



Preventive Maintenance of Inkjet Printers: The Case of the City of Kabinda (DRC)

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ABSTRACT

Inkjet printers are widely used in public administrations, schools, businesses and service centres in the city of Kabinda. However, their availability and service life are affected by breakdowns linked in particular to insufficient preventive maintenance, the variable quality of consumables, dust and power supply disruptions. This study aims to analyse the main

causes of breakdowns and preventive maintenance practices in the city of Kabinda, and then to propose a model suited to the local context. The study adopts a quantitative approach supplemented by qualitative observations, involving 60 respondents selected through purposive sampling, comprising 45 users and 15 technicians. Data were collected using a questionnaire, semi-structured interviews and direct observations, and then analysed using frequencies and percentages. The results indicate that clogged print heads

account for 36.7 per cent of reported causes, faulty cartridges for 23.3 per cent, whilst 45 per cent of respondents state that they never carry out preventive maintenance. Corrective maintenance remains the most common type (65 per cent). These results show a link between insufficient preventive maintenance and the faults observed, although they do not, on their own, establish statistical causality. The study proposes a five-step model: periodic inspection, preventative cleaning, diagnosis, minor corrective action and follow-up and evaluation. It also recommends a maintenance schedule, user training, electrical protection, better management of consumables and a comparative cost-benefit analysis of preventative and corrective maintenance.

Keywords: Inkjet Printers; Preventive Maintenance; Printer Diagnostics; Equipment Reliability; Printhead Cleaning; Maintenance Strategies; Service Life; Kabinda; Democratic Republic of the Congo (DRC).

1. Introduction

Inkjet printers are now indispensable pieces of equipment in government departments, educational institutions, businesses and service centres. They facilitate the rapid production of administrative, academic and professional documents. Despite their importance, these devices regularly suffer breakdowns that affect their availability and result in additional repair or replacement costs.

In the city of Kabinda, many users operate their printers without following recommended preventive maintenance practices. This situation leads to clogged print heads, premature wear and tear of components, and a decline in the devices' performance. Added to this are the use of substandard consumables, fluctuations in the power supply and a shortage of specialist technicians.

Given this situation, it seems appropriate to investigate the causes of inkjet printer failures and to propose preventive maintenance strategies tailored to the context of the city of Kabinda. The results of this study may help to extend the service life of the equipment, reduce maintenance costs and enhance the continuity of services that rely on these printers.

2. Research question

The use of inkjet printers in Kabinda is characterised by frequent breakdowns that disrupt users' activities. In most cases, repairs are only carried out after a breakdown has occurred, whereas preventive maintenance would help to avoid many such failures. This situation highlights the need to identify the factors responsible for these breakdowns and to determine the preventive maintenance strategies best suited to

the local context in order to improve the lifespan of this equipment.

3. Research questions

Main research question:

Which preventive maintenance strategies can improve the service life of inkjet printers in the city of Kabinda?

Specific questions:

- What are the main causes of inkjet printer breakdowns in Kabinda?
- What preventative maintenance practices are currently being carried out by users and technicians?
- What measures can be implemented to reduce breakdowns and extend the service life of the printers?

4. Objectives

4.1. General objective

To analyse diagnostic and preventive maintenance strategies aimed at improving the lifespan of inkjet printers in the city of Kabinda.

4.2. Specific objectives

- To identify the main causes of inkjet printer breakdowns;
- To assess current preventive maintenance practices in Kabinda;
- Propose maintenance strategies tailored to the local context in order to reduce breakdowns and maintenance costs.

5. Research hypothesis

5.1. General hypothesis

The implementation of appropriate diagnostic and preventive maintenance strategies contributes significantly to improving the service life of inkjet printers in the town of Kabinda.

5.2. Specific hypotheses

Breakdowns are mainly due to a lack of regular preventive maintenance and the use of poor-quality consumables.

Implementing a preventative maintenance programme reduces the frequency of breakdowns and repair costs.

Training users in best practices for use and maintenance improves printer performance and longevity.

6. Literature review

6.1. Concept of an inkjet printer

An inkjet printer is an output device that reproduces text and images on paper by ejecting microdroplets of ink. It is widely used in schools, government offices, businesses and households due to its relatively low cost and good print quality. Leading manufacturers, such as HP Inc., Canon Inc., Epson and Brother Industries, recommend regular maintenance to maintain the performance of the equipment.

6.2. Printer diagnostics

Diagnostics refers to the set of techniques used to identify the causes of a fault. It involves observing symptoms, carrying out hardware and software tests, and checking the print heads, cartridges, drive rollers, sensors and power supply. Correct diagnostics reduce repair time and minimise maintenance costs.

