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Reliability of Computer System

[1]*Osahenvemwen, O. A. and* [2]*Ogbeide K. O.*

[1]Department of Electrical and Electronic, Faculty of Engineering and Technology.
Ambrose Alli, University, Ekpoma, Edo State, Nigeria.
[2]Department of Electrical and Electronic, Faculty of Engineering,
University of Benin, Benin City, Edo State

Abstract

This work presents a reliability study of computer system used in cyber café in Nigeria and deployed reliability tools to evaluate the performance of computer system for a period of one year duration. Reliability tools, known as Key Performance Indicators (KPIs) were deployed to determine the performance of eleven computer components prompted to different faults in computer system. Various computer cyber café are considered in this investigation, with the following assumption parameters: operating time between 7.00 am to 7.00 pm, Monday to Saturday. Therefore the totals expected up time are 3744 hours deduced from the period from 1st August 2011 to 28th July 2012. The faults occurrences of the computer components were highlighted. While, the computer component, mouse has the highest failure occurrence followed by power supply failure occurrence, overheating failure etc, also mother board failure component has the lowest occurrence in this investigation. The total down time per each fault and the total up-time per each fault are also presented. The observed down time totals are given as 32%, while the total up time for all the components are given as 68%. The Mean Time To Failure (MTTF), Mean Time To Repair (MTTR) and Mean Time Before Failure (MTBF) are presence in this study. It is observed that the present of high Mean Time Before Failure (MTBF) also, increases the total down time in computer system.

Keywords: Mean Time To Repair (MTTR), Mean Time Between Failure (MTBF), Reliability, Failure rate and Electronics

1.0 Introduction

The use of electronics devices in day to day activities has become imperative for human existence. These electronics devices play a great role in social network, e-commerce, entertainments, communication etc. However, man has been faced with various challenges from these electronic devices. Therefore, there is need to determine the satisfaction obtained from these electronics devices, by deducing it from intended system performance. Satisfaction is measured in terms of performance deduced from a device. In determining the performance of electronics devices, reliability tools were deployed in achieving reasonable results. A practical definition of reliability is "the probability that a piece of equipment operating under specified conditions shall perform satisfactorily for a given period of time" [1]. The reliability is a number between 0 and 1. Reliability theory is the foundation of reliability engineering. For engineering purposes, reliability is also defined as the probability that a device (or equipment or process) will perform its intended or designed function during a specified period of time under stated conditions. Mathematically, this may be expressed as

$$R(t) = Pr\{T > t\} = \int_t^{\infty} f(x)\,dx \qquad (1)$$

Corresponding author: ***Osahenvemwen, O. A.,*** E-mail: osahenvemwnaustin@ymail.com, Tel.: +2348037273256

where $f(x)$ is the failure probability density function and t is the length of the period of time (which is assumed to start from time zero). Reliability engineering focuses on costs of failure caused by system downtime, cost of spares parts, repair equipment, personnel and cost of warranty claims. The focus of safety engineering is normally not on cost, but on preserving life and nature, and therefore deals only with particular dangerous system failure modes [1],[2]. Reliability involves these following areas;

1. Reliability is a probability. This means that failure is regarded as a random phenomenon: it is a recurring event, and we do not express any information on individual failures, the causes of failures, or relationships between failures, except that the likelihood for failures to occur varies over time according to the given probability function. Reliability engineering is concerned with meeting the specified probability of success, at a specified statistical confidence level [3].
2. Reliability is predicated on "intended function:" generally, this is taken to mean operation without failure. However, even if no individual part of the system fails, but the system as a whole does not do what was intended, then it is still charged against the system reliability. The system requirements specification is the criterion against which reliability is measured [4, 5].
3. Reliability applies to a specified period of time. In practical terms, this means that a system has a specified chance that it will operate without failure before time t. Reliability engineering ensures that components and materials will meet the requirements during the specified time. Units other than time may sometimes be used. The automotive industry might specify reliability in terms of miles; the military might specify reliability of a gun for a certain number of rounds fired. A piece of mechanical equipment may have a reliability rating value in terms of cycles of uses [6, 7].
4. Reliability is restricted to operation state (or explicitly defined) conditions. This constraint is necessary because it is impossible to design a system for unlimited conditions. A Mars Rover will have different specified conditions than a family car. The operating environment must be addressed during design and testing. Also, that same rover may be required to operate in varying conditions requiring additional scrutiny [7].

