MAINTENANCE MANAGEMENT PRACTICES OF AUTOMATIC TELLER MACHINES AND OPERATIONAL PERFORMANCE OF COMMERCIAL BANKS IN KENYA

WANDERA TAKA IMMACULATE

A RESEARCH PROJECT REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF DEGREE OF MASTER OF BUSINESS ADMINISTRATION (MBA) IN THE FACULTY OF BUSINESS AND MANAGEMENT SCIENCES IN THE UNIVERSITY OF NAIROBI

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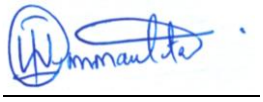
DECLARATION

I hereby declare that this research project is my original work and has not been presented in any other institution of higher learning for academic purpose.

Signature  Date: 17/11/2022

Name: **Wandera, Taka Immaculate**

Registration Number: **D61/7521/2017**

Department: **Department of Management Science and Project Planning**

University: **University of Nairobi**

Supervisor

This research project has been submitted for examination with my approval as the University supervisor.

Signature ___  Date: ___18/11/2022_____

Name: **Ms. Angela Kaguara**

Department: **Department of Management Science and Project Planning**

University: **University of Nairobi**

DEDICATION

I wholeheartedly dedicate this research work to my lovely parents George and Felicia Wandera, my husband Kelvin Musau, my daughter Xania Nthenya and the business fraternity all over the world.

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My special gratitude and honor go to the Sovereign God due to sufficiency of his grace and wisdom with whom all things are possible. A lot of gratitude to my supervisor, Ms Angela Kaguara and moderator Mr. Stephen Nyamwange whose guidance, support, constructive criticism, persistent encouragement, and availability was significant in the completion of this research project. To my parents, George, and Felicia, thank you for sowing the seeds of education in me and always challenging me to aim higher, indeed the sky is not the limit. To my husband Kelvin and my daughter Xania, special thanks for your patience, support, understanding and encouragement throughout the study period.

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ACRONYMS

ATM	-	Automatic Teller Machine
BSC	-	Balance Scorecard
CBK	-	Central bank of Kenya
KPI	-	Key Performance Indicators
MM	-	Maintenance Management
NPS	-	Net Promoter Score
OEE	-	Overall Equipment Efficiency
OM	-	Operation Management
OP	-	Operational performance
PM	-	Preventive Maintenance
DMAIC	-	Define, Measure, Analyze, Improve and Control
TQM	-	Total Quality Management

OPERATIONAL DEFINITION OF TERMS

ATM Channel: A department within commercial banks in charge of Automatic Teller Machines (ATMs) monitoring and maintenance.

Automatic Teller Machine: This is a machine equipped with multitask technology that can perform tasks such as cash withdrawal and deposit, cheque deposit, account balance inquiry, cash transfer, provision of mini statement and payment of utilities.

Commercial bank: Financial organization that takes deposits and offers credit facilities to individuals and businesses with the aim of making profit.

Maintenance management: Actions that get rid of system failure and ensure that machines defined functions and standards of operations are upheld for the required period.

Reactive maintenance: Repairs that are done when the equipment has already broken down (corrective and emergency maintenance).

Proactive maintenance: Corrects the root causes of malfunctions; its goal is to reduce unplanned down- time, equipment failure and the risk associated with operating a faulty equipment.

Corrective maintenance: maintenance that involves diagnosis of a fault after it has occurred and fixing the fault to reinstate the machine to working condition

Emergency maintenance: A reactive maintenance which covers unforeseen work required to be urgently undertaken on short or without notice to rectify a fault of either hardware or software where without timely action a service may be degraded or fail.

Predictive maintenance: One of proactive maintenance that involve use of a computerized tool which observes, tracks and monitors in real time the state and performance of equipment as it functions

Preventive Maintenance: A type of proactive maintenance that involves predetermined routine checkup of equipment and assets to avoid abrupt downtime.

Operational performance: These are outcomes such as reliability, quality, cost and speed of service that are measurable characteristics to the firm's success.

ABSTRACT

This study aimed to understand the MM practices adopted by ATM channels and operational performance of commercial banks in Kenya. The theories used in the study were: system theory, reliability theory and transaction cost theory. The study employed a descriptive cross-sectional design as the study sought to bring out relationships between constructs. The study focused on all the 14 ATM channel departments in commercial banks in Kenya ranked in the large and medium peer group categories by the CBK. Primary data was collected from 14 ATM channels managers and 14 Service desk staffs by use of an electronic questionnaire. Data collected was analyzed using STATA version 15.1 software. Regression analysis was used to establish if and which of the MM practice(s) adopted have impact on OP (cost, reliability, and quality). Regression was used to quantify the association between MM and OP. With regards to the study findings, the study concluded that application of proactive MM practices especially preventive maintenance resulted to high operational performance. The initial cost of implementing proactive maintenance may be high but the return on investment is high compared to reactive maintenance. MM practices should be seen as value addition processes and not a necessary bad expense. The study brought out the main determinants that management ought to put into consideration during selection of a fit for purpose MM practice. These comprised of a better understanding of the equipment series and functionality, familiarity with maintenance protocols, and organizational needs against the allocated resources. This study concluded that MM practices (preventive) positively impact OP (ATM reliability, ATM maintenance cost and ATM services quality) of commercial banks. The study recommends that future studies should focus on the challenges affecting application of predictive maintenance in commercial banks in Kenya. In addition, a comparative study should be carried out between the maintenance management practices in service industries and manufacturing industries. Further research needs to be focused on best approaches for successfully implementing the MM practices in different business systems. From the study 35% of the OP in commercial banks is attributed to MM practices, further research can be done to determine the other factors that influence the remaining 65%.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Companies are increasingly adopting the use of machinery to catapult production efficiency while maintaining cost-effectiveness and competitiveness in the dynamic market ecosystem (Nyori, 2015). According to Ding & Saenz (2020), Covid-19 pandemic has created workforce disruption, forcing most companies around the world to invest in automation as an alternative strategy to sustain production while minimizing human interaction. With the increasing mechanization, maintenance management (MM) comes in handy as a strategic concern in these industries. Maintenance is required to keep the equipment healthy condition and available for its normal operations to achieve consistent production of quality goods and services. According to Sambrekar, Vishnu & Sridharan (2018), the root cause of failures is not addressed by reactive type of maintenance and more often will result in recurrence of the faults. Reactive maintenance costs are greater than that of proactive maintenance practices. Majority of companies embrace proactive maintenance practices as it leads to long term improvement of operational performance (Pannerrselvam, 2009).

The study was supported by the system theory, transaction cost theory and reliability theory. A system is a unified model with input, process, output and feedback as its components. MM was viewed a system with inputs such as firm spare parts, customer feedback and machine data which are transformed into quality and reliable services. The transaction cost theory suggests that a firm must minimize its production costs in order to succeed in the market (Thomas and Weiss, 2021). Maintenance costs must be controlled through having negotiated long term contracts with maintenance service providers, technical human resources and suppliers of spare parts and other

relevant services. Another theory applied in MM is the reliability theory, which recognizes the relationship of reliability and maintenance and hence the use of reliability centered maintenance (RCM). RCM is a practice that considers the best maintenance strategies for a machine that are cost effective and ensure reliability of the machine (Vishnu and Regikumar, 2016).

Machine uptime or availability is one of the critical elements in the service level agreement (Campbell, 2006). In the banking industry ATMs are expected to have 99% uptime for continuous provision of services to the bank clients. Unplanned and abrupt breakdowns result in high cost of repairs to reinstate the machine to operation and frustrates the bank clients due to interrupted services (Kamau, 2014). To improve reliability and quality of services cost effectively, this study brings out the need for implementing well thought-out maintenance practices, integrating and streamlining policies in selection of the MM practices, and monitoring the machines to discover and resolve the root causes of failure in time.

1.1.1 Maintenance Management

Maintenance is performed to eliminate machine failure, trap hazards and to ensure that equipment continue to work within designed tolerance and specifications (Marquez & Gupta, 2005). MM guarantees that the specified functions and standards of operations of the equipment or machines are upheld for the required period (Mikler, 2015). As machines age and utilization increases, its modules are subjected to wear and tear and gradual deterioration, and this may cause unplanned downtime due to machine abrupt failure if not well maintained. Therefore, businesses invest in maintenance of their machines to sustain their operational efficiencies (Aptean, 2021).

The key performance indicators (KPI) of machines are reliability, quality production and speed, whose combination result to the overall equipment effectiveness (OEE) (Parida, Kumar, Galar, & Stenström, 2015).

To maximize operational performance most firms, employ several strategic measures; however, the human factor is mostly left out. (Campbell, 2006). Support from management team links operational performance and failure. Therefore, to remain profitable, firms effectively combine optimal MM practices with a management that backs up its team and continuously work to improve its processes (Campbell, 2006). There is also a need for good and innovative MM approaches and practice to be established to address the challenges that arise especially from unplanned downtimes, making rigorous and continuous research in this space an asset to the sector (Kamau, 2014). This research aimed to establish the MM practices adopted by ATM channels within Commercial Banks and the effects on operational performance (OP).

1.1.2 Operational Performance

Operational performance is a critical quantifiable measurable aspect of the outcome of an organization and consists of operational indicators, such as cost, quality, speed, flexibility, and reliability of its products or service (Maingi, 2013). Weinstein, Vokurka & Graman (2009) states that organization to do well in its niche, it must apply effective and efficient production processes, evaluate the changes, and continuously aim to better those processes. Operational performance of a firm is dependent on business performance indices such as relative share in the market as well as customer satisfaction levels. Therefore, production costs must be minimized without compromising quality of products and services while increasing its availability and reliability (Weinstein, et.al., 2009). Various research has been done on factors that influence operational

performance. According to the review by Garg & Deshmukh (2006) and Velmurugan & Dhingra (2015), OP is attributed to maintenance practices as well as other continuous improvement techniques like Six Sigma, Total Quality Management (TQM), DMAIC and Kaizen.

1.1.3 Commercial Banks in Kenya

Banks have a foundational role in the global financial sector. Zavadska (2018), defines commercial banks as financial institutions whose function is to take deposits, grant loans and provide basic operations such as cash withdrawal, savings accounts, and issue certificates of deposit to individuals and enterprises. In Kenya, banking began in 1896, National Bank of India (Now KCB Group) opening its first branch in Mombasa. In 1911, Standard Chartered set the first branch in Mombasa and Nairobi. The Central Bank of Kenya (CBK) was formed 1966 to control and regulate bank activities. The first locally owned bank was Co-operative bank of Kenya in 1965 and it used to provide services to the local co-operative societies. This was followed by National Bank of Kenya in 1968, then the government registered Kenya Commercial Bank by acquiring a 40% stake of Grindlays Bank. The CBK Bank Supervision Annual Report of 2021 indicates that there are 38 commercial banks in Kenya.

There are six main channels of delivery of banking services i.e., branch banking, internet banking, Mobile banking, phone banking, agency banking and ATM channels. Commercial banks have advanced in provision of their services by embracing technology, one being the use of ATM. Mourad (2012) defined ATMs as electronic computerized self-service delivery channels that allow customers to make basic transactions without the aid of a bank teller. As of June 2022, there are 2,327 ATMs distributed countrywide in Kenya. ATMs to reduce the queues in the banking hall, cut down operational cost as well as increase efficiency in service delivery.

Today, due to levels of innovations in banking ATMs with complex hardware and software are used in providing variety of banking transactional services. There is ever increasing competition within financial service institutions, globally and in Kenya, therefore, these institutions aim to ensure maximum uptime of their ATMs network and ATM services. According to Siran (2017), most commercial banks in Kenya outsource maintenance services to cut down operational cost and ensure quick services. Given the inherent nature of ATMs to experience random and unpredictable breakdowns, proactive practices are adopted to improve operational performance (Exner, Schnürmacher, Adolphy & Stark, (2017).

1.2 Research Problem

A competitive business environment forces firms to adopt maintenance management practices that will impact positively to its operational performance. Firms must be aware of their costs and the origin of the costs, be reliable, efficiently offer quality services and products as expected by their clients (Awinja, 2015). With the increasing mechanization, MM comes in handy as a strategic concern in many industries. In the banking industry, ATMs are considered one of the most used financial service delivery channels due to variety of services they offer and are accessible 24hours every day. Unavailable ATMs, both off-site and on-site, always result in customers visiting the banking halls to seek services. This in turn results in longer waiting time as a big number of customers queue to be served - such recurring inconveniences ultimately lead to customers considering other options or competitors (Ogbeide & Ejechi, 2018).

