



**STRATEGIES TO IMPROVE THE MAINTENANCE MANAGEMENT SYSTEM OF  
PUBLIC FACILITIES IN LIMPOPO, SOUTH AFRICA**

by

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## DECLARATION

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## **ABSTRACT**

Public facilities in Limpopo Province, South Africa, are poorly managed, often neglected in financial planning, or are subject to budget shortfalls. There are a number of dilapidated facilities in nearly all the public institutions (schools, hospitals, sports grounds, conference halls, etc.) of Limpopo Province. A common reason for such neglect is poor implementation of the maintenance management system (MMS). This study seeks to fill the knowledge gap by empirically identifying the causes and effects of poorly managed facilities and recommend strategies to improve MMS of public facilities. Literature relative to the research area was extensively reviewed. A qualitative research design was employed for this study and a case study approach was adopted. Three government institutions (Department of Public Works and two municipalities) within the region of Mopane District in Limpopo were selected as the cases for the research study. Exploratory design was adopted. Interviews were used to collect primary data for the study. A total of 30 participants were initially targeted. However, 25 participants were scheduled and interviewed. Data was analyzed in a form of thematic analysis.

The findings revealed that poor implementation of maintenance management system in public facilities leads to faster deterioration of facilities. Deteriorated facilities increase the cost burden, maintenance backlog and contribute to safety risks. It also became evident that the available maintenance systems were not being implemented. Lack of implementation was due to numerous challenges faced by facility managers such as lack of resources (manpower and equipment), inadequacy of funds, lack of expertise, lack of leadership, lack of staff training, poor policies that were not enforceable, lack of maintenance departments or poor maintenance structures, and lack of security systems. To achieve better conditions of public facilities, the study identified critical success factors to guide the development of strategies that can be implemented to improve the performance of maintenance management system: enforcing corruption law(s) to rule out unethical officials who happen to misuse maintenance funds; employing more skilled maintenance personnel; creating maintenance departments in each public facility; amending policies that will constitute guidelines for maintenance strategies or practices that are to form part of the maintenance management system of each facility; continuous

training and development of maintenance personnel to enhance their skills and awareness; consideration of a high security system in each facility to prevent theft and vandalism; improving the procurement systems; and increasing the budgets.

It is highly recommended that government adopt the proposed strategies developed in this study. With regard to further study, it is highly recommended to focus on other provinces or South Africa as a whole, as well as on the private sector. This will provide a broader perspective and extend knowledge not only limited to public institutions, but also to various fields including private institutions.

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## DEFINITION OF TERMS

<b>Terms</b>	<b>Definitions</b>	<b>Reference(s)</b>
<b>Accessible population</b>	Accessible population is the difference between the target population individuals who will or may not participate or who cannot be available at the study period.	(Bartlett et al., 2001:1)
<b>Asset register</b>	Asset register is a record of information on each asset that supports the effective financial and technical management of assets and meets statutory requirements.	(KZN Treasury, 2018)
<b>Case study</b>	A case study is an intensive, systematic investigation of either a single individual, group or community in which the researcher examines in-depth data relating to several variables.	(Baškarada, 2014:1)
<b>Condition assessment</b>	Condition assessment is an analysis of the condition of a facility or building in terms of age, design, construction methods, and materials with the intention of determining the state of defects, if any, and functionality.	(Karanja & Mayo, 2016:1)
<b>Convenience sampling</b>	Convenience sampling is defined as accidental or opportunity sampling.	(Alvi, 2016:29)
<b>Corrective maintenance</b>	Corrective maintenance is a maintenance activity which is required to correct a failure that has occurred or is in the process of occurring.	(Straub, 2012:188)
<b>In-house maintenance</b>	In-house maintenance involves conducting an activity or operation within company resources (labour and material), instead of relying on outsourcing.	(Amos & Gadzekpo, 2016:90)
<b>Maintenance</b>	It is defined as a combination of technical and administrative actions contributing to the performance and satisfactory operation of facility maintenance which may include everything such as routine cleaning, repairs and replacements.	(Basari et al., 2013:1260).
<b>Maintenance budget</b>	Maintenance budget is a cost projection based on the overall costs of labour, equipment, material and other related items required for executing maintenance work.	(Blessing et al., 2015:3)

<b>Maintenance management system</b>	Maintenance management system is defined as a combination of planning, executing, controlling and measuring the maintenance performance of facilities.	(Blessing et al., 2015:2)
<b>Maintenance policy</b>	Maintenance policy is a guiding principle for how the organization can achieve its vision and goals, while considering the values and methodologies of the organization.	(Fredriksson & Larsson, 2012:113)
<b>Maintenance priorities</b>	A system that helps maintenance managers to effectively utilize the maintenance budget and resources in accordance with maintenance needs of a particular component or equipment.	(Simeh, Mohamed & Hartmann, 2014)
<b>Maintenance scheduling</b>	Maintenance scheduling is the process in which all resources which are required for work are scheduled for execution within a specified time frame.	(Midas, 2015:3)
<b>Maintenance standard</b>	Standard accepted by the person paying or receiving for the work, or by external personnel with the responsibility for enforcing minimum standards.	(Cobbinah, 2010:9)
<b>Maintenance strategy</b>	Maintenance strategy is the management approach adopted in order to achieve the maintenance objectives.	(Fredriksson & Larsson, 2012:18)
<b>Outsourcing</b>	Outsourcing is procurement of external services from companies other than the procuring organization.	(Kurdi, Abdul-Tharim, Jaffar, Azli, Shuib &AbWahid, 2011:451)
<b>Political, Environmental, Social &amp; Technological (PEST)</b>	PEST is an analytical tool that helps facility managers to identify the key external and internal factors that should be taken into consideration when facing challenges in order to achieve success in a project or initiative.	(Koumparoulis, 2013:32)

<b>Planned maintenance</b>	Planned maintenance is a structured maintenance that is carried out with the use of schedule to a predetermined plan in order to keep facilities modern, safe and comfortable in the a long term.	(Oluwatoyin, 2014:420)
<b>Preventive maintenance</b>	Preventive maintenance is used to surmount the disadvantages of corrective maintenance, by mitigating the likelihood of its incidence, avoiding unexpected failure and achieving cost effectiveness.	(Mydin, 2015:61)
<b>Strategic maintenance management (SMM)</b>	Strategic maintenance management is an organizing process that involves both formulation and execution. It cannot be used the only operational effectiveness, nor as armchair theorizing and strategic planning; both are important aspects of strategy, and neither is a sufficient conception of strategic management without the other.	(Chen, 2010:1)
<b>Strategic maintenance planning</b>	Involvement of a review and analysis of the organization's facility portfolio, corporate and service delivery objectives and the facility maintenance environment.	(Choka, 2012:17)

## LIST OF ABBREVIATIONS

ALGE:	The Association of Local Government Engineering
ASGISA:	Accelerated and Shared Growth Initiative for South Africa
CIDB:	Construction Industry Development Board
CMMS:	Computerized Maintenance Management System
CPUT:	Cape Peninsula University of Technology
DPWI:	Department of Public Works & Infrastructure
DPW:	Department of Public Works
GT:	Grounded Theory
GIAMA:	Government Immovable Asset Management
GIAMLG:	Guidelines for Infrastructure Asset Management in Local Government
IMESA:	Institution of Municipal Engineering of Southern Africa
MMS:	Maintenance Management Systems
NAMS:	National Asset Management Steering
NCOP:	National Council of Provinces
NDPW:	National Department of Public Works
NGP:	New Growth Path
NIMS:	National Infrastructure Maintenance Strategy
NIAMM:	National Immovable Asset Maintenance Management Planning Guidelines
PEST	Political, Environmental, Social and Technological
RQs:	Research Questions
SA:	South Africa
SALGA:	South African Local Government Association
SOEs:	State-Owned Enterprises

SONA: State of the Nation Address

## **CHAPTER ONE**

### **INTRODUCTION**

#### **1. BACKGROUND**

South Africa's public sector has the largest portfolio of facilities in the southern hemisphere and is regulated by the Department of Public Works & Infrastructure (DPWI) (Department of Public Works and Infrastructure & Construction Industry Development Board, 2008:5). The three levels of government (i.e. national, provincial and local) and state-owned enterprises (SOEs) manage the main portfolios of immovable facility assets (Buys & Tonono, 2017:77). These portfolios contain approximately 243 000 facilities (93,000 buildings), valued at R120 billion and their operating costs increases by R4 billion per year (Department of Public Works and Infrastructure & Construction Industry Development Board, 2008:5).

According to Kalgo, Dankolo and Bello (2017:1), almost all public facilities are in very poor or terrible condition. Choka (2012:5) mentioned that the conditions and the maintenance backlog of public facilities demonstrate an inherent facility maintenance management problem within the public sector. Deferred maintenance of the order book is currently estimated to be around R13 billion (Bici, 2006:77; Construction Industry Development Board, 2016:4). The deterioration rate of facility components depends on the materials used, construction methods used, the environmental conditions, the use of the facilities and the overall facility management by stakeholders (Kalgo, et al., 2017:1).

It is crucial for maintenance to be implemented in order to ensure that facilities continue to serve their purpose, retain their functionality, retain their value and ensure that they are enjoyable and safe to occupy (Basari, Wahab & Hassan, 2013:1260). For this reason, maintenance work must be managed proactively, effectively and efficiently (Choka, 2012:5). In addition, if maintenance managers do not fully understand the various factors that might cause the facility to reach undesirable condition, they will not be able to achieve the commitment to achieve this goal (Mojela, 2013:6). Availability of resources and allocation of equipment, budget, personnel, facilities condition report and maintenance

strategy play a huge role in achieving the efficiency of public facility maintenance and improve conditions (Mojela, 2013:6).

Therefore, this indicates that there are various factors that contribute towards dilapidation of public facilities besides financial issues. There is ample literature about maintenance management systems of public facilities. Many have focused on particular sectors of government facilities e.g. schools, universities and hospitals, but this study will explore all sectors in order to identify and formulate/develop strategies of maintenance management systems that will be applicable to all sectors.