Failure rate **(λ)**, every product has a failure rate λ, which is the number of units failure occurred per unit time. This failure rate changes throughout the life of the products. Failure is referred to any devices that stop working properly [1].
The relationship of failure rate is given as;

$$Failure\ In\ Time(FIT) = \frac{1}{MTTF} \tag{2}$$

The most common reliability parameter is the Mean Time To Failure (MTTF), which can be used to specified the failure rate (this is expressed as a frequency or Conditional Probability Density Function (CPDF)) of the number of failures during a given period. MTTF is applied to any parts that will be thrown away on failing. During the 'useful life period' it's assuming a constant failure rate; MTTF is often used *to* measure usage for non-repaired items.
The two most important Key Performance Indicators (KPIs) in reliability and maintenance are Mean Time Between Failures (MTBF) and Mean Time To Repair (MTTR) respectively.
MTBF is referred to as mean operating time between failures, it also applied to equipment that is undergoing repairs and returned to service. The MTBF is a measure used for items which are in fact repaired after a failure. *MTBF* is the inverse of the failure rate and it can be used interchangeably, i.e.

$$MTBF = \frac{1}{\lambda} \tag{3}$$

Many people misunderstand *MTBF* and wrongly assume that the *MTBF* Figure indicates a minimum and guaranteed time between failures. If failures occur randomly then they can be described by an exponential distribution given as;

$$R(t) = e^{-\lambda t} = e^{\frac{-t}{MTBF}} \tag{4}$$

Also, the definition of reliability parameters as followed [3];

- The Mean Time Between Failures (MTBF) is calculated by dividing the total up time by the number of breakdowns or failures.

$$MTBF = \frac{T}{R} = \frac{Total\ up\ time}{Number\ of\ failure\ or\ breakdown} \tag{5}$$

- The Mean Time is referred to as the average time and the Mean Time Between Failures (MTBF) is the average time between one failure to another. Most of the time, it is commonly understood as the average time along which something works until the time comes that it fails and it needs repairing.
- While, the Mean Time To Repair (MTTR) is calculated by dividing the total down time by the number of breakdowns or failures.

$$MTTR = \frac{Total\ down\ time}{Number\ of\ failure\ or\ breakdown} \quad (6)$$

The Mean Time To Repair (MTTR) is a factor expressing the mean active corrective maintenance time required to restore an item to an expected performance level. This includes for example trouble-shooting, dismantling, replacement, restoration, functional testing, but shall not include waiting times for resources [2][8][5].
Mean Time To Repair (MTTR) is the mean time needed for something to be repaired after it failed, also can be referred to as the time taken to repair a failed hardware module. However, the right term for a thing that cannot be repaired is Mean Time To Failure (MTTF). Often time, MTBF is define as the sum of MTTR and MTTF (MTTF + MTTR = MTBF). These parameters are very useful to determine the performance of devices that are often operated frequently, such as vehicles, machinery, and electronic equipment [2].

$$MTTF = \frac{Total\ up\ time}{Number\ of\ units\ under\ test} \quad (7)$$

Maintainability it's a measure of how easy it is to restore function. It measured by how long it takes to restore function to the system, this "restore function" is also includes the time spent preparing to repair, repair time and starting up after repairs.

$$Restore\ time = prepare\ to\ repair + repair + startup\ time \quad (8)$$

Availability it is a relative measure of the extent that equipment (or a system) can perform it design functions [6].
Average Availability can be calculated from