A study by Velmurugan & Dhingra (2015) found out that the maintenance approach that a firm employ, positively affects their operational performance and competitiveness through product value perception and delivery of services. However, the research identified the importance of

management support and incorporation of real- time equipment health monitoring systems into MM practices as critical aspects of MM for further research. Moreover, the choice of MM strategy is primarily affected by availability of capital in the operations budget, management support, and information on the MM type, combination, degree, approach and/or practice that is fit-for-purpose (Muganyi, 2018; Kamau, 2014). A higher level of maintenance practices a firm chooses, means higher cost of implementation, but reduces downtime, frequency of breakdowns and repairs costs and this translates to quality services, equipment availability to the customers and generally minimum total maintenance cost (Wainstein, et al, 2009). The researchers recommended further study on effective implementation of MM in different business set up. The study by Makara (2017), found out that most of the Parastatals in Kenya somewhat employ preventive maintenance (PM) approaches at recommended future research on determinants of MM selection and application on other sectors.

Therefore, this research aimed to answer the following questions: What are the maintenance management practices adopted ATM channels in commercial banks in Kenya? What are the organizational determinants of maintenance management practices adopted by ATM channels in commercial banks in Kenya? What is the effect of MM practices adopted by ATM channels on OP of commercial banks in Kenya?

1.3 Research Objectives

The study was guided by the objectives enumerated below

i. To determine the extent to which maintenance management practices are adopted by ATM channels in commercial banks in Kenya.
ii. To assess the determinants of maintenance management practices adopted by ATM channels in commercial banks in Kenya.
iii. To determine the effect of maintenance management practices adopted by ATM channels on operational performance of commercial banks in Kenya.

1.4 Value of the Study

This research generated evidence and insights on maintenance strategies that if adopted and systemized in areas where machines or equipment are being used in production of goods and services to improve their operational performance, cost effective, reliable and high quality. This study findings will be of importance to commercial banks ATM channels operations managers because its insights on the MM practices can be adopted by the ATM channels to maintain a high operations performance; to achieve high reliability, offer quality service to clients and effectively utilizing their resources. The operations managers will have the basis in determining the MM practices to adopt for their channels during selection process.

The ATM maintenance service providers are beneficiaries of this study as the research brought out the correlation between MM and the performance of firms which guides on services marketable to the commercial banks. The study brings out the trends in MM practices and this gives the ATM service providers the capacity to provide the needed services and advise their clients accordingly.

To the scholars and future researchers, the reviewed literature in addition to the results of this study will guide to establish research gaps in their studies and enhance their areas of research. The study will add to existing works on maintenance management and findings will be of significance in adding more knowledge to the academicians in the field of operations management.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This section highlighted a review of related literature on MM practices and operational performance as presented by several researchers, authors, analysts, and scholars. It presents the analysis of the theories which the study was anchored, brings out the knowledge gap and finally the conceptual framework which that relates to MM practices and OP.

2.2 Theoretical foundation

Several theories and models have been linked to MM as evidenced in various literature reviewed. The theories include system theory, reliability theory and transaction cost theory among others. The theories in perspective of MM are discussed below

2.2.1 System Theory

In this theory, system is viewed as a model that is unified and has interrelated parts that are dependent on one another. The basic parts of the system are input, process, output and feedback. The inputs undergo transformation process to yield output and feedback from output is send back as input. The feedback from output such as customer feedback and are sent back to the model to better the decisions to improve and lead to growth in performance.

The system theory is relevant in MM where inputs are perceived as technicians, spare parts, customer feedback, external services, information/data, and tools. The MM system transforms these inputs into output such as equipment availability, quality service, profits, and reduced costs.

2.2.2 Reliability Theory

Reliability applies when equipment consistently performs its purpose within stated period and under controlled consistent environmental and operational condition (Muganyi, 2018). Many firms now recognize that reliability and maintenance interconnects and have embraced reliability centered maintenance (RCM) practice.

The importance of this theory is that it brings out RCM approach as a practice that provide appropriate maintenance of an asset at the right time. RCM maximizes cost-effectiveness and puts into account all best maintenance practices and hence improve equipment reliability and quality of its products and services. Reliability is considered as useful element in application of equipment life cycle cost (LCC), logistic support, spare part allocation, the equipment life cycle profit (LCP), and technical resource planning.

2.2.3 Transaction Cost Theory

Transaction Cost Theory is an approach that accounts for all the costs in economic exchange of goods and services, it covers service contracting costs and labor costs, logistics costs and coordination costs (Makara, 2017). These costs vary from one organization to another. The theory indicates that costs in a firm must be minimized for it realize good performance in the market.

This theory is applicable in this research as it agrees that a firm must put its costs at minimal for it to succeed at the market space. As applies in maintenance management, maintenance cost to be reduced include negotiated long term ATM maintenance contracts in spare parts supply, repairs, and labor in terms of hiring technical human resource.

2.3 Maintenance Management Practices

MM practices have evolved over the years and now includes integrated reactive and proactive practices. According to Henderson, Pahlenkemper and Kraska (2014), evolution and integration of reactive and proactive practices in MM has greatly affected equipment sustainability and reliability, as demonstrated in figure 1 below. Various authors have defined maintenance, with those definitions evidently evolving and now placing maintenance at a strategic position within the service industry. Earlier maintenance was considered as repairs when a machine needed to be fixed but today (Besnard, 2013) defines Maintenance as total management of a firm processes to maintain or restore the optimal status of an equipment for it to perform efficiently its function (Besnard, 2013). Maintenance strategy comes in place to ensure the devices are kept healthy, the procedure entails "checking, servicing, reworking and fixing faulty modules and purchase and rework decisions". Execution of the strategy needs a firm to have reasonable and tactical plans (Velmurugan & Dhingra, 2015). An organization selects a maintenance strategy depending on its well thought strategic objectives set by the management.

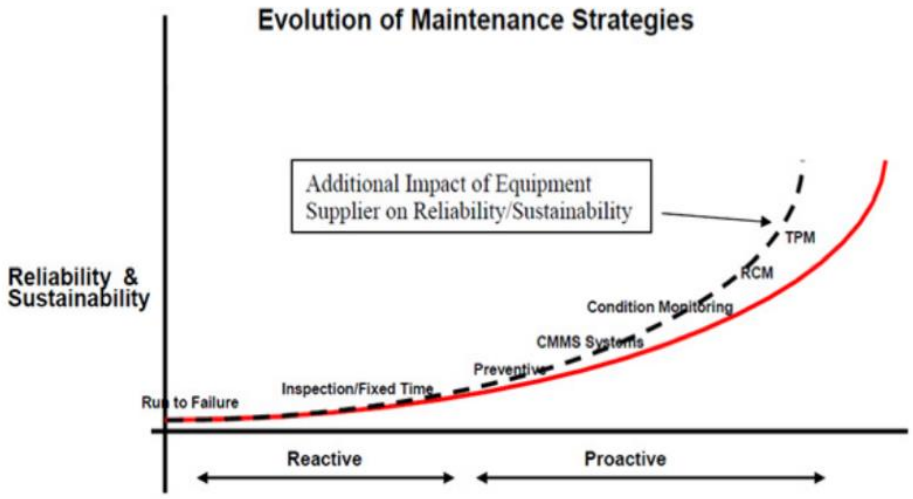


Figure 2.1: Evolution of Maintenance Strategies (Henderson et al., 2014)

An organization selects a maintenance strategy depending on its well thought strategic objectives set by the management. MM practices have been categorized by previous authors in different ways. Evolution of maintenance has been presented in (Mikler, 2011; Teixeira & Landre, 2016), where three evolution groups in maintenance are highlighted with matching periods. Firstly, maintenance which concentrated on repairs of faulty devices which happened up to 1940s. Secondly, preventive maintenance, comprises of planned and scheduled tasks and actions, which developed up to 1970s. Third generation summarizes the current approach mostly involving use of technology to predict, prevent and eliminate equipment failures. Third generation of maintenance techniques involves practices such as use of monitoring systems, study of various hazards and the controls, management support and teaming up, as well as consistency and maintenance (Teixeira & Landre, 2016). On the other hand, there is fourth maintenance generation which brings up actions such as failure prevention, early equipment monitoring and controlling and reliability that have been widely researched during the last two decades. There is a parallel approach to operation maintenance are brought out in a study by Legutko (2009).

Total Productive Maintenance (TPM) can be categorized into two: reactive and proactive (Sambrekar, Vishnu & Sridharan, 2018). Reactive maintenance is applied to repairs after occurrence of a fault, while proactive tasks come in to evade break and fix and prevent frequent failures. Proactive strategy comprises of preventive and predictive maintenance plan of action. In Mwangi (2014) and Vishnu and Regikumar (2016) we get a category of organizational MM practices such as break and fix or run to failure maintenance, preventive maintenance, proactive maintenance, condition-based maintenance and reliability centered maintenance. The other category of interest interconnects the predictive, corrective and interval based and condition-based

maintenance practices. These strategies are connected and are applied with the aim to maximize profits and equipment reliability.

TPM, PM and RCM practices, if appropriately executed, improves OEE. In the banking industry, MM is categorized into First Line Maintenance (FLM) and Second Line Maintenance (SLM). First Line Maintenance involves much more basic situations (Nixdorf, 2013; Wang, Li, Han, Sarkar & Zhou, 2017). ATMs are somewhat touchy, so even minor issues can take them out of service. For example, the receipt paper jams, more often cash jams and sometimes the ATM just needs a reboot since most ATMs are Windows-based. Each of these is basic and does not require much training. Many credit unions and banks do their own First Line Maintenance because it is easy to train the branch personnel how to fix the minor problems that may arise. On the other hand, Second Line Maintenance applies to repairs that require a tool bag. These are repairs that involve trained and qualified technicians and expertise, replacement of large and complex parts.

2.3.1 Reactive Maintenance

Reactive maintenance is an unplanned action or practice of operating or running an equipment until part of it or the whole unit breaks down is when it is fixed. Reactive maintenance comprises corrective and emergency maintenance (Wilson, 2013). Corrective maintenance refers to maintenance actions implemented after the occurrence of a problem – it involves establishing and resolving the problem. The idea is to fix it when it breaks. Generally, firms operating on corrective maintenance mostly finds it ineffective from the business perspective. This is due to the abrupt failures which puts the company in a scenario where they must react to the breakdown instead of having foreseen and planned for such actions in advance.

However, this strategy can also be applied when the machine has a technical hitch but still operational or when its downtime will not significantly impact organizational performance. (Velmurugan *et al*., 2015). The cost incurred in bringing an equipment back to operational state after failure can be more than the production value received. Moreover, during utilization some of the parts are subjected to vibration, some overheat and many devices in the equipment are likely to be damaged resulting to costly replacements (Marquez & Gupta, 2005).

2.3.2 Proactive Maintenance

Proactive maintenance is described as an automated strategy that simplifies maintenance process by eliminating and reducing failures in real- time without affecting the equipment reliability (Muganyi, 2018). He also states that proactive maintenance involves capacity building the team to solve problems as they occur. Proactive maintenance strategy aims to establish and correct the root causes of the faults and helps to eliminate unplanned breakdowns caused by these abrupt failures. Much credit has been given to proactive maintenance as a novel maintenance strategy that increases and sustains machine uptime (Ding & Kamaruddin, 2015). Proactive maintenance encompasses two core concepts i.e., preventive, and predictive maintenance.

Preventive Maintenance (PM) was introduced as an alternative for corrective maintenance. Primarily, PM involves routine tasks derived from equipment functionalities in its components' lifetime. Usually, PM tasks follow a fixed schedule in that they can be performed daily, weekly, monthly or some other agreed intervals. PM activities are planned and scheduled based on equipment's requirements and historical data of failures (Basri, Razak, Samat & Kamaruddin, 2017). The planned activities are scheduled based on labor resource availability, documented task priority, work order management and inventory of spare parts, duration to action the tasks and other terms of references related to the equipment

In banking, PM is done based on the ATM's manual, the bank operational protocol, the ATM's history among other variables. Faults on ATMs are because of heavy utilization tear and wear, environmental factors like too much heat due to absence of air conditioner, accumulation of dust debris majorly along busy roads in urban centers. Dust particles clog the ATM components and may the moving components. Delicate parts such as rollers, gears, transport belts and suction cups wear out causing unavoidable failures. The consequences range from downtime penalties, avoidable additional costs, and customer frustrations. Therefore, PM aims at reducing downtime resulting from machine usage and environmental factors through the regular servicing of the machine (Supriatna & Singgih, 2016).

Predictive maintenance practice uses data analytics devices to continuously keep track of the status of equipment components and operation and alerts on possible faults in equipment and processes for action to be taken before the it breaks down completely (Exner *et al.*, 2017). Study by Coleman, (2017) indicates that when a firm uses predictive maintenance increase machine lifespan, it minimizes downtime due to unscheduled equipment failure, and reduce the cost of replacing damaged parts. Bukhsh, Saeed, Stipanovic and Doree (2019) highlights that firms that use predictive maintenance invests in good capital, professional personnel, and training. The initial investment seems to be too much but the return on investment (ROI) far compensates the upfront costs since predictive maintenance focuses on minimizing maintenance costs, applies processes that have zero wastes and reduce the number of major faults. The study however suggests more research on the impact on different industries. The research by Wang *et al.*, (2017) found that as retail banks continue to undergo digital transformation, the role of the ATMs for a successful omnichannel strategy is evolving. Banks are adopting predictive maintenance as a strategy to sustain machine uptime and service delivery. Specialized technologies and big data have played a critical role in predicting and informing timely maintenance, thus improving machine uptime.