## **2. PROBLEM FORMULATION**

According to Cloete (2002:3), the lifespan of facilities depends on the level of maintenance they are subjected to. In general, maintenance includes the necessary processes and services performed to maintain, repair, protect and maintain the standards of the facility so that it can perform its expected functions throughout its life cycle without seriously affecting its function and use (Basari et al., 2013:1260). Additionally, maintenance enhance and ensures the usefulness, appearance, quality, and value of the facility and retained facilities at an acceptable level to the users (Noorliza, et al., 2014:12; Simpeh, Mohamed & Hartmann, 2014:843). Therefore, the necessity of effective maintenance of public facilities is very important. Preventive maintenance of public facilities is also very important, because failures in this area may result in substantial costs when replacing poorly maintained assets in the future (SALGA, 2013:5).

However, in most public facilities in South Africa, facility maintenance is considered an area that receives little attention, leading to its more rapid deterioration (Noorliza et al., 2014:12). The neglect of the maintenance is attributed to several factors. For example, Cloete (2002:3) believes that the maintenance of facilities in many government organizations is considered less important than the construction or acquisition of new facilities. This is indicative that the government puts more effort in procuring new facilities whilst the maintenance of existing facilities is neglected. The inadequacy of budget or funds provision, allocation and management are contributory factors to the poor status of public facilities maintenance (Lee & Scott, 2008:81; Adamu & Shakantu, 2016:5). Mavasa

(2007:76) revealed that grants related to maintenance of public facilities is accorded a low priority. Moreover, Smith (1995:77) explained that maintenance is a cost that facility or maintenance managers do not understand well. It turns out to be an orphan at the budget table (Adamu & Shakantu, 2016:5). There are instances where the budget provided for maintenance is reduced when organisations are faced with financial constraints (Buys, 2004:997; Simpeh, 2013). The consequences of ignoring facility maintenance are not obvious in the short term. Therefore, managers tend to short-sighted maintenance budgets (Adamu & Shakantu, 2016:1105). The Department of Public Works (2019) also mentions that a budget shortfall is sometimes caused by negligence where in some cases, maintenance of certain facilities is not included in the budget or underestimated. Insufficient or inappropriate maintenance budgets, if not increased significantly, will continue to lower service standards or the government will have to replace / upgrade facilities or equipment in the near future, resulting in excessively high costs (SALGA, 2013).

Poor planning, improper maintenance systems and lack of expertise are also other factors affecting government maintenance of facilities negatively (National Department of public Works, 2006:15). According to Kovacevic et al. (2016:194), maintenance errors occur due to inadequate implementation of maintenance systems or lack of expertise of maintenance personnel. With regard to lack of expertise, Gibson (2004:47) revealed that only 13 out of the 47 district municipalities (28%) and 42 out of the 231 local municipalities (18%) have members registered with the Institution of Municipal Engineering of Southern Africa (IMESA) which shows that many government sector managers do not have key management skills and experience. Corruption is also another factor. It reduces the effectiveness of public investment and infrastructure, including facilities, of a country, as allocation of maintenance monies is spent elsewhere or disappears without any trace (Rivas, 2013:18).

The need to improve the maintenance of government facilities is paramount. In fact, the cabinet has recognized the importance of the maintenance of internal government facilities and the role that effective maintenance will play in supporting South Africa's New Growth Path (NGP). President Ramaphosa stated during the 2019 State of the Nation



Address (SONA) that "expanding and maintaining infrastructure has the potential to create large-scale jobs, attract investment, and lay the foundation for sustainable economic expansion" (The Presidency, 2019). In his address, president Ramaphosa called on public sectors to make use of neglected facilities and ensure that they are rehabilitated and effectively maintained. He continued, "It is far cheaper to invest in infrastructure maintenance than to build new infrastructure, yet we continue to produce grand plans for new projects while so much of what we have is idle or in a state of disrepair" (The Presidency, 2019). The then Minister of Public Works, Nkosinathi Nhleko, addressed the National Council of Provinces (NCOP) and emphasized the need to improve the maintenance of public facilities and the need to reduce the maintenance backlog of 93 000 government facilities as a priority (Mahlangu, 2017).

An excellent strategic maintenance management system is needed to mitigate these challenges and thereby improve the maintenance of public facilities in South Africa. Rivas (2013:14) argues that a clearly defined strategy and maintenance management system is essential to keep all facilities in top condition, which will create an environment conducive to their construction purposes. Mavasa (2007:18) further indicated that the South African government has established an excellent maintenance management system and planning within the maintenance department for public facilities. In fact, the department of public works has developed several good documents (e.g. National Infrastructure Maintenance Strategy (NIMS), Government Immovable Asset Management (GIAMA) Act of 2007, National Immovable Asset Maintenance Management Planning Guidelines (NIAMM), Guidelines for Infrastructure Asset Management in Local Government (GIAMLG) 2006-2009, etc.) to provide guidelines for the maintenance strategies of public facilities. However, the majority of the challenges highlighted continue to persist which hamper the execution and implementation of the maintenance management system.

This study will therefore investigate the current maintenance management system adopted in public facilities and establish the challenges that hinder the effectiveness of implementation of the system. Success factors that can be used to improve the public facilities maintenance management system will be determined and become part of the improvement strategy recommended by this study.

### **3. PROBLEM STATEMENT**

Although the South African government through the Department of Public Works has developed maintenance management systems (MMS) for managing public facilities. Several challenges still persist in the implementation of the MMS. Many researchers have tried to provide solutions to the problem. However, most established concepts predicts the extent of failure in implementation of MMS and the cause and effect of deteriorated facilities. But scant attention has been given to the critical challenges that continue to persist affecting the implementation of MMS in the public sector. The surge of dilapidated public facilities justifies the need for this study to identify the gap affecting the implementation of MMS with the aid to recommend a more effective strategy for maintenance management system of public facilities in Limpopo Province, South Africa.

### **4. AIM AND OBJECTIVES**

The following are the aim and objectives of this study.

#### **4.1 Aim**

The aim of the study is to develop strategies that can assist to improve maintenance management systems of public facilities and consequently improve their current state or condition.

#### **4.2 Objectives**

The specific objectives include the following:

**Obj1:** To evaluate the current maintenance management systems adopted for public facilities.

**Obj2:** To determine the challenges faced when implementing and executing the maintenance management system of public facilities.

**Obj3:** To establish the critical success factors in the maintenance management process that can contribute to effective maintenance management system of public facility.

**Obj4:** To recommend appropriate strategies that can assist to improve the current maintenance system of public facilities.

## **5. RESEARCH QUESTIONS**

**Rq1:** What is the state of the current maintenance management systems adopted for public facilities?

**Rq2:** What are the challenges faced when implementing and executing maintenance management systems in public facilities?

**Rq3:** What are the critical success factors in the maintenance management process that can contribute to effective maintenance of public facility?

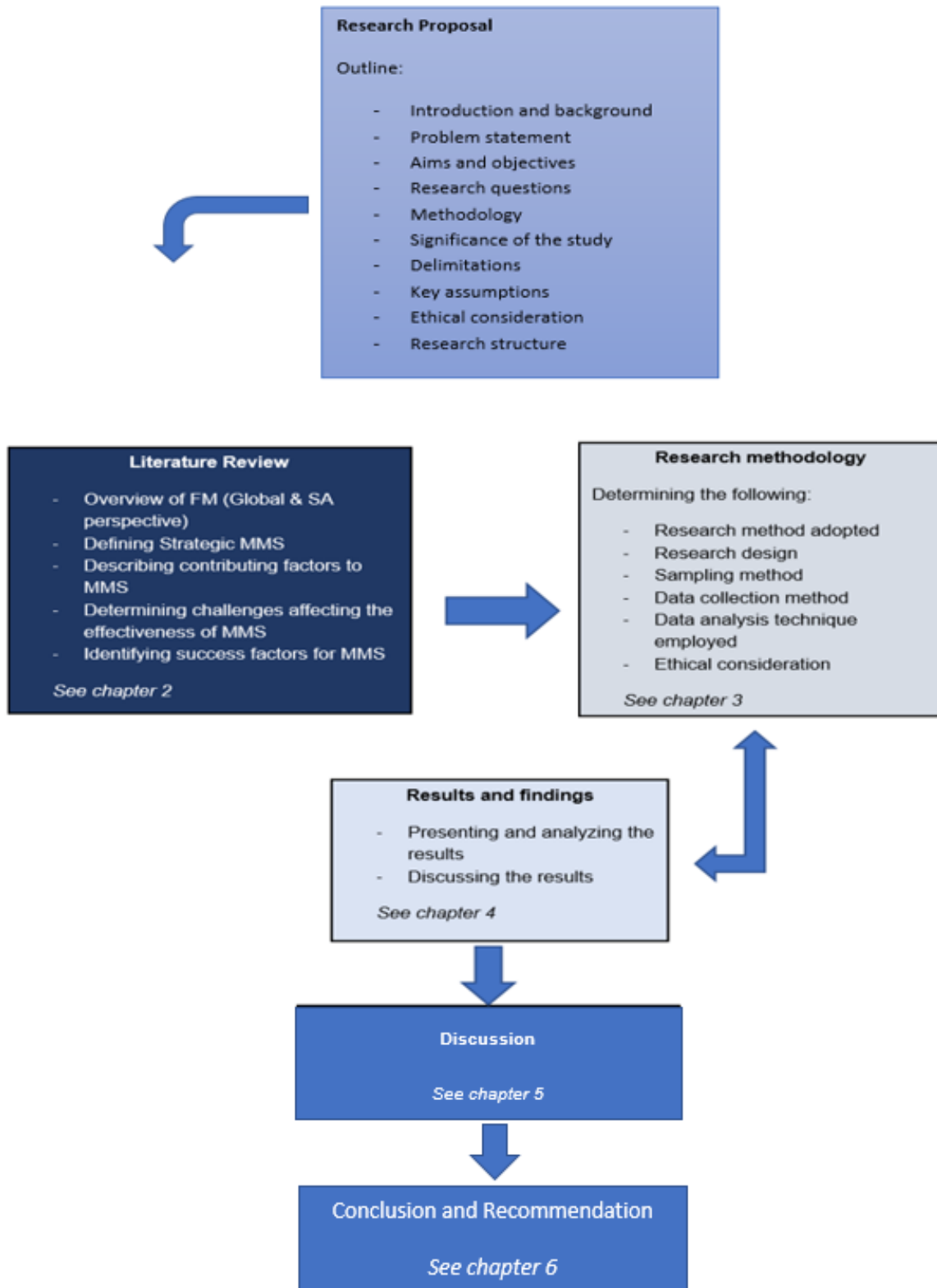
**Rq4:** What strategies can be adopted to improve the current maintenance system of public facilities?

