MAINTENANCE MANAGEMENT AND OPERATIONAL PERFORMANCE OF SERVICE PARASTATALS IN KENYA

BY

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A MANAGEMENT RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF DEGREE OF MASTER OF BUSINESS ADMINISTRATION (MBA) IN THE SCHOOL OF BUSINESS OF THE UNIVERSITY OF NAIROBI

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DECLARATION

I hereby declare that this research project is my original work; it has not been submitted to any other institution of higher learning for academic purposes.

Signed …… Date. ……..

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

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DEDICATION

I dedicate this management research project to my Lord God, who created me and put me in this great Country Kenya, this far he has brought me. Without his care, mercies and grace this work could not have come to completion. Glory be to his name for ever and ever.

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ABSTRACT

Maintenance management practices that a firm adopts, impact heavily on its operational performance. A firm must hence adopt practices which offer it operational success. There are many maintenance management practices in use in different organizations. The study aimed at knowing maintenance management and operational performance of service parastatals in Kenya. The study was guided by the following theories; Transaction cost theory and Resource Based view theory. The study employed a cross-sectional survey design. A cross-sectional survey enabled the researcher to bring out the unique way maintenance management practices impact operations performance. The target population for this study was 29 Service Parastatals in Kenya. Primary data was collected by means of structured questionnaire. The questionnaires were self-administered via drop and pick later method to the respective operations managers of various service Parastatals. The data collected was analysed using descriptive statistics (measures of central tendency, regression and measures of variations) with the help of Statistical Package for Social Sciences (SPSS) version 20 to achieve the objectives of the study. Regression was used in determining the relationship between maintenance management practices and operations performance. Based on the findings of this study conclusion was that service parastatals have high relationship between operations performance and all maintenance management practices since they explain a large variation of Operations Performance. The study also concluded that majority of the service parastatals applied Preventive Maintenance practices at a moderate rate. The study further concluded that moderate application of maintenance practices also led to a moderate performance in the various parastatals studied. On the operation performance, the study concluded that preventive maintenance, productive maintenance, condition based maintenance and reliability-centered maintenance all have a significant effect on operations performance in service parastatals. The study further concluded that holding preventive maintenance, productive maintenance, and condition based maintenance and reliability-centered maintenance constant, other factors influence operations performance. However, it also meant that there are other variables that affect the operations performance of the service parastatals. These findings showed that preventive maintenance was the most influential factor in operations performance. The study recommends that top management of the parastatals studied should take keen interest in application of maintenance practices in their firms so as to improve from moderate to high. The study findings were applicable to service parastatal institutions only. The findings can therefore not be generalized to all organizations. The study recommends that further research should be done on challenges affecting application of maintenance management in service parastatals in Kenya.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Importance of maintenance functions and, therefore, of maintenance management, has grown in recent years. Maintenance has achieved a significant role in organizations performance because it is directly responsible for the proper operation of the production process. Maintenance area needs to keep equipment in good working conditions and available to achieve high productivity level of quality products. According to Carnero and Novés (2009), maintenance management highly affects operation performance. The cost of repairing in corrective mode is on average about three times higher than the cost of repairing in preventive mode and also has less performance than preventive mode. This is because reactive maintenance does not tackle the root cause of a problem and always results in repetitive failure. Many organizations tend to adopt the proactive maintenance philosophies since these approaches are committed to long term improvement of maintenance management (Pannerrselvam, 2009). A factor that can bring efficient maintenance management is the operational involvement since one of the main causes of breakdowns comes from abusing operations and lack of primary care from the operators.

The study was anchored on Transaction cost theory and resource based theory. Transaction cost theory postulates that, a firm exists because of its capacity to economize on the costs of its market oriented production (Spencer, 2009). This means that, production costs need to be reduced for a firm to succeed in the chosen market. Spencer (2009) noted that efficiency advantages of any organization are greatest

where long term contracts are negotiated including employment issues. The other theory which can be applied in maintenance management is the resource-based view theory. The theory paraphrased stipulates that, for a firm to excel in its area of operation with competition from other firms, its resources must have competitive advantage. The resource-based view (RBV) of Wernerfelt (1984), suggests that competitiveness can be achieved by innovatively delivering superior value to customers. (Borg & Gall, 2009). International business theorists also explain the success and failures of firms across boundaries by considering the competitiveness of their subsidiaries or local alliances in emerging markets.

The Parastatals in Kenya are required to be running through out as long as there is proper maintenance management. Therefore, they are under tight production schedules with limited timeliness to undertake their maintenance and repairs. The costs of this maintenance are normally high. These state corporations are vested with implementation of responsibilities enforced by The Constitution of Kenya (2010), which makes it clear that the maintenance management must support national development objective, In pursuit of the important task, it then requires that proper policies, procedures be implemented (Murray, 2007). The corporations span through all the sectors of the government and cover specialized functions that cannot easily be managed in the general roles of the parent ministries including aligning to the county laws which is currently a challenge. This large proportion of the National budget user calls for efficient use of the resource for the intended purposes and objectives. An efficient and effective management system in State Corporation is, therefore necessary, in managing and maintaining corporation's resources to achieve their intended objectives (Rotich, 2011). Therefore this

study aimed at establishing relationship of maintenance management practices and operations performance in service Parastatals in Kenya.

Currently, Kenya loses billions of taxpayers' money to improper maintenance management practices, specifically poor machinery and technological installations maintenance management. This commonly happens in the country's Parastatals due to issues, such as, inadequate technological capacity, lack of management support in maintenance, and substandard service on contracted maintenance service delivery. This calls for the pressing need to make appropriate policies and decisions to save the situation. Since the state requires to realize its value for money in the process of serving its people, every Parastatal is required to account for its maintenance expenses. Therefore, maintenance management is a valuable step in keeping optimal service delivery to the public through availability of technological equipment's and systems used to serve the stake holders.

1.1.1 Maintenance Management Practices

Marquez and Gupta (2007) define maintenance management as the activities of management that determine maintenance objectives or priorities, strategies and responsibilities and implement them by means such maintenance planning, maintenance control and supervision and several improving methods including economic aspects in the organization. Marquez and Gupta (2007) went further to regard maintenance management as a process and also as a framework. As a framework, they noted that it is the essential supporting structure and the basic system needed to manage maintenance

effectively. As a process, it is the course of action and the series of steps or stages to be followed.

Maintenance management establishes goals and objectives through standards and work procedures in order to obtain a better utilization of available resources, which are staff, equipment and materials. Effective maintenance extends equipment life, improves equipment availability and retains equipment in proper condition. Cholasuke (2010), identified factors associated with high effective maintenance management: policy deployment and organization; maintenance approach; task planning and scheduling; financial aspect; continuous improvement; human resource management; contracting and information management.

There are various maintenance management practices, organizations need to strategically choose the best maintenance management practices which offer them the best operational performance. According to Veldman (2011), maintenance management practices can generally be classified into two i.e. Unplanned and planned maintenance, in unplanned there is corrective and emergency while in planned maintenance there is preventive and predicative. According to Marquez and Gupta (2007), there are nine-(9) maintenance management approaches. These are run to failure, redundancy, scheduled replacement, scheduled overhauls/planned, unplanned maintenance, preventive maintenance, age or use based maintenance, and condition based maintenance (CBM) and re-design/design improvement. While this classification by Marquez and Gupta (2007), is somehow similar to the classification by Veldman (2011) it introduces run to failure, redundancy, scheduled and predictive maintenance management practices.

1.1.2 Operational Performance

Operations performance is the firm's performance measured against standard or prescribed indicators of effectiveness, efficiency, and environmental responsibility such as, cycle time, productivity, waste reduction, and regulatory compliance. Gupta and Marquez (2009) assert that, for an organization to be operationally successful, it must increase its productivity and minimize its costs. Mulwa (2010) noted that, for a firm to succeed, it must adopt efficient and effective production processes monitor and continuously improve those processes. Therefore the production costs of an organization must be minimized while at the same time increasing its productivity, capacity, reliability and availability (Al-Turki, 2011). According to Sharma and Yadava (2011), organizations are now adopting maintenance management as a profit generating business element. Firms are now operating more efficiently, effectively and economically to sustain their long term survival.

Daya and Duffaa (2015), noted that maintenance can be viewed as a value adding activity instead of a necessary evil of expenses. Al-Turki (2011), suggested that maintenance controls should be enhanced in order to achieve maintenance optimization. Sharma and Yadava (2011) noted that the best maintenance optimization practice is the one which considers maintenance policy, cost and reliability measures. Wilson (2012), identified that some business processes which should be used for optimizing operational performance. These are: minimizing maintenance costs, maximizing profitability of production by adopting optimal maintenance practices/concepts to reduce maintenance costs, maximizing plant utilization and capability and retaining high asset value, maximizing performance efficiency and

maximizing work safety at economic cost. Further, Ben- Daya et al. (2000) also identified equipment availability as a measure of a Firm's operational success. Eti (2009), also noted that reduction of failure rate can be a measure of optimized maintenance. Marseguerra (2012), also noted that reliability as a measure of optimized maintenance management should determine the level of preventive maintenance required.