6.3. Preventive maintenance

According to the international standard NF EN 13306, preventive maintenance refers to all actions carried out before a fault occurs in order to reduce the likelihood of equipment failure. For inkjet printers, this includes, in particular, cleaning the print heads, checking the cartridges, internal cleaning, protection against dust and power surges, as well as compliance with operating conditions.

6.4. Printer lifespan

A printer's service life depends on several factors: frequency of use, the quality of consumables, the working environment, power supply conditions and the quality of maintenance operations. Regular preventative maintenance helps to reduce breakdowns and improve the availability of the equipment.

6.5. Previous studies

Several studies show that preventative maintenance is less costly than repairs following a breakdown. They also conclude that raising user awareness and implementing a maintenance schedule help to extend the service life of printers.

7. Methodology

This research adopts a quantitative approach supplemented by qualitative observations. It is descriptive and analytical in nature, with a field study conducted in the town of Kabinda.

Study population:

- Public administrations;
- Educational establishments;
- Photocopying centres;
- Private companies;
- IT maintenance technicians.

Sample: A sample of 60 respondents was selected using the purposive sampling method.

Data collection techniques:

- Questionnaire;
- Semi-structured interview;
- Direct observation of printers.

Analysis techniques:

- Descriptive statistics (frequencies, percentages);
- Tables and graphs;
- Comparative analysis of maintenance practices.

8. Overview of the study area

The city of Kabinda is the capital of Lomami Province in the Democratic Republic of the Congo. It is a major administrative, commercial and educational centre. Public services, schools, universities, private companies and photocopying centres use inkjet printers on a daily basis.

Despite this high level of use, several organisations do not have a preventive maintenance programme in place. Equipment is often only serviced when it breaks down, leading to service interruptions and high repair costs.

9. Presentation and analysis of results (structure)

Sample: 60 respondents (45 users and 15 technicians)

Causes of Breakdowns:

Causes of breakdowns	Number	Percentage
Faulty cartridges	14	23.3%
Clogged print heads	22	36.7%
Excessive dust	10	16.7%
Power cuts and power surges	8	13.3%
Mechanical faults	6	10.0%
Total	60	100 per cent

Analysis: Clogged print heads are the main cause of failure (36.7 per cent). This suggests that preventative cleaning procedures are inadequate. Faulty cartridges (23.3 per cent) are also a significant cause, highlighting the importance of using high-quality consumables.

Maintenance frequency:

Frequency	Number	Percentage
Never	27	45%
Once a year	18	30 per cent
Every six months	10	16.7 per cent
Every three months	5	8.3%
Total	60	100 per cent

Analysis: The majority of respondents (45 per cent) never carry out preventive maintenance, which explains the high frequency of breakdowns.

Types of maintenance carried out:

Types of maintenance carried out	Number of staff	Percentage
Corrective only	39	65%
Preventive	21	35 per cent
Total	60	100 per cent

Analysis: The results show that corrective maintenance is by far the most common practice. This practice increases repair costs and reduces the service life of printers.

The results of the study show that:

- ❖ The lack of preventive maintenance is associated with a higher frequency of breakdowns;
- ❖ Users who carry out regular maintenance report fewer malfunctions;
- ❖ The use of high-quality cartridges and protection against power surges improves printer performance.

These observations confirm the general hypothesis that the implementation of diagnostic and preventive maintenance strategies improves the service life of inkjet printers.

Discussion of the results

The results obtained highlight that the most frequent faults are linked to a lack of regular maintenance, the use of substandard consumables and power supply disruptions. These findings are consistent with the scientific literature on the maintenance of IT equipment, which shows that preventive maintenance reduces breakdowns, improves equipment availability and lowers repair costs.

The study therefore recommends the implementation of a preventive maintenance schedule, user training and the installation of electrical protection devices in order to extend the service life of the printers.

10. Proposal for a preventive maintenance model

The proposed model comprises five stages:

❖ Step 1: Periodic inspection

- ✓ Checking the printer's general condition;
- ✓ Check the cartridges;
- ✓ Check the cables and power supply.

❖ Step 2: Preventative cleaning

- ✓ Cleaning the print heads;
- ✓ Removing dust from the interior;
- ✓ Cleaning the drive rollers.

❖ Step 3: Diagnostics

- ✓ Printing a test page;
- ✓ Checking print quality;
- ✓ Checking for error messages.