## **6. METHODOLOGY FOR THE STUDY**

This study used qualitative research methods. This method is used to answer research questions and achieve the research objectives. The study began with a large body of literature to outline the research in its entirety. A pilot interview was conducted to test, refine, and restructure the interview guide. Semi-structured interviews were used as a data collection tool. Interviews were conducted individually with the selected participants, who were drawn from:

- Senior management level
- Middle management level
- Junior management level

For this study, non-probability purposive sampling method was employed for targeted population selection. Thematic analysis was used to analyze qualitative data collected through interviews. The validity and reliability of the instruments were tested to ensure that the data was sound and replicable, and the results were accurate. The overall research study process adopted to achieve the objectives of the study is shown in Figure 1 below.



**Figure 1:** Research study process

## **7. SIGNIFICANCE OF THE STUDY**

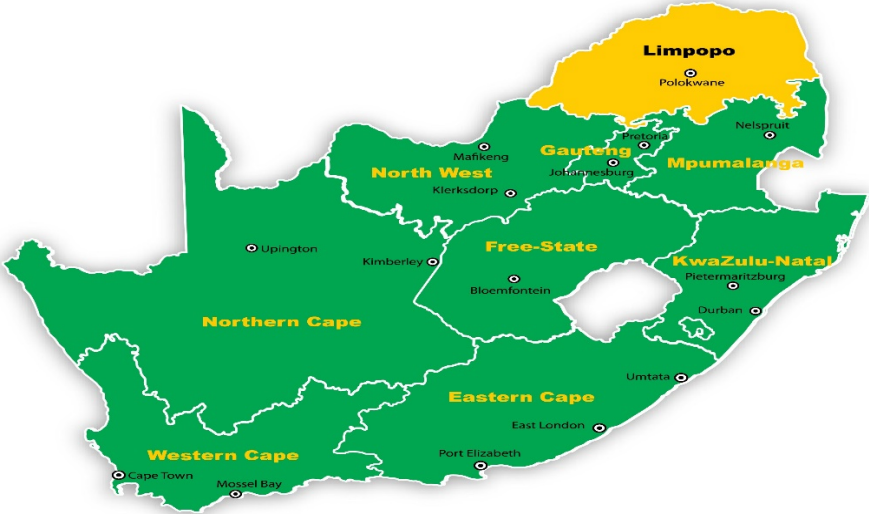
This study it is expected to help the government spheres (local, national and provincial) with strategies to improve maintenance management systems of public facilities in Limpopo Province, South Africa. The study identified challenges affecting the implementation and execution of the maintenance management system for public facilities and also identified success factors that can be adopted to improve conditions of facilities. In the past, some researchers have tried to provide solutions to the problem of improving the maintenance management system. However, most have established concepts and theories to predict the extent of deterioration of facilities. Abuzant (2011:3) established a model to procure maintenance services for local municipalities at better cost to aid improve maintenance management system. Other studies also report on the significance of facilities maintenance management systems of institutions, such as universities and health facilities. However, scant attention has been given to the critical challenges that continue to persist and affect the implementation of maintenance management systems in the public sector. The increase of dilapidated public facilities justifies the need to develop a more effective strategy for a maintenance management system. Therefore, the developed strategies of the maintenance management system in this study could be adopted by the maintenance or facilities department of any government institution within its spheres (local, provincial & national) to improve the conditions of public facilities. The study can also contribute to the academic sphere for student use and as part of literature in the built environment discipline.

This research will also help establish a knowledge system in the field of facilities management and maintenance management. It will also serve as a reference for academics and researchers, and the research will help them discover key areas in the educational process that many researchers are unable to explore.

## **8. DELIMITATIONS**

The study aimed at developing strategies of maintenance management system in public facilities. To achieve this, the study was confined within the region of Limpopo Province of South Africa. The study was further limited to only one local (municipality) and two provincial (public works) government institutions within the province. The limitations to

local and provincial sphere of the region, was because of difficulty in securing permissions for data collection in other governmental spheres of different provinces, as well as time constraints, accessibility, and lack of funds. The data collection was done telephonically, thus limiting the possibility of group interviews or focus group discussion. This limitation was due to the Covid-19 pandemic, with the restrictions on travelling and face-to-face or physical contact to curb the spread of Covid-19. The research was further limited to participants who were only involved in facility maintenance within the public sector. Figure 2 below shows the location of the area where the research was conducted.



**Figure 2:** Limpopo Province of South Africa

**9. KEY ASSUMPTIONS**

This study assumes the following:

- It is assumed that local (municipalities) and provincial (public works) government have maintenance departments.
- It is assumed that local and provincial governments have challenges with their maintenance management systems.

- It is assumed that maintenance professionals will allow time for consultation for interviews and will provide relevant information through interviews to justify the study objectives and research questions.

## **10. ETHICAL CONSIDERATIONS**

The individuals from government institutional departments were assured 100% anonymity. The identity of participants was kept confidential although recorded on the research instruments. In compliance with accepted national and international ethical standards, there was no compensation paid to any participants for contributing to the study. The study and its process did not endanger the society, environment, or the research participants. Quality was assured with respect to following:

1. Quality of data
2. Accuracy in calculations
3. Correctness and completeness of questionnaire
4. General conduct and completeness of interviewers

## **11. RESEARCH STRUCTURE**

This study is structured as follows:

### **Chapter one: Introduction**

The first chapter comprises background of the study, problem formulation, the aim and objectives, the research questions, methodology, significance, delimitations, key assumptions and ethical considerations.

### **Chapter two: Literature review**

This chapter reviews work conducted by different researchers in publications such as textbooks, articles, journals, newspapers, reports and dissertations related to this study.

### **Chapter three: Methodology**

This chapter elaborates the methodology adopted in this study. It further discusses the research design, data collection instruments, sample and population size, and how the data has been analyzed.

#### **Chapter four: Findings and interpretation**

This chapter presents the study findings, and analyzes and interprets the data collected. The results were analyzed in a thematic process, and both qualitative and quantitative methods were employed to interpret the data.

#### **Chapter five: Discussion**

This chapter presents discussion of research findings.

#### **Chapter six: Conclusions and recommendations**

This chapter concludes the study and offers recommendations based on the findings and analysis.

### **12. CHAPTER SUMMARY**

The first chapter of the study provided the background of the study, discussed the problem formulation, developed the aim and objectives of the study, the research questions, and described the methodology adopted for the study. The significance of the study, delimitation and ethical considerations were also provided in this chapter. The next chapter discusses the literature. Where it'll discuss the overview of facility maintenance and its importance, strategies of maintenance management system, implementation challenges and solutions.



## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2. INTRODUCTION**

This chapter provides the theoretical basis/background and identifies the variables that are critical to the research. The literature covers the importance of general facility maintenance; an effective maintenance management system; and challenges of implementing maintenance management systems in the public sector, both internally and externally. It also details factors that can be applied to overcome the challenges of implementation. Literature related to this study previous authors is reviewed and referenced.

The primary sources of literature review for this study were previous research papers, case studies, conference papers, published dissertations, peer-reviewed journals, published and unpublished articles on general maintenance, facility maintenance and maintenance management systems.

#### **2.1 OVERVIEW OF FACILITY MAINTENANCE**

Generally, maintenance has different meanings to different people. Many authors have defined and redefined the term. However, a different definition indicates that maintenance is the upkeep of assets (Lateef, Khamidi & Idrus, 2010:76). According to Straub (2012:187), maintenance means offsetting lost performance within the acceptable performance loss range. Whether this loss is "acceptable" depends on the criteria set by the owner and/or user (Astrub, 2012:187). On the other hand, Olanrewaju et al. (2010:137) understand maintenance as the process performed to protect, repair, protect and maintain buildings or plant / equipment components so that they can perform their intended functions. In this study, maintenance is defined as the process and necessary services performed to maintain, protect and maintain facilities so that they can perform their expected functions throughout their life cycle and continue to provide a favourable environment for users.

Broadly, facilities can be generally classified into buildings, grounds and service systems (Xaba, 2012:217). According to Omar et al. (2016:1), facility maintenance is an integration of multidisciplinary activities that manage the impact on people and the environment. It includes all activities and services associated with maintaining the operation of facilities (Omar, et al., 2016:1). For facilities maintenance to be carried out effectively, it is important that the maintenance organization, which refers to the creation an organizational structure for facilities maintenance, should consist of clearly defined roles and responsibilities for management (Xaba, 2012:217). Generally, there are three generic management levels or organizational structures of personnel required in a facility maintenance unit, namely senior management, middle management and junior management, which usually consists of technicians and artisans (Ogbeifun, 2011:19). Figure 3 illustrates the organizational management level.



**Figure 3:** Management levels

**Source:** Abuzant (2011:9)

Generally, senior managers do not necessarily need to have technical skills, but modern management skills are essential because their main function is to coordinate and integrate the activities carried out by a multidisciplinary network (Ogbeifun, 2011:19). According to Wuni, Yeboah and Bofo (2018:3), poor maintenance of public facilities cannot be said to be a natural problem; it is undoubtedly caused by a variety of factors. Where these factors

exit in an organization setup, negligent attitudes on the part of management have been blamed (Wuni et al., 2018:3). According to Nawi, Salleh and Anuar (2014:43), the main consequences of poorly maintained public facilities are accidents and user injuries. Improperly maintained or neglected facilities may cause nuisance and cause accidents and personal injury (Nawi et al., 2014:43).