1.1.3 Maintenance Management and Operational Performance

According to Al-Turki (2011), maintenance management are the activities of planning, organizing, implementing, monitoring and controlling in order to sustain a certain level of availability, value and reliability of the system and its components (assets) and its ability to operate to a certain standard level of quality. Therefore, the choice of the maintenance management practice applied impacts heavily on the performance of the firm. The main measures of operational performance of a firm are reliability, maintainability, productivity, efficiency, availability and production per unit cost, among others (Wilson, 2012). Since Firm's maintenance costs are normally high (Al-Turki, 2011) application of best maintenance management practices can boost a firm's operational performance. The maintenance management practices which offer better operational performance therefore need to be established in research.

Maintenance system used can very highly affect maintenance performance. The cost of repairing in corrective mode is on average about three times higher than the cost of repairing in preventive mode and also has less performance than preventive mode. This is because reactive maintenance does not tackle the root cause of a problem and always results in repetitive failure (Carnero & Novés, 2009). Many organizations tend to adopt the proactive maintenance philosophies since these approaches are committed to long

term improvement of maintenance management. A factor that can bring efficient maintenance management is the operational involvement since one of the main causes of breakdowns comes from abusing operations and lack of primary care from the operators.

1.1.4 Parastatals in Kenya

Parastatals in Kenya are established under the state corporation act (cap 446), which gives them autonomy; their objectives are usually wide concerning both the organization and the country (Kramon & Posner, 2011). The corporations are accountable to many stakeholders. The first corporations in Kenya were first established by the colonial government to provide essential services to the white settlers. Indigenous Africans participation in economic activities such as trade and cash crop farming was, generally, discouraged. Following independence in 1963, the independent Kenya government devised strategies to achieve three goals that were considered imperative for development: a fast overall economic growth rate, equitable distribution of development benefits and Kenyanization of the economy. These organizations are created to meet both commercial and social goals. They exist for various reasons including: to correct market failure, to exploit social and political objectives, provide education, health, redistribute income and develop marginal areas. They are governed by number of regulations from 1960s, and a system regulated by Treasury Circulars in the 1970s, 1980s and 1990s. In 2005 the government sought to improve its public procurement systems by enacting the Public Procurement and Disposal Act (PPDA) and creating the Public Procurement Oversight Authority (PPOA) and regulations implementing the Act gazetted by the GOK on January 1, 2007 (PPDA, 2005).

Governments establish state corporations in areas which they consider to be of strategic importance and whose operations require more attention and focus or specialized knowledge and technical skills. Abubakar (2010) observes that unlike government operations, management of corporations is commercial or business oriented. They are expected to have; high performance, self-sustainability and compete effectively with other commercial or private enterprises in the economy undertaking similar functions or offering same services.

The corporations are expected to relieve government of some of the burden of decision making and overload with technical and specialized issues. Placing enterprise decisions outside politics and ministerial bureaucracy is assumed to promote the efficiency of both enterprises and government (Wamalwa, 2013). Some government direction and control, on the other hand is inevitable, for government is ultimately responsible for corporations performance. The service parastatals provide non-tangible benefits to the citizens through delivery of quality services. A high degree of service delivery to citizens is expected from these organizations through high operational performance.

1.2 Research Problem

Maintenance management practices that a firm adopts, impact heavily on its operational performance (Gupta & Marquez, 2007). A firm must hence adopt practices which offer it operational success. There are many maintenance management practices in use in different organizations. The problem of most firms is that, they have not adopted these practices fully to their advantage due to technological challenges and mainly due to tight production schedules (Sharma & Yadava, 2011).

Parastatals in Kenya are under obligation from the government to maintain a minimum running availability of production and service delivery. They therefore need to adopt the best maintenance management practices which will enable them meet this objective at optimal cost. The adopted maintenance management practices ought to reduce the organization maintenance costs. The adopted strategies should also enable the organization meets their other target objectives, world class status of availability and performance efficiency (Wamalwa, 2013). To achieve the set objectives, optimum maintenance management practices need to be adopted, ensuing challenges dealt with and the organization performance indicators need to be monitored so as to implement improvement actions.

Studies have been done on maintenance management practices and operations performance in Kenya and internationally. Mutloane (2009), did a study on maintenance management for effective operations management at Matimba Power Station in South Africa. The study found that experience has shown that progress of implementing change is slow if there was no proactive involvement of all participants and stakeholders, especially employees at lower levels involved in operations. A work management process, which is one of the pillars of total productive maintenance, was recently implemented at Matimba and is currently experiencing teething problems which are being attended to.

On the other hand, Mwangi (2014), investigated the maintenance management practices and operational performance in electricity producing stations in Kenya. The study found that there was no one particular practice which was largely applied in relation to

the others. However broadly, preventive maintenance practices were largely applied than reactive maintenance. The study found out that the level of top management support for maintenance management was low. This was causing a decline effect on operational performance.

Similarly, Choka (2012), did a study on the impact of maintenance management systems on maintenance condition of built facilities of public universities in Kenya. A survey of maintenance condition of the buildings in the two public universities revealed that their condition is in need of repair especially the older building stock. In Kenyatta University most of the buildings were relatively new and so majorities have not been subjected to a lot of disrepair. From the studies little has been done on maintenance management practices and operations performance in service Parastatals in Kenya. Therefore this study sought to answer the question: What is the relationship between maintenance management practices and operations performance in service Parastatals in Kenya?

1.3 Research Objective

The study was guided by the following objectives

i. To establish the maintenance management practices and the extent of use in service Parastatals in Kenya.
ii. To establish the relationship between maintenance management practices and operations performance of service Parastatals in Kenya.

1.4 Value of the Study

To the top management of the Service Parastatals, this study will allow them to gauge their performance against those of similar public institutions. In particular, they will get

to know their weaknesses as far as maintenance management in their firms is concerned and hence determine actions plans for improvement.

The findings from this study will be of importance because it will have the capacity of being used to formulate positive fiscal policies which are relevant and sensitive to the forces influencing maintenance management practices and operations performance in state corporations in Kenya. This study will benefit the government and especially the Parastatals management in making policy decisions whose overall objectives are to improve maintenance and increase performance.

To the academic realm the literature review and the findings of this study will enable this group of beneficiaries to find research gaps to enhance their areas of study. To the academicians the study will contribute to the existing literature in the field of maintenance management practices. It should also act as a stimulus for further research to refine and extend the present study especially in Kenya. Findings of the study will be useful to researchers and scholars as it will contribute to the body of knowledge in the area of operations performance.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of the related literature on maintenance management practices and operations performance as presented by various researchers, scholars, analysts and authors. The chapter also provides the theories underpinning the study.

2.2 Theoretical Foundation

This section examines the various theories that were used to inform the study on the maintenance management practices and operations performance. The study was guided by the following theories; Transaction cost theory and resource based view theory.

2.2.1 Transaction Cost Theory

The transaction cost approach to the theory of the firm was created by Ronald Coase (1937). Transaction cost theory is a theory accounting for the actual cost of outsourcing production of products or services including transaction costs, contracting costs, coordination costs, and search costs. The inclusion of all costs is considered when making a decision and not just the market prices. Essentially this theory illustrates the make versus buy decision for companies. The theory deals with the real costs of allocating resources in an imperfect world of misunderstandings, misaligned goals, and uncertainty. Since management consultants deal with this very issue, it may be that the theory can help explain the existence of the profession.

A company's costs can be classified in two categories: production costs and transaction costs. Production costs are those that are most familiar. They are all the costs that are

associated directly with productive activities (Masten 2012), such as manufacturing, logistics, and product development. Transaction costs, on the other hand, are those costs associated with organizing economic activity. They thus vary with organizational form (Masten 2012). Or as Arrow (2009), puts it, "The distinction between transaction costs and production costs is that the former can be varied by a change in the mode of resource allocation, while the latter depend on the technology and tastes, and would be the same in all economic systems. It has been estimated that at least 45 per cent of the gross national product in a developed society is generated by transaction costs

Transaction cost theory was relevant to the study because it means that, production costs need to be reduced for a firm to succeed in the chosen market. Efficiency advantages of any organization are greatest where long term contracts are negotiated including employment issues. Applied to maintenance management, this theory agrees that, the most important market transaction costs are the cost of determining the price of a product or service, the cost of negotiating and creating the contract, and the cost of information failure. The most important internal transaction costs are associated with the administrative cost of determining what, when, and how to produce, the cost of resource misallocation, and the cost of demotivation. In any given industry the relative magnitude of market and internal transaction costs will determine what is done where.

2.2.2 Resource Based View Theory

The resource-based view (RBV) of Wernerfelt (1984), suggests that competitiveness can be achieved by innovatively delivering superior value to customers. The extant literature focuses on the strategic identification and use of resources by a firm for developing a

sustained competitive advantage (Borg & Gall, 2009). International business theorists also explain the success and failures of firms across boundaries by considering the competitiveness of their subsidiaries or local alliances in emerging markets. Local knowledge provided by a subsidiary or local alliance becomes an important resource for conceptualizing value as per the local requirements (Gupta et al., 2011).