- Reliability(based on MTBF)
- Maintainability (based on MTTR)

$$Availability = \frac{MTBF}{MTTR+MTBF} \quad (9)$$

The actual availability is different from the average availability and actual availability is given as:

$$Actual\ availability = \frac{uptime}{uptime+downtime} \quad (10)$$

Reliability engineering is closely related to safety engineering, in that they use some common methods for their analysis and may require input from each other [2, 9 -11].
Mean Down Time (MDT*)* it is the total down time of an item. This includes;

- Mean Time To Restoration or Repair MTTR (mean active maintenance time),
- Logistic Delay Time (*LDT*) includes; (waiting for recourses (e.g. spares, test equipment, skilled personnel), travelling, transportation, etc.) and

Administrative Delay Time (*ADL*) includes; (personnel assignment priority, organizational constraint, transportation delay, labour strike, etc) [12, 13].

2.0 Research Method

This research work is on reliability of computer components system, which involves 100 computers system used in a cyber café located in Benin City, Nigeria. This experiment was carried out in one year duration (from 1st Aug 2011 to 28th July 2012). Reliability tools, know as key Performance Indicators (KPIs) were used to determine the performance of eleven components in a computer system. The computer cyber café reliability analysis is assumed to operate at 23^0c, from 7.00 am to 7.00 pm and from Monday to Saturday, therefore the total expects up time is 3744 hours deduced from one year. The data in Table 1 are obtained from the investigation [14].

Total of (11) eleven computer components were highlighted in Table 1 with the corresponding faults and various reliability parameters.

3.0 Results and Discussion

From this research work, Eleven (11) types of faults were considered, with their various numbers of occurrences, which are presented in Fig. 1. In Fig. 1 show the various levels of faults occurrences from computer desk top component, used in cyber cafe system. It is observed that, mouse computer component has the highest failure rate occurrences, followed by power supply unit component.

In Fig. 3, it is observed that the totals down time from the analysis were obtained as 32%, while the total up time for all the components were obtained as 68%. The pie chart in Fig. 3 shows the total downtime and uptime experienced in computer cyber café system in one year period of investigation. Also, increase in total uptime, will lead to effective performance of the computer component devices in cyber café and users satisfaction is guarantee from this computer (electronics) devices. However, increase in total down time will lead to non - performance of computer device, loss of revenue from the manufacturers of computer devices and dissatisfaction from prospective user of computer devices.

Fig. 4, show various parameters levels used to determine the reliability of computer system. The MTTR in the system is very small, MTTF value and MTBT value obtained from the processor failure has the highest, followed by RAM failure and mother board failure rate. The reliability system increases as the MTTF increases. The MTTF is usually specified in hours, but can also be used with other units of measurement, such as miles or cycles. Reliability increases as the MTTF increases and maintainability increases as the MTTF increases.

4.0 Conclusion

The need and role of electronics devices in our day to day activities cannot be overemphasis. Therefore, there is need to evaluate the reliability of these electronics devices, to determine their performance in relative to user satisfaction. The computer systems are often used in offices, schools, researches centers, home, cyber café, industries, banking system etc. These computer systems are made up of various components which are highlighted and these computer components are prompted to various degrees of faults. This investigation was carried out in Benin City, in Nigeria. Reliability tools were used to determine the performance of these computer components considered in this study. The faults occurrence of the computer components were presented, while the mouse failure has the highest occurrence followed by power supply failure rate, overheating failure rate and mother board failure rate component has the lowest occurrence in this investigation. The total down time per each faults and the total up-time per each faults were also presented. The totals observed down time were obtained as 32%, while the total up time for all the components were obtained as 68%. The Mean Time To Failure (MTTF), Mean Time To Repair (MTTR), Mean Time Before Failure (MTBF) were presented in this study. It is observed that the Mean Time To Failure (MTBF) obtained from the analysis, show a high performance of the computer components.