## **2.2 IMPORTANCE OF FACILITY MAINTENANCE**

The value of facility maintenance cannot be underestimated. Maintenance begins the day the builder leaves the site or the day it is handed over. Design, materials, technology, functions, use and their interrelationships determine the amount of maintenance required for a facility throughout its life cycle (Olagunju, 2012:1245). According to Abdul, Arazi and Kamidi (2010:131), proper maintenance of facilities helps to minimize deterioration, defects, degradation and failure, ensuring optimum performance during their life cycle and providing value for the user's commitment and enhancing positive perception in the community. In addition, Ali (2013:16-17) found that effective facility maintenance has the following benefits:

- Functional requirements for facilities are always achieved
- It provides conducive environment for residents/users
- It improves the quality of building components to meet current requirements
- It extends the life of facilities
- It maintains the physical characteristics of the facilities in conjunction with services, and reduces the likelihood of premature failure
- It maximizes economic and financial returns from facility use
- Ensures the safety of the users and residents

Maintenance can also provide employment opportunities as some of the maintenance work requires specialists or professionals to carry out the maintenance or repair work, thus having a positive impact on the economy (Kportufe & Sena, 2015:11). Other reasons for ensuring the effectiveness of facility maintenance as perceived by various authors are shown below in Table 1.

**Table 1:** Importance of facility maintenance

Reason	Reason description	Reference
<b>Maintenance of asset/facility</b>	The use of a maintenance management system helps to maintain a building's physical look while also extending its longevity. It also reduces the pace of depreciation by preventing the loss of original fabric and economic worth.	Abdullah et al. (2015:363)
<b>Keeping repair costs down</b>	The establishment of an effective maintenance management system may be able to reduce the need for, and the scope of, major building facility repairs. For example, a modest but regular task like cleaning gutters and drains can be far less expensive and time consuming than dealing with a significant outbreak of dry rot in timber roof trusses after years of neglect.	Zuraidi (2012: 83)
<b>Promoting the use of convenience and security</b>	Maintenance is capable of ensuring that the building facility is in a usable state for the parties/users involved.	Abdullah et al. (2015:363)

According to Jortberg and Lemer (2010:9), the neglect of facility maintenance has consequences such as maintenance backlogs which is generally due to shortage of funds or management failure to recognize the need for it. The neglect can lead to rapid increases in deterioration of the elements and finishes of the facilities (Jortberg & Lemer, 2010:9). Table 2 below shows potential consequences of the neglect of facility maintenance.

**Table 2:** Consequences of poor facility maintenance

Potential consequences of poor facility maintenance	Example of the consequences
<b>Threats to health and safety</b>	<ul style="list-style-type: none"> <li>• Deterioration of health</li> <li>• Safety failure</li> <li>• Structural failure</li> </ul>
<b>Services failure</b>	<ul style="list-style-type: none"> <li>• Loss of service power</li> <li>• Failure of heating, ventilation, and air-conditioning</li> </ul>
<b>Excessive cost</b>	<ul style="list-style-type: none"> <li>• Cost of energy</li> <li>• Domino effect – minor failures leading to major failures</li> <li>• Cost of replacement vs cost of repairs</li> <li>• Production losses</li> <li>• Assets losses (facility content)</li> </ul>
<b>Cost to society</b>	<ul style="list-style-type: none"> <li>• Inability to recruit and retain workers</li> <li>• Lack of morale</li> <li>• Neglected image</li> <li>• Lack of preparedness</li> </ul>

**Source:** Jortberg and Lemer (2010:9)

Thus, facilities will suffer damage in a short amount of time if regular and systematic maintenance is not performed (Abdullah et al., 2015:363). Maintenance should be prioritised since facilities are too valuable assets to be ignored (Ofori et al., 2015:185).

### **2.3 MAINTENANCE MANAGEMENT SYSTEMS**

To put up a good maintenance management system, a lot of technical labour and competent individuals are required (Blessing et al., 2015:2). It entails planning, implementing, regulating, and evaluating the facility's maintenance performance (Blessing et al., 2015:2). Choka (2012:24) noted that having an effective maintenance management system is essential to ensure that maintenance costs are kept low and that maintenance personnel can perform maintenance effectively. Conversely, Abdullah et al. (2015:365)

believe that lack of effective and continuous maintenance management system will lead to faster facility deterioration. According to Bothma and Cloete (2000:17), the following are some of the immediate advantages of a properly established maintenance management system:

- Strategic maintenance plan;
- System allocating limited resources based on priority;
- Formalized maintenance plan and schedule;
- Accurate zero-based budget;
- Actual maintenance expenses;
- Facility records;
- Current condition records of facilities.

Furthermore, according to Bothma and Cloete (2000:17), a correctly integrated maintenance management system will provide the following long-term benefits:

- A shift from unscheduled maintenance to planned maintenance;
- Long-term maintenance cost savings;
- Lower life cycle cost;
- Increased facility availability and safety;
- Shorter downtime and backlog.

As part of the maintenance management system, there are various technical factors to consider such as policy to provide guideline, approach to executing maintenance, planning and budget allocation for maintenance works (Abdullah et al., 2015:365). A maintenance management system should comprise the following:

- Maintenance policy;
- Maintenance prioritization;
- Performance or condition standards;
- Maintenance condition assessment;
- Budgeting;
- Asset inventory/register;
- Maintenance strategies;

- Maintaining activity scheduling and planning within the planned program to make the most efficient use of resources;
- Maintenance execution.

### 2.3.1 Maintenance policy

The first and most important aspect to consider when developing a maintenance management system is maintenance policies. A policy is a set of guidelines for allocating resources and taking actions in between different sorts of maintenance tasks. Fredriksson and Larsson (2012:113) define maintenance policy as a guiding principle for how an organization can achieve its vision and goals, while considering its values and methodologies. According to Lee and Scott (2009:271), the following are the three fundamental aspects of establishing a maintenance policy:

- Choosing a maintenance plan;
- Identifying a maintenance standard;
- Allocation of resources for maintenance.

The organization must agree to formulate a maintenance policy to ensure that it is valuable to the company and feasible for the management team (Lee & Scott, 2009:273). Therefore, a maintenance policy must be formulated early in the planning process so that the maintenance personnel can plan the maintenance method correctly (Peng, 2013:22). Figure 4 depicts the major components and their sequences for establishing maintenance policy. Once the policy is developed, maintenance prioritization can then be established.



**Figure 4:** The significant components and sequences in formulating maintenance policy

**Source:** Lee and Scott (2009:279)

### 2.3.2 Maintenance prioritization

Setting maintenance priorities helps to effectively utilize the maintenance budget (Simpheh et al., 2014:884). According to Wing, Mohammed and Abdullah (2016:1), it is common for facility or maintenance managers to have difficulty determining maintenance priorities. Facilities or maintenance managers are facing increasing pressure and need to prioritize limited resources to complete required maintenance work and capital renewal requirements (Wing et. al., 2016:1). Unscheduled facility maintenance, system unavailability, and higher expenses to repair or replace damaged components owing to short or emergency notice procurement are all repercussions of poor maintenance resource and/or capital prioritizing (Lavy, 2014:1183). Effective prioritization requires one to understand an organization’s business and take cognizance of multiple factors (Moore & Starr, 2016:598). Health and safety, security, legal requirements, increased operating costs, loss of revenue, vandalism, business interruption, contract issues, possible failure of critical building structures, policy decisions, environmental impact, community awareness, and heritage issues are all examples of such factors (Department of Public Works, 2018: 23). Table 3 sets out an example of how maintenance personnel determined the priority of maintenance need (Department of Public Works, 2018: 23).

**Table 3:** Priority ranking system

Priority ranking	Definition
1	<p>Works needed to:</p> <ul style="list-style-type: none"> <li>• meet maintenance related statutory obligation and due diligence requirements</li> <li>• ensure the health and safety of building occupants and users</li> <li>• prevent serious disruption of building activities and/or may incur higher costs if not addressed within 1 year.</li> </ul>
2	<p>Works that:</p> <ul style="list-style-type: none"> <li>• affect the operational capacity of the building</li> <li>• are likely to lead to serious deterioration and therefore higher future repair costs if not addressed between 1 to 2 years.</li> </ul>
3	<p>Works that:</p> <ul style="list-style-type: none"> <li>• have minimal effect on the operational capacity of the building but are desirable to maintain the quality of the workplace</li> <li>• are likely to require rectification within 3 years.</li> </ul>
4	<p>Works that:</p> <ul style="list-style-type: none"> <li>• can be safely and economically deferred beyond 3 years and reassessed at a future date.</li> </ul>

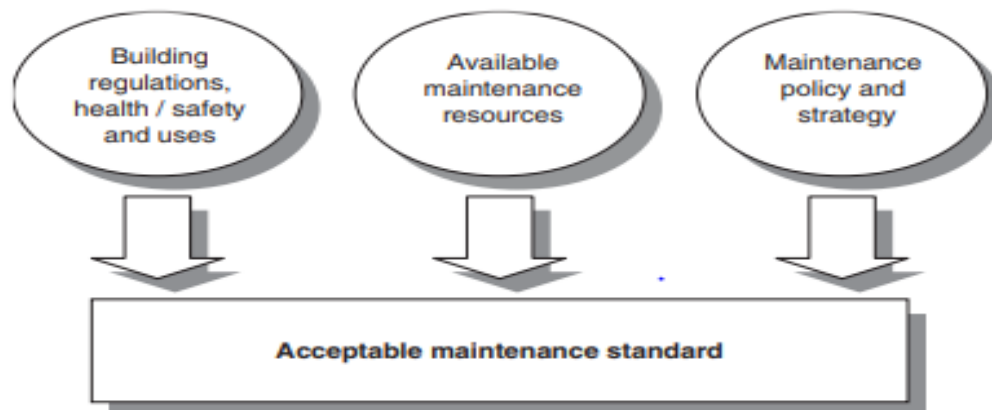
**Source:** DPW (2018:23)



### 2.3.3 Maintenance condition standards

According to Oluwayin (2014:40), maintenance work is usually associated with cost, therefore defining an acceptable maintenance standard can be difficult. However, maintenance standards might be acceptable to the person who pays for the labour or the person who receives the benefit, or to some outside authority in charge of enforcing minimal standards (Cobbinah, 2010:9).