According to resource based theory resources are inputs into a firm's production process and can be classified into three categories as; physical capital, human capital and organizational capital (Currie, 2009). A capability is a capacity for a set of resources to perform a stretch task of an activity. Each organization is a collection of unique resources and capabilities that provides the basis for its strategy and the primary source of its returns. In the 21st-century hyper-competitive landscape, a firm is a collection of evolving capabilities that is managed dynamically in pursuit of above-average returns. Thus, differences in firm's performances across time are driven primarily by their unique resources and capabilities rather than by an industry's structural characteristics (Currie, 2009). This theory tries to explain the effects of management commitment on performance in state corporations in Kenya.

The importance of the resource-based view (RBV) in this study was that it brings out management of resources which affects operations performance in service Parastatals in Kenya. Resources includes financial, physical, human, commercial, technological, and organizational assets used by firms to develop, manufacture, and deliver products and services to its customers. They can be classified as tangible (financial or physical) or

intangible (i.e., employee's knowledge, experiences and skills, firm's reputation, brand name, organizational procedures) (Cocks, 2010).

2.3 Maintenance Management

Organizations are now adopting maintenance management as a profit generating business element. Maintenance management practices include; preventive maintenance, productive maintenance, condition based maintenance and reliability-centered maintenance among others.

2.3.1 Preventive Maintenance

Preventive maintenance involves the systematic inspection of equipment where potential problems are detected and corrected in order to prevent equipment failure before it happens. Preventive maintenance is a planned or schedule maintenance that is done on the onset of failure to prevent or delay breakdowns and to minimize the impact of a breakdown (Wild, 2012). This maintenance management practice is based on the principle that prevention is better than cure. It consists of maintenance activities performed before equipment breaks down with the intent of keeping it operating acceptably to reduce likelihood of failure (Dilworth, 2012). The advantages of this practice are that it reduces rate of breakdowns, increases asset availability, maintain optimum efficiency of the equipment and reduces workload on maintenance staff. PM also increases productivity and safety of the workers (Murthy, 2009).

Planning is the biggest advantage of preventative maintenance over less complex strategies. Unplanned, reactive maintenance has many overhead costs that can be avoided during the planning process. The cost of unplanned maintenance includes lost production,

higher costs for parts and shipping, as well as time lost responding to emergencies and diagnosing faults while equipment is not working (Wild, 2012). Unplanned maintenance typically costs three to nine times more than planned maintenance. When maintenance is planned, each of these costs can be reduced. Equipment can be shut down to coincide with production downtime. Prior to the shutdown, any required parts, supplies and personnel can be gathered to minimize the time taken for a repair. These measures decrease the total cost of the maintenance. Safety is also improved because equipment breaks down less often than in less complex strategies.

2.3.2 Productive Maintenance

Productive maintenance is a system of maintaining and improving the integrity of production and quality systems through the machines, equipment, processes, and employees that add business value to an organization. Productive maintenance is the practice of taking small scale repairs/ remedial actions by operations staff when the equipment is still in operation. When all the employees of an organization are involved in such repairs actions, this is termed as total productive maintenance. Total productive maintenance involves predicting occurrence of failure and fostering active involvement in maintenance by production workers rather than separate maintenance workers. Its goals are zero breakdowns and zero defects (Gupta, 2007). Total productive maintenance emphasizes operator involvement in routine maintenance.

One of the main objectives of productive maintenance is to increase the productivity of plant and equipment with a modest investment in maintenance. Total quality management and total productive maintenance are considered as the key operational activities of the

quality management system. In order for productive maintenance to be effective, the full support of the total workforce is required. This should result in accomplishing the goal of productive maintenance (Cocks, 2010): "Enhance the volume of the production, employee morale and job satisfaction. The main objective of productive maintenance is to increase the overall equipment effectiveness of plant equipment. Productive maintenance addresses the causes of accelerated deterioration while creating the correct environment between operators and equipment to create ownership. According to Arrow, (2009), productive maintenance emphasizes proactive and preventative maintenance to maximize the operational efficiency of equipment. It blurs the distinction between the roles of production and maintenance by placing a strong emphasis on empowering operators to help maintain their equipment. The implementation of a Total Productive Maintenance (TPM) program creates a shared responsibility for equipment that encourages greater involvement by plant floor workers. In the right environment this can be very effective in improving productivity

2.3.3 Condition Based Maintenance

Condition based maintenance (CBM) is a maintenance strategy that monitors the actual condition of the asset to decide what maintenance needs to be done. CBM dictates that maintenance should only be performed when certain indicators show signs of decreasing performance or upcoming failure (Cholasuke, 2010). Checking a machine for these indicators may include non-invasive measurements, visual inspection, performance data and scheduled tests. Condition data can then be gathered at certain intervals, or continuously (as is done when a machine has internal sensors). Condition based maintenance can be applied to mission critical and non-mission critical assets. Unlike in

planned scheduled maintenance (PM), where maintenance is performed based upon predefined scheduled intervals, condition based maintenance is performed only after a decrease in the condition of the equipment has been observed. Compared with preventative maintenance, this increases the time between maintenance repairs, because maintenance is done on an as-needed basis (Daya & Duffaa, 2015).

Condition based maintenance is the maintenance which is normally done when operating conditions deviate from the norm. It is done to detect incipient failures long before they occur (Veldman, 2011). It uses condition monitoring techniques to determine whether a problem exists in running equipment and for how long the equipment can operate before failure. This maintenance management practice detects and identifies specific components in an equipment that are degrading, determine root cause of the problem and take remedial actions before failure of the equipment or operating asset. The goal of condition based maintenance is to spot upcoming equipment failure so maintenance can be proactively scheduled when it is needed – and not before. Asset conditions need to trigger maintenance within a long enough time period before failure, so work can be finished before the asset fails or performance falls below the optimal level.

2.3.4 Reliability-Centered Maintenance

Reliability-centered maintenance (RCM) is a process to ensure that systems continue to do what their users require in their present operating context. It is generally used to achieve improvements in fields such as the establishment of safe minimum levels of maintenance. Marquez (2009), noted RCM that is the maintenance done based on

probability of equipment failing and cost of such failure. RCM allows detection of failures long before they occur to ensure minimum interruptions to the production process. It also eliminate occurrence of failures before they show up (Marquez, 2009). According to Ngatia (2013), RCM is the process of determining and ensuring that any asset continues to operate as expected under its present condition. It is a prioritized maintenance practice to first carry maintenance to assets with high risk value in terms of safety and economics. Marquez et al., (2009) identified RCM as maintenance a practice which was gaining global importance.

Reliability centered maintenance (RCM) is a corporate-level maintenance strategy that is implemented to optimize the maintenance program of a company or facility. The final result of an RCM program is the implementation of a specific maintenance strategy on each of the assets of the facility (Currie, 2009). The maintenance strategies are optimized so that the productivity of the plant is maintained using cost-effective maintenance techniques. An effective reliability centered maintenance implementation examines the facility as a series of functional systems, each of which has inputs and outputs contributing to the success of the facility. It is the reliability, rather than the functionality, of these systems that are considered. Reliability-centered maintenance identifies the functions of the company that are most critical and then seeks to optimize their maintenance strategies to minimize system failures to ultimately increase equipment reliability and availability (Pintelon & Gelders, 2012). The most critical assets are those that are likely to fail often or have large consequences of failure. With this maintenance strategy, possible failure modes and their consequences are identified; all while the function of the equipment is considered. Cost-effective maintenance techniques that

minimize the possibility of failure can then be determined. The most effective techniques are then adopted to improve the reliability of the facility as a whole.

2.3.5 Total Productive Maintenance

Total productive maintenance (TPM) is a system of maintaining and improving the integrity of production and quality systems through the machines, equipment, processes, and employees that add business value to an organization. TPM focuses on keeping all equipment in top working condition to avoid breakdowns and delays in manufacturing processes. According to Daya and Duffaa (2015), one of the main objectives of total productive maintenance is to increase the productivity of a factory and its equipment with a modest investment in maintenance. Total quality management and total productive maintenance are considered as the key operational activities of the quality management system in Toyota Production system. In order for TPM to be effective, the full support of the total workforce is required. This should result in accomplishing the goal of TPM Enhance the volume of the production, employee morale and job satisfaction (Al-Turki 2011). Another objective of TPM is to increase the overall plant equipment effectiveness. TPM addresses the causes of accelerated deterioration while creating the correct environment between operators and equipment to create ownership.

Total productive maintenance brings maintenance into focus as a necessary and vitally important part of the business (Sharma & Yadava 2011). It is no longer regarded as a non-profit activity. Down time for maintenance is scheduled as a part of the manufacturing day and, in some cases, as an integral part of the manufacturing process. Marquez (2009), noted that the goal of total productive maintenance is to hold emergency

and unscheduled maintenance to a minimum. Maintenance technicians aren't necessarily using the same machine every day. But machine operators are the people who use assets day in and day out, and know what normal looks like. They can keep an eye out for changes with their equipment and log issues immediately, full breakdowns are much less likely to happen.

