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Erratic Power Supply and Its Effects on Household Equipment Reliability

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Abstract

Equipment reliability is very important to user because it gives them value for their money, also it gives them confidence that they can get whatever chores they wanted done at any time they wanted and get whatever satisfaction that is desired at any particular time. Most household equipment makes use of electricity as their source of energy. Energy is very important to household equipment because without it they cannot perform their required function. Most communities in Nigeria are characterized by erratic power supply and this was found to have greatly reduced the useful life of these equipment, it was also discovered that because of these erratic power supply the mean time between failure (MTBF), mean time to failure (MTTF), availability (A) of these equipment have been greatly reduced while the failure rate, mean time to repair (MTTR) has increased, thus reducing the reliability (R) of the equipment. Solutions were proffered to these identified problems which will help to increase the reliability of this equipment.

Keywords: availability; erratic; MTBF; MTTF; MTTR; power supply; reliability.

1. Introduction

The reliability of equipment is a factor that every user of such equipment always look out for when purchasing the equipment. Every user does not want to replace them except when they are convinces that the equipment has satisfactorily used it useful life span. This is not always the case because it has been discovered that most household equipment hardly satisfies their users at all before failing. Basically, manufacturers of household equipment have expected useful life for their manufactured equipment during which they expect such equipment to function satisfactorily without failures or even if there are failures such are expected to be minimal when they are operated within specification and certain given conditions.

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Erratic power supply is a condition during which power supply is not stable, not regular in pattern, movement is unpredictable or better still said to be unreliable. According to [1] it can also be equated to negative power situations where flip-flop nature of the supply causes damage to the equipment being powered. Power supply is a very important factor in the life of equipment, it impacted negatively on the manufacturing, productivity, growth and more importantly in the life of electronic equipment because they are made up of many components or parts put together and which depends largely on the stability of power supply to them [2,3,4,5]. Power supply is therefore a great determinant of the adequate functioning of equipment.

The problem of erratic power supply is a great challenge that all sector of the people has had to face; from government agencies and parastatals to the ordinary man [6,7,8]. The national airspace management agency had to partner with stormberg to provide it with solar energy as an alternative and reliable power source for communication and radar coverage in the airspace because of the challenge that it is being faced with due to erratic power supply, Huawei Nigeria, a leader in telecommunication equipment vendor also blamed erratic power supply from the national power grid for the poor telecommunication services in the country while it was reported that hospitals equipment were damaged due to erratic power at the Tamale hospital, Ghana, a situation that has seriously impacted negatively on the operations of the hospital and which has put the hospital under extreme pressure to raise funds for the repair of broken down equipment [9,10,11]. Unreliable power supply not only slows down or damages production or results in shut down of plant it also leads to equipment damage, additional maintenance and the organization's reputation for the quality of product [12].

Household equipment are those equipment that are used within the household to satisfy the need of the people, example of which include, refrigerators, light bulbs, air conditioners, fans, water dispenser, pressing iron, radio set, DVD and television set. This equipment makes life a lot easier for the people within a household.

Demand for electricity has grown rapidly as nations modernize and its economy develops [13]. Electricity gives a very convenient way of transferring energy which has made it use to continue to grow. Most household equipment makes use of electricity as their source of energy and thus have contributed to the increase in the demand for electricity.

Until the first world war, reliability was never considered important because the equipment available then were very simple, with comparatively very few components and favorable working (environment) condition that could provide an acceptable level of reliability.

The objective of this work is to examine the effect of erratic power supply on the reliability of household equipment. This work is however limited to the response of respondents to questionnaires and oral interview.

2. Materials and Methods

The method used for the collection of data for this work is the questionnaire method and oral interview. A total of 1500 questionnaires were administered, 19 questions were set to enable get facts from respondents on their experiences with their household equipment as a result of erratic power supply. Among the questions that this work sought answers to were; the effect of erratic power supply on mean time between failures, mean time to

failure, mean time to repair, availability and reliability of the equipment. The household equipment that were considered by this work are: television set, washing machine, radio set, refridgerator, air conditioner, fan, pressing iron, blender and microwave oven.