Different approaches to interpreting the acceptable standard were found by Lee and Scott (2008:273), who stressed the importance of defining maintenance standards since it affects planning and management. Building or facility laws, health and safety, and the availability of maintenance resources such as plans and policies all influence the accepted norm (Lee & Scott, 2008:273). Figure 5 summarizes the key influences on acceptable maintenance standards.



**Figure 5:** Key influences on acceptable maintenance standards

**Source:** Lee and Scott (2008:272)

Choka (2012:27) mentioned the following as the benefits of utilizing condition standards:

- Ensuring that facilities are not under- or over-maintained;
- Ensuring effective use of maintenance budgets;
- Providing maintenance service providers with guidance on the expectations and levels of maintenance required for each facility; and,
- Allowing comparison of the real state of the facilities.

Table 4 depicts an example of a maintenance standard.

**Table 4:** South African Department of Public Works rating/grading standard system

Functional Purpose	Specified Standard	Rating
Highly sensitive purpose with critical results (e.g. hospital operating theatre) or high profile public building (e.g. Parliament House).	Building to be in the best possible condition. Only minimal deterioration will be allowed.	S5
Good public presentation and a high quality working environment are necessary (e.g. modern multi-storey CBD building).	Building to be in good condition operationally and aesthetically, benchmarked against industry standards for that class of asset.	S4
Functionally-focused building (e.g. laboratory).	Building to be in reasonable condition, fully meeting operational requirements.	S3
Ancillary functions only with no critical operational role (e.g. storage) or building has a limited life.	Building to meet minimum operational requirements only.	S2
Building is no longer operational - it is dormant, pending disposal, demolition, etc.	Building can be allowed to deteriorate, however, must be marginally maintained to meet minimum statutory requirements.	S1

**Source:** DPW (2018:20)

#### 2.3.4 Maintenance condition assessment

After determining the condition standards, condition assessment can then take place. According to Karanja and Mayo (2016:1), the most significant aspect in the maintenance management system is condition assessment, which serves as the foundation for planning and managing facility maintenance. The goal of a condition assessment is to work out how much preventative maintenance is required for facility upkeep (Wahida et al., 2012:777). As physical and operational surroundings have an impact on facilities, the condition or state of the facilities evolves throughout time (Karanja & Mayo, 2016:1). Thus, accurate and consistent condition assessment is required for carrying out maintenance works before they impact on the performance of the facility negatively (Choka, 2012:26). In addition, the type and scope of maintenance work required to restore a facility component to its target condition (standard) should be considered as part of the condition assessment process (Choka, 2012:32). Condition assessment technically assesses the physical condition of a facility and its components (Abbott et al., 2007:656). According to Choka

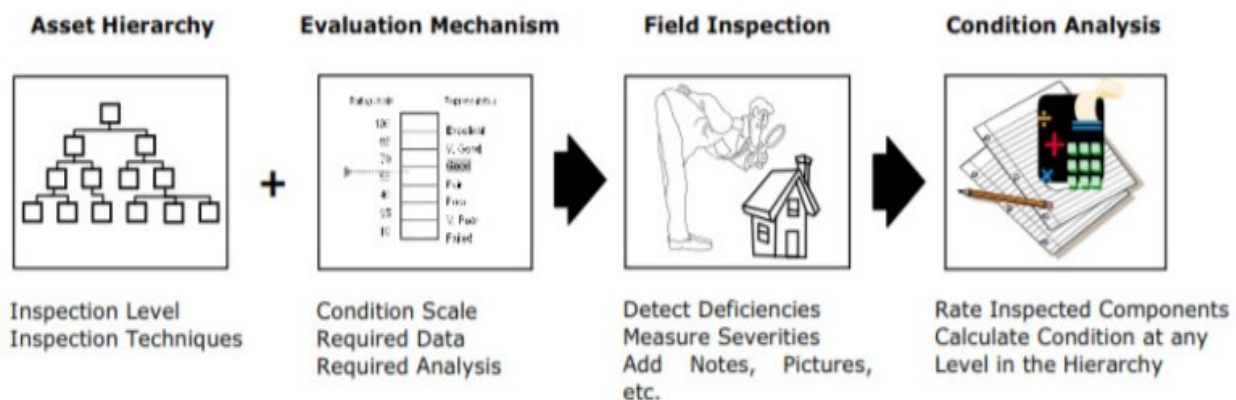
(2012:32) and Queensland Department of Housing and Public Works (2017:3), condition assessment generally comprises of:

- Physical inspection of the facility to determine its current condition and individual items or services related to established condition standards (for example, air conditioning, fire protection, etc.);
- Determining the maintenance required to restore the operation of the facility and its services;
- Prioritizing maintenance tasks in order of importance; and,
- The assessor determining how to mitigate any direct risks until repair work or other activities are performed to resolve the problem.

Premature facility failures, shorter useable facility lifespan, and greater repair and replacement costs could all result from a lack of competent condition assessment, affecting service delivery capacity and quality (Queensland Department of Housing and Public Works, 2017:3). A discussion of the condition assessment process follows below.

### 2.3.4.1 Condition assessment processes

According to Wahida et al. (2012:778), condition assessment requires some useful processes to assist in decision making. Figure 6 depicts the four key technical processes of the condition assessment, each of which is explained further.



**Figure 6:** The process of condition assessment

**Source:** Linggar, Aminullah and Triwiyono (2019:3)

### **Step 1: Asset Hierarchy**

The first step in the condition assessment process is to determine the asset hierarchy. Its objective is to classify the facility's components which further assist in determining the inspection level and technique (Wahida et al., 2012:778). For example, a facility can be divided into different clusters e.g. electrical, mechanical, plumbing, etc. These clusters can be further divided into more detailed component levels such as interior doors/exterior, doors, ceilings, windows, etc. (Karanja, 2017:24).

### **Step 2: Evaluation mechanism**

The second step of the process is evaluation mechanism. The scale is determined, the required data collection and analysis mechanism is determined (Wahida et al., 2012:778). In other words, the inspector develops a condition scale, and determines how to collect and analyze the data (Linggar et al., 2019:3).

### **Step 3: Field inspection**

The third step of the process is field inspection. The goal of this step is to find defects in the facility's components and structure, as well as the severity of such defects (Wahida et al., 2012:778).

### **Step 4: Condition analysis**

The last step is condition analysis. This is where the condition of the examined item will be graded and computed based on the inspection level and asset hierarchy (Wahida et al., 2012:778). Different types of rating system are used by different ae organization.

#### **2.3.4.2 Condition assessment rating system**

The Department of Public Works in South Africa has created and published a five-point colour coding scale system through experience and research development (Abbott et al., 2007:651). A five-point scale is mostly used by many authors due to reliability and accuracy of results compared to a three-point scale or more than five-point scale, as either makes it more difficult to interpret results (Abbott et al., 2007:651). Below are examples of rating scales.

**Table 5:** Five-point condition rating scale

CONDITION RATING	CONDITION	ACTION REQ'D	DESCRIPTION
5	Very Good	Planned Preventative Maintenance	The component or building is either new or has recently been maintained, does not exhibit any signs of deterioration
4	Good	Condition-based Maintenance	The component or building exhibits superficial wear and tear, minor defects, minor signs of deterioration to surface finishes and requires maintenance/servicing. It can be reinstated with routine scheduled or unscheduled maintenance/servicing.
3	Fair	Repairs	Significant sections or component require repair, usually by a specialist. The component or building has been subjected to abnormal use or abuse, and its poor state of repair is beginning to affect surrounding elements. Backlog maintenance work exists.
2	Bad	Rehabilitation	Substantial sections or component have deteriorated badly, suffered structural damage or require renovations. There is a serious risk of imminent failure. The state of repair has a substantial impact on surrounding elements or creates a potential health or safety risk.
1	Very Bad	Replacement	The component or building has failed, is not operational or deteriorated to the extent that does not justify repairs, but should rather be replaced. The condition of the element actively contributes to the degradation of surrounding elements or creates a safety, health or life risk.

**Source:** Abbott et al. (2007:652)

**Table 6:** International rating/grading standard system

Simple Condition Rating Model	
Rank	Description of Condition
1	<b>Very Good Condition</b> Only normal maintenance required
2	<b>Minor Defects Only</b> Minor maintenance required (5%)
3	<b>Maintenance Required to Return to Accepted Level of Service</b> Significant maintenance required (10-20%)
4	<b>Requires Renewal</b> Significant renewal/upgrade required (20-40%)
5	<b>Asset Unserviceable</b> Over 50% of asset requires replacement

**Source:** The Association of Local Government Engineering (ALGE) and the National Asset Management Steering (NAMS) Group (2016:1).

### **2.3.5 Maintenance budget**

According to Blessing et al., (2015:3), a maintenance budget is based on the estimated cost of labor, equipment, materials, and other project expenses necessary to complete maintenance tasks. The National Infrastructure Maintenance Strategy (Construction Industry Development Board, 2016:4) defines a maintenance budget as an estimate of the annual minimum maintenance budget in relation to the present day replacement cost of the facilities in order to provide a fair basis for continued service delivery. Factors such as the organization's policies, facility management strategies, current conditions and age profiles, operational requirements and overdue maintenance will determine how maintenance funds are allocated (Blessing et al., 2015:3). The estimates should be examined by the applicable public sectors responsible for oversight (e.g. Department of Public Works, Education, Health etc.) in order to ensure that they are in the right order of magnitude. In other words, the maintenance personnel will be responsible to monitor and continuously update the actual expenditure on labour rates, material and service costs against the budget for the year (Blessing et al., 2015:3). While keeping this in mind, the maintenance cycle for each facility is not constant year to year and will necessitate the addition of the following components to the budget (Construction Industry Development Board, 2016:4):

- Annual maintenance;
- Emergency/breakdown maintenance, such as a burst water pipe caused by main pipe blockage; and,
- Periodic/preventive refurbishment - for example painting of an external building walls in order to retain the building and prevails its image for the next 3-5 years or more.