2.4 Performance Measurement

A firm's performance measurement is the bridge between the decisions made and its goals and objectives. Parida *et al*., (2015) grouped performance measurement into two categories: result oriented result determinant. Managers employ a Balance Scorecard (BSC) system to assess, monitor, course correct and align their teams with the key business objectives to yield better results (Hwang & Chang, 2020). Firms also value the need to measure customer service satisfaction, they have adopted various tools and the commonly used is the Net Promoter Score (NPS) which measures customer experience and monitors business growth. Commercial banks ATM channels in Kenya set their OP targets on ATM maintenance cost, uptime of ATMs (reliability), and quality of service delivered to their clients. The ATM channels monitor, assess, and correct these parameters using the BSC at specified period to ensure the needs of their customers are met. Therefore, this study focuses on measuring OP of Commercial banks ATM channels in relation to these key OP indicators: ATM service reliability, ATM service quality and ATM maintenance cost.

2.4.1 Service Quality

Parida, Kumar, Galar, & Stenström, (2015) asserts that, quality is one of the key indicators that sustains the efficiency of a firm. Quality is theorized as the comparison between the predictable and the apparent performance. Responses from end users help to set corrective measures and set a base for continuous improvement process. NPS is held up as a gold standard of customer experience assessment. The NPS metrics helps a firm to objectively quantify customer experience (loyalty and satisfaction) based on solicited customer feedback. The score is used to inform

strategies and actions aimed at solving or correcting problems, improving quality of services offered and customer experience.

2.4.2 Service Reliability

Reliability refers to the chance that an equipment will operate without failing. Reliability is an important outcome measure as it gives an indication to the firm that services will be available to their clients whenever they need. Maintenance management optimizes uptime of equipment by being able to prevent or predict failures and action before they occur (Exner *et al.*, 2017). Firms apply the BSC to set performance objectives and targets in relation to service reliability (equipment uptime), monitor progress and use the data to inform continuous improvement and course corrections to yield better results (Hwang & Chang, 2020).

2.4.3 Maintenance Cost

Maintenance is considered a service that adds value and not as an acceptable bad expense (Thomas & Weiss, 2021). Maintenance costs are costs associated with machine maintenance chain - personnel, parts or modules, and service tools or equipment – whether conducted in-house or outsourced. Thomas and Weiss (2021), further suggest that when maintenance cost is controlled, a firm can realize the value and maximize profitability of an equipment. Study by Muganyi, (2018) suggests that the cost of maintenance will be reduced by a firm reducing the reactive maintenance practices and embracing proactive maintenance practices. Firms apply the BSC to set performance objectives and targets in relation to machine maintenance costs, track cost burn rate (cost contributors and trends) and use the cost data to inform cost minimization strategies and actions.

2.5 Maintenance Management Practices and Operational Performance

MM is one of the most critical processes within any organization as it maximizes machine functionality and service delivery thus optimizing operational performance. Therefore, MM is essential for a firm to maintain its competitiveness within the sector and the market (Maingi, 2013). Evidence has shown the losses that industry players face due to MM omission or ineffectiveness (Sharma, 2019; Ng'era, 2013; Legutko, 2009; Slack, Chambers & Johnston, 2010). Nevertheless, maintenance is currently listed as a cost center and some studies have presented the effects of MM practices on the operational performance indicators. The figure below clearly demonstrates the costs associated with the different MM strategies and models employed.

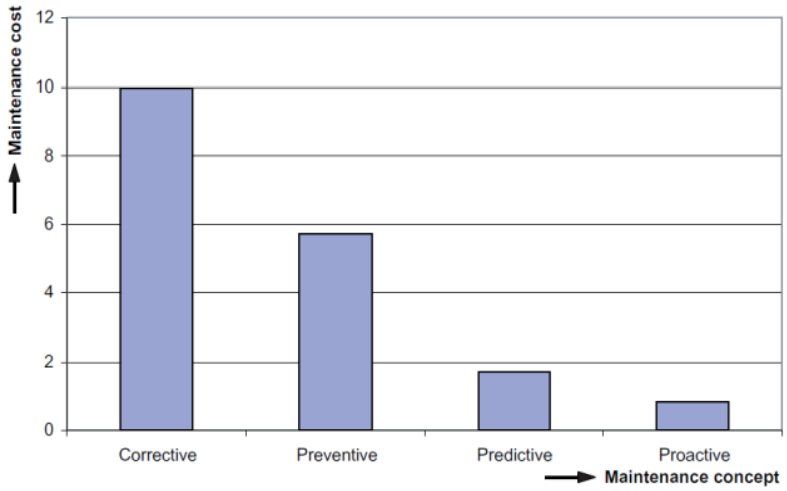


Figure 2.2: Cost structures under the different MM strategies (Papic, Aronoy & Pantelic, 2009)

Production environment has currently undergone numerous changes, and this has made MM activities to be more complex. These changes are best indicated by factors such as changes in production technology, globalization, business model restructuring, organization structures, human resource development, and the difficulty in assessing the MM information (Mikler, 2011).

It is also noted that a typical company has elements such as software, management systems and human resources in addition to the hardware assets. This means that deviation from the production process could result from failure of essential devices of the equipment, quality of replaced parts, management systems or human error (Alsyouf, 2004). Numerous institutions have invested technology and sound maintenance systems in service delivery to enhance operational efficiency and sustain competitive advantage.

Most commercial banks in Kenya have a variety of ATMs ranging from cash dispensing self-serve ATMs, intelligent ATMs, cash recycling ATMs, cheque processing ATMs among others. To support this technological advancement and complex equipment, the commercial banks employ varied maintenance strategies and practices based on their operational preference and protocol, management support, and budgetary allocation to ensure equipment uptime and increased ATM availability for customer use (Sambrekar *et al*,2018). Kamau (2014) and Bokrantz, skoogh, Berlin and Stahre (2020) proposes that maintenance managers should focus on both people and resources, professional and well-trained equipment operators, and maintenance engineers as the key team to effective maintenance strategy. A study by Awinja (2015) found out that ATMs increase customer access to core banking service and significantly help banks attain efficiency in delivering customer services.

2.6 Empirical Review and Knowledge Gap

The reviewed literature clearly demonstrates the evolution of MM strategies and practices within the industry. Numerous studies have placed MM at the heart of operations and clearly demonstrated how MM affects operational performance. Commercial banks, globally and within

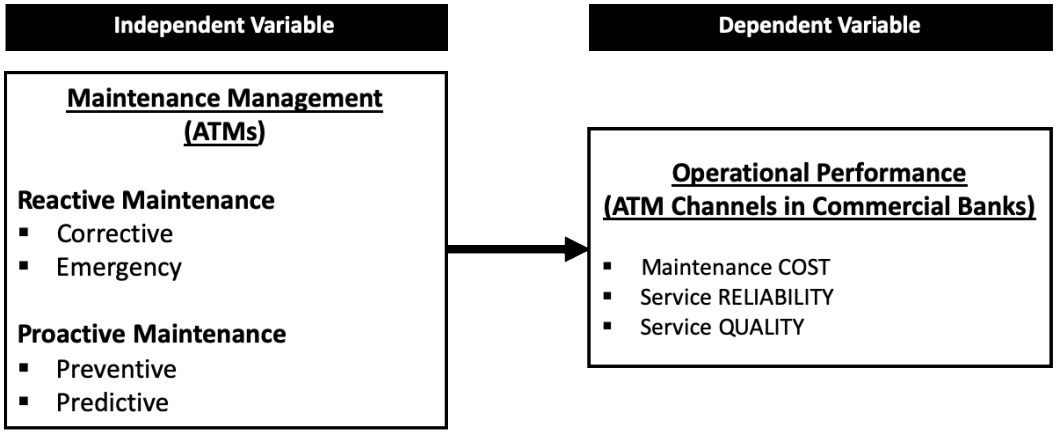
Kenya, operate within a dynamic and highly competitive business environment. To enhance their operational performance, banks have employed varied MM strategies and practices - with varied results, due to the numerous factors, predictors, and determinants (Velmurugan *et al*., 2015). Usually, the key aim of MM is to reduce failures of an equipment, thus maximizing production of a firm. This can be achieved by applying various maintenance practices. According to Parida *et al.*, (2015) the leading organizations typically apply MM practices that are less than 15% reactive, between 20% and 40% preventive, and between 45% and 60% predictive maintenance. It is, however, not evident which is the best MM approach that ensures efficiency and is cost effective. In transaction cost theory, Kamau (2014) indicates cost minimization as one of the measures that influence performance of a firm. Bukhsh *et al. (*2019) highlights that firms that use predictive maintenance invests in good capital, professional personnel, and training and development. The initial investment seems to be too much but the return on investment (ROI) far compensates the upfront costs since predictive maintenance focuses on minimizing maintenance costs, applies processes that have zero wastes and reduce the number of major faults. The study however suggests more research on the impact on different industries for instance service industry.

Therefore, there is value add in understanding the MM landscape within commercial banks in Kenya, key determinants to the choice of maintenance practices employed, and how the employed MM practices influence operational performance. This will document existing decision-making pathways i.e., events, decisions triggers, decision drivers and outcomes.

2.7 Conceptual Framework

Maintenance of ATM is central to operational efficiencies and performance of financial organizations (Aptean, 2021). MM strategies, approaches and practices have evolved over the years and now includes integrated reactive and proactive approaches which in this study are the independent variables. Businesses today aim to reduce both unplanned and planned downtime of equipment to increase reliability, reduce operational cost, provide quality and speedy services to clients which are captured as the dependent variables. OP is a critical quantifiable measurable aspect of the outcome of an organization and were measured through maintenance cost, service reliability and service quality. This study aimed to document the different MM approaches and practices employed by commercial banks ATM channels, organizational leadership support, and how that affects operational performance of the commercial banks.

Figure 2.3: Conceptual framework on MM and OP



Source: Adopted from Veldman et al., (2011): Typology of condition-based maintenance.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the approaches adopted in undertaking the study to accomplish the research objectives. Details herein present research design that was implemented, population of study, and data that was collected and analysis tools.

3.2 Research Design

Descriptive cross-sectional design was employed as the study sought to bring out relationships between constructs. This enabled the researcher to describe MM practices adopted by commercial banks ATM channels and impact on OP. Descriptive cross-section design was selected over other designs due to its advantage of being less time consuming and it allowed incorporation of both qualitative as well as quantitative methods during collection of data.

3.3 Population of Study

The study applied a census approach which included the entire population as a sample in instances where the population of study is small. Therefore, the study focused on all the 14 ATM channel departments in commercial banks in Kenya ranked in the large and medium peer group categories by the CBK,2022 (Appendix A). The large and medium peer group were studied because they have established ATM channels departments and a network of ATM installed across the country.

3.4 Data Collection

Primary data was collected from 14 ATM channels managers and 14 Service desk staffs by use of a semi-structured, electronic researcher administered questionnaire. Questionnaire was preferred

tool for data collection as it enabled the researcher to obtain more information within a short period. The questionnaire was designed in way to gather data related to the definite objectives of the study. The Questionnaire was divided into 4 sections. Section A consisted of the respondent information, Section B had information about the bank, section C composed of the MM practices and section D contained data on OP. Guided by the study objectives, the questionnaire facilitated data collection on MM practice adopted, running period of practice, MM service provider (who, skills, tools, parts), communication systems, determinants of adopted MM practices, ATM maintenance cost, service reliability, and service quality (Table 1).

3.5 Data Analysis

The raw data collected was subjected to quality data checks and cleaning immediately after data collection. Data was analyzed using STATA version 15.1 software. Appropriate statistical outputs presented findings on ATM maintenance management practices applied by commercial banks ATM channels, determinants of maintenance management practices, and operation performance. Frequency tables, percentages, and means summaries were generated. Regression was conducted to analyze if and which of the MM practice(s) adopted have impact on OP (cost, reliability, and quality). Regression was used to quantify the association between MM and OP.

The study used simple regression model as follows: $\mathbf{Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \mu}$

Where: -

Y = Operations Performance

X_1 = Reactive - Emergency Maintenance

X_2 = Reactive - Corrective Maintenance

X_3 = Proactive - Preventive Maintenance

X_4 = Proactive - Predictive Maintenance

β_1- β_4 = Regression co-efficient or value changes relative to each independent variable

μ = The model's random error term.

A T-test was undertaken at 0.95 significant level to determine and explain the strength and significance of the effect of dependent variable to the independent variables (MM practices – emergency, corrective, preventive, and predictive maintenance) to the dependent variable (OP indicators- Cost, reliability, and quality).