Failure rate (λ)

This is the number of failures occurring per unit time

$$\lambda(t) = \frac{1}{Ns} x \frac{dNf}{dt} \quad (1)$$

Mean time between failure (MTBF)

This is the mean of the time that elapses between failures.

$$MTBF = \frac{1}{\lambda} \quad (2)$$

Mean time to repair (MTTR)

This is the mean of the time required to perform maintenance actions

Mean time to failure (MTTF)

It is the average of the time that elapses before failure

$$MTTF = \frac{T}{n} \quad (3)$$

Where T = time, n = number of failures

Availability (A)

It is the probability that an item will perform its required function at a stated instant of time or over a stated period of time

$$A = \frac{MTBF}{MTBF+MTTR} \quad (4)$$

Reliability (R)

It is the probability that an equipment will perform its required function at a given time under given conditions

$$R = e^{-\lambda t} \quad (5)$$

3. Results and Discussion

Out of the 1500 questionnaires that were administered, 1264 were returned by the respondents thus making 84% of the total questionnaire administered.

Figure 1 shows the effect of erratic power supply on the failure rates of various equipment. The result of which shows that the failure rate of television set is the highest, closely followed by radio set and air conditioner which we discovered was as a result of the number of hours and frequency that the equipment are used. Averagely, the television set is switched on for 17 hours daily by our respondents while for blender, pressing iron and washing machine most of the respondents do not make use of them daily and most of the respondent do not have the microwave oven which makes the failure rates for these equipment to be very low in this study.

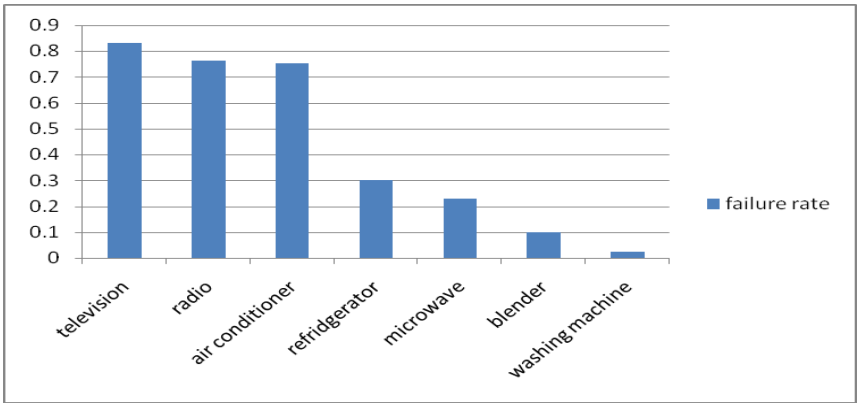

Figure 1: failure rate of the household equipment

Figure 2 shows the effect of erratic power supply on mean time between failures. From the results it is discovered that television has the lowest mean time between failures followed closely by the refrigerator, air conditioner and radio set which can be inferred to be also as a result of the number of hours to which these equipment were used.

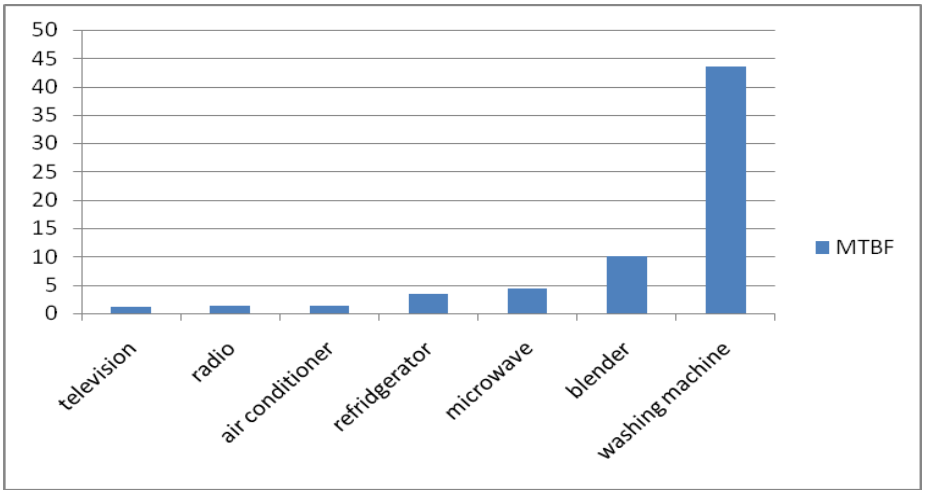

Figure 2: mean time between failure of the household equipment

Figure 3 depicts the mean time to failures of the equipment, which shows that this is lowest for radio set, then television, refridgerator and air conditioners. This results shows radio set is the one that fails easily as a result of erratic power supply.