Table 7 shows an example of how budget is allocated based on percentage adjustment of maintenance work; the highlighted section shows the interest of this study.



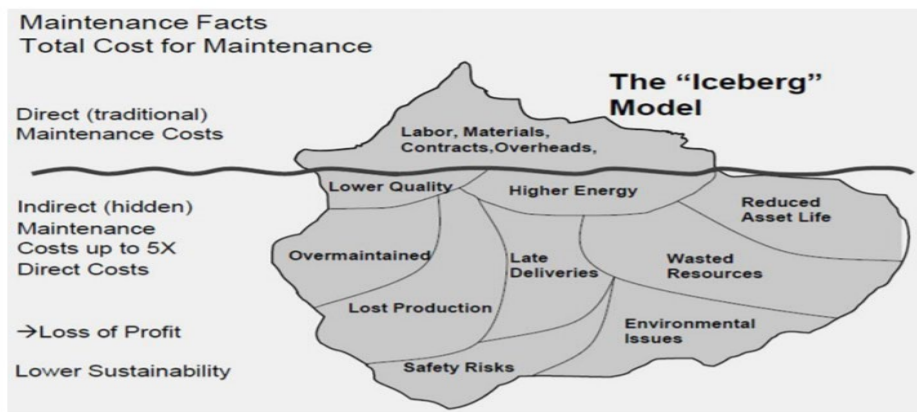
**Table 7: Maintenance budget allocation for maintenance work**

Type of infrastructure	Average Annual Maintenance Budget as % of Replacement Cost	Key Assumptions	Replacement or Major Rehabilitation over and above the Annual Maintenance Budget requiring specific capital budget
Bulk water storage	4-8%	Mostly for periodic repair of electrical and mechanical works, storm damage repair, routine maintenance and periodic maintenance	every 30 to 50 years
Water treatment works	4-8%	Mostly for electrical and mechanical equipment	every 20 to 30 years
Water reservoirs	2-3%	Generally low maintenance mostly of telemetry and electrical equipment, storm damage repair, pipe work repair, safety and security, routine maintenance and periodic maintenance	every 20 to 30 years
Water reticulation	4-8%	Mostly for telemetry and pumping equipment, emergency leak repair and ongoing leak repair due to degradation, storm damage repair	every 20 to 30 years
Sewage treatment works	4-8%	Mostly for electrical and mechanical equipment, storm damage and periodic maintenance.	every 20 to 30 years
Sewer reticulation	4-8%	Mostly for pumping equipment, emergency leak repair and ongoing leak repair due to degradation, blockage removal, storm damage repair,	every 20 to 30 years
Roads and storm water	5-10%	Mostly for emergency repair, storm damage repair, and periodic maintenance (resurfacing every 7 to 10 years).	every 20 to 30 years
Electricity reticulation	10-15%	Mostly for emergency repair, storm damage repair, safety and security, routine maintenance and periodic maintenance.	every 20 to 30 years
Public buildings	4-6%	Mostly for emergency repair, storm damage repair, and periodic maintenance (e.g. repainting and cosmetic upgrades every 5 to 10 years).	every 30 to 50 years
Hospitals	5-8%	Mostly for emergency repair, storm damage repair, and periodic maintenance (e.g. repainting every 3 to 5 years, and cosmetic and operational upgrades every 7 to 10 years).	every 20 to 30 years
Schools	4-6%	Mostly for emergency repair, storm damage repair, and periodic maintenance (e.g. repainting every 5 to 7 years, ).	every 30 to 50 years
Electricity generation	5-8%	Mostly for electrical and mechanical equipment and dependent on age and technology of works	every 30 to 50 years
Electricity reticulation	10-15%	Mostly for emergency repair, storm damage repair, safety and security, routine maintenance and periodic maintenance (e.g. every 7 to 10 years).	every 20 to 30 years

**Source:** Construction Industry Development Board (2016:3)

According to Oluwafemi and Ibrahim (2014:1187), the "Iceberg Model" is viewed as a hidden cost that has a significant impact on an organization's upkeep, much exceeding direct expenditure connected with traditional maintenance. Direct cost of maintenance are costs related to labour, materials, contracts and overheads (Wienker et al., 2016:414). Other costs associated with maintenance are indirect cost, which are the consequential cost resulting from failure of execution such as delays in material deliveries, lost production, wastage of materials, environmental issues and many others (Wienker et al., 2016:414). These costs can be five times higher than the direct cost which many

organizations often underestimate or do not cater for. Figure 7 shows an iceberg of maintenance costs.



**Figure 7:** Maintenance facts on total cost for maintenance

**Source:** Wienker et al., (2016:414)

### 2.3.6 Asset register

According to KZN Treasury (2018), the asset registry is a registry of information about each asset, which promotes good financial and technical asset management and meets regulatory requirements. All assets or facilities possessed by an organization must be registered and recorded in the organization's assets inventory or register in order for it to manage its facilities efficiently (Oluwafemi & Ibrahim, 2014:1187). The asset inventory contains information such as the names of facilities, serial numbers of assets or facilities, the location of the asset or facility, its functioning condition, depreciation value, maintenance status, and inventory number, among other things (Oluwafemi & Ibrahim, 2014:1187). The KZN Treasury (2018) mentions the following as the challenges faced by the public sector in appropriately implementing asset registers:

- Lack of historical asset information, such as as-built data, which is a core condition of every infrastructure contract;
- Lack of awareness of the network's scope and presence;
- Inadequate record-keeping and personnel turnover;
- Lack of budget allocations makes it difficult to stick to a regular repair program, if one exists.



### **2.3.7 Maintenance strategies**

Maintenance strategies are divided into two groups by Mydin (2015:60): scheduled and unexpected maintenance. He describes planned maintenance as work that may be scheduled and completed (for example, daily housekeeping) and unplanned maintenance as work done on an emergency basis (i.e. when lift is having problems, burst pipe etc.) (Mydin, 2015:60). According to Oluwatoyin (2014: 420), planned maintenance is a large-scale maintenance constructed and executed according to a predetermined plan. Unlike routine maintenance, it keeps the facility up-to-date, safe and comfortable for a long time. Rastegari and Salonen (2015:1) note that planned maintenance can be divided into two categories: corrective and preventative maintenance. The application of these categories depends on the maintenance objectives of the facility, the nature of the facility or equipment to be maintained, and the working environment (Rastegari & Salonen, 2015:1). These categories are discussed below.

#### **2.3.7.1 Corrective maintenance**

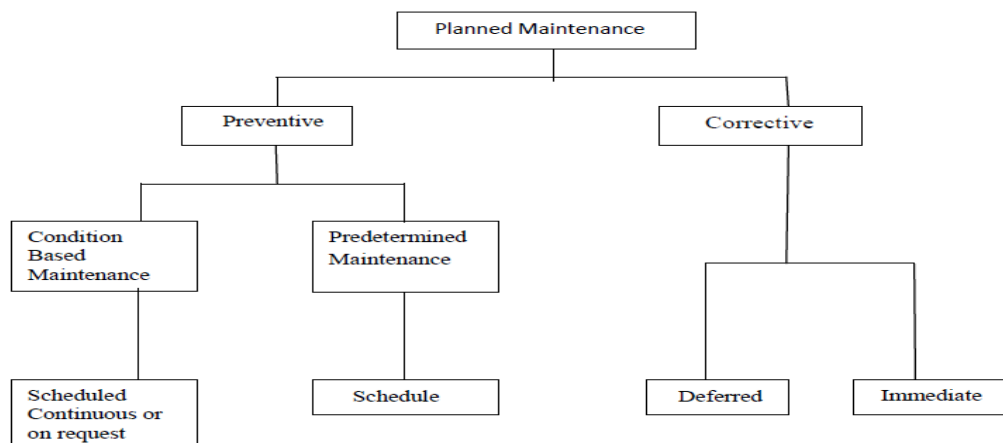
Astraub (2012: 188) defines corrective maintenance as "any maintenance activity necessary to correct a failure that has occurred or is occurring". Mydin (2015:60) describe corrective maintenance as a type of maintenance performed after a breakdown. Whilst corrective maintenance is one of the simplest approaches, its application could be very costly (Mydin, 2015:60). It is simple because it is able to cover all actions of elements which have failed or broken down and require repairs. It is, however, costly since the breakdown or failure of a single component might result in considerable damage to other parts of the facility (i.e. failure of the roof might cause harm to the ceiling and the interior part of the building) (Mydin, 2015:60). According to Mital et al. (2015:217), actions to take when employing a corrective maintenance technique when a system or element has failed and has to be restored are as follows:

- Once a fault is found, the fault must be confirmed. If the failure is not confirmed, the equipment will generally be restored. This distinctive discovery dilemma wastes a lot of time and costs a lot of money. They also need to keep excessively large inventories. If the failure is confirmed, prepare the project for maintenance and generate a failure report.

- Locate and isolate the failing component.
- The failed part will be removed and either discarded or repaired. If a part is discarded, it should be replaced with a new one.
- After repair, the item can be reassembled, realigned, and adjusted. It must be thoroughly examined before being reintroduced into service.

### 2.3.7.2 Preventative maintenance

Preventive maintenance aims to overcome the deficiencies of corrective maintenance by reducing the possibility of failures, avoiding unexpected failures and achieving profitability (Mydin, 2015:61). Preventive maintenance is performed at predetermined intervals (based on time or usage), with the goal of reducing the chance that the project will not reach an acceptable state. The main benefits of preventative maintenance are that costs can be lowered by avoiding significant damage; also, the amount of time a component of a facility is out of service can be minimized, and the user's health and safety can be enhanced (Mydin, 2015:61). The downside to this method is that planned maintenance tasks are often difficult to complete in terms of spare parts and labor costs (Mydin, 2015:61). Both preventative and corrective maintenance can be considered as scheduled maintenance, according to Astraub (2012:188) (see Figure 8). Table 8 shows the summary between the two approaches (preventive and corrective). Figure 9 also shows the relationship of corrective and preventative maintenance.



