# Challenges of Preventive Maintenance of Automated Teller Machine (ATM) Operations in Nigeria

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## Abstract

Maintaining the availability of production equipment such as Automated Teller Machines (ATMs), and guaranteeing production efficiency are crucial to sustaining production capacity and the key elements influencing profitability in a competitive business climate. Studies have demonstrated that neglecting maintenance and its importance to business operations or production processes frequently has a variety of unintended consequences, including problems with finances, technology, and customer happiness. Also, it should be noted that the impact of preventive maintenance on the availability and useful life of Automated Teller Machines (ATMs), it is clear that effective maintenance is not just about fixing problems after machine breakdown (i.e. corrective maintenance) but preventing them from occurring or reducing them to a minimum. Hence, from the analysis and result, it is recommended that corrective maintenance should not be solely depended on as the only maintenance strategy but banks should adopt preventive maintenance programs in maintaining their Automated Teller Machines (ATMs) to sustain the recommended availability as the age of the machine. Many management personnel often view maintenance as an expense, a more positive approach in looking at it is to view maintenance works as a profit center. Maintenance is not just about ensuring the proper function of the machine and equipment (to continue to fulfill its intended purpose) but also plays a key role in achieving the company's goals and objectives by improving productivity and profitability as well as overall performance efficiency.

**Keywords:** Automated Teller Machine, uptime, downtime, net present value, complex endeavor, customer satisfaction, preventive maintenance.

## Introduction:

Preventive maintenance is defined by Dhillon (2002) as all actions carried out on a planned, periodic, and specific schedule to keep an item/equipment in stated working condition through the process of checking and reconditioning. These actions are precautionary steps undertaken to forestall or lower the probability of failures or an unacceptable level of degradation in later service, rather than correcting them after they occur. It is also called time-driven or interval-based maintenance and is performed without regard to equipment condition. It consists of periodically scheduled inspection, part replacement, and repair of components/item adjustment, calibration, lubrication, and cleaning. PM schedules regular inspection and maintenance at set intervals to reduce failures for susceptible equipment. It is important to note that depending on the redefined intervals, practicing PM can lead to a significant increase in inspection and routine maintenance. On the other hand, it can help reduce the frequency and severity of unplanned failures. Dhillon

(2002) noted that preventive maintenance can be costly and ineffective if it is the only type of maintenance practiced.

Preventive maintenance is an important component of maintenance activity. Within a maintenance organization, it usually accounts for a major proportion of the total maintenance effort. PM may be described as the care and servicing by individuals involved in maintenance to keep equipment/facility in a satisfactory operational state by providing for systematic inspection, detention, and correction of incipient failures either before their occurrence or before they developed into major failures.

Preventive maintenance encompasses activities including adjustments, replacement, and basic cleanliness that forestall machine breakdowns. Preventive activities are primarily condition based. The condition of a component, measured when the equipment is operating, governs planned/scheduled maintenance. Typical preventive maintenance activities include periodic inspections, condition monitoring, critical item replacements, and calibrations. To accomplish this, blocks of time are incorporated into the operations schedule. One can easily see that this is the beginning of a proactive mode rather than a reactive one. The purpose of preventive maintenance is to ensure that product quality is maintained and that delivery schedules are met. In addition, a machine that is well cared for will last longer and cause fewer problems.

Current trends in management philosophy such as just-in-time (JIT) and total quality management (TQM) incorporate preventive maintenance as a key factor in their success. JIT requires high machine availability, which in turn requires preventive maintenance. Also, TQM requires equipment that is well-maintained to meet the required process capability.

## An Overview of Preventive Maintenance (PM)

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Preventive maintenance is also seen as a measure of management excellence. It requires a long-term commitment, constant monitoring of new technology, a constant assessment of the financial and organizational tradeoffs in contracting out versus in-house maintenance, and an awareness of the impact of the regulatory and legal environment.