Table 1. The reliability tools used in computer component faults analysis

S/N	Types of Faults	Number of failure occurrence	Down time per fault	Total down time per fault (hrs)	Total Expect up time Per	Mean Time Between Failure (MTBF)	Mean Time To Repair (MTTR)	Mean Time To Failure (MTTF)
1	Mouse failure	6	0.10	1.00	623.00	103.83	0.167	56.64
2	Keyboard failure	2	0.17	0.34	623.26	311.63	0.170	56.66
3	Blank screen failure	3	0.45	2.25	621.35	207.12	0.750	56.49
4	Mother board failure	1	1.42	1.42	622.18	622.18	1.42	56.56
5	Hard disk failure	2	1.28	2.56	621.04	310.52	1.28	56.45
6	Overheating	3	1.08	3.24	620.36	206.79	1.08	56.40
7	CMOS defect	2	0.54	1.48	622.12	311.06	0.74	56.56
8	Power supply	4	1.09	4.36	619.24	154.81	1.09	56.29
9	IDE connect (cable)	2	1.12	2.24	621.36	310.68	1.12	56.49
10	RAM failure	1	1.15	1.15	622.45	622.45	1.15	56.59
11	Processor failure	1	1.56	1.56	622.04	622.02	1.56	56.55

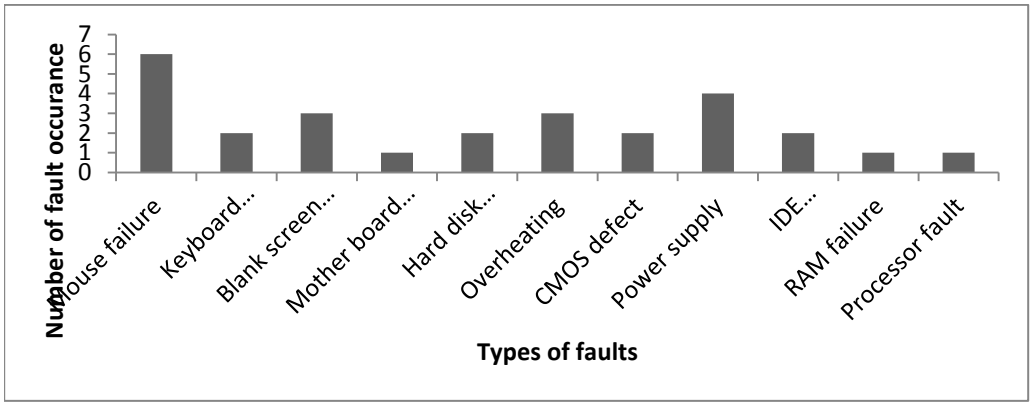

Fig. 1 Types of fault occurrence

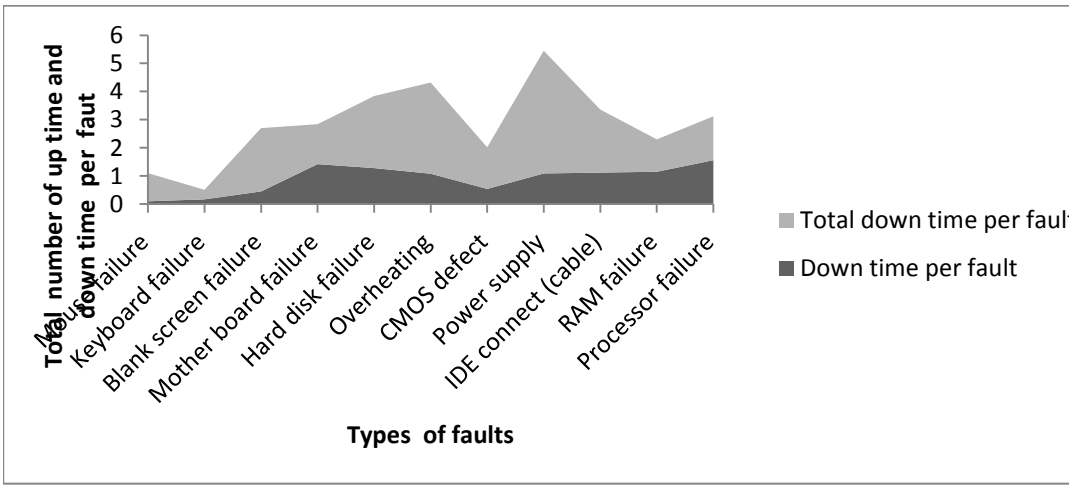

Fig. 2 Total down time uptime per fault

The various faults are highlighted in Fig 2 based on the corresponding total down time per fault and the totals up time per each fault are presented.