Table 3.1: Summary of Data Collection and Analysis

Objectives	**Data and collection methods**	**Data analysis**
To determine maintenance management practices adopted ATM channels in commercial banks in Kenya.	Questionnaire (self-administered) - Practice adopted - Running period of practice - Service provider (who, skills, tools, parts) - Communication system	Content analysis – MM practices coded, frequency and percentages generated.
To assess the determinants of maintenance management practices adopted by ATM channels in commercial banks in Kenya.	Questionnaire (self-administered) - What determines MM practices adopted? - Who decides? - What informs the decisions?	Content analysis – determinants of MM practices coded, frequency and percentages generated.
To determine the effect of maintenance management practices adopted by ATM channels on operational performance of commercial banks in Kenya.	Questionnaire (self-administered) - Maintenance cost - Service reliability - Service quality	Regression analysis to determine if and which of the MM practice(s) adopted have impact on OP (cost, reliability, and quality)

CHAPTER FOUR: RESEARCH FINDINGS AND DISCUSSION

4.1 Introduction

This chapter presents analysis of study finding obtained from the included commercial banks organized by the study objectives. It presents response rate across the commercial banks, characteristics of the respondents, characteristics of the commercial banks studied, maintenance management practices adopted by ATM channels in commercial banks, determinants of maintenance management practices adopted by ATM channels in commercial banks, and the effect of maintenance management practices adopted by ATM channels on operational performance of commercial banks.

4.2 Response Rate

The study used electronic researcher administered questionnaire to collect data from 14 commercial banks in Kenya in the medium (8) and large peer (6) groups. Data was collected from 28 respondents (2 from each bank) from the ATM channel service desk and ATM channel managers. Responses were received from all the 28 respondents which gave a return rate of 100%, as indicated in table 4.1 below. The high return rate was achieved due to constant follow up through phone calls and text messages.

Table 4.1: Response Rate

Bank Category	# Banks Targeted	# Banks achieved	# Respondents targeted	# Respondent achieved	Response rate
Large peer group	6	6	12	12	100%
Medium peer group	8	8	16	16	100%
TOTAL	**14**	**14**	**28**	**28**	**100%**

4.3 Characteristics of the Study Respondents

The researcher intended to understand the characteristics of the 28 study respondents (14 ATM channel service desk officers and 14 ATM channel managers) in terms of period of service in the bank, gender, and level of education attained. Table 4.2 indicates the descriptive analysis of the respondents' demographic information. The study found out that the ATM channel managers had worked in the bank for an average of 12 years (Range = 6 to 26 years), with an average 6.9 stationed in the ATM channel department (Range = 1 to 15 years). The study also found out that the ATM channel service desk officers had worked in the bank for an average of 8.9 years (Range = 3 to 20 years), with an average 5.8 stationed in the ATM channel department (Range = 3 to 17 years). This clearly indicated that the respondents had worked within the respective institutions and the ATM channels department for a significant period and were able to give relevant data needed in the research. This gave confidence on the quality, credibility and validity of the collected data, and its relevance to respond to the objectives of the study. Table 4.2 below shows that 6 ATM channel managers were male and 7 were female, whereas 6 ATM channel service desk officers were male and 9 were female. The distribution further shows that all (100%) the ATM channel managers had a bachelor degree while majority (93%) of the ATM channel service desk officers had a bachelor degree.

Table 4.2: Characteristics of the study respondents

Variable	Characteristics	ATM channels manager	Service desk staff
Years worked (Bank)	Min	6	3
	Max	26	20
	Mean	12	8.9
Years worked (ATM channels department)	Min	1	3
	Max	15	17
	Mean	6.9	5.8
Gender	Male	6	6
	Female	7	9
Education Level	College diploma	0	1
	Bachelor's Degree	13	14

4.4 Characteristics of the Commercial Banks Studied

4.4.1 General Characteristics of the Commercial Banks

A summary of the characteristics of the commercial banks was presented in Table 4.3. Exactly 14 commercial banks in Kenya in the medium (8) and large peer (6) groups involved in the study. The study showed that all the commercial banks had been in operation for an average of 47.4 years and had an average of 132 ATMs in their branches and offsites across the country. Majority of the commercial banks had ATMs installed within their branches (average = 93) as compared to their offsites (average = 39).

Table 4.3: Characteristics of Commercial Banks in Kenya

Variable		n
No. of Banks per Peer Group	1 (Large)	6
	2 (Medium)	8
Years in Operation	Average	47.4
	Min	14
	Max	126
No. of ATMs in Branches	Average	93
	Min	5
	Max	314
No. of ATMs in Offsites	Average	39
	Min	0
	Max	94
No. of ATMs	Average	132
	Min	20
	Max	380

4.4.2 ATMs Distribution within the Commercial Banks

The study found out that banks in peer group 1 had more ATMs (average = 226) when compared to banks in peer group 2 (average = 61). Figure 4.1 shows that 57% (8) of the commercial banks had more than 75 ATMs, 7% (1) of the commercial banks had between 51 and 75 ATMs, 29% (4) of the commercial banks had between 26 and 50 ATMs, and 7% (1) of the commercial banks had 25 or less ATMs installed within their branches and offsites countrywide.

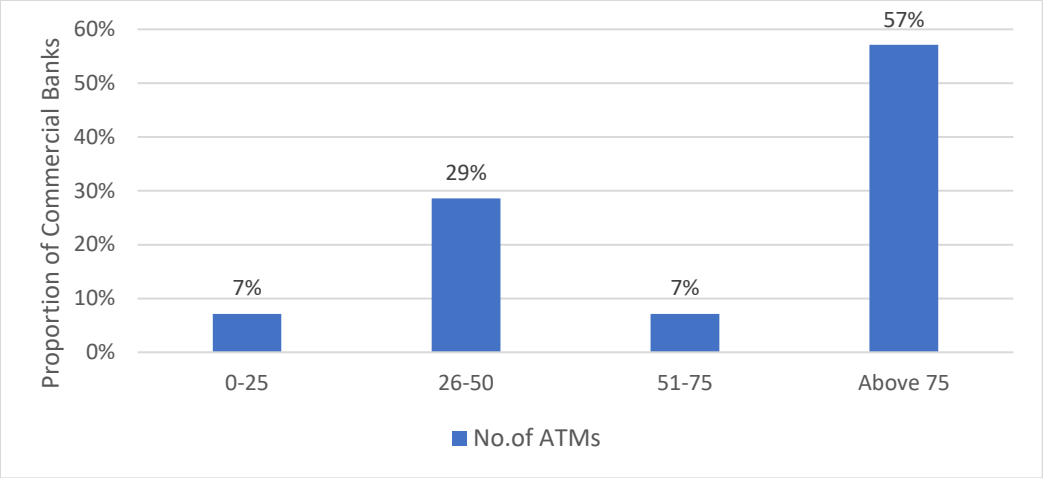


Figure 4.1: ATM Distribution in Commercial Banks

4.4.3 ATMs Distribution within Branches and Offsites of Commercial Banks

Generally, out of the 1848 ATMs linked to the 14 banks studied, 71% (1306 ATMs) were located in the bank branches, while 29% (542 ATMs) were located in the bank offsites. Majority (11) of the commercial banks had most of their ATMs located in the bank branches, while a minority (3) of the commercial banks had most of their ATMs located in the bank offsites. As shown in figure 4.2 below, 36% and 57% of the commercial banks had 0-25 ATMs in branches and offsites respectively. 7% of the commercial banks had 26-50 ATMs in both branches and offsites while 14% of the commercial banks had 51-75 ATMs in both branches and offsites.43% and 21% of the commercial banks above 75 ATMs in branches and offsites respectively.

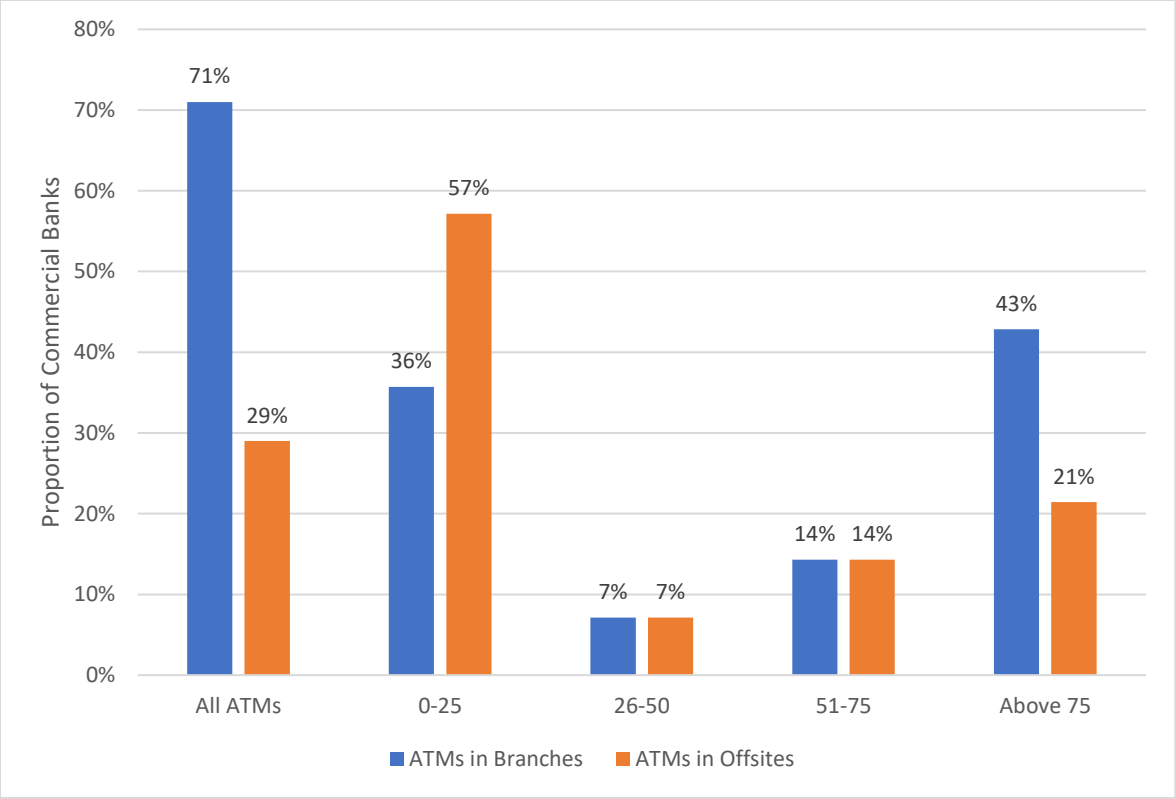


Figure 4.2: Distribution of ATMs within Branches and Offsites of Commercial Banks

4.4.4 ATMs Models in Commercial Banks

As shown in figure 4.3 below 50% (7) of the commercial banks had only one of the ATM models, 29% (4) of the commercial banks had 2 of the ATM models, 14% (2) of the commercial banks had 3 of the ATM models and 7% (1) of the commercial bank had 5 of the ATM models installed within their branches and offsites countrywide.

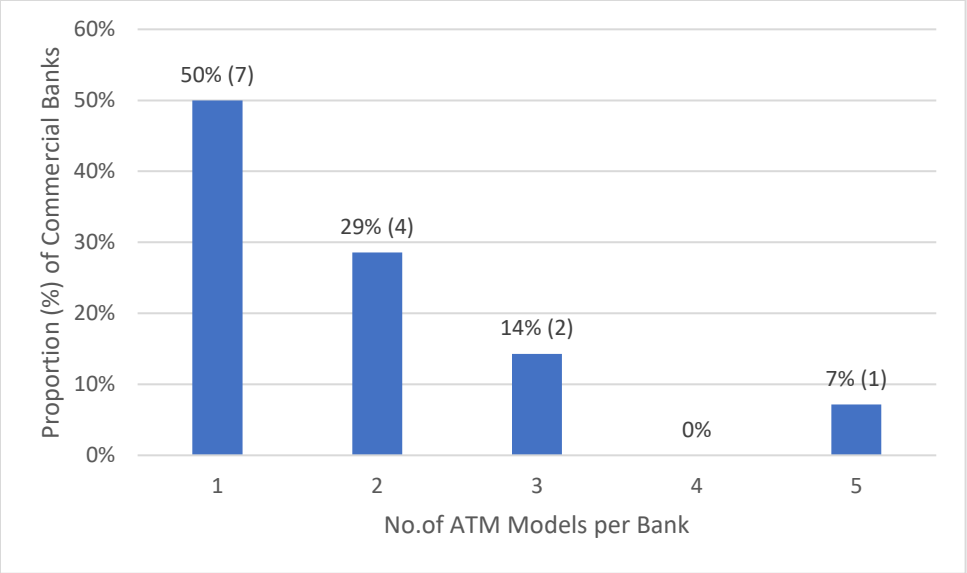


Figure 4.3: Number of ATM Models per Commercial Bank

4.4.5 ATMs Models Market Share

There were six (6) models of ATMs installed across the 14 commercial banks' branches and offsites. The study found out that the most predominant ATM model (model 'A') made up 60.5% (1118), model 'B' made up 24.9% (460), model C made up 11.3% (209), model D made up 1.6% (29), model E made up 1.2% (22), and model 'F' made up 0.5% (10) of the total ATMs installed by commercial banks in Kenya, as illustrated in figure 4.4 below.