**Preventive maintenance as a measure of management excellence:**

It requires a long-term commitment, constant monitoring of new technology, a constant assessment of the financial and organizational tradeoffs in contracting out versus in-house maintenance, and an awareness of the impact of the regulatory and legal environment. The resulting benefits of preventive maintenance are many. Some of them are listed below:

i. Safety: Machinery that is not well-maintained can become a safety hazard. Preventive maintenance increases the margin of safety by keeping equipment in top running condition.
ii. Lower cost: A modern and cost-effective approach to preventive maintenance shows that there is no maintenance cost optimum. However, maintenance costs will decrease as the cost of production losses decreases. No preventive maintenance action is performed unless it is less costly than the resulting failure.
iii. Reduction in failures and breakdowns: Preventive maintenance aims at reducing or eliminating unplanned downtime, thereby increasing machine efficiency. Downtime is also reduced when the preventive maintenance process gives maintenance personnel sufficient warning so repairs can be scheduled during normal outages.
iv. Extension of equipment life: Obviously, equipment that is cared for will last longer than equipment that is abused and neglected.
v. Improved trade-in/resale value of equipment: If the equipment is to be sold or traded in, a preventive maintenance program will help keep the machine in the best possible condition, thereby maximizing its used value.
vi. Increased equipment reliability: By performing preventive maintenance on equipment, a firm begins to build reliability into the equipment by removing routine and avoidable breakdowns.
vii. Increased plant productivity: Productivity is enhanced by the decrease in an unexpected machine breakdown. In addition, forecast shutdown time can allow the firm to utilize alternate routings and scheduling alternatives that will minimize the negative effect of downtime.
viii. Fewer surprises: Preventive maintenance enables users to avoid the unexpected. Preventive maintenance does not guarantee the elimination of all unexpected

downtime, but empirically it has proven to eliminate most of it caused by mechanical failure.

ix. Reduced cycle time: If process equipment is incapable of running the product, then the time it takes to move the product through the factory will suffer. Taninecz (1997) found, from an Industry Week survey, that there is a strong correlation between preventive maintenance and cycle-time reductions as well as near-perfect on-time delivery rates. In addition, approximately 35 percent of the surveyed plants that widely adopted preventive maintenance achieved on-time delivery rates of 98 percent, compared to only 19.5 percent for non-adopters.

x. Increased service level for the customer and reduction in the number of defective parts: These have a positive direct effect on stock-outs, backlog, and delivery time to the customer.

xi. Reduced overall maintenance: By not allowing machinery to fall into a state of disrepair, overall maintenance requirements are greatly decreased.

One way end users can further minimize unit-related failures is to institute a comprehensive PM program that is implemented by original equipment manufacturer (OEM) trained technicians. When correctly implemented, PM visits to ensure maximum reliability of data center equipment by providing systematic inspections, detection, and correction of incipient failures, either before they occur or before they develop into major defects that result in costly downtime. Typical PM programs include inspections, tests, measurements, adjustments, parts replacement, and housekeeping practices.

**Maintenance concept:**

The main question faced by management is how maintenance costs and the reliability of systems are quantified and optimally balanced. Generally, maintenance has been defined as the combination of all technical, administrative, and managerial actions during the lifecycle of an item intended to retain or restore it to a state in which it can perform the required function. (Dhillon, 2002). Key to any manufacturing operation is the 'care and feeding' of its production equipment. In particular, maintenance actions can be classified into two types: corrective maintenance and preventive maintenance. Corrective maintenance is adopted in cases where units can be fixed. If units fail, then they may begin to be repaired immediately or may be scrapped. After repair completion, units can operate again. According to different ways of performing corrective maintenance, maintenance was defined in the literature as minimal repair, general repair, imperfect repair, and so on. Preventive maintenance is adopted in the case where maintenance of units after failure may be costly and sometimes may require a long time to rectify the failed units. The most important problem is to determine when and how to maintain units to prevent failure. However, it is not wise to maintain units with unnecessarily high frequency. From this viewpoint, the object of maintenance optimization problems is to determine the frequency and timing of preventive maintenance according to costs and effects (Hongye, 2008).

**Elements of Preventive Maintenance:**

i. **Inspection:** Periodically, inspecting materials/items to determine their serviceability by comparing their physical, electrical, mechanical, etc., characteristics (as applicable) to expected standard.

ii. **Servicing:** Cleaning, lubricating, charging, preservation, etc., of items/materials periodically to prevent the occurrence of incipient failures.
iii. **Calibration:** Periodically determining the value of characteristics of an item by comparison to standard: It consists of the comparison of two instruments one of which is certified standard with known accuracy, to detect and adjust any discrepancy in the accuracy of the material/parameter is compared to the established standard value.
iv. **Testing:** Periodically, testing or checking out to determine serviceability or to detect electrical/mechanical-related degradation.
v. Alignment: Making changes to an item-specified variable element of material for achieving the optimum system of performance.
vi. **Adjustment:** Periodically adjusting specified variable elements of material for achieving the optimum system of performance.
vii. **Installation:** Periodic replacement of limited-life items or the items experiencing time cycle or wear degradation, to maintain the specified system tolerance.