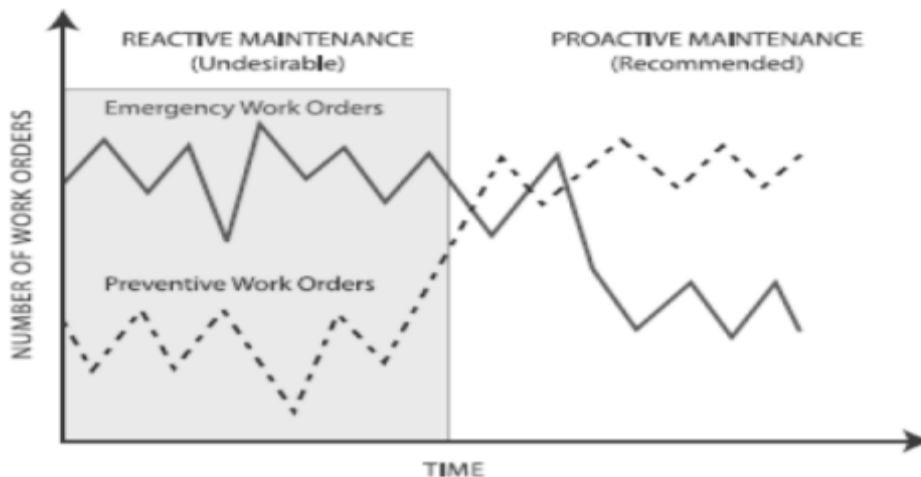
**Figure 8:** Classification of preventative and corrective as planned maintenance

**Source:** Yates and Ge (2010:399)

**Table 8:** Comparison between corrective and preventive maintenance approaches

Corrective Maintenance	Preventive Maintenance
It reduces holistic failure.	It has fewer risk factors.
It lowers the need for regular repairs that are based on capacity consumption.	It extends the lifespan of facility life.
It can avoid probable damage caused by on-the-spot refurbishment.	It follows a schedule.
	It prevents or causes fewer disruptions.

**Source:** Zulkarnain et al. (2011:196)



**Figure 9:** Relationship between corrective (reactive) and preventive (proactive) maintenance

**Source:** Mydin (2015:63)

Figure 9 and the literature mentioned above suggest that preventative maintenance is the most recommended approach. However, it is crucial for maintenance or facility departments to select an appropriate approach for facility or equipment based on its needs of efficiency and functionality.

### **2.3.8 Maintenance planning and scheduling**

Maintenance priority, inspections, life cycle costs, facility requirements, health hazards, fire protection, and life safety are all variables that go into maintenance planning and scheduling (Babor & Plian, 2008:37). Both can be difficult since the processes may need maintenance staff to determine and schedule repair work while taking into account the needs of many parties and the work limits imposed (Al-Sodani & Alajeeli, 2017:1806). The two factors are discussed below.

#### **2.3.8.1 Maintenance planning**

The process of determining the decisions and future actions required to achieve specific goals and objectives in the most effective and effective way is called a maintenance plan (Al-Turki, 2010:237). The goal of maintenance planning is to cut costs, eliminate risks, and improve the organization's competitiveness (Al-Turki, 2010:237). According to Al-Turki (2010:237) and Babor and Plian (2008:37), maintenance planning is an organized process that determines the following:

- The immediate term - daily and weekly plans
- Medium term - plans that range from a month to a year
- Long term - plans that stretch throughout a number of years

According to Lind and Muyingo (2012: 16), opportunity maintenance is a new type of maintenance strategy. Through the interaction of cutting-edge technology, globalization, and economic changes, opportunistic maintenance means that by using predictive time methods to evaluate performance under uncertain conditions and predict the expected weather in the future, equipment or components can be repaired in the most cost-effective manner (Lind & Muyingo, 2012: 16).

#### **2.3.8.2 Maintenance schedule**

The process of arranging the tasks outlined in the maintenance plan into a time frame is known as scheduling (Al-Turki, 2010:238). It considers the intended goals, interrelationships between the many scheduled tasks, resource availability throughout time, and any other internal and external limitations and constraints (Al-Turki, 2010:238). According to Hameed, Ahn and Cho (2010:880), maintenance actions conducted at

regular intervals are intended to lessen the likelihood of component failures and breakdowns. Scheduled maintenance, on the other hand, is viewed as ineffectual because component replacement will be carried out regardless of the condition (Hameed et al., 2010:880). According to Gökçe et al. (2010:17), these 5 generic steps can be followed when scheduling maintenance work:

- **Step 1:** Create a list of equipment or components of facilities that need to be maintained.
- **Step 2:** This list will form the basis from which a maintenance plan can be defined.
- **Step 3:** Set up a data structures to store and retrieve information. Once data is collected, an interface must be created within this step to allow the maintenance scheduling to extract relevant views of the facility performance and other facility maintenance resources critical for scheduling.
- **Step 4:** With the aid of process patterns, the scheduler can produce an insight into how different activities are interrelated and produce a more effective maintenance solution.
- **Step 5:** The final section presents an example of how an initial development supports a more complete maintenance management system.

Additionally, maintenance activities can be scheduled in different categories to allow easy performance and analysis of work (Gökçe et al., 2010:17). The categories are as follows:

- **Weekly schedule** - made to provide a week's worth of work for each employee in an area.
- **Daily schedule** - developed to provide a day's work for each maintenance employee in the area.
- **Gantt charts** - used to represent the timings of tasks required to complete a project.
- **Bar charts** - used for technical analysis which represents the relative magnitude of the values.

### **2.3.9 Maintenance execution**

According to Ogbeifun (2011:26), maintenance execution is determined by the volume of work as well as the convenience and benefits of various sourcing techniques. There are two common methods of maintenance execution, namely in-house and outsourcing. The two common methods are discussed below.

#### **2.3.9.1 Outsourcing**

Kurdia et al. (2011:451) define outsourcing as "contracting services from sources outside the organization." According to Tayauova (2012: 189), outsourcing consists of two words: "out" and "sourcing", where sourcing refers to the "process of transferring work, responsibilities and decision-making power to others". Tayauova (2012:189) further points out that companies must outsource work because other people can do the work cheaper, faster and better. It is critical to ensure that the organization's mission, long-term goals, and objectives are met when outsourcing (Kurdia et al., 2011:451). Kurdia et al. (2011:451) mention that there are two options that can be taken to decide whether to outsource or not, namely:

- The organization determines whether to keep or outsource all of its services.
- The organization outsources some services while keeping others in-house (especially if the FM function is part of the overall strategic management process).

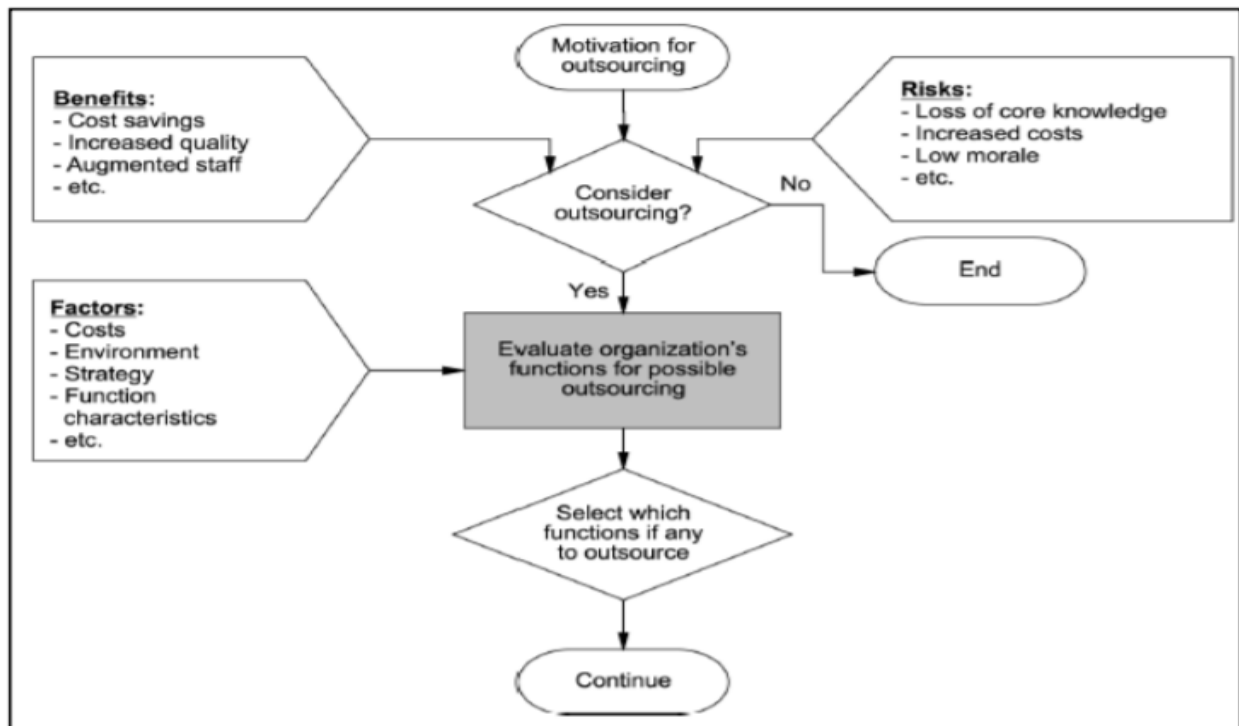
Al-Hammad et al. (2010:98) the advantages and disadvantages of choosing outsourcing methods as maintenance execution methods, namely:

- Reduces overall operational cost
- Gains skills and knowledge
- Addresses the problem of a shortage of skilled staff
- Assists organizations to focus on their main activities
- Shares risk
- Improves services quality

Disadvantages of outsourcing are:

- **Monitoring costs:** Organizations may incur costs to ensure outsourced functions are delivered at the required level of quality and on time;
- **Reduced motivation:** if outsourcing involves the transfer of people to contractors, the organization cannot motivate them;
- **Loss of control:** Once the management function is transferred to the contractor, the flexibility of control will be limited for the organization;
- **Loss of internal skills / professional knowledge:** Internal employees may lose their experience due to transfer of functional management to contractors; and,
- **Security risk / confidentiality threat:** Introducing contractors into the organization means that others might access confidential information, increasing risk.