2.4 Operational Performance

Operations seek to achieve the objectives of quality, cost, timeliness/speed and flexibility. Russel and Taylor (2011), argued that to compete on quality, organizations must view it as an opportunity to please the customer and not just as a way to avoid problems or reduce rework costs. Award winning companies have their entire system designed to understand the individual expectations of their customers. It is argued that every employee is empowered to take immediate action to satisfy a customer wish or to resolve a problem. Competing on flexibility demands that customers get more variety and higher speed of delivery (Russel & Taylor, 2011). It includes providing a wide variety of products or services and also the ability of a firm to customize the existing ones quickly in order to respond to customer needs. The customer would prefer a higher quality service but to pay less for it. In the airline industry, quality is enhanced by having redundant systems that help meet customers demand for both flexibility and higher speed of service delivery. This may lead to higher quality for the customer, but it causes the problem of idle capacity (Kaynak, 2003). The efficiency and effectiveness of an organization are factors in the achievement of any of the above objectives.

Daya and Duffaa (2015), noted that maintenance can be viewed as a value adding activity instead of a necessary evil of expenses. Al-Turki (2011), suggested that maintenance controls should be enhanced in order to achieve maintenance optimization. Sharma and Yadava (2011) noted that the best maintenance optimization practice is the one which considers maintenance policy, cost and reliability measures. Wilson (2012), identified some business processes which should be used for optimizing operational performance. These are: minimizing maintenance costs, maximizing profitability of production by adopting optimal maintenance practices/concepts to reduce maintenance costs, maximizing plant utilization and capability and retaining high asset value, maximizing performance efficiency and maximizing work safety at economic cost. Further, Ben- Daya et al (2000) also identified equipment availability as a measure of a Firm's operational success. Eti (2009), also noted that reduction of failure rate can be a measure of optimized maintenance. Marseguerra (2012), also noted that reliability as a measure of optimized maintenance management should determine the level of preventive maintenance required.

2.5 Empirical Review

Oliveira, Lopes, and Figueiredo (2014), studied the maintenance management practices of companies of the industrial pole of Manaus Brazil. A questionnaire was developed and sent to the company of the industrial pole and the received data was analyzed using descriptive statistics. The study found that the effectiveness of the maintenance function in an industrial unit depends on the equipment involved, the training of personnel, and mainly on the adopted strategy for maintenance management. In addition to modern equipment ownership, it is necessary to understand the concern

about flaws, in its details, in order to attack not the consequences but the causes using the most appropriate tools and techniques.

Mutloane (2009), did a study on maintenance management for effective operations management at Matimba Power Station in South Africa. The study found that experience has shown that progress of implementing change is slow if there was no proactive involvement of all participants and stakeholders, especially employees at lower levels involved in operations. A work management process, which is one of the pillars of total productive maintenance, was recently implemented at Matimba and is currently experiencing teething problems which are being attended to.

On the other hand, Fredriksson (2012), did an analysis of maintenance strategies and development of a model for strategy formulation in Sweden. The study found that More frequent and maintenance focused education opportunities for the maintenance craftsmen concerning new technology in assets will contribute to a higher level of efficiency and effectiveness for the maintenance work. The management should encourage the craftsmen's ideas and utilize the competence they possess. This will also engage and motivate them to improve the organization which will facilitate reaching the desired state –a proactive environment. It is also essential that education concerning the ongoing changes within the organization is provided so that the customers gain knowledge about what is changing, why it is changing and what the objective of the change is. Otherwise, the resistance to change will most certainly be high.

Mwangi (2014), investigated the maintenance management practices and operational performance in electricity producing stations in Kenya. The study found that there was

no one particular practice which was largely applied in relation to the others. However broadly, preventive maintenance practices were largely applied than reactive maintenance. The study found out that the level of top management support for maintenance management was low. This was causing a decline effect on operational performance. Similarly, Choka (2012), did a study on the impact of maintenance management systems on maintenance condition of built facilities of public universities in Kenya. A survey of maintenance condition of the buildings in the two public universities studied revealed that their condition is in need of repair especially the older building stock. In Kenyatta University most of the buildings weree relatively new and so majorities have not been subjected to a lot of disrepair.

Kariuki (2013), studied the maintenance practices and performance of power sector in Kenya. The case study was done with a target population of all the three operational areas with different generation technology of hydro, thermal and geothermal. The study used primary data which was gathered by means of a self-administered questionnaire issued to respondents and secondary data which was extracted from internal operational reports in Eastern hydro power stations. The study established that KenGen has in place good maintenance practices. When they were benchmarked with world best practice, it was apparent that breakdown maintenances works were extremely high but surprisingly the plants availability recording very good results. There was a weak relationship between O&M cost, number of breakdowns and the plant availabilities.

2.6 Summary

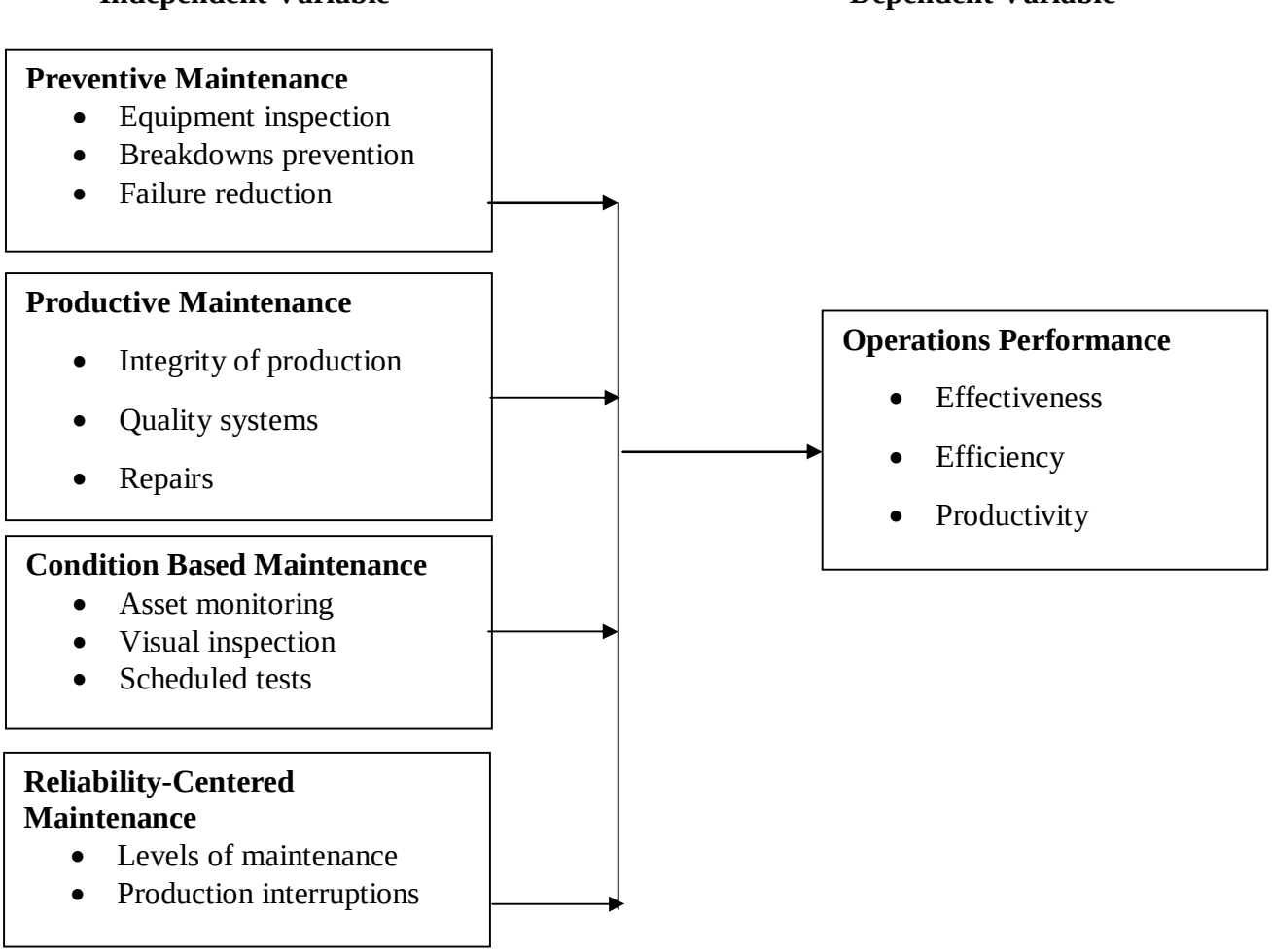
Various researchers have discussed maintenance management practices and operations performance. Arrow (2009), in the transaction cost theory noted that production costs need to be reduced for a firm to succeed in the chosen market. Efficiency advantages of any organization are greatest where long term contracts are negotiated including employment issues. Currie (2009), in the resource based view theory noted that the theory brings out management of resources which affects operations performance. Resources in Parastatals includes financial, physical, human, commercial, technological, and organizational assets used by firms to develop, manufacture, and deliver products and services to its customers. On the preventive maintenance practice Wild, (2012), asserted that maintenance management practice is based on the principle that prevention is better than cure. It consists of maintenance activities performed before equipment breaks down with the intent of keeping it operating acceptably to reduce likelihood of failure.