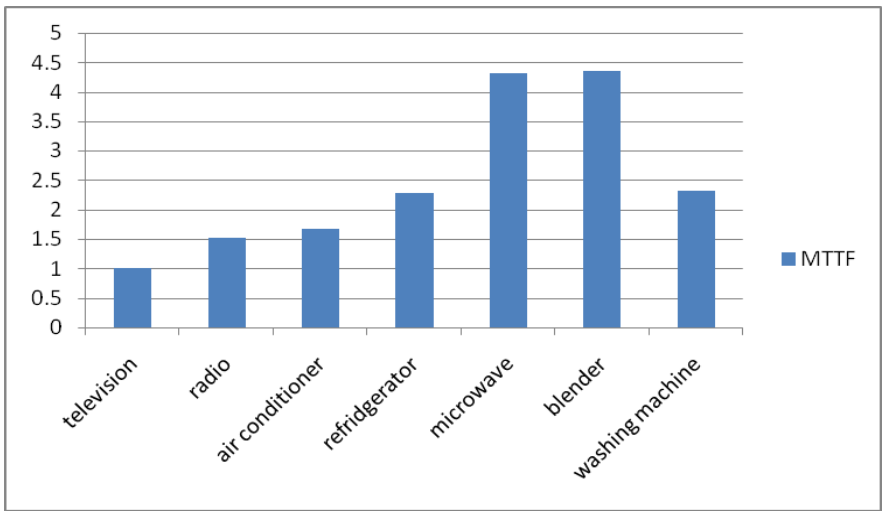

Figure 3: mean time to failure of the household equipment

The results of figure 4 indicates that for mean time to repair radio set has the lowest, after which comes the refrigerator and air conditioner and the highest is the microwave oven. The meaning is that because of the frequency of failures in the radio set one can infer that it makes the time spent on its repairs to be low while because the microwave oven seldom fails then the time spent on repairs is high.

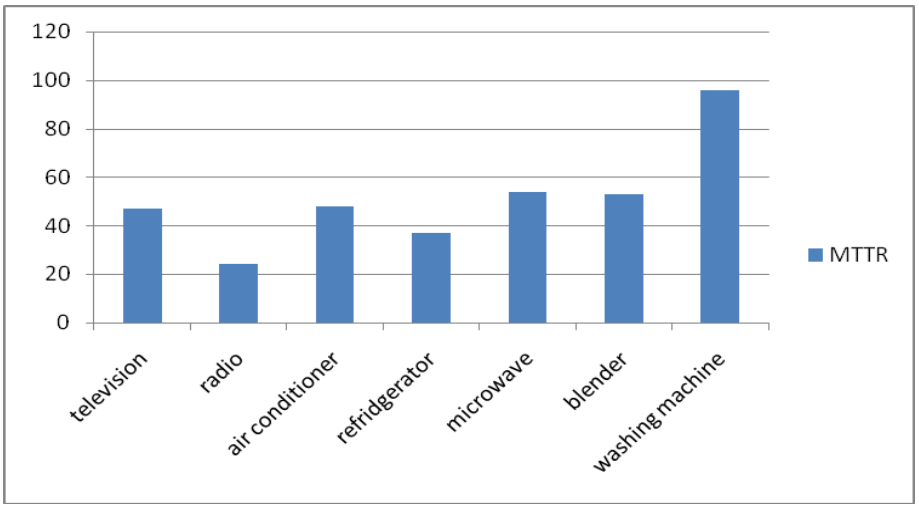

Figure 4: mean time to repair of the household equipment

The results of figure 5 shows the effect of erratic power supply on the availability of household equipment and from these results we discovered that it greatly determines the availability of the equipment because the equipment that are out of service for most of the time have very low availability when compared with their counterparts that seldom fails.

