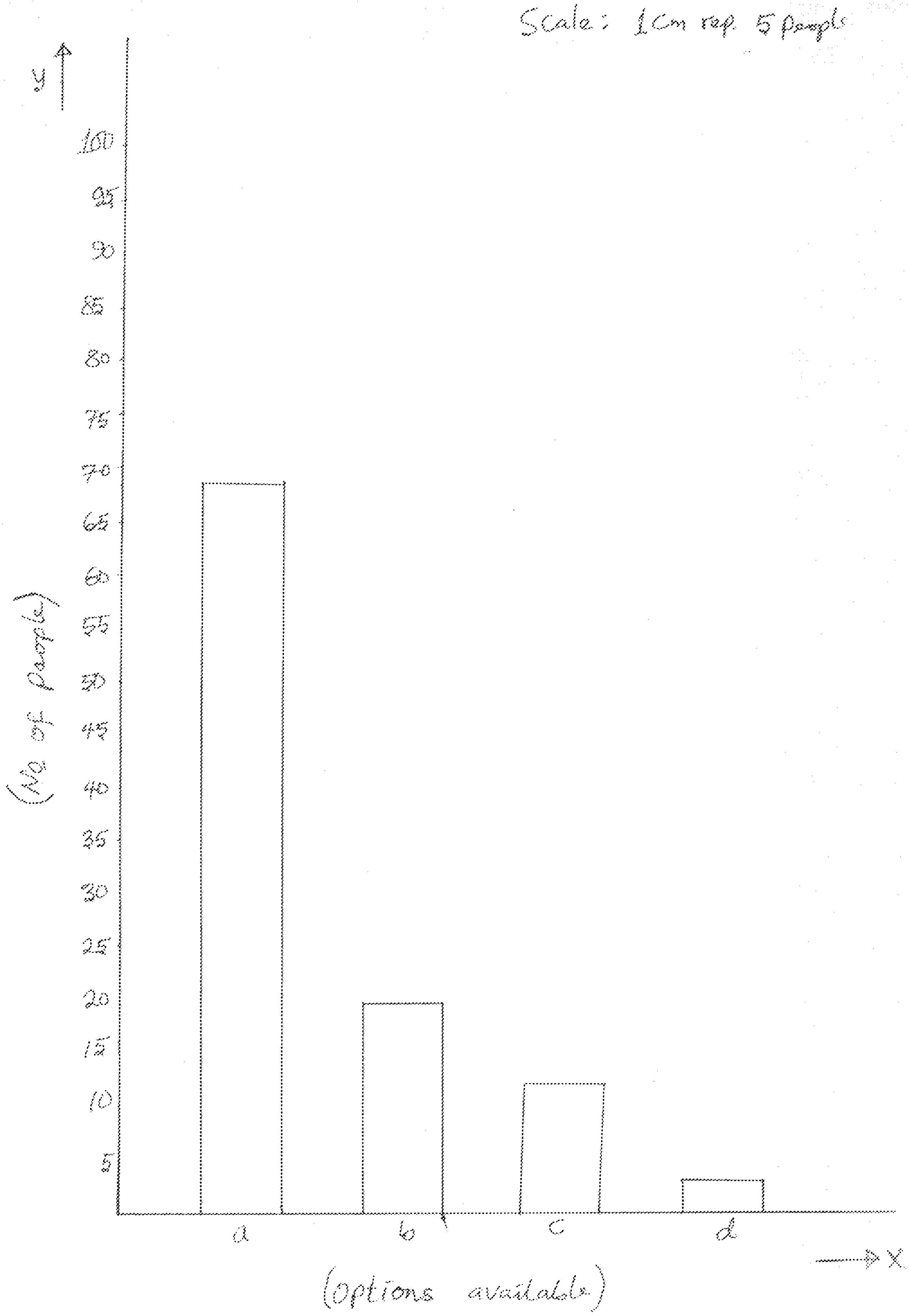
Graph No 6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Graph No 7

2.3 COMPARISON BETWEEN OVERHEAD LINES AND UNDERGROUND CABLE SYSTEM.

In this section, the merits and demerits of both overhead and underground cable and conductor networks were examined in comparison.