Similarly, according to Gupta (2007), Productive maintenance is the practice of taking small scale repairs/ remedial actions by operations staff when the equipment is still in operation. On the other hand, condition based maintenance dictates that maintenance should only be performed when certain indicators show signs of decreasing performance or upcoming failure (Cholasuke, 2010). Checking a machine for these indicators may include non-invasive measurements, visual inspection, performance data and scheduled tests. Marquez (2009), noted reliability-centered maintenance that is the maintenance done based on probability of equipment failing and cost of such failure. RCM allows

detection of failures long before they occur to ensure minimum interruptions to the production process.

2.7 Conceptual Framework

The conceptual framework describes the relationship shared between the independent and dependent variables in the study. The independent include; preventive maintenance, productive maintenance, condition based maintenance and reliability-centered maintenance while the dependent variable is operations performance.



2.8 Research Gap

There are studies done on maintenance management practices and operations performance in Kenya. However, this study identifies gaps in methodology, variables used and the theory. Mwangi (2014), investigated the maintenance management practices and operational performance in electricity producing stations in Kenya. The study used quality maintenance, run to failure maintenance and breakdown maintenance as variables, it further used systems theory, and transaction costs theory. The study further used descriptive cross sectional survey design as its methodology. This maintenance management study used four maintenance practices as independent variables; preventive maintenance, productive maintenance, condition based maintenance and reliability-centered maintenance, it further applied two economic theories, transaction cost theory and resource based view theory, the study also used descriptive research design and multiple regression analysis.

Similarly, Choka (2012), did a study on the impact of maintenance management systems on maintenance condition of built facilities of public universities in Kenya. The study found that the condition of buildings is in need of repair especially the older buildings stock. The newer buildings were in relatively better condition as majorities had not been subjected to a lot of wear. Kariuki (2013), studied the maintenance practices and performance of power sector in Kenya. The study established that KenGen had in place good maintenance practices. When they were benchmarked with world best practice in power sector, it was apparent that breakdown maintenances works were extremely high but surprisingly the plants availability recording hand very good results. This study (maintenance management and operational performance of service parastatals in

Kenya) used four independent variables; preventive maintenance, productive maintenance, condition based maintenance and reliability-centered maintenance, it further applied two economic theories, transaction cost theory and resource based view theory, the study further applied descriptive research design and multiple regression analysis. Therefore the study sought to fill in the gap on methodology, variables used and the theories applied by bringing out the relationship between maintenance management practices and operations performance in service Parastatals in Kenya. It also sought to establish the maintenance management practices in use and extent of their use in service parastatals in Kenya.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides a discussion of the outline of the research methodology that was used in this study. It focuses on the research design, population, data collection and data analysis methods used in the study.

3.2 Research Design

The study adopted a cross-sectional survey in analyzing maintenance management practices and operations performance in service state corporations in Kenya. A survey is deemed to be appropriate for this study because it will bring out the unique way maintenance management practices impact operations performance. According to Cooper and Schindler (2006), cross-sectional survey targets, either the entire population or a subset is selected, and from these individuals, data are collected to help answer research questions of interest. The information gathered represents maintenance management practices and operations performance in service Parastatals in Kenya.

3.3 Population of the Study

This study focused on 29 Service Parastatals in Kenya as per Corporation Act CAP 446 of 2013. Therefore it was a census survey of all the 29 Service Parastatals in Kenya.

3.4 Data Collection

Primary data was collected by means of a structured questionnaire. The questionnaires were self-administered via drop and pick later method to the respective operations

managers of various service Parastatals. The questionnaire allowed greater uniformity in the way questions were asked, ensuring greater compatibility in the responses.

According to Cooper and Schindler (2006), the use of structured questions on the questionnaire allows for uniformity of responses to questions; while unstructured questions gave the respondent freedom of response which helped the researcher to gauge the feelings of the respondent, he or she used his or her own words. The structured questions were in form of a five point scale, whereby respondents were required to indicate their views on a scale of 1 to 5.

3.5 Data Analysis

Before the actual analysis of data using appropriate electronic means, data was cleaned, edited and checked for accuracy. These processes were essential to ensure that the collected data is systematically organized in a manner that facilitates analysis.

The data collected was analyzed using, Descriptive statistics a technique used in presenting and organizing data these included: tabulation, diagrams, and numerical procedures all which aimed at summarizing the material in a form which display its distinctive features that aid analysis. Descriptive statistics was used to quantitatively describe the important features of the variables using frequency, mean, percentage and standard deviation.

Regression quantified the association between maintenance management practices and operations performance. The study used 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_I = Preventive Maintenance

X_2 = Productive Maintenance

X_3 = Condition Based Maintenance

X_4 = Reliability-Centered Maintenance

B_1– β_4 are the regression co-efficient or change introduced in Y by each independent variable

μ is the random error term accounting for all other variables that affect operations performance but not captured in the model. A T-test at 95% confidence interval was used to determine and explain changes in the dependent variable and significance of the independent variable to the dependent variable.

CHAPTER FOUR: DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter presents data analysis of the findings obtained from the field. It presents the background information of the respondents, findings of the analysis based on the objectives of the study. Descriptive statistics was used to discuss the findings of the study.

4.1.1 Questionnaire

The study targeted a sample size of 29 respondents from which 22 filled in and returned the questionnaire making a response rate of 76%. This was achieved through dropping off the questionnaire to respondents, emailing the same to those who agreed to print and complete, followed by phone calls reminding them of the timelines. The response rate was satisfactory to make conclusions for the study as it acted as a representative. According to Mugenda and Mugenda (1999), a response rate of 50% is adequate for analysis and reporting; a rate of 60% is good and a response rate of 70% and over is excellent. Based on the assertion, the response rate was excellent.

Table 4.1: Response Rate

	Questionnaires Administered	Questionnaires filled & Returned	Percentage Response
Respondents	29	22	76

4.2 Demographic Information

The study sought to establish the demographic information of the respondents in terms of, period of service, level of education attained and Gender.

4.2.1 Period of Service

Respondents were requested to indicate their period of service in the service parastatal. The findings are as shown below

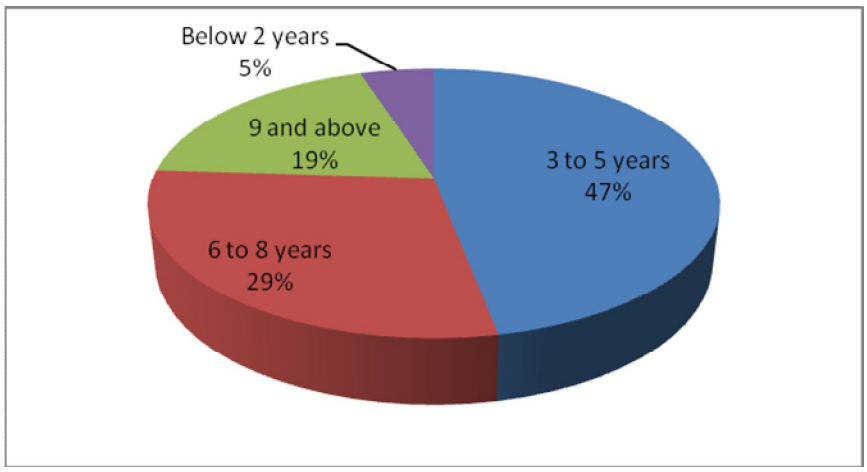


Figure 4.1: Period of Service

47% of the respondents had served in the parastatals for 3 to 5 years, 29% had served for 6 to 8 years, 19% had served for 9 years and above while 5% had served for 2 years and below.

4.2.2 Level of Education Attained

The findings on the distribution of the respondents in terms of Level of Education Attained were presented on the figure below.

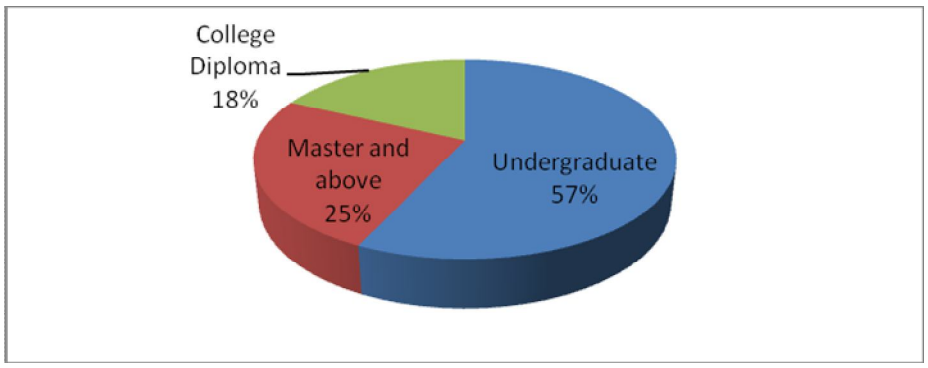


Figure 4.2: Level of Education Attained

Based on the findings, majority (57%) of the respondents were of degree level, 25% had attained master and above while only 18% had college diplomas.