**Challenges with Banking ATM System Interfaces Design:**

i. **Security breaches:** There have been several breaches and potentially fraudulent acts committed against Banking ATMs, including pin-based theft, card-trapping assaults, and skimming, Cracking, phishing/vishing, ATM malware, hacking, and physical attack are all examples of cyberattacks (Nana & Nana, 2013).

ATM security described in the literature relied on a variety of biometric techniques, including voice, fingerprint, hand shape, and facial recognition, iris and retinal scanning, signature verification, vascular patterns, With clever camera technology and LED array, it is possible to recognize keystrokes and vein patterns. utilized to take these digital photos, and both credit cards and smart cards are compatible with their safety, ATM safety, etc. (Go et al., 2014; Mandot & Verma, 2015).

Fingerprints and iris images were frequently suggested as effective security methods due to their distinct physiological characteristics, convenience, less risk of monetary theft, and projected cost of the password administrator. (Kassem et al., 2014; Mike & Momodu, 2015). Biometric fingerprint authentication, however, faced with the obstacle of detecting fake fingerprints, needed fingerprint image processing time and resources before it can be successfully processed (Mike & Momodu,2015).

ii. **Interface challenges:** Nigerian banking ATM system interfaces do not accommodate everyone who wants to use them. ATM systems in Nigeria do not seem to be designed for users of all literacy levels and skills; instead, they seem to be designed for specialized users. In the past, user interfaces (UI) were created using structured and iterative techniques that included user task analysis and a functional design approach but ignored the users' behavioral intentions to utilize technology or their wide range of abilities in all aspects of life (Park & Song, 2015).

The lack of a customizable interface on ATMs makes them appear complex and challenging to operate, which is one major obstacle to the adoption of banking ATM systems in Nigeria (Bedman, 2013; Sagib & Zapan, 2014).

ATM system interface developers in Nigeria have not taken advantage of the new technological innovations designed on high-level usability platforms to close the existing usability gaps often observed in the ATM systems in Nigeria (Ilyas et al., 2013).

According to UNESCO, only 59.67% of literate Nigerians are adults aged 15 years and older (UNESCO, 2015). The latest United Nations estimate of the current Nigerian population as of March 9, 2017, was put at 190,279,273 with a median age of 18 years (Worldometers, 2017). According to United Nations World Population Prospects the 2015 Revision, about 62% of Nigeria's population is aged 15 years or older (United Nations World Population Prospects, 2015). The implications of the above statements are:

- 117,973, 149.26 (62% of 190,279,273) Nigerians are aged 15years or older.
- 47,578,571.10 (40.33% of 117973149.26) Nigerians aged 15 years or older are illiterate or semiliterate.
- The existing banking ATMs do not adequately cater to about 40.33% of illiterate or semiliterate adults aged 15 years and older. That is about 47,578,571.10 adults aged 15 years and older.

The existing ATM system interfaces in Nigeria have failed to provide easy-to-use ATM system interfaces for a variety of people with varying abilities and literacy levels, which supports the need for this research to identify strategies to improve ATM interfaces. An interface that fails to incorporate the user, and "compromises" the users' varying abilities and capabilities that determine whether the product will be easy-to-use, has failed (Hyysalo & Johnson, 2014).

**Table 1: Common ATMs problems and their causes:**

| breakdown scenario | Main problem | Causes |
|---|---|---|
| 1. | Pick failure of cash handler | Damaged central board |
| 2. | GOP not responding | A weak or malfunctioning sensor |
| 3. | Presenter Error | Misalignment of mean timing disc |
| 4. | Card Jam | Dirty read head due to long period of use without maintenance |
| 5. | Starker Error | Mutilated Note |
| 6. | Note the jam between the pick module and pre-lvdt | Misalignment of lvdt belt |

**Table 2: Common ATMs problems and their causes**

| Problems | Total Downtime for each problem (hours) | Number of machines (hours) | Mean Downtime (hours) | Uptime (hours) |
|---|---|---|---|---|
| Cam Jam | 123.6 | 5 | 24.72 | 143.28 |
| Starker Error | 143.15 | 5 | 28.63 | 139.37 |
| Presenter Error | 123.2 | 5 | 24.64 | 143.36 |
| GOP Not Responding | 70.5 | 5 | 14.1 | 153.9 |
| Pick Failure Of Cash Handler | 112.7 | 5 | 22.54 | 145.46 |

**Machine Downtime:** Using the operational availability method to calculate the availability of the machine in different scenarios:

$$Ao = \frac{MTBM}{MDT+MTBM}$$

Ao = Operational Availability
MTBM = Mean Time before Maintenance
MDT = Mean Downtime
Note: Total Operating Cycle/week = 168hours
Thus, MDT + MTBM = 168

The calculated availabilities are those obtained under the corrective maintenance strategy. ATMs are meant to operate 24/7 (i.e. 100%) and any machine with availability less than 98.5% is below the recommended benchmarked availability.