Electric energy can only be transmitted from one place to another through either the overhead or under ground line conductors.

(1) In case of overhead lines, the inductance is more predominant whereas capacitance is predominant in case of underground conductors.

(2) The conductors in the overhead lines are less expensive than the underground conductors.

(3) The size of the conductors for the same power transmission is smaller in case of overhead lines than the underground conductors because of better heat dissipation in overhead line conductors.

(4) The insulation cost is more in case of underground cables than the overhead lines.

(5) Overhead lines are easier to construct, install and maintain than the underground conductors.

(6) Overhead lines requires less equipment and less trained manpower than the underground cables.

(7) The erection cost of an overhead line is much less than the underground cable.

(8) Notwithstanding the cost, underground cables and conductors give a greater safety to the public, less interference with the amenities and better outlook to the cities than the overhead distribution conductors of the same kind.

(9) Based on the last reason, underground conductors are, therefore, used for power stations an sub-stations connections or a link in overhead lines, and for submarine crossings. Hence, it is much more reliable.

(10) Underground cables network, however, reduce the rate of electrocution, vandalization of conductors and other installed facilities and less hazardous than the overhead systems.

SCHOOL OF ENGINEERIN & ENGINEERING TECHNOLOGY
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

RESEARCH QUESTIONNAIRE

Dear Sir/Madam,

Kindly complete this questionnaire for the collection of data on a project titled: THE INVESTIGATION OF THE ENVIRONMENTAL HAZARDS OF RUNNII CABLES & CONDUCTORS (BOTH POWER & TELEPHONE) IN THE OPEN AIR.

Information obtained would be treated as strictly confidential and your name would not feature in any way in the research work for which the questic are drawn up. It was designed solemnly for academic purpose requiring your faithful responses.

Please tick ( ) as appropriate.

1. Have you ever thought that overhead cable networks could constitute a source of public disturbances and insecurity to your environment?

   (a) never (b) a great deal (c) often (d) Quite often

2. How many times have you seen any defect(s) of running both power and telephone lines in the open air?

   (a) twice (b) thrice (c) once (d) none

3. How frequent have you heard/seen the followings:

   (a) accidents on poles (b) black-outs (c) distribution cables breakage (d) loss of tone signals

4. Do you agree that the illegal connections could be source of hazards to the overhead lines?

   (a) strongly agreed (b)agreed (c) partially agreed (d) disagreed

5. What factors do you consider could lead to these environmental hazards?

   (a) rainfall/wind (b) sunshine (c) conductor thefts (d) reckless motorists (e) bush burning

6. Is there any alternative method of running both power and telephone line

   (a) disagreed (b) agreed (c) strongly agreed (d) probably

7. Which of these methods do you think is most suitable for distribution in Nigeria?

   (a) underground (b) overhead with high insulation (c) no idea (d) laying on high poles.

8. Have you ever thought of the fluctuating and irregular supply of electrici could be very hazardous to the consumers?

   (a) very much (b) very little (c) rarely (d) a little

9. How many times have you witnesses any danger(s) of overhead power and telephone networks in the open air?

(a) none (b) once (c) thrice (d) twice

10. Do you also agree that carbon (II) oxide, carbon (IV) oxide, ozone (O_3) and Sulphur (IV) Oxide are sources of hazards to both the conductors and environment?

(a) agreed (b) strongly agreed (c) partially agreed (d) disagreed.

11. Do you believe there is any latest development of running cables and conductors in order to protect both lives and cables, and the environment

(a) strongly believed (b) not at all (c) believed (d) not often.

CHAPTER FOUR

CONCLUSION AND RECOMMENDATIONS

4.1 CONCLUSION:

The environmental hazards of running both power and communication cables in the open air, and report of cables out within the network was examined.

It could be concluded then that future hope of making the overhead networks hazards free is unrealistic and practically impossible. However, if the reports obtained from the research work is anything to go by, the overhead systems of laying cables should be discouraged as mush as possible especially in cities of Nigeria.