4.2.3 Gender Distribution

On the gender distribution of the respondents the results were presented on figure 4.3

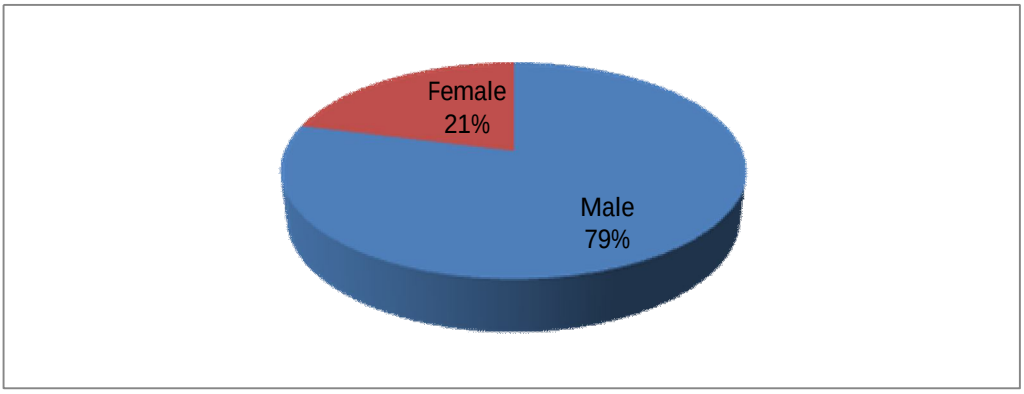


Figure 4.3: Gender Distribution

Majority of the respondents (79%) were male while 21% were females working in the parastatals.

4.3 Maintenance Management Practices

The study further sought to investigate the Maintenance Management Practices applied in various service parastatals in Kenya based on respondents response to the questionnaire.

4.3.1 Preventive Maintenance

Respondents were requested to indicate the extent to which the following statements relating to maintenance management practices applied to them. The respondents were to use a scale of 1-5, where (1= strongly disagree, 2= disagree, 3= moderately agree, 4= Agree and 5= strongly Agree)

Table 4.2: Preventive Maintenance

Preventive Maintenance	**Mean**	**Standard deviation**
My Parastatal does equipment inspection regularly	3.09	1.21
The organization conducts breakdowns prevention measures	3.01	1.20
The organization system are inspected for failure reduction	3.13	1.23
There are maintenance activities performed before equipment breaks down	3.20	1.23
Preventive maintenance reduces breakdowns, increases asset availability	3.13	1.22
Preventive maintenance maintain optimum efficiency of the equipment and reduces workload on maintenance staff	3.01	1.21
Average mean	3.095	

The findings reveal that majority of the parastatals applied Preventive Maintenance practices at a moderate rate. This is evident by the average mean of 3.095. Respondents to moderate extent indicated that: their Parastatal does equipment inspection regularly a (mean = 3.09, SD= 1.21), The organization conducts breakdowns prevention measures a (mean = 3.01, SD= 1.20),The organization system are inspected for failure reduction a

(mean =3.13, SD=1.23), There are maintenance activities performed before equipment breaks down a (mean = 03.20, SD= 1.23), Preventive maintenance reduces breakdowns, increases asset availability a (mean =3.13, SD= 1.22), Preventive maintenance maintain optimum efficiency of the equipment and reduces workload on maintenance staff a (mean =3.01, SD=1.21). The findings indicates that even though the service parastatals in Kenya are aware of the Preventive Maintenance its application is still at low phase.

4.3.2 Productive Maintenance

In addition respondents were requested to indicate the extent to which each of the following statements relating to productive maintenance (PM) applied to them on a scale of 1-5, where (1= strongly disagree, 2= disagree, 3= moderately agree, 4= Agree and 5= strongly Agree)

Table 4.3: Productive Maintenance

Productive Maintenance	**Mean**	**Standard deviation**
The organization maintains and improves the integrity of production	3.19	1.23
The quality systems are maintained through machines check ups	3.27	1.22
The organization takes small scale repairs/ remedial actions by operations staff when the equipment is still in operation	3.12	1.17
The Operators predicts occurrence of equipment failure and foster active involvement in maintenance in the organization	3.18	1.20
It increases the productivity of the organization and equipment with a modest investment in maintenance	3.11	1.24
Productive maintenance enhances the volume of the production, employee morale and job satisfaction	3.35	1.19
Average mean	3.20	

On average the respondents agreed to a moderate rate that the parastatal they were working in applied Productive Maintenance practice. This is as revealed by an average mean of 3.20.

Specifically the respondents indicated on a moderate rate that: The organization maintains and improves the integrity of production (mean =3.19 , SD=1.23), The quality systems are maintained through machines checkups (mean =3.27, SD=1.22), The organization takes small scale repairs/ remedial actions by operations staff when the equipment is still in operation (mean =3.12, SD= 1.17), The Operators predicts occurrence of equipment failure and foster active involvement in maintenance in the organization (mean =3.18, SD=1.20), It increases the productivity of the organization and equipment with a modest investment in maintenance (mean =3.11, SD=1.24) and that Productive maintenance enhances the volume of the production, employee morale and job satisfaction (mean =3.35, SD=1.19).

4.3.3 Condition Based Maintenance

Respondents were also requested to indicate the extent to which each of the following statements relating to condition based maintenance (CBM) applied to them on a scale of 1-5, where (1= strongly disagree, 2= disagree, 3= moderately agree, 4= Agree and 5= strongly Agree).

Table 4.4: Condition Based Maintenance

Condition Based Maintenance	Mean	Standard deviation
The technicians monitors the actual condition of the asset to decide what maintenance needs to be done	3.13	1.18
Maintenance is only performed when certain indicators show signs of decreasing performance	3.15	1.19
Machines in the organization are inspected through non-invasive measurements (e.g. Listening for abnormal sound etc.)	3.31	1.17
Condition based maintenance increases the time between maintenance repairs, because maintenance is done on as-needed basis	3.00	1.20
It is done when operating conditions deviate from the norm	3.17	1.22
It detects and identifies specific components in an equipment that are degrading	3.02	1.21
Average mean	3.13	

An average mean of 3.13 indicates that at a moderate rate the parastatals were making use of Condition Based Maintenance.

Specifically the respondents agreed moderately that: The technicians monitors the actual condition of the asset to decide what maintenance needs to be done (mean =3.13, SD=1.18), Maintenance is only performed when certain indicators show signs of decreasing performance (mean =3.15, SD=1.19), Machines in the organization are inspected through non-invasive measurements (e.g. Listening for abnormal sound etc.) (mean = 3.31, SD = 1.17), Condition based maintenance increases the time between

maintenance repairs, because maintenance is done on as-needed basis (mean =3.00, SD=1.20), It is done when operating conditions deviate from the norm (mean =3.17, SD=1.22) and that it detects and identifies specific components in an equipment that are degrading (mean =3.02, SD=1.21).

4.3.4 Reliability-Centered Maintenance

Further respondents were requested to indicate the extent to which each of the following statements relating to reliability-centered maintenance applied to them on a scale of 1-5, where (1 = strongly disagree, 2 = disagree, 3 = moderately agree, 4= Agree and 5 = strongly Agree). The findings are as shown on the table below.

Table 4.5: Reliability-Centered Maintenance

Reliability-Centered Maintenance	**Mean**	**Standard deviation**
The organization ensure that technological systems continue to do what their users require in their present operating context	3.11	1.24
Reliability-centered maintenance establishes safe minimum levels of maintenance	3.3	1.24
Allows detection of failures long before they occur in the organization	3.21	1.18
The maintenance strategies are optimized so that the productivity of the organization is maintained	3.28	1.19
Reliability centered maintenance implementation examines the facility as a series of functional systems	3.12	1.17
Reliability-centered maintenance identifies the critical functions of the organization	3.09	1.20
Average mean	3.19	

As shown by an average mean of 3.19 respondents indicated moderate use of Reliability-Centered Maintenance practice in various parastatals.

Moderately respondents agreed that the organization ensure that technological systems continue to do what their users require in their present operating context (mean =3.11, SD= 1.24), Reliability-centered maintenance establishes safe minimum levels of maintenance (mean =3.3, SD=1.24), Allows detection of failures long before they occur in the organization (mean =3.21, SD= 1.18), The maintenance strategies are optimized so that the productivity of the organization is maintained (mean =3.28, SD=1.19), Reliability centered maintenance implementation examines the facility as a series of functional systems (mean =3.12, SD=1.17) and that reliability-centered maintenance identifies the critical functions of the organization (mean =3.09, SD=1.20).