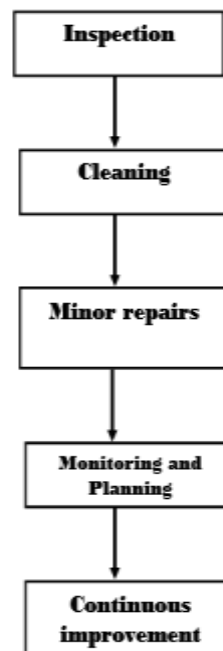
❖ Step 4: Minor corrective maintenance

- ✓ Replace the cartridges;
- ✓ Realigning the print heads;
- ✓ Updating the printer driver.

❖ Step 5: Monitoring and evaluation

- ✓ Keeping a log of maintenance work;
- ✓ Planning the next maintenance;
- ✓ Periodic performance assessment.

Simplified diagram of the model



This model is easy to implement in government departments, schools, businesses and service centres in Kabinda.

Recommendations

In light of the objectives of this study, the following recommendations are made:

➤ To users of inkjet printers

- Follow the manufacturer's instructions for use;
- Clean the print heads regularly to prevent them from becoming blocked;
- Use good-quality ink cartridges that are compatible with your printer model;
- Avoid leaving the printer unused for long periods;
- Protect the equipment from dust, damp and fluctuations in mains voltage.

➤ To maintenance technicians

- Establish a preventive maintenance schedule for each printer;

- Carry out a systematic diagnosis before any corrective action is taken;
- Keep a record of faults, repairs and parts replaced;
- Raise users' awareness of best practice in printer maintenance.

➤ **To managers in government departments, businesses and educational establishments**

- Set aside an annual budget for the preventative maintenance of IT equipment;
- Provide regular training for users on basic printer maintenance techniques;
- Fit electrical installations with surge protection devices;
- Draw up an IT maintenance policy that prioritises preventative rather than corrective measures.

➤ **To researchers**

- Extend research to other types of printers, particularly laser printers;
- Carry out comparative studies across different provinces of the Democratic Republic of the Congo in order to improve IT maintenance practices.

10.1. Methodological details and limitations of the study

This research should be interpreted as a descriptive and analytical study of an exploratory nature, focusing on the city of Kabinda. The sample of 60 respondents was selected using purposive sampling and comprises 45 users and 15 technicians. This strategy enables information to be gathered from those directly involved in the use, and maintenance of printers, but it does not allow the results to be generalised to the whole of the Democratic Republic of the Congo.

A second limitation concerns the nature of the data. The results are primarily descriptive and are based on observed frequencies and percentages. Whilst they enable trends and associations to be identified, they are not, on their own, sufficient to demonstrate a statistically established causal relationship between the lack of maintenance and the service life of printers. A follow-up study could track the same equipment over a specified period and measure the number of breakdowns, downtime, costs and maintenance operations

before and after the introduction of a preventative maintenance programme.

The maintenance frequencies proposed below constitute an indicative operational schedule. They must be adjusted according to the printer model, usage load, environment and the manufacturer's specifications.

10.2. Proposed operational schedule for preventative maintenance

The following schedule is intended to clarify the frequency of maintenance operations. It does not replace the specific instructions provided by each manufacturer.

Task	Recommended frequency	Person responsible	Objective	Remarks
Visual inspection and general check	Monthly	User / technician	To detect dust, cables, leaks and faults	Adjust according to frequency of use
External cleaning and dust removal	Monthly	Trained user	Limit dust build-up	Power off
Print quality check / test page	Monthly or as soon as a fault occurs	User	Early detection of faults	Depending on the tools in the model
Print head cleaning	As required and as specified by the manufacturer	User / technician	Reducing blockages	Avoid unnecessary cleaning
Checking cartridges and consume	At every replacement	User / technician	Avoid incompatibilities and faults	Check model and quality of
Check power supply and electrical protection	Half-yearly	Technician	Reduce electrical risks	Appropriate protection

Comprehensive preventive inspection	Half-yearly	Technician	Assess the general condition	More frequent for intensive use
Driver/firmware update	Depending on the manufacturer	Technician	Maintain compatibility and stability	Use official sources
Service log	After each operation	User / technician	Ensure traceability	Date, symptom, action, result

10.3. Management of consumables: original, compatible and remanufactured cartridges

The quality of consumables is an important factor to monitor. The study data indicate that faulty cartridges account for 23.3 per cent of reported causes. However, this result does not automatically mean that every failure can be attributed to the use of compatible or remanufactured cartridges.

Type	Main advantage	Risks or limitations	Recommended action
Original	Compatibility as specified by the manufacturer	Generally higher cost	Prefer where possible
Compatible	Potentially lower cost	Variable quality	Choose a reliable supplier
Refurbished / recharged	Lower purchase cost	Variable quality and condition	Check origin and performance

Consumables policy should prioritise compatibility, traceability and quality rather than a systematic distinction between original and compatible cartridges. The manufacturer's specifications and the model's characteristics must remain the technical benchmark.