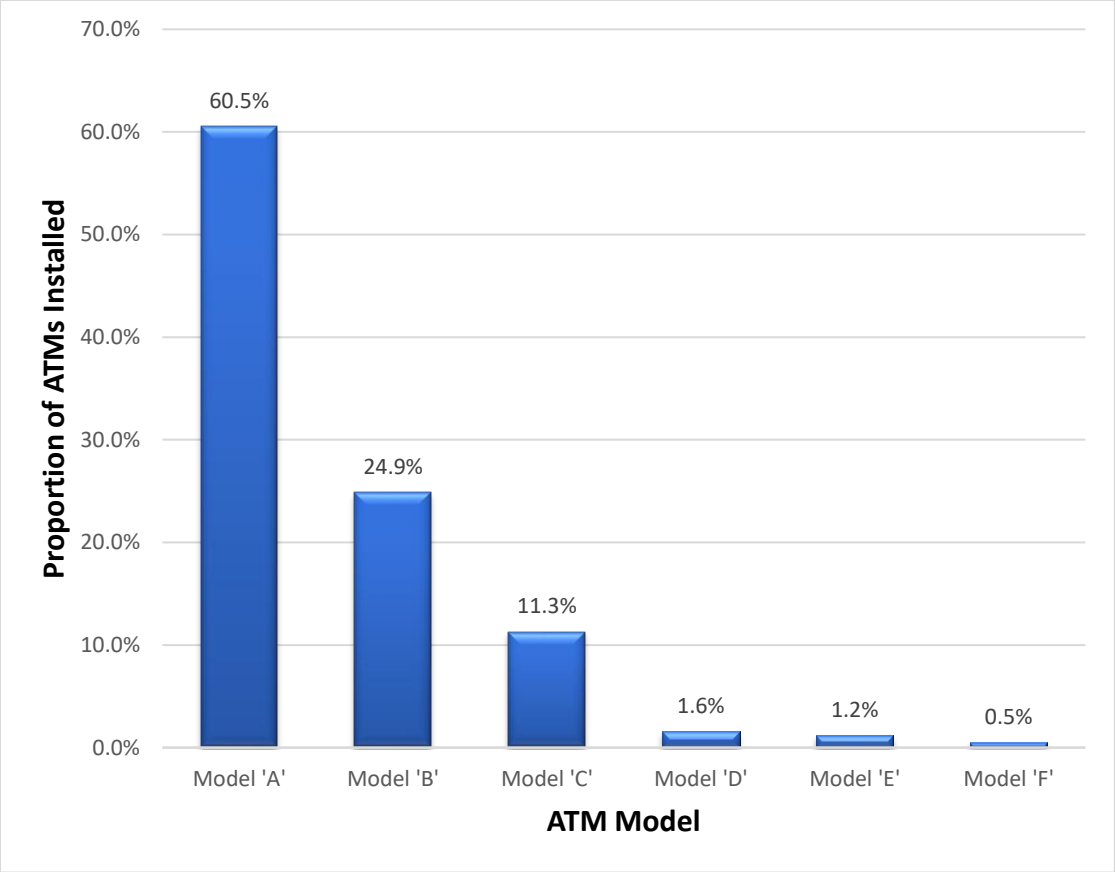


Figure 4.4: ATMs Models and Market share in commercial banks in Kenya

4.5 ATM Maintenance Services in Commercial Banks

4.5.1 First-line and Second-line Maintenance Service Providers

First Line Maintenance (FLM) involves fixing minor ATM problems as they arise e.g., clearing a note jam, while on the other hand, Second Line Maintenance (SLM) applies to repairs that requires a specialized tool bag, a trained and qualified technician and involves replacement of large and complex ATM parts. As illustrated in figure 4.5 below, majority (92%) of the commercial banks had internal dedicated teams who were trained and offered FLM services, while 4% outsourced

first line services from Service Provider 1, and the remaining 4% (one commercial bank) did not have FLM as part of the MM protocol. Regarding second line maintenance, Service Provider 6 maintained most ATMs at 48%, Service Provider 1 and 6 maintained 15%, Service Provider 3 and 7 maintained 7%, while Service Provider 2 and 5 maintained 4% of the ATMs.

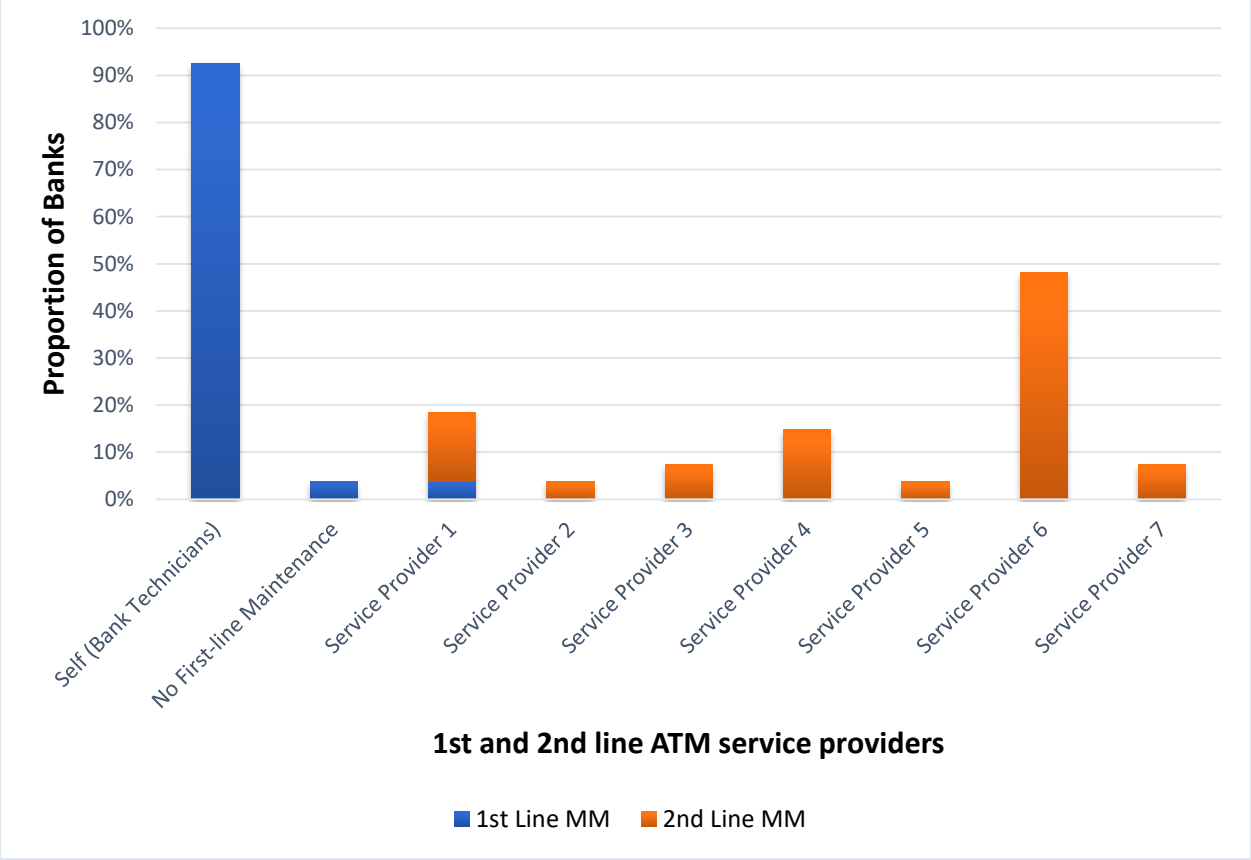


Figure 4.5: 1st and 2nd Line Maintenance ATM Service Providers

4.5.2 Preventive Maintenance Service Providers

As illustrated in figure 4.6 below, majority (48%) of the commercial banks had contracted Service Provider 6 to provide PM services for their ATMs; while 4% contracted Service Provider 2, 3, and 5; while 15% contracted Service Provider 1 and 4, and 7% contracted Service Provider 7, and 4% contracted Service Provider 2 and 5 to conduct PM services.

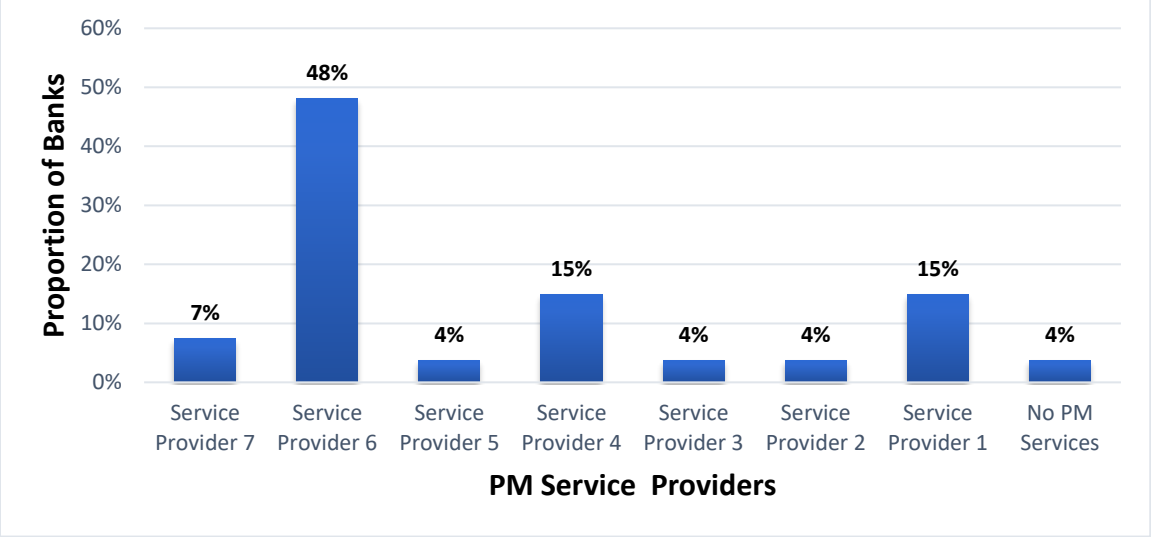


Figure 4.6: Preventive Maintenance Service providers

4.6 Maintenance Management Practices Adopted by ATM Channels in Commercial Banks

In order to determine the maintenance management practices adopted by commercial banks in Kenya, the study observed that a majority (50%) of the commercial banks in Kenya under study practiced proactive maintenance, 39% of the commercial banks in Kenya under study practiced reactive maintenance, and 11% of the commercial banks in Kenya under study practiced both reactive and preventive maintenance, as shown in figure 4.7 below.

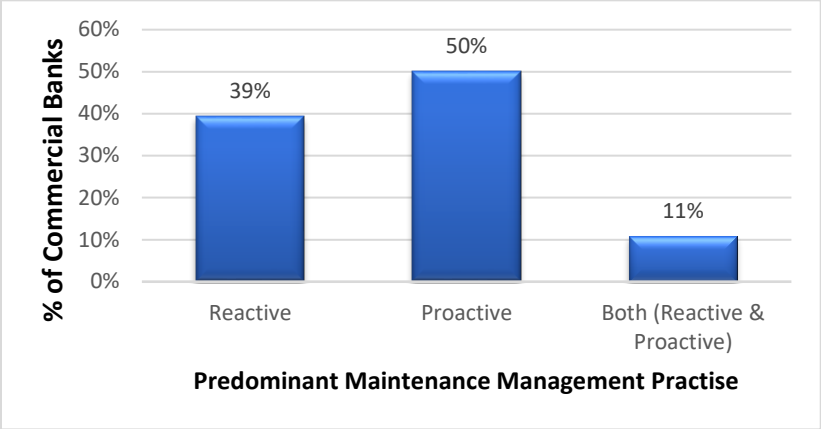


Figure 4.7: Predominant Maintenance Practice in Commercial Banks in Kenya

Additionally, data on key maintenance management practices applied by commercial banks ATM channels was collected and analyzed. Respondents were required the following 4 statements related to maintenance management practices as applied to their bank on a scale of 1 to 5, where 1=Very low degree, 2=low degree, 3=Average, 4=High degree, and 5=Very high degree. As presented in the figure 4.8 below, on average 93.7% of the respondents were confident to a high degree and very high degree that the 4 key maintenance management practices for ATMs were applied by their banks.