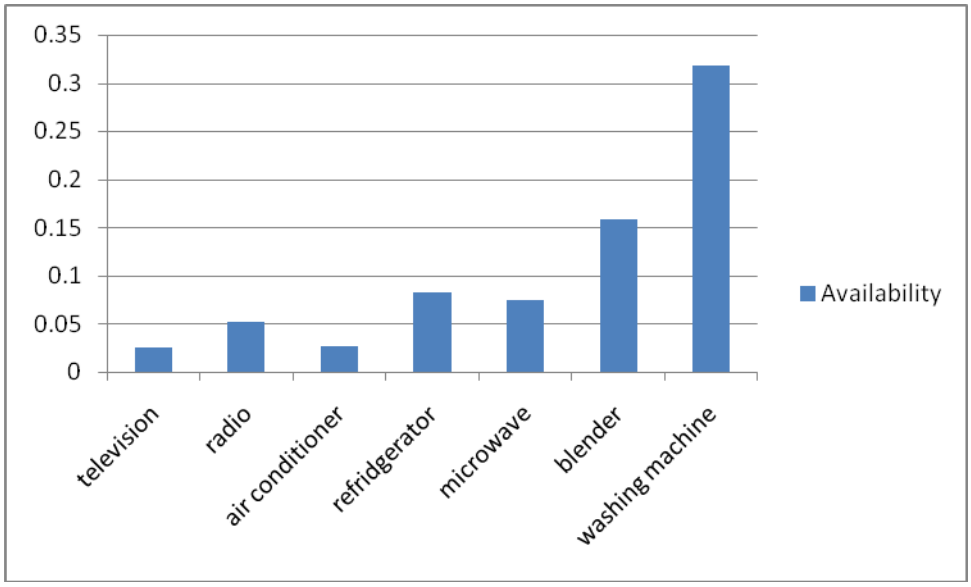

Figure 5: Availability of the household equipment

The effect of erratic power supply on reliability of the household equipment is shown in figure 6 which shows that the reliability of those equipment is greatly determined by erratic power supply that is the higher the rate of failure, the lower the reliability of the equipment.

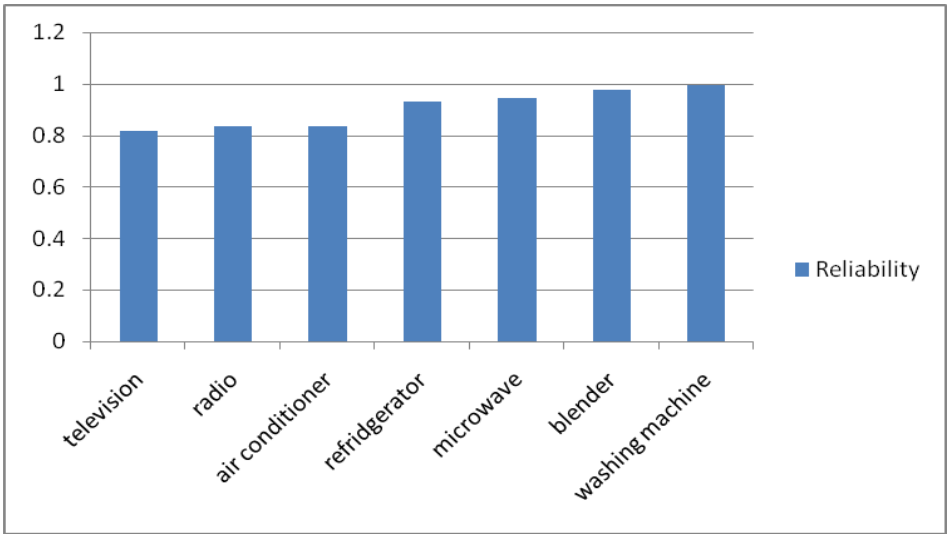

Figure 6: Reliability of the household equipment

4. Conclusion

This work has assessed the effect of erratic power supply on the reliability of household equipment and from the research it was discovered that erratic power greatly affects the failure rate of equipment, it was also discovered that the effect is proportional to the number of hours that the equipment is put to use in a day and those equipment that are rarely used have a very low failure rate as a result of the fact that when there is power failure they are not in use and even when they are used the number of hours that they are used are not always for a very

long time while those that are often used have a very high failure rate possibly because they are the ones that are often in use when the erratic power supply is experienced. Another finding is that most of the respondents that experience these failures do not use voltage regulators for their equipment and where they are used they are not the adequate ones and others are below the ratings of the equipment that they are supposed to regulate.

This research has also shown that the reliability of household equipment is highly dependent on the stability of power supply and that they are directly proportional, that is, the higher the stability of power supply the higher the reliability of the equipment.

5. Recommendations

It is therefore recommended that to achieve an optimum reliability the problems facing the power generation, transmission and distribution must be addressed, a way of doing this is by making available waivers on taxes on electricity generation equipment. The problem of overloading on individual transformers that often lead to voltage and current surges should be addressed by providing more transformers so that the loads can be evenly distributed, voltage regulators are also recommended to be used with the equipment so that in the case of surges it can be absorbed by the regulator without affecting the equipment. The use of uninterruptible power supply is recommended with television sets so that it can provide it with additional protection that will improve its reliability and life span. Lastly, all equipment should be turned off and unplugged from the source of power whenever they are not in use.

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