10.4. Adapting the model according to manufacturers and models

The general principles set out here apply to inkjet printers, but the specific procedures may vary depending on the manufacturer and model. Manufacturers may offer specific

functions for nozzle checking, cleaning, alignment, calibration or diagnostics. Any maintenance work must therefore be carried out in accordance with the manual or maintenance tools for the model in question.

For example, official HP documentation describes several levels of printhead cleaning and states that this process uses ink; it therefore recommends not carrying out cleaning operations unnecessarily. This observation reinforces the importance of a preliminary diagnosis. □ cites □ turn0search6 □ turn0search7 □.

The proposed model should therefore be understood as a maintenance management framework rather than a single technical procedure applicable to all brands.

10.5. Electrical protection and operating environment

Power cuts and power surges account for 13.3 per cent of the causes reported in the study. Preventive maintenance must therefore take into account the equipment's electrical environment. Where technical and financial conditions permit, the use of a UPS, a voltage regulator or an appropriate protective device is recommended.

Printers should also be installed in a space that is as clean, dry and well-ventilated as possible, with exposure to dust kept to a minimum. These measures complement maintenance without replacing it.

10.6. Economic assessment: framework for comparison

The initial study does not contain sufficiently detailed financial data to calculate the actual cost savings between preventive and corrective maintenance. It would therefore be methodologically incorrect to state an unmeasured percentage saving. However, a calculation framework can be proposed for future data collection in Kabinda.

Indicator	Preventive maintenance	Corrective maintenance
Direct costs	Cleaning, inspections, maintenance consumables, scheduled interventions	Parts, labour, travel and repairs
Downtime	Anticipated and planned	Often unplanned, depending on the breakdown
Monitoring	Schedule and log	Fault history and repair re
Recommended action	Annual cost of preventative maintenance	Annual cost of repairs and capital expenditure

A subsequent economic study could compare, over the same period and for comparable equipment, the total cost of preventative maintenance with the total cost of corrective measures.

10.7. Enhancing user training

The results show that 65 per cent of respondents state that they carry out only corrective maintenance. This situation justifies simple and regular awareness-raising. A practical guide could cover external cleaning, checking print quality, storage conditions, the use of compatible consumables, electrical safety, the correct shutdown of equipment and consulting a technician when the task exceeds the user's skills.

Training should not turn the user into a technician. Its aim is to enable them to recognise the first signs of a fault and to carry out the simple procedures specified by the manufacturer, whilst avoiding uncontrolled dismantling.

10.8. In-depth discussion of the results

The results show that clogged print heads (36.7 per cent) are the most common cause among those reported, as well as a significant proportion of respondents who never carry out preventative maintenance (45 per cent). Corrective maintenance accounts for the majority (65 per cent). Taken together, these observations support the value of a preventive maintenance programme.

However, interpretation must remain cautious: the co-occurrence of these phenomena within the same sample does not constitute experimental proof of causality. The appropriate conclusion is that inadequate maintenance is associated with the observed failures and constitutes a plausible risk factor, to be confirmed by longitudinal or quasi-experimental studies.

The five-step model addresses this situation by introducing a preventive approach: pre-failure inspection, targeted cleaning, diagnosis, minor rectification and follow-up. Traceability makes it possible to track the equipment's history and identify recurring interventions.

10.9. Regulatory status of NF EN 13306

NF EN 13306 is a standard governing maintenance terminology. The 2018 version is designated by AFNOR as the current version; previous editions are indicated as superseded. □ cites □ turn0search1 □ turn0search3 □.

In this article, the reference to NF EN 13306 serves to provide a framework for the concepts of maintenance and not to present the proposed model as a certified procedure or as fully compliant with the standard. The model is a proposal by the author adapted to the context of inkjet printers in Kabinda.

Conclusion

The aim of this study was to analyse diagnostic and preventive maintenance strategies for inkjet printers in order to improve their service life in the city of Kabinda.

The theoretical analysis shows that the majority of faults observed in this equipment result from a lack of preventive maintenance, the use of substandard consumables, exposure to dust and power supply disruptions. These factors lead to increased repair costs, reduced equipment availability and a decline in user productivity.

To remedy this situation, a preventive maintenance model based on periodic inspection, cleaning, diagnostics, minor corrective actions and equipment monitoring has been proposed. Its implementation would help to reduce breakdowns, improve printer reliability and extend their service life.

This research contributes to the body of work on the maintenance of IT equipment in the context of the city of Kabinda. However, its findings would benefit from being consolidated by larger-scale field studies involving a broader sample and a longer observation period.

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