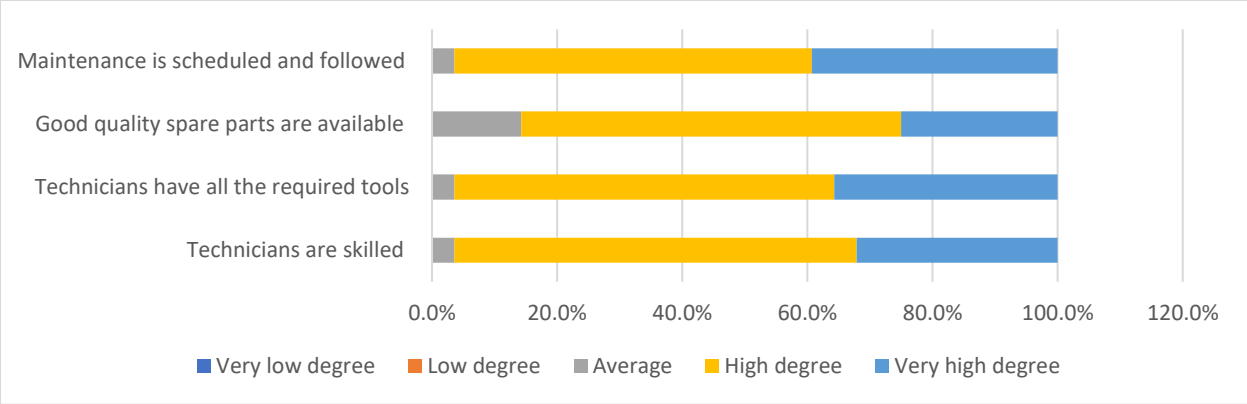


Figure 4.8: Key Maintenance Management Practices Applied in Commercial Banks

4.6.1 Predictive Maintenance Practices

Data on key predictive maintenance practices applied by commercial banks ATM channels was collected and analyzed. Respondents were required to rate each of the following 3 statements relating to predictive maintenance practices applied to their bank on a scale of 1 to 5, where 1=Very low degree, 2=low degree, 3=Average, 4=High degree, and 5=Very high degree. As presented in the figure 4.9 below, on average 47.6% of the respondents were confident to a high degree and very high degree that the 3 key predictive maintenance practices for ATMs were applied by their banks.

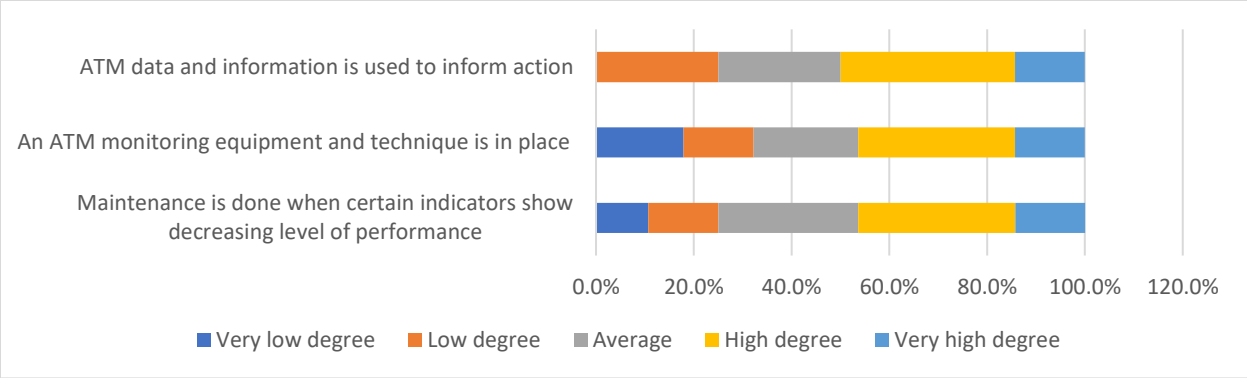


Figure 4.9: Predictive Maintenance Practices Applied in Commercial Banks

4.6.2 Preventive Maintenance Practices

Data on key preventive maintenance practices applied by commercial banks ATM channels was collected and analyzed. Response was provided as to the extent to which each of the following 4 statements relating to preventive maintenance practices applied to their bank on a scale of 1 to 5, where 1=Very low degree, 2=low degree, 3=Average, 4=High degree, and 5=Very high degree. As presented in the figure 4.10 below, on average 73.8% of the respondents were confident to a high degree and very high degree that the 3 key preventive maintenance practices for ATMs were applied by their banks.

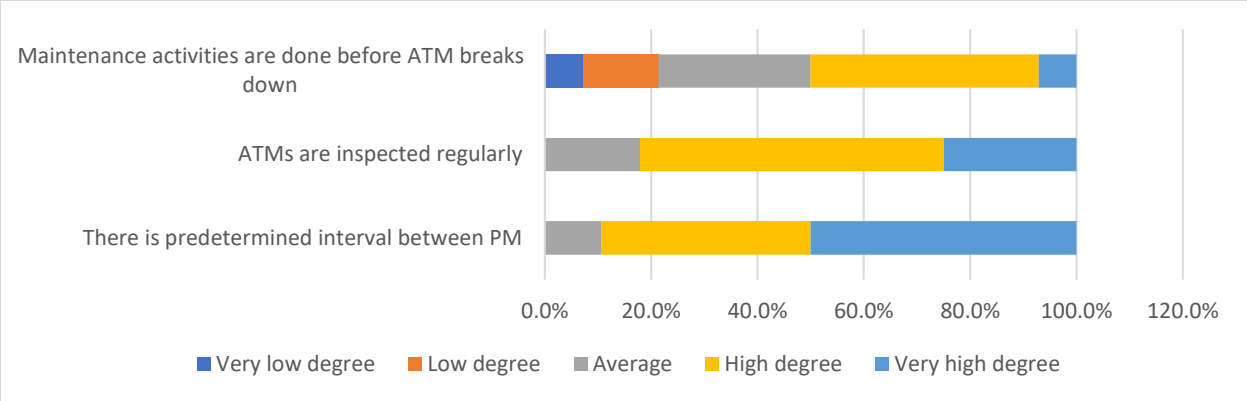


Figure 4.10: Key Preventive Maintenance Practices Applied by Commercial Banks

4.6.3 Emergency Maintenance Practices

Data on key emergency maintenance practices applied by commercial banks ATM channels was collected and analyzed. Response was obtained on the extent to which each of the following 4 statements relating to emergency maintenance practices applied to their bank on a scale of 1 to 5, where 1=Very low degree, 2=low degree, 3=Average, 4=High degree, and 5=Very high degree. As presented in the figure 4.11 below, on average 60.7% of the respondents were confident to a high degree and very high degree that the 3 key emergency maintenance practices for ATMs were applied by their banks.

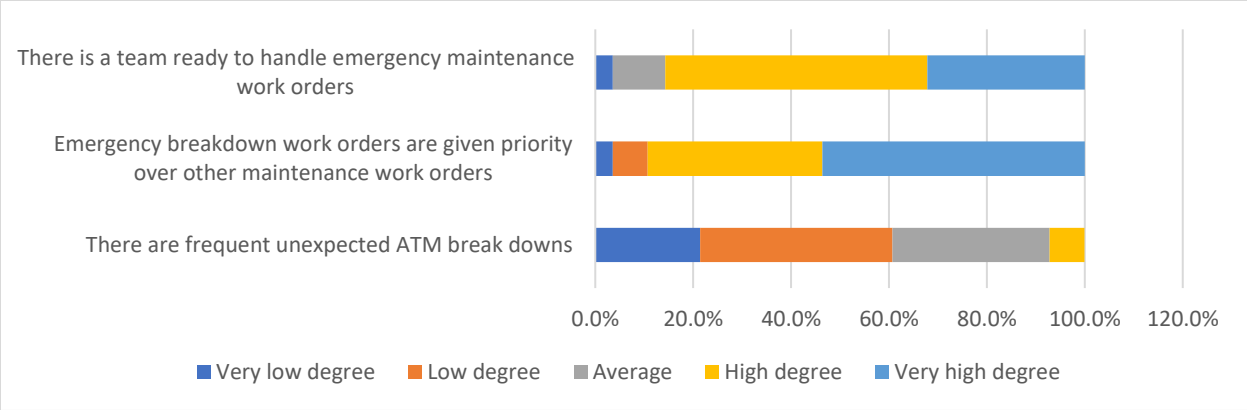


Figure 4.11: Key Emergency Maintenance Practices Applied by Commercial Banks

4.6.4 Corrective Maintenance Practices

Data on key corrective maintenance practices applied by commercial banks ATM channels was collected and analyzed. Respondents were requested to indicate the extent to which each of the following 4 statements relating to corrective maintenance practices applied to their bank on a scale of 1 to 5, where 1=Very low degree, 2=low degree, 3=Average, 4=High degree, and 5=Very high degree. As presented in the figure 4.12 below, on average 56.0% of the respondents were confident to a high degree and very high degree that the 3 key corrective maintenance practices for ATMs were applied by their banks.

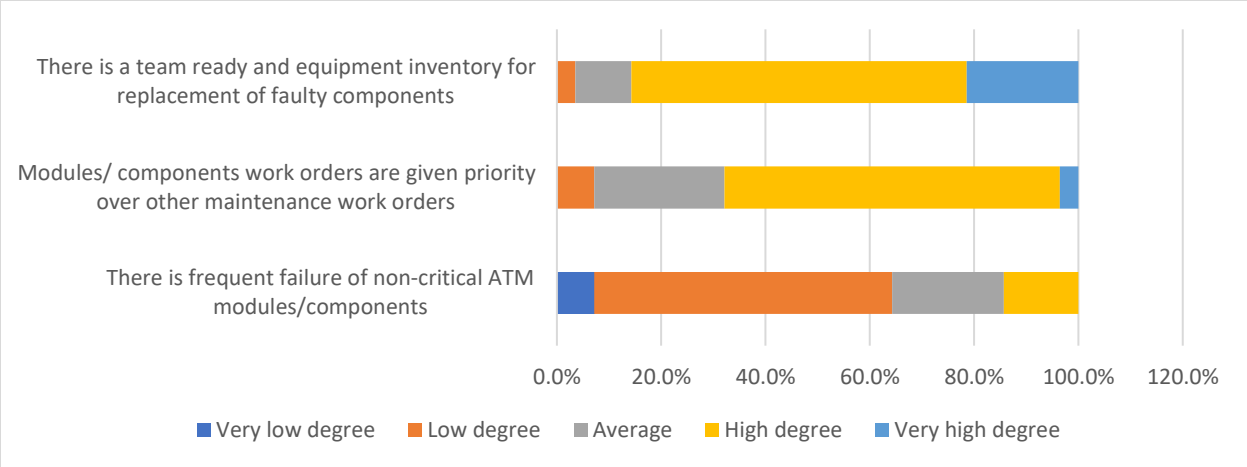


Figure 4.12: Key Corrective Maintenance Practices Applied by Commercial Banks

4.7 Determinants of MM Practices Adopted by ATM Channels in Commercial Banks

The study findings reveal that the overall decision regarding the Maintenance Management Practices adopted by commercial banks were majorly made by middle level managers (75%), as demonstrated in the figure 4.13 below.

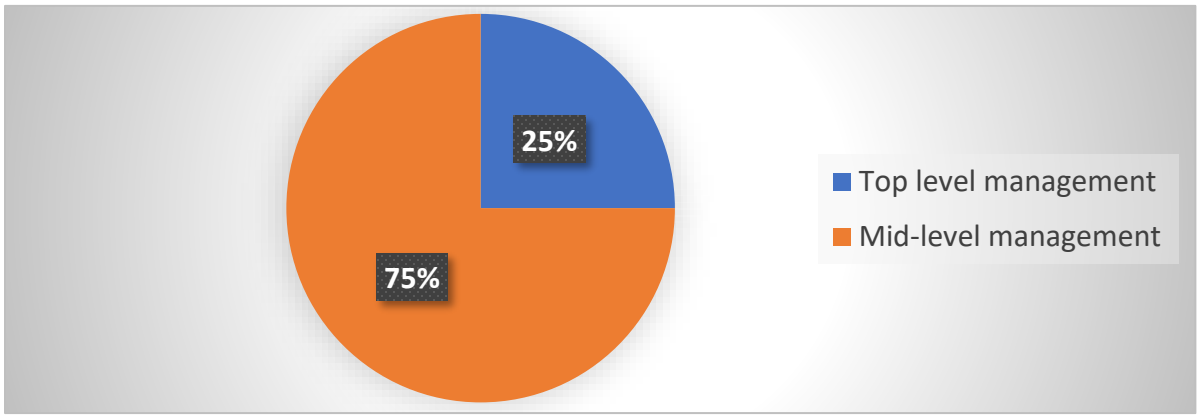


Figure 4.13: Decision Makers on MM Practices Adopted by Commercial Banks

Additionally, respondents were requested to indicate the extent to which each of the following factors were considered in selecting maintenance management practices adopted by their bank on a scale of 1 to 5, where 1=Very low degree, 2=low degree, 3=Average, 4=High degree, and 5=Very high degree. As presented in the figure 4.14 below, the banks considered Budget available and Vendor advise (93%), ATM utilization (89%), Value/ type of ATM (64%), Management preference (54%), and Manufacturer guide (50%) when selecting the Maintenance Management Practices for their banks, to a high degree and very high degree.