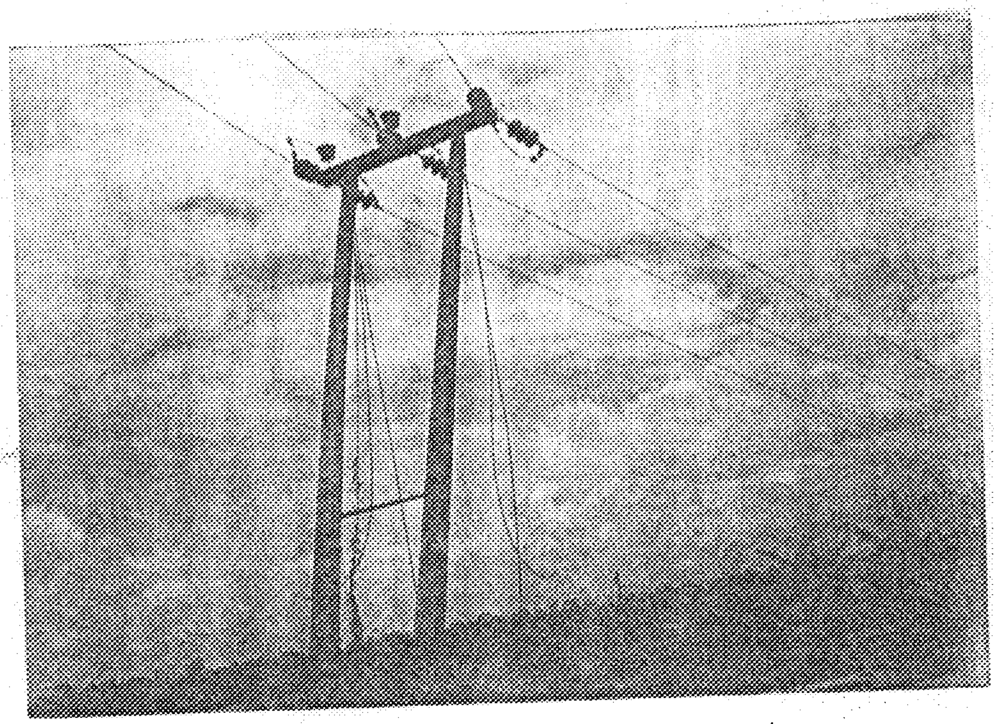
4.2 RECOMMENDATIONS:

Based on the fact that the overhead cable networks is greatly hazardous to the environment, I, therefore, recommend the underground cabling systems for both power and communication distribution line, especially in cities since they give a greater safety to the public, less interference with amenities, and better outlook to the city.

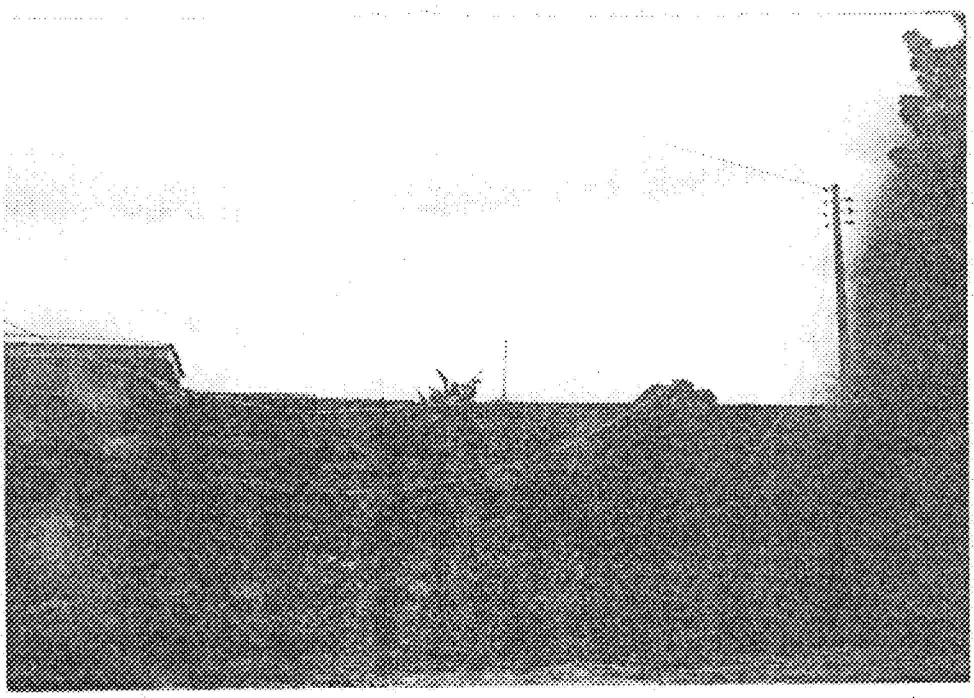
For now, I would like the federal environmental protection Board (FEPB) to pay more attention to the overhead power and communication cable hazards and find a lasting solution to them.