**Table 3: Machine Availability**

| Problems | Availability% |
|---|---|
| Cam Jam | 85.2% |
| Starker Error | 82.9% |
| Presenter Error | 85.3% |
| GOP Not Responding | 91.6% |
| Pick Failure Of Cash Handler | 86.5% |

The downtime varies for different scenarios due to various degrees of delay and repair downtime, which can hardly be predetermined. It depends on the severity of the breakdown and the parts of the machine that are affected. These values are very low compared to the expected value of 98.5%, which is the industry-benchmarked uptime of ATMs. Because the data lacks specific failure details, the downtime intervals are often considered generic age-to-failure data. Likewise, the specific maintenance details are often considered generic.

ESTA, in an article titled ATM life cycle cost and currency, highlighted what makes an ATM successful and illustrated the effect of downtime

i. What makes an ATM successful?
ii. Several transactions were completed.
iii. Minimized number of customers disappointed.

Below shows the number of the transaction by the hour:

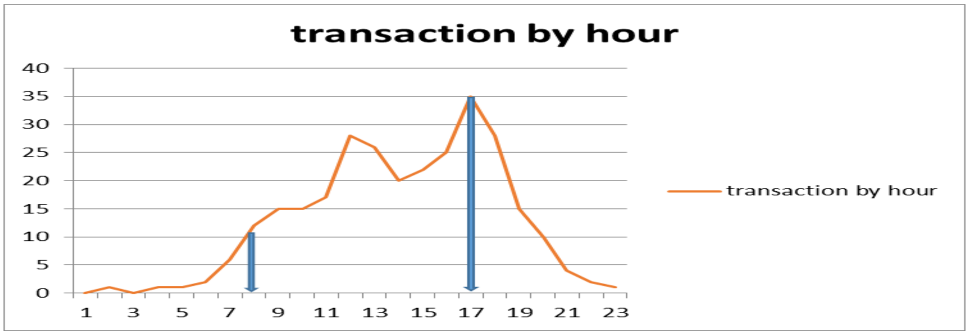


**Figure 1: Number of transactions by hour**

**ATM down from 17:00 to 18:00**

Availability is 23/24 = 95.8% with 35 customers disappointed (i.e. 35 transaction lost). These figures depend on the area of interest; in some other areas the number of transactions lost could be far greater than that, the exact amount lost due to such downtime is the area of consideration for this research.

## Conclusion:

This study describes the role of preventive maintenance as a support function and its impact on an organization's operational efficiency concerning the availability, performance, and useful life of Automated Teller Machines (ATMs) which are fundamental in achieving profitability and sustaining customers' goodwill. Preventive maintenance (PM) as a function in an organization can increase operation efficiency, reduce downtime or unplanned stoppages, improve service quality and consequently, increase profitability and customer satisfaction, which are the most significant motivations for a company's investment.

An effective preventive maintenance practice can keep machines in a reliable condition, increase the life length of the machine, reduce failures and costly breakdowns; and decrease overall operating costs.

## Recommendations:

Based on the conclusion, the following is recommended:

i. Usability design should reflect the culture in practice to improve user experience in the aspect of human, computer, and interaction interface design to address literacy levels and cultural differences of users
ii. Information quality, system quality, support service quality, and instructor quality should be embedded in a banking ATM system interface to make the system easy to use and useful
iii. The feedback loop should be embedded in ATMs machines for a better and essential interface design to take care of all cultures and the sentimental of the users.
iv. A scheduled maintenance program should be implemented for each component (i.e. work identification).
v. Necessary resources needed for successful execution should be acquired (i.e. skilled personnel, spares, and tools) for effective procedures.
vi. Information and on-the-spot training for the execution of the effective resource campaign strategy (i.e. acquire, deploy, and operate the systems).
vii. Ramp attention to the three major categories of ATM preventive maintenance activities: Inspection, Repair or Replacement, and Replenishment.

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