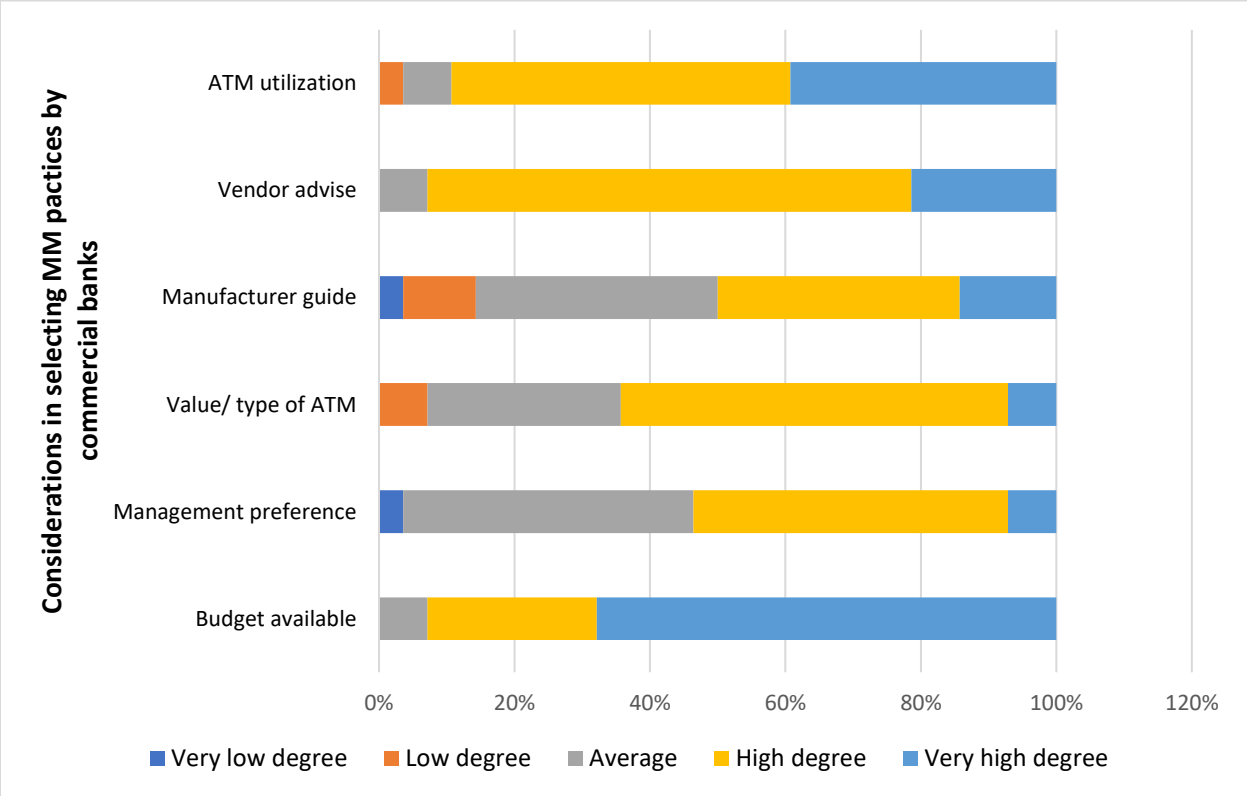


Figure 4.14: Determinants of MM Practice Selection by ATM Channels

4.8 Operational Performance of ATM Channels Departments in Commercial Banks

The study sought to establish the ATM maintenance cost, service reliability, and service quality as measures of operational performance. Data was obtained on scope to which the respondents agreed with statements relating to ATM (i) maintenance cost, (ii) service reliability, and (iii) service quality aspects of operation performance in their bank on a measure of 1 to 5, where 1=Very low degree, 2=low degree, 3=Average, 4=High degree, and 5=Very high degree. Table 4.5 below shows the tabulated results.

Table 4.4: Operational Performance of Commercial Banks

OP Parameters	Mean	SD
ATM maintenance cost		
Cost of maintaining ATMs is expectedly low compared to other service delivery workstreams	3.07	0.81
The ATM profit margins are in line with the annual target	3.50	0.96
The bank engages in innovative maintenance strategies to cut down cost	3.50	1.11
ATM service reliability		
Frequency of ATM failure in my bank is low	3.61	0.96
ATMs in my bank always provide expected services within promised time	4.18	0.61
ATM uptime is always high in my bank	4.36	0.62
ATM service quality		
Customers are loyal to my bank	4.11	0.63
Customers give good complements to ATM services in my bank	4.00	0.61
My bank has a good public image compared to competitors	4.36	0.62
OP Mean	**3.85**	

On average, the respondents agreed that banks' ATM channels departments were performing generally above average as shown by the OP mean of 3.85. The findings showed that the banks' ATM channels departments ensured that ATM maintenance cost was low (mean=3.36), ATMs offered reliability financial services to customers (mean=4.05), and ATMs offered high quality financial service quality (mean=4.15).

4.9 Effect of MM Practices Adopted by ATM Channels on OP of Commercial Banks

Data on application of the MM practices and the operational performance was tabulated in table 4.5 below. Each of the MM practices and OP statements were rated on a Likert rating scale which was of out of 5. Since corrective and emergency maintenance practices are termed as undesirable MM practices (since they are only done when part of or the whole ATM unit breaks down or when the equipment abruptly fails), they were assigned a negative value when computing the MM practices adoption score (Pannerrselvam, 2009).

Table 4.5: Data on Adoption of Maintenance Management Practice and Operation performance

Item No.	Commercial Bank	Operational Performance	MM Practice Adoption
1	CB'1	11	2
2	CB'2	11.2	2.8
3	CB'3	13.3	6.7
4	CB'4	12.7	5.9
5	CB'5	10.8	5.7
6	CB'6	12.2	4
7	CB'7	11.3	3.9
8	CB'8	12.3	5
9	CB'9	10	5.6
10	CB'10	11	4.5
11	CB'11	11.5	3.4
12	CB'12	9.7	2.4
13	CB'13	11.3	4.8
14	CB'14	13.5	6.6

4.9.1 Model Summary

Data in table 4.5 above was analyzed using STATA 15.2. The output was presented in the model summary output in table 4.6, which was used to show the strength of the relationship between the variables. R^2 obtained was denoted as the proportion of variation in the dependable variable predicted by the independent variable.

Table 4.6: Model Summary

Model Summary				
Model	R	R-Squared	Adjusted R-Squared	Standard Error of the Estimate
1	0.5895	0.3475	0.2931	0.1737

a. Predictors: Application of maintenance management practices

b. Dependable variable: Operational performance (quality, cost and reliability)

The table model had R-Squared of 0.3475, which implied that the MM practices adopted by ATM channels department accounted for 35% of the factors that affected operational performance of the commercial banks.

4.9.2 Analysis of Variance (ANOVA)

The table 4.7 below shows ANOVA test used to assess model significance in describing the strength of the relationship between MM practices and OP by use of their means. The model was tested at 95% confidence level and p value is 0.05.

Table 4.7: Analysis of Variance (ANOVA)

Model	**Sum of squares**	**Degree of Freedom**	**Mean Square**	**F**	**Sig.**
Regression	5.745	1	5.745	6.39	0.0265
Residual	10.7887	12	0.8991		
Total	16.5337	13	1.2718		

a. Dependable variable: Operational performance

b. Predictors: Application of maintenance management practices

The result gave a p value of 0.0265 which is less than 0.05 significant level, denoting a statistically significant relationship between operational performance and maintenance management practices. The model is therefore a good representation of the relationship.

4.9.3 Regression Coefficients

The study used the multiple regression analysis model as follows:

Table 4.8: Regression coefficients

OperationalPerformance	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
X1_emergency_maintenance	-.0977199	.343288	-0.28	0.782	-.8742913	.6788515
X2_corrective_maintenance	.1054466	.5385904	0.20	0.849	-1.11293	1.323823
X3_preventive_maintenance	1.46831	.3830448	3.83	0.004	.6018026	2.334818
X4_predictive_maintenance	.2585489	.208775	1.24	0.247	-.213733	.7308308
_cons	4.963784	1.216436	4.08	0.003	2.212014	7.715554

The table 4.8 above indicates the specific influence that each of the independent variables (X_1 – X_4) had on the dependent variable (OP).

Therefore, from the regression model $Y= \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \mu$

Where: -

Y = Operations Performance

X_1 = Reactive - Emergency Maintenance

X_2 = Reactive - Corrective Maintenance

X_3 = Proactive - Preventive Maintenance

X_4 = Proactive - Predictive Maintenance

β_1- β_4 = Regression co-efficient or value changes relative to each independent variable

μ = The model's random error term.

The regression equation was constituted as follows:

$OP = 4.9638 + 1.4683\ X_3$

The regression output show that; OP was constant at 4.9638 units without considering application of any of the four MM practices.

Relationship between emergency maintenance and OP: Emergency maintenance (X_1) has a negative relationship with OP, indicating that 0.01 units decrease in Emergency maintenance results in 1 unit increase in OP. However, the relationship is not statistically significant at 95% confidence interval as (P-value = 0.782).

Relationship between corrective maintenance and OP: Corrective maintenance (X_2) has a positive relationship with OP, indicating that 0.11 units increase in corrective maintenance results in 1 unit increase in OP. However, the relationship is not statistically significant at 95% confidence interval as (P-value = 0.849).

Relationship between PM and OP: PM (X_3) has a positive relationship with OP, indicating that 1.47 units increase in PM results in 1 unit increase in OP. The relationship is statistically significant at 95% confidence level as (P-value = 0.004).

Relationship between predictive maintenance and OP: Predictive maintenance (X_4) has a positive relationship with OP, indicating that 0.26 units increase in predictive maintenance results in 1 unit increase in OP. The relationship is not statistically significant at 95% confidence interval as (P-value = 0.247).

4.10 Discussion

The findings as shown in figure 4.7 indicated that 50% of the commercial banks adopted proactive (predictive and preventive) maintenance management. This was also observed in the research findings of Makara (2017) and Kamau (2014) where preventive maintenance was found to be the dominant maintenance practice. The regression analysis summary in table 4.8 indicated that preventive maintenance has positive relationship with OP, indicating that 1.47 units increase in PM results in 1 unit increase in OP. The relationship is statistically significant at 95% (P-value = 0.004). This implies that the application of proactive maintenance assured of better operational performance. Predictive maintenance also had positive relationship with OP, but the application was low at 47.6 as indicated in the study findings. Bukhsh, Saeed, Stipanovic and Doree (2019) highlighted that firms that use predictive maintenance invest in more capital to cater for expensive computerized systems, professional personnel, and training. The initial investment cost seems to be more but the return on investment far compensates the upfront costs.

On reactive maintenance, 39% of the commercial banks in the study applied reactive practice. Emergency maintenance was seen to have negative relationship with OP. Corrective maintenance was found to have a positive relationship with OP, but the relationship was not statistically significant. This evident in the study findings by Marquez & Gupta (2005) which indicated that on application of reactive maintenance, the cost incurred in bringing an equipment back to operational state after failure was more than the production value received. This study findings also showed that 93 % of the commercial banks had high to very high degree invested in maintenance management best practices; having well trained technicians with quality repair tool kits, inventory of quality spare parts and scheduled maintenance.

This study found that majority (75%) of the decisions on maintenance management practices were made by the middle level managers. This is because they managed the ATM channels operations and had a better understanding of the models, maintenance protocols, organizational needs against the allocated resources. According to the study respondents, the following were the main determinants of MM practice and their relative importance when selecting MM practices to be adopted by ATM channels departments: budget allocation to the ATM channel and service provider recommendations or maintenance protocols (93%), ATM utilization (89%), the value and type of ATM (64%), management preference (54%) and manufacturer guide (50%). The findings agreed with the recommendations by Kamau (2014) and Muganyi (2018) where management support was key in decision making regarding which MM practices adopted, availability of capital budget, information on types of MM practices that is fit for purpose were also identified as determinants when selecting MM practice.

Businesses invest in maintenance management practices of their machines to sustain their operational efficiencies (Aptean, 2021). This study established a significant relationship between MM practices and OP. A study by Ekanem, Usoro and Baridam (2022) found a significant correlation between variables of MM like reactive and proactive practices on organizational performance aspects and success in the manufacturing industry. This implies that commercial banks that applied maintenance management practices realized reduction in maintenance cost, service reliability and service quality improvement. The results of this study showed a positive significant relationship between proactive MM practices, in particular preventive maintenance, and operational performance of commercial banks. A unit change in preventive maintenance while holding other factors constant led to an increase on OP by a factor of 1.5. This finding was coherent

with a study by Makara (2017) which showed that preventive maintenance had a statistical significant positive impact OP in service parastatals.