I would also like to recommend to the housing authorities to clearly examine the lands and abide by the land regulations concerning the right of ways before the erection of buildings and sales of land for use.

I would, finally, suggest that some establishments like NEPA and NITEL should be associated in carrying out such research projects

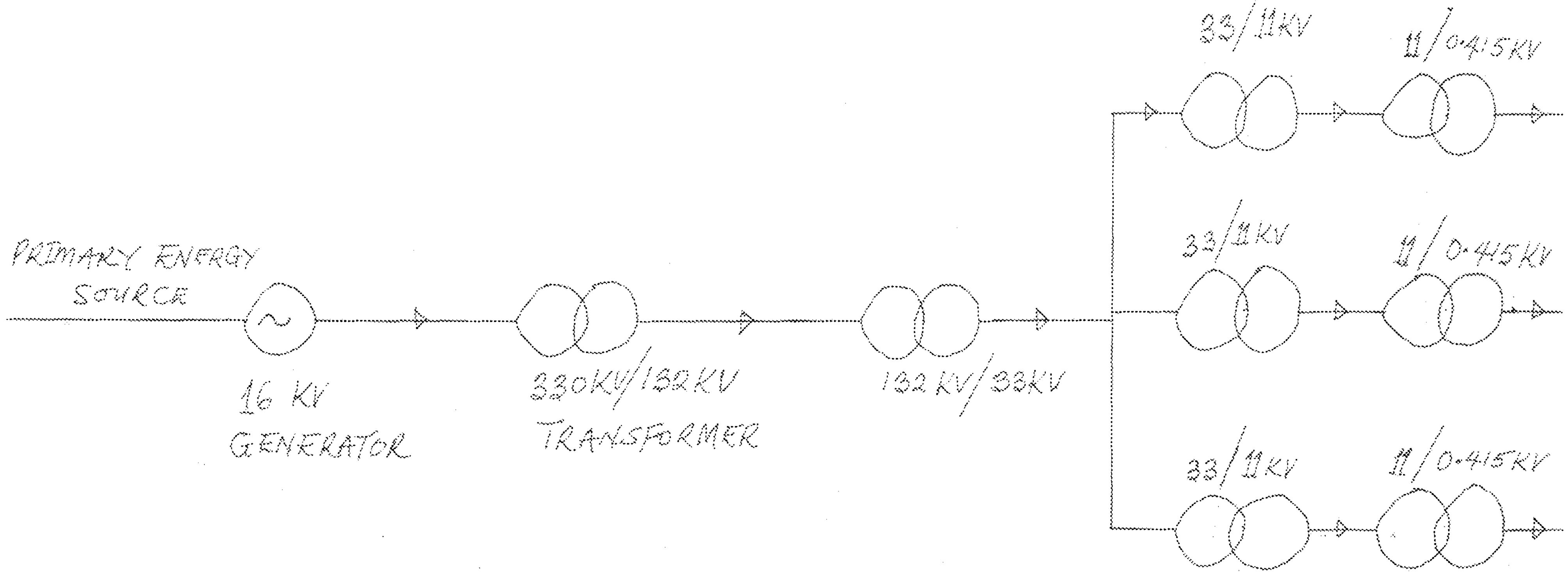


A 33KV DISTRIBUTION LINE IN THE OPEN AIR.