4.4 Operations Performance

The study also sought to establish the extent to which each of the statements below relating to operations performance applied to the various parastatals studied. On a scale of 1-5, where (1= strongly disagree, 2= disagree, 3= moderately agree, 4= Agree and 5= strongly Agree). The findings were tabulated on table 4.6

Table 4.6: Operations Performance

Operations Performance	Mean	Standard deviation
The organization ensures services are effective (producing expected results)	3.00	1.24
The organization ensures customers are served efficiently (with minimum wasted effort)	3.17	1.24
The productivity of the organization is maintained	3.02	1.25
There is consistent monitoring of performance in the organization	3.03	1.25
There is deliberate waste reduction in the organization equipment's	3.00	1.23
Average mean	3.04	

On average the respondent agreed that the parastatals were performing moderately as shown by a mean of 3.04. Respondents specifically indicated that: The organization ensures services are effective (producing expected results) (mean=3.00, SD=1.24), The organization ensures customers are served efficiently (with minimum wasted effort) (mean=3.17, SD=1.24), The productivity of the organization is maintained (mean=3.12, SD=1.25), There is consistent monitoring of performance in the organization (mean=3.03, SD=1.25), There is deliberate waste reduction in the organization equipment's (mean=3.00, SD=1.23).

4.5 Regression Analysis

Model Analysis

In this study, a multiple regression analysis was conducted to test the influence of predictor variables on the dependent variable. The study used statistical package for social sciences (SPSS V 21.0) to code, enter and compute the measurements of the multiple regressions.

Model Summary

The model summary is presented in the table below

Table 4.7 : Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.811 [a]	0.658	0.684	0.313

Source; Research findings, 2017

The study used coefficient of determination to evaluate the model fit. The adjusted $R^{2,}$ also called the coefficient of multiple determinations, is the percent of the variance in the dependent explained uniquely or jointly by the independent variables. The model had an average adjusted coefficient of determination (R^2) of 0.684 and which implied that 68.4% of the variations in operations performance are explained by the independent variables understudy (preventive maintenance, productive maintenance, condition based maintenance and reliability-centered maintenance).

Analysis of Variance

The study further tested the significance of the model by use of ANOVA technique. The findings are tabulated in table below.

Table 4.8 : Summary of One-Way ANOVA Results.

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	127.05	3	42.35	2.1679	.0021[b]
	Residual	1928	21	91.8095		
	Total	2055.05	23			

Critical value = 2.0311

Source; Research findings, 2017

From the ANOVA statics, the study established the regression model had a significance level of 0.21% which is an indication that the data was ideal for making a conclusion on the population parameters as the value of significance (p-value) was less than 5%. The calculated value was greater than the critical value (2.1679> 2.0311) an indication that preventive maintenance, productive maintenance, condition based maintenance and reliability-centered maintenance all have a significant effect on operations performance. The significance value was less than 0.05 indicating that the model was significant.

Coefficients

In addition, the study used the coefficient table to determine the study model. The findings are presented in the table below.

Table 4. 9 : Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.484	0.3142		4.7231	0
	preventive maintenance	0.651	0.0661	0.421	9.8487	0.021
	productive maintenance,	0.571	0.1114	0.369	5.1256	0.011
	condition based maintenance	0.627	0.0876	0.543	7.1575	0.003
	reliability-centered maintenance	0.594	0.2142	0.325	2.773	0.012

Source; Research findings, 2017

Predictors: (Constant), preventive maintenance, productive maintenance, condition based maintenance and reliability-centered maintenance.

Dependent Variable: operations performance

As per the SPSS generated output as presented in table above, the equation becomes:

$Y=1.484+0.651X1+0.571X2+0.627X3+0.594X4+\varepsilon$

The regression equation above has established that holding preventive maintenance, productive maintenance, and condition based maintenance and reliability-centered maintenance constant, other factors influencing operations performance will be 1.484. The findings also show that taking all other independent variables at zero, a unit change in preventive maintenance would lead to an increase in operations performance by a factor of 0.651, On the other hand, the findings also show that unit change in productive

maintenance while holding the other factors constant would lead to an increase in operations performance by a factor of 0.571, a unit change in condition based maintenance while holding the other factors constant would lead to an increase in operations performance by a factor of 0.627 and a unit change in reliability-centered maintenance while holding the other factors constant would lead to an increase in operations performance by a factor of 0.594.

4.6 Interpretations of the Findings

The study targeted a sample size of 29 respondents from which 22 filled in and returned the questionnaires making a response rate of 76%. 47% of the respondents had served in the parastatals for 3 to 5 years, majority (57%) of the respondents were of degree level while majority (79%) were male. This indicates that respondents were fairly distributed in terms of period of service, level of education attained was graduate and above while majority of respondents were male.

The findings reveal that majority of the parastatals applied Preventive Maintenance practices at a moderate rate. This is evident by the average mean of 3.095. In addition, on average the respondents agreed to a moderate rate that the parastatals they were working in applied Productive Maintenance practices. This is as revealed by an average mean of 3.20. An average mean of 3.13 indicates that at a moderate rate the parastatals were making use of Condition Based Maintenance As shown by an average mean of 3.19 respondents indicated moderate use of Reliability-Centered Maintenance practice in various parastatals. The moderate application of maintenance practices also led to a moderate performance in the various parastatals studied as shown by a mean of 3.04.

The study used coefficient of determination to evaluate the model fit. The adjusted $R^{2,}$ also called the coefficient of multiple determinations, is the percent of the variance in the dependent explained uniquely or jointly by the independent variables. The model had an average adjusted coefficient of determination (R^2) of 0.684 and which implied that 68.4% of the variations in operations performance are explained by the independent variables understudy (preventive maintenance, productive maintenance, condition based maintenance and reliability-centered maintenance).

From the Analysis of Variance (ANOVA) statics, the study established the regression model had a significance level of 0.21% which is an indication that the data was ideal for making a conclusion on the population parameters as the value of significance (p-value) was less than 5%.

The calculated value was greater than the critical value (2.1679> 2.0311) an indication that preventive maintenance, productive maintenance, condition based maintenance and reliability-centered maintenance all have a significant effect on operations performance. The significance value was less than 0.05 indicating that the model was significant.

The regression equation above has established that holding preventive maintenance, productive maintenance, and condition based maintenance and reliability-centered maintenance constant, other factors influencing operations performance will be 1.484. This implied that there are other variables that affect the operations performance of the parastatals that were not included in the model.

The findings also show that taking all other independent variables at zero, a unit change in preventive maintenance would lead to an increase in operations performance by a

factor of 0.651, On the other hand, the findings also show that unit change in productive maintenance while holding the other factors constant would lead to an increase in operations performance by a factor of 0.571, a unit change in condition based maintenance while holding the other factors constant would lead to an increase in operations performance by a factor of 0.627 and a unit change in reliability-centered maintenance while holding the other factors constant would lead to an increase in operations performance by a factor of 0.594.

These findings implied that preventive maintenance was the most influential factor in operations performance with a coefficient of 0.651.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter comprised of a summary of the findings made as a result of the data analyzed. Further, the chapter has made some conclusions based on the study. Based on the findings, suggestions for areas of further research have been outlined. Finally, the chapter draws certain recommendations to the management of the service parastatals.

5.2 Summary of Findings

On the demographic information the study found that majority of the respondents at 47% had served in the parastatals for 3 to 5 years, for education levels majority (57%) of the respondents were of degree level while majority (79%) were male. This indicates that respondents were fairly distributed in terms of period of service, level of education attained was first degree and above. While the findings on gender was that majority of the respondent were male, an indication that majorly maintenance activities in service parastatals are carried out by men.

On the maintenance management the findings reveal that majority of the service parastatals applied Preventive Maintenance practices at a moderate rate. This is evident by the average mean of 3.095. The parastatals also applied Productive Maintenance practices at a moderate rate as shown by an average mean of 3.20. An average mean of 3.13 indicates that at a moderate rate the parastatals were making use of condition based maintenance. As shown by an average mean of 3.19 respondents indicated moderate use of Reliability-Centered Maintenance practice in various service parastatals.

The findings revealed that the moderate application of maintenance practices also led to a moderate performance in the various parastatals studied as shown by a mean of 3.04.

From the regression model, the study revealed that the model had an average adjusted coefficient of determination (R^2) of 0.684 which implied that 68.4% of the variations in operations performance are explained by the independent variables understudy (preventive maintenance, productive maintenance, condition based maintenance and reliability-centered maintenance).

From the ANOVA statics, the study established the regression model had a significance level of 0.21% which is an indication that the data was ideal for making a conclusion on the population parameters as the significance value (p-value) was less than 5%. The calculated value was greater than the critical value (2.1679> 2.0311) an indication that preventive maintenance, productive maintenance, condition based maintenance and reliability-centered maintenance all have a significant effect on operations performance. The significance value was less than 0.05 indicating that the model was significant.

The regression equation established that holding preventive maintenance, productive maintenance, and condition based maintenance and reliability-centered maintenance constant, other factors influencing operations performance will be 1.484. This implied that there are other variables that affect the operations performance of the parastatals that were not included in the model.

The findings also show that taking all other independent variables at zero, a unit change in preventive maintenance would lead to an increase in operations performance by a factor of 0.651, On the other hand, the findings also show that unit change in productive

maintenance while holding the other factors constant would lead to an increase in operations performance by a factor of 0.571, a unit change in condition based maintenance while holding the other factors constant would lead to an increase in operations performance by a factor of 0.627 and a unit change in reliability-centered maintenance while holding the other factors constant would lead to an increase in operations performance by a factor of 0.594.

These findings implied that preventive maintenance was the most influential factor in operations performance with a coefficient of 0.651.