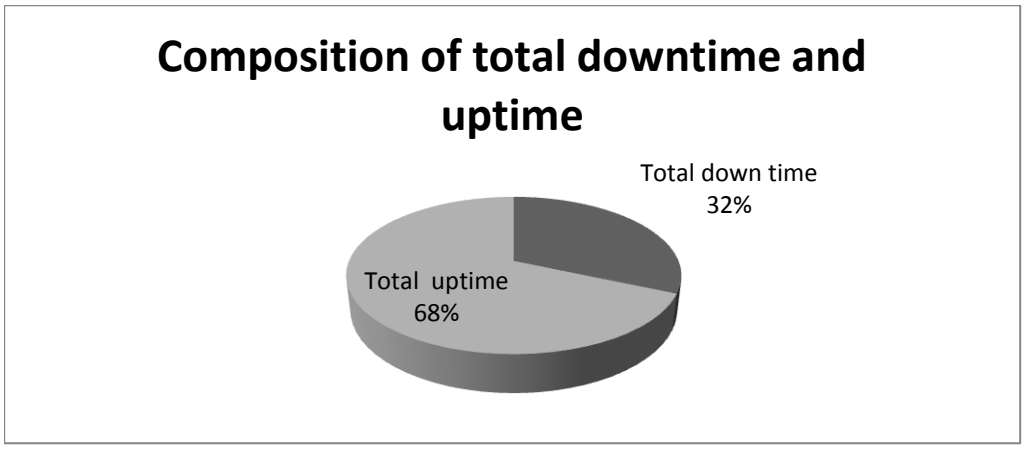

Fig. 3 Total Downtime and Uptime in Percentage.

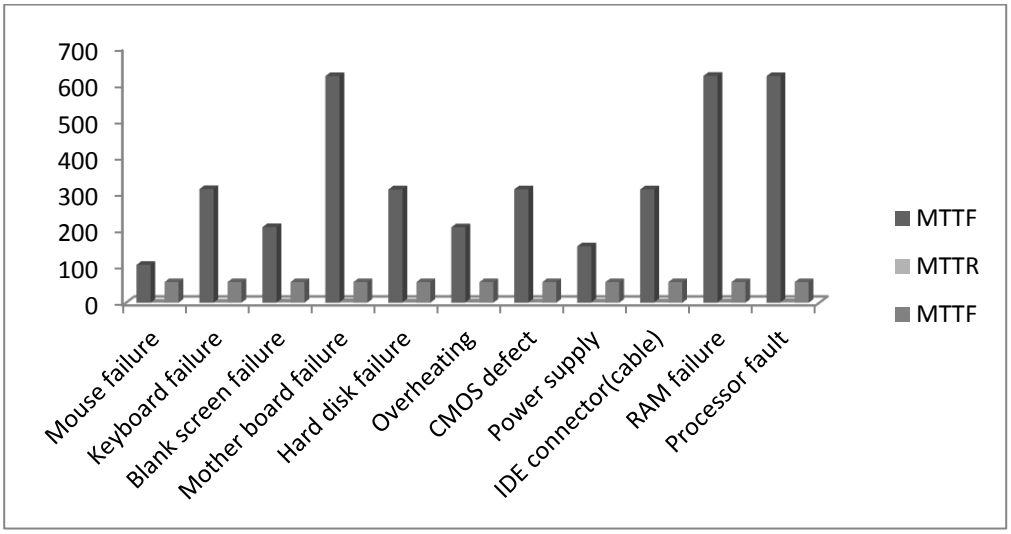

Fig. 4. the presentation of MTTF, MTTR and MTBF

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