THE CONDUCTORS THAT CUT AND FELL DOWN.

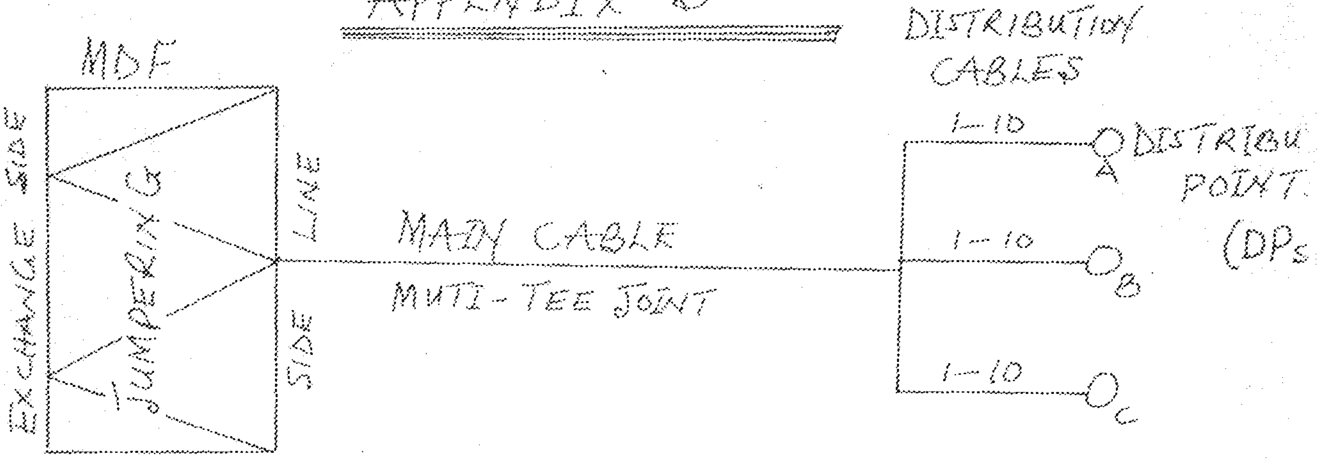
APPENDIX A



SCHEMATIC DIAGRAM SHOWING THE ELECTRICITY DISTRIBUTION FROM GENERATING STATION.

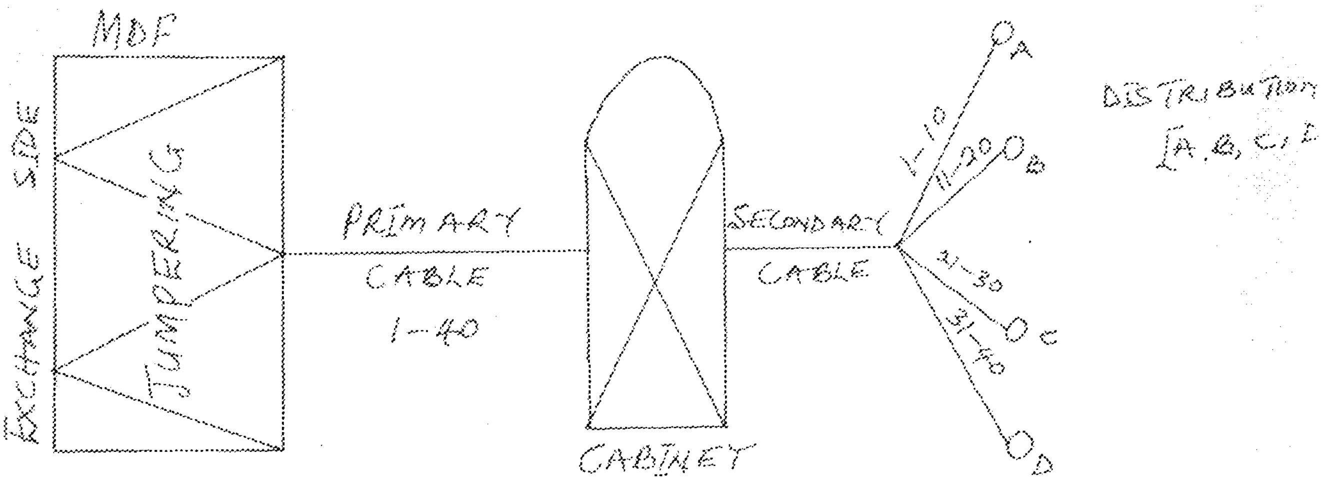
SCHEMATIC DIAGRAM SHOWING ELECTRICITY DISTRIBUTION FROM GENERATING STATION.