5.3 Conclusion

From the regression model, the study revealed that the model had an average adjusted coefficient of determination (R^2) of 0.684 which implied that 68.4% of the variations in operations performance are explained by the independent variables researched on (preventive maintenance, productive maintenance, condition based maintenance and reliability-centered maintenance). The study concludes that for the service parastatals to have high operations performance they should apply all maintenance management practices since they explain a large variation of Operations Performance.

The study concludes that maintenance management are the activities of planning, organizing, implementing, monitoring and controlling in order to sustain a certain level of availability, value and reliability of the system and its components (assets) and its ability to operate to a certain standard level of quality. Therefore, the choice of the maintenance management practice applied impacts heavily on the performance of the firm.

The main measures of operational performance of a firm are reliability, maintainability, productivity, efficiency, availability and production per unit cost, among others. Since Firm's maintenance costs are normally high application of best maintenance management practices can boost a firm's operational performance. The maintenance management practices which offer better operational performance therefore need to be established in research.

The study also concludes that maintenance system used can very highly affect Operations performance. The cost of repairing in corrective mode is on average about three times higher than the cost of repairing in preventive mode and also has less performance than preventive mode. This is because reactive maintenance does not tackle the root level of a problem and always results in repetitive failure.

5.4 Recommendations

It is recommended that, top management of the parastatals studied should take keen interest in application of maintenance practices in their firms so as to improve from moderate to high.

This shall make operations performance also improve from moderate to high performance due to positive relationship between variations of maintenance practices and operations performance. They need to explore the best maintenance management practices which are likely to improve their operational performance and increase the level of application of those practices. The parastatals top management should also increase their level of support, especially on the human factor. Such measures to include training

of staff, and providing funds and time required to execute preventive and corrective maintenance.

5.5 Suggestions for Further Studies

The study sought to establish the maintenance management practices and the extent of use in service Parastatals in Kenya and to also establish the relationship between maintenance management practices and operations performance of service Parastatals in Kenya. However it was established that even though (preventive maintenance, productive maintenance, condition based maintenance and reliability-centered maintenance) influenced the operations performance the level of application was low. Research should be conducted to establish the challenges affecting application of maintenance management in service parastatals. Future research should also focus on how top management strategies affect application of maintenance management in firms. In addition comparative study on maintenance management application should be carried out between Service firm in the private sector and service parastatals.

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APPENDIX I: RESEARCH QUESTIONNAIRE

Section: A: Demographic Information

1. Indicate your period of service in this Parastatal

   Below 2 years ( ) 3 to 5 years ( )

   6 to 8 years ( ) 9 years and above ( )

2. Please indicate the highest level of education attained? (Tick as applicable)

   College Diploma [ ]

   Undergraduate [ ]

   Master [ ]

   Others (specify)

   ……...

3. Gender

   Male ( ) female ( )

SECTION B: Maintenance Management Practices

4. Indicate the extent to which each of the following statements relating to maintenance management practices applies to you. Key Use a scale of 1-5, where (1= strongly disagree, 2= disagree, 3= moderately agree, 4= Agree and 5= strongly Agree)

Preventive Maintenance	**1**	**2**	**3**	**4**	**5**
My Parastatal does equipment inspection regularly					
The organization conducts breakdowns prevention measures					
The organization system are inspected for failure reduction					
There are maintenance activities performed before equipment breaks down					
Preventive maintenance reduces breakdowns, increases asset availability					
Preventive maintenance maintain optimum efficiency					

of the equipment and reduces workload on maintenance staff					

5. Indicate the extent to which each of the following statements relating to productive maintenance applies to you. Key Use a scale of 1-5, where (1= strongly disagree, 2= disagree, 3= moderately agree, 4= Agree and 5= strongly Agree)

Productive Maintenance	**1**	**2**	**3**	**4**	**5**
The organization maintains and improves the integrity of production					
The quality systems are maintained through machines check ups					
The organization takes small scale repairs/ remedial actions by operations staff when the equipment is still in operation					
The Operators predicts occurrence of equipment failure and foster active involvement in maintenance in the organization					
It increases the productivity of the organization and equipment with a modest investment in maintenance					
Productive maintenance enhances the volume of the production, employee morale and job satisfaction					

6. Indicate the extent to which each of the following statements relating to condition based maintenance applies to you. Key Use a scale of 1-5, where (1= strongly disagree, 2= disagree, 3= moderately agree, 4= Agree and 5= strongly Agree)

Condition Based Maintenance	**1**	**2**	**3**	**4**	**5**
The technicians monitors the actual condition of the asset to decide what maintenance needs to be done					
Maintenance is only performed when certain indicators show signs of decreasing performance					

Machines in the organization are inspected through non-invasive measurements (e.g. Listening for abnormal sound etc.)					
Condition based maintenance increases the time between maintenance repairs, because maintenance is done on as-needed basis					
It is done when operating conditions deviate from the norm					
It detects and identifies specific components in an equipment that are degrading					

7. Indicate the extent to which each of the following statements relating to reliability-centered maintenance applies to you. Key Use a scale of 1-5, where (1= strongly disagree, 2= disagree, 3= moderately agree, 4= Agree and 5= strongly Agree)

Reliability-Centered Maintenance	**1**	**2**	**3**	**4**	**5**
The organization ensure that technological systems continue to do what their users require in their present operating context					
Reliability-centered maintenance establishes safe minimum levels of maintenance					
Allows detection of failures long before they occur in the organization					
The maintenance strategies are optimized so that the productivity of the organization is maintained					
Reliability centered maintenance implementation examines the facility as a series of functional systems					
Reliability-centered maintenance identifies the critical functions of the organization					

8. Indicate the extent to which each of the following statements relating to operations performance applies to you. Key Use a scale of 1-5, where (1= strongly disagree, 2= disagree, 3= moderately agree, 4= Agree and 5= strongly Agree)

Operations Performance	**1**	**2**	**3**	**4**	**5**
The organization ensures services are effective (producing expected results)					
The organization ensures customers are served efficiently (with minimum wasted effort)					
The productivity of the organization is maintained					
There is consistent monitoring of performance in the organization					
There is deliberate waste reduction in the organization equipment's					

9. Which maintenance management practices does your Parastatal use and to what extent in Percentage? …….....

……

……

10. What is the relationship between maintenance management practices and operations performance in your Parastatal?

……

……....

……

APPENDIX II: SERVICE PARASTATALS

S/no	Name of Parastatal	Location	Activity	Type of Machine/Technology
1	Kenya Wildlife Service	Country wide stations	Wildlife Conservation	Fleet of Motor vehicles
2	Kenya Forest Service	Country Wide stations	Forest Conservation	Fleet of Motor Vehicles
3	Kenya Ferry Services	Mombasa county	Ferry services	Fleet of ferries
4	Kenya Airways	Nairobi	Passenger Transport	Fleet of Airplanes
5	Kenya Railways	Nairobi	Goods Transport	Locomotives and wagons
6	Kenya Plant Health Inspectorate Services	Nairobi	Plants Health	Spraying equipment's
7	Egerton University	Njoro Nakuru	Teaching Services	Vehicles
8	Kenya Multi-Media University	Nairobi	Teaching Services	ICT Systems
9	Kenya Pipeline Company (KPC)	Nairobi	Fuel Transport	Fluid pumps and pipe networks
10	Kenya Power Company	Nairobi	Electricity transmission	Transformers and transmission lines
11	Athi Water Services Board	Nairobi	Water distribution	Water gates and pipe lines
12	Kenya Bureau of standards	Nairobi	Quality Checks	Measurement Equipment's
13	Kenya Broadcasting Corporation	Nairobi	Information Dissemination	Sound Transmitters
14	Kenya Red Cross Society	Nairobi	Humanitarian Services	Ambulances and Aeroplanes

15	National Housing Corporation	Nairobi	Housing technology	Architectural tools
16	Kenyatta National Services	Nairobi	Medical Services	Theatre Equipment's
17	Kenya Medical research Institute	Nairobi	Research	Research Equipment's
18	Kenya Nutritionists and dieticians Institute	Nairobi	Training and development	Information systems
19	Kenya Forestry research Institute	Nairobi	Research	Forestry equipment's
20	Energy regulatory	Nairobi	Pricing Regulation	Office Equipment's
21	Kenya Water Towers Agency	Nairobi	Water source protection	Fleet of vehicles
22	National Environmental management Authority	Nairobi	Environment regulations	Information systems, fleet of vehicles and tools
23	National oil Corporation of Kenya	Nairobi	Fuels distribution	Fuel Dispensers
24	National Cereals and produce Board	Nairobi	Grain storage and distribution	Storage management systems
25	Kenya Agriculture research Institute	Nairobi	Agriculture research	Farm Tractors
26	Kenya Animal Genetics resource Centre	Nairobi	Animal genetics research	Laboratory equipment's
27	Pyrethrum Regulatory Authority	Nakuru	Pyrethrum regulation	Information systems
28	Kenyatta International Convention Centre	Nairobi	Facility management	Information and air conditioning systems
29	Kenya Safari lodges and Hotels	Nairobi	Tourism	Information systems and fleet