This study findings show that the use of corrective maintenance practice had a marginal positive impact on operational performance, consistent with a study by Ekanem, Usoro and Baridam (2022) that found out that corrective maintenance if implemented immediately after detection of faults can positively affect OP.

The use of emergency maintenance practice impacted negatively in operational performance. This agreed with study by Kamau (2014) which found that reduction in application of run to failure and break and fix maintenance resulted in optimization of OP.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This section covers the summary of the research findings after data analysis. Further the chapter has the conclusion, recommendations, and limitations of the study. Proposals on further research is also indicated

5.2 Summary of Findings

Majority (50%) of the commercial banks in kenya had embraced proactive maintenance, while a few were on reactive maintenance and other few combined both reactive and proactive maintenance practices. This study finding showed that (73.8%) of the commercial banks applied preventive maintenance. Corrective and predictive maintenance were also applied at a moderate rate.

This study found that majority (75%) of the decisions on maintenance management practices were made by the middle level managers. The following were the main determinants of the MM practice and their relative importance when selecting MM practices to be adopted by ATM channels departments: budget allocation to the ATM channel and service provider recommendations or maintenance protocols (93%), ATM utilization (89%), the value and type of ATM (64%), management preference (54%) and manufacturer guide (50%).

From the ANOVA analysis, the model was tested at 95% confidence with a p value of 0.05. The result presented a p-value of 0.0265. This therefore denoted a significant positive relationship exited between OP and MM practices in commercial banks in Kenya. The regression model had R^2 of 0.35 which implies that MM practices accounted for 35% of the that factors that impact on

operations performance. The regression equation showed that PM has a positive relationship with OP, indicating that 1.47 units increase in PM results in 1 unit increase in OP. The relationship is statistically significant at 95% confidence interval (P-value = 0.004)

5.3 Conclusion of the Study

Application of proactive MM practices especially preventive maintenance resulted to high operational performance. The initial cost of implementing proactive maintenance may be high but the return on investment is high compared to reactive maintenance. MM practices should be seen as value addition processes and not necessary expenses.

The study brought out the main determinants that management ought to put into consideration during selection for a fit for purpose MM practice. These comprised of a better understanding of the equipment series and functionality, familiarity with maintenance protocols, and organizational needs against the allocated resources.

This study concluded that MM practices (preventive maintenance) positively impact OP (reliability, maintenance cost and services quality) of commercial banks; practicing preventive maintenance ensures that machine errors are identified and corrected in time therefore reducing unplanned downtime for repairs.

5.4 Recommendations of the Study

The recommends commercial bank management to consider important determinants such as understanding of the equipment series and functionality, familiarize with maintenance protocols, and organizational needs against the allocated resources to inform better decision-making in selection of MM practices. It is also important for the management in industries that have automated processes to apply more of proactive MM practices, particularly preventive maintenance, as the study has shown that preventive maintenance significantly and positively impact OP.

5.5 Limitations of the Study

Several challenges were encountered in attempt to get information from some of the commercial banks ATM Channel employees. The difficulties were enhanced by the system rules and procedures that had to be followed to get the information, delaying the projected timelines in data collection. There was resistance from some respondents to accept the questionnaires and others had to be assured of the level of confidentiality and anonymity for fear of providing sensitive information about their banks. This was addressed by assurance through constant follow up phone calls, text messages and emails to be able to achieve the response target. Due to the short duration of the research period, the researcher devoted a lot of time to ensure this study is completed in time.

5.6 Suggestions for Further Studies

The study presents findings on the maintenance management practices in commercial banks in Kenya and the effect on operational performance and the determinants of selecting maintenance management practice. Although this study found that proactive maintenance (preventive) was highly used in the commercial banks and that it had significant effect on operations performance, the application of predictive maintenance was still low. The future studies should focus on the challenges affecting application of predictive maintenance in commercial banks in Kenya.

In addition, a comparative study should be carried out between the maintenance management practices in service industries and manufacturing industries. Further research can deal with approaches that can help to effectively implement the MM practices in various business set-ups. From the study 35% of the OP in commercial banks is attributed to MM practices, further research can be done to establish the other factors accounting for the 65% variation.

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APPENDICES

APPENDIX I: COMMERCIAL BANKS IN KENYA

Directory of Commercial Banks in Kenya in peer group 1 and 2, with ATM channels

(Source: CBK, 2022)

S/no	Bank Name	Headquarters
1	Co-operative Bank	Nairobi, Kenya
2	Equity Bank	Nairobi, Kenya
3	NCBA Bank Kenya	Nairobi, Kenya
4	ABSA Bank	Nairobi, Kenya
5	Kenya Commercial Bank	Nairobi, Kenya
6	Standard Chartered Bank	Nairobi, Kenya
7	I & M Bank Limited	Nairobi, Kenya
8	National Bank of Kenya	Nairobi, Kenya
9	Prime Bank	Nairobi, Kenya
10	Stanbic Bank	Nairobi, Kenya
11	Bank of Africa	Nairobi, Kenya
12	Diamond Trust Bank	Nairobi, Kenya
13	Ecobank Kenya	Nairobi, Kenya
14	Family Bank Limited	Nairobi, Kenya

APPENDIX II: RESEARCH QUESTIONNAIRE

Maintenance Management of ATMs and Operational Performance of Commercial Bank in Kenya

Section A: Respondent Information		
RI1	Date	___ ___/___ ___/2022
RI2	How long have you worked with this bank (completed years)?	……
RI3	What's your position/ role in the bank	1=ATM channels manager 2=Service desk staff 8=Other
RI4	How long have you worked in this current position (completed years)?	
RI5	Gender	1=Male 2=Female
RI6	What is the highest level of education attained?	1=Secondary/ "A" level 2=College certificate 3=College diploma 4=Bachelor's Degree 5=Post-graduate Degree 8= Other
Section B: Bank Information		
BI1	Name of the Bank	……
BI2	Bank category (peer group)	
BI3	Period the bank has been in operation (Years)	……
BI4	Number of ATMs in branches	……
BI5	Number of ATMs in Offsites	……
BI6	Total number of ATMs (in branches and offsites)	……
BI7_1	How many models of ATM do you have?	……

BI7_2	How many of the [MODEL] ATMs do you have?	……
BI7_3	Who provides **first line maintenance** to the [MODEL] ATMs? *[Self or another Vendor Name]*	……
BI7_4	Who provides **second line/ full maintenance** to the [MODEL] ATMs? *[Self or another Vendor Name]*	……
BI7_5	Who provides **preventive maintenance** to the [MODEL] ATMs? *[Self or another Vendor Name]*	……
Section C: Maintenance Management		
MM1	What is the predominant maintenance practice adopted by your bank?	1=Reactive (Emergency and Corrective) 2= Proactive (Preventive and predictive) 3=Both
MM1_1	What is the predominant maintenance practice adopted by your bank on [MODEL] ATMs?	1=Reactive (Emergency and Corrective) 2= Proactive (Preventive and predictive) 3=Both
MM2	Indicate to what degree the following statements relate to **maintenance management services and practices** applied in your bank (Scale: 1- Very low degree, 2- low degree, 3-Average, 4- High degree, 5- Very high degree)	
MM2_1	*Technicians are skilled*	**1** □ **2** □ **3** □ **4** □ **5** □
MM2_2	*Technicians have all the required tools*	**1** □ **2** □ **3** □ **4** □ **5** □
MM2_3	*Good quality spare parts are available*	**1** □ **2** □ **3** □ **4** □ **5** □
MM2_4	*Maintenance is scheduled and followed*	**1** □ **2** □ **3** □ **4** □ **5** □
MM3	Indicate to what degree the following statements relate to **preventive maintenance practices** applied in your bank (Scale: 1- Very low degree, 2- low degree, 3-Average, 4- High degree, 5- Very high degree)	
MM3_1	*There is predetermined interval between PM*	**1** □ **2** □ **3** □ **4** □ **5** □
MM3_2	*ATMs are inspected regularly*	**1** □ **2** □ **3** □ **4** □ **5** □
MM3_3	*Maintenance activities are done before ATM breaks down*	**1** □ **2** □ **3** □ **4** □ **5** □

MM4	Indicate to what degree the following statements relate to **predictive maintenance practices** applied in your bank (Scale: 1- Very low degree, 2- low degree, 3-Average, 4- High degree, 5- Very high degree)	
MM4_1	*Maintenance is done when certain indicators show decreasing level of performance*	**1** □ **2** □ **3** □ **4** □ **5** □
MM4_2	*An ATM monitoring equipment and technique is in place*	**1** □ **2** □ **3** □ **4** □ **5** □
MM4_3	*ATM data and information is used to inform action*	**1** □ **2** □ **3** □ **4** □ **5** □
MM5	Indicate to what degree the following statements relate to **emergency maintenance practices** applied in your bank (Scale: 1- Very low degree, 2- low degree, 3-Average, 4- High degree, 5- Very high degree)	
MM5_1	*There are frequent unexpected ATM break downs*	**1** □ **2** □ **3** □ **4** □ **5** □
MM5_2	*Emergency breakdown work orders are given priority over other maintenance work orders*	**1** □ **2** □ **3** □ **4** □ **5** □
MM5_3	*There is a team ready to handle emergency maintenance work orders*	**1** □ **2** □ **3** □ **4** □ **5** □
MM6	Indicate to what degree the following statements relate to **corrective maintenance practices** applied in your bank (Scale: 1- Very low degree, 2- low degree, 3-Average, 4- High degree, 5- Very high degree)	
MM6_1	*There is frequent failure of non-critical ATM modules/components*	**1** □ **2** □ **3** □ **4** □ **5** □
MM6_2	*Modules/ components work orders are given priority over other maintenance work orders*	**1** □ **2** □ **3** □ **4** □ **5** □
MM6_3	*There is a team ready and equipment inventory for replacement of faulty components*	**1** □ **2** □ **3** □ **4** □ **5** □
MM7	Determinants of Maintenance Management Practices	
MM7_1	Who makes the overall decision regarding the Maintenance Management Practices adopted by your bank?	1=Top level management (CEO, COO, CFO) 2= Mid-level management (Branch manager, Operations manager, ICT/Service/ATM channels manager) 3= Other staff (Custodian, Service desk officer/IT Officer)
MM8	Indicate to what degree the following factors are considered in selecting the Maintenance Management Practice adopted by your bank (Scale: 1- Very low degree, 2- low degree, 3-Average, 4- High degree, 5- Very high degree)	
MM8_1	1= Maintenance cost/ budget available	**1** □ **2** □ **3** □ **4** □ **5** □

2 3 4 5	2= Management preference 3= Value/ type of ATM 4= Manufacturer guide 5= Vendor advise 6= Other (specify)	**1** □ **2** □ **3** □ **4** □ **5** □ **1** □ **2** □ **3** □ **4** □ **5** □ **1** □ **2** □ **3** □ **4** □ **5** □ **1** □ **2** □ **3** □ **4** □ **5** □ **1** □ **2** □ **3** □ **4** □ **5** □
Section D: Operational Performance (Cost, Reliability, Quality)		
OP1	Indicate to what degree the following statements relate to ATM m**aintenance cost** in your bank (Scale: 1- Very low degree, 2- low degree, 3-Average, 4- High degree, 5- Very high degree)	
OP1_1	*Cost of maintaining ATMs is expectedly low compared to other service delivery workstreams*	**1** □ **2** □ **3** □ **4** □ **5** □
OP1_2	*The ATM profit margins are in line with the annual target*	**1** □ **2** □ **3** □ **4** □ **5** □
OP1_3	*The bank engages in innovative maintenance strategies to cut down cost*	**1** □ **2** □ **3** □ **4** □ **5** □
OP2	Indicate to what degree the following statements relate to ATM **service reliability** in your bank (Scale: 1- Very low degree, 2- low degree, 3-Average, 4- High degree, 5- Very high degree)	
OP2_1	*Frequency of ATM failure in my bank is low*	**1** □ **2** □ **3** □ **4** □ **5** □
OP2_2	*ATMs in my bank always provide expected services within promised time*	**1** □ **2** □ **3** □ **4** □ **5** □
OP2_3	*ATM uptime is always high in my bank*	**1** □ **2** □ **3** □ **4** □ **5** □
OP3	Indicate to what degree the following statements relate to ATM **service quality** in your bank (Scale: 1- Very low degree, 2- low degree, 3-Average, 4- High degree, 5- Very high degree)	
OP3_1	*Customers are loyal to my bank*	**1** □ **2** □ **3** □ **4** □ **5** □
OP3_2	*Customers give good complements to ATM services in my bank*	**1** □ **2** □ **3** □ **4** □ **5** □
OP3_3	*My bank has a good public image compared to competitors*	**1** □ **2** □ **3** □ **4** □ **5** □

THANK YOU FOR COMPLETING THE QUESTIONNAIRE.