APPENDIX B.



(a)

RIGID NETWORK WITH MULTIPLE TEEING.



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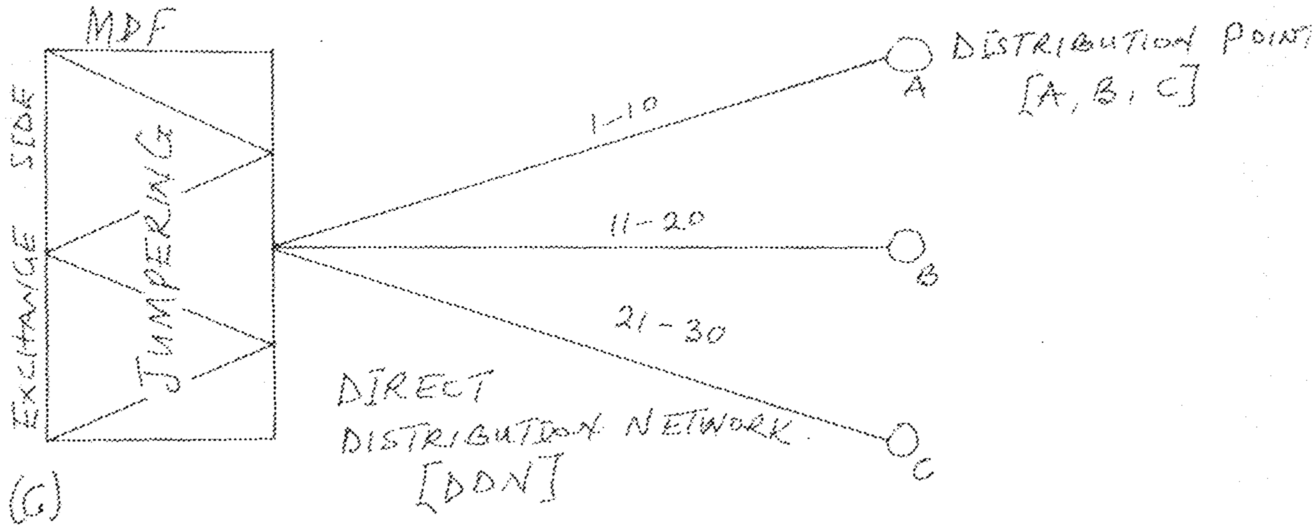

(c)

FLEXIBLE AND NON-FLEXIBLE NETWORKS [b&c].

APPENDIX 1

Typical Voltage in use (at present)

Main transmission (KV)	Sub - transmission	Primary Distribution	Secondary Distribution
69	13.8KV	2.40KV	0.2KV
138	23.0KV	4.16KV	120/240V
220	34.5KV	13.8KV	240V
330	69.0KV	-	480V

APPENDIX 2.

Electromagnetic radiation from overhead conductors' lines and Equipment

Line Voltage KV	Electric field Strength (V/M)	Magnetic flux Density (UT)
400	11,00	40
275	6000	40
132	2000	11
33	350	7
11	120	7
0.415	<1	1

APPENDIX 3

Various Earth Resistances to Displacement.

Class	Earth type	Percentage of pole Resisting moment.
1	Hard rock	50
2	Shale, sandstone, or soft	50
3	Dry hard pan	50
4	Crumbly damp	40
5	Firm, moist	35
6	Plastic, wet	30
7	Loose, dry of loose	25
8	Marches swamps.	20

The stability of the pole depends on a number of factors such as type of earth, depth of settling, moisture content of the soil, setting technique used, and size of pole butt.

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