Figure 10 depicts the elements that impact outsourcing decisions, as well as the motivators, rewards, dangers, and circumstances that are frequently encountered in such decisions.



**Figure 10:** Elements that influence the decision of outsourcing

**Source:** Kurdia et al. (2011:451)

### **2.3.9.2 In-house**

According to Amos and Gadzekpo (2016:90), in-house maintenance involves the use of traditional experts to provide and manage facility services. The in-house experts must plan and monitor, supervise, manage quality measures and maintain control of any activities that have been developed for the organization to keep the functions of the organization's facilities running smoothly and maintain the relevant level of expertise in the management team (Amos & Gadzekpo, 2016:90). Choosing in-house maintenance as the execution method has its own advantages and disadvantages. According to Ahamed, Perera and Illankoon (2013:301), the benefits of using an in-house team for maintenance work is:

- In-house employees own their work and often outperform outsourcing;
- The results of financial analysis in the long-term usually support in-house execution as more cost-effective than outsourcing;
- It offers organizations the opportunity to grow employees instead of outsourcing expertise; and,
- In-house maintenance has also increased customer and employee satisfaction.

Whilst disadvantages are:

- Unclear scope will cause problems in service management where the cost of supervision is high; and,
- Without an accurate description of roles and responsibilities, it is difficult to measure the performance of maintenance personnel.

The choice of maintenance execution depends on the organization. Some organizations prefer the in-house method while others prefer outsourcing, yet others use the combination of both since in-house and outsourcing have unique qualities and abilities to achieve the best value for money and purpose of maintenance work (Ahamed et al., 2013:302).



## 2.4 UTILIZATION OF A COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM (CMMS)

According to Weinker, Henderson and Volkerts (2016:416), proactive facility maintenance management is impossible without a support of computer-based software system such as a computerized maintenance management system (CMMS), although the success rate of CMMS implementation is surprisingly low (Weinker et al., 2016:416). This follows the major misunderstanding that the role of CMMS is itself a maintenance strategy, not as a support tool for the organization's existing maintenance management system or strategy (Weinker et al., 2016:416). The two most important features for implementation of CMMS are to ease the adaption of maintenance processes and user-friendliness (Campbell, 2016:79). According to Rendra (2015:138), the purpose of having CCMS is to:

- Determine the maintenance tasks to be performed, list each work and the steps to complete it;
- Describe the content of each work or step;
- **Plan works:** Specify the required time, extent of labour, and provide specific objective information instead of subjective information for each task;
- **Schedule work:** Ensure that all supporting assets are available and set a fixed date or time; and,
- **Support the actual performance:** Monitors the execution of work, generates reports, reacts and speeds the work up to ensure its timeous completion.

According to Simon and Poor (2014:238), good CMMS software should provide an organization with the following:

- Organization of all maintenance information in a clear database.
- Comfortable calendar scheduling preventive maintenance with possibility of manual intervention and accessories.
- Print work orders and their easy conversion into finished maintenance events and alarms.
- Complete overview of carried work upkeep (ISO audit), repairs and costs.

- Capacity utilization statistics and other publications for improving the management and maintenance planning.
- Ability to operate in local or network version. Installation is simple and does not necessarily require implementation assistance.
- Access is protected by a password, and each user's access authority is defined by the administrator. The access rights are extended to a single server.
- Interconnect the status of spare parts in the ERP system with specific programming functions and add the data to your specifications

A summary of a good CMMS is shown in a Figure 11 below.



**Figure 11:** A summary of a good or effective CMMS

**Source:** Simon and Poor (2014:238)

According to Wienker et al. (2016:415), the number of successful CMMS deployments is only around 25-40%, and only 6-15% use CMMS to it full capacity. Wienker et al. (2016:415) give the following as the reasons for poor implementation of CMMS:

- Trying to implement new maintenance management strategies and related processes and tools, such as CMMS, for organizations that are not yet ready;

- Believing that CMMS is a strategy rather than a tools to promote the effective implementation of the maintenance management process (MMP);
- Insufficient IT infrastructure; and,
- Insufficient resources for implementation.

Laurila (2017:14) mentions that the selection of wrong CMMS software, poor implementation and poorly articulated goals often lead to poor facility maintenance. The consequence of a poor CMMS is that people who want to use the system are interrupted or slowed down in their daily work and quickly stop using the tool (Laurila, 2017:14). Other consequences mentioned by Rendra (2015:141) for poor implementation or selection of CMMS are:

- Increased time spent due to missing components and incomplete information;
- Increase overtime and reduce productivity;
- Overuse or underuse of maintenance personnel; and
- Unnecessary parts replacement due to improper preventive maintenance.

Therefore, it is important to choose the correct CMMS and use it effectively to maintain optimal performance, achieve a higher level of planned maintenance activities, and thus make more effective use of personal resources (Simon & Poor, 2014:236). Though, CMMS does not perform maintenance, it provides good information for the facility/operation manager to adequately and efficiently run the facility services.

### **CHALLENGES OF IMPLEMENTING AN EFFECTIVE MAINTENANCE MANAGEMENT SYSTEM (GLOBAL PERSPECTIVE)**

According to Rahman et al. (2012:2), public facilities dilapidate due to poor implementation of maintenance management system. Authors from different countries have identified several related and unrelated factors which hinder the implementation of maintenance. Alshehri et al. (2015) conducted a study titled “The common problems facing the building maintenance departments” in Saudi Arabia and enumerated challenges faced within public maintenance departments. Ofori, Duodu and Bonney (2015:187) also highlighted several challenges in their study conducted in Ghana titled “Establishing factors

influencing building maintenance practices: Ghanaian perspective”. Other studies conducted by Choka (2012) in Kenya, Ali et al. (2016) in Malaysia, Simpeh (2018) in Ghana, Olanrewaju, et al. (2015) in Nigeria and Kamarazaly, Mbachu and Phipps (2013) in the UK also revealed a number of challenges. The several challenges highlighted by these authors are discussed below in Table 9:

**Table 9:** Global maintenance management system challenges

Country	Type of challenges	Concerns	References
Ghana	1. Failure to implement preventive maintenance	Ofori et al. (2015:187) states that the government of Ghana has neglected preventive maintenance of facilities, such as checking the efficiency of rain gutters and repairing mechanical and electrical installations, leading to more extensive regular maintenance. And thus increase chances of long term major repairs or repairs are required but may have been avoided or delayed.	Ofori,et al. (2015:187)
	2. Users lack of maintenance knowledge	Ofori, et al. (2015:187) states that the misuse of facility by users has led to high maintenance costs and often the Ghanaian government neglects maintenance as they cannot keep up with the cost.	
	3. Non-use facility	The non-use or non-occupation of facilities after completion makes the Ghanaian government not to give enough attention to the maintenance work (Ofori et al., 2015:187). This leads to rapid deterioration. If inactive components and items are not maintained, they may require urgent maintenance, which will cost more and require more Manpower/experts.	
	4. Unfamiliarity with local conditions and site conditions	Lack of consideration of biological factors that can harm the building or facility at the design stage can and lead to continuous maintenance (Ofori et al., 2015:187). Therefore, the designer must be familiar with construction site conditions, such as soil conditions. Ignoring changes in soil conditions can lead to settlement, which can lead to cracking of structural elements.	
	1. Lack of adequate personnel	Kimathi (2017:57-61) stated that, understaffing is one of the key challenges and the main cause of severe staff shortage, especially in public hospitals, including: high turnover rate of medical staff, lack of adequate structure to determine the needs of medical staff and place them accordingly.	Kimathi (2017:57-61)
	2. High corruption rates	The lack of effective monitoring systems becomes a huge challenge and in the process departments loses	

Kenya	<ol style="list-style-type: none"> <li>3. Lack of adequate funds</li> <li>4. Lack of effective monitoring systems</li> <li>5. Poor working conditions and delayed salaries</li> </ol>	<p>huge amount of money budgtd for maintenance of facilities.</p> <p>Kimathi (2017:57-61) indicated that, the issue with this factor is that it often results in workers resigning or strike or strike threats.</p>	
Nigeria	<ol style="list-style-type: none"> <li>1. Irregular flow of fund</li> <li>2. Exploitation largely around control of resources</li> <li>3. Lack of accountability for resources in the hospital creating crisis</li> <li>4. Incompetence due to poor recruitment practices</li> <li>5. Inadequate tools for measuring output</li> </ol>	<p>According to Kimathi (2017:57-61) the irregular flow of funds may lead to hospitals relying on other sources of funding to operate health facilities. There are also often delays in the payment or not receiving payments at all which becomes a huge challenge in the up keeping of maintenance works.</p> <p>This challenge often exist when appointments of management/administrative positions are made, they are based on entry-level qualifications and specialty, regardless of experience and further training, the best candidate may not be favored (Ahmed &amp; Gidado, 2010:1176).</p> <p>Most government hospitals do not have tools to measure employee output (Ilozor, 2013:398).</p>	Kimathi (2017:57-61)
	<ol style="list-style-type: none"> <li>1. Lack of expertise/knowledge</li> <li>2. Lack of funds</li> <li>3. Unclear job description and department structure</li> </ol>	<p>According to Alshehri, et al. (2015: 235), Saudi Arabian government sector's representatives/employees lack or have poor knowledge in terms of educational background and experience of maintenance. This often result in wrong or poor implementation of strategies and poor budgets allocations (i.e. underestimates).</p> <p>Allocation of funds is one of the most challenges faced by Saudi Arabic governmental facility managers. As maintenance work is often considered as a secondary obligation and therefore, not enough funds are allocated (Alshehri, et al., 2015: 235).</p> <p>The study of Alshehri, et al. (2015: 235), they have noted that maintenance departments in Saudi Arabia did not have a structured approach to improve the maintenance management process and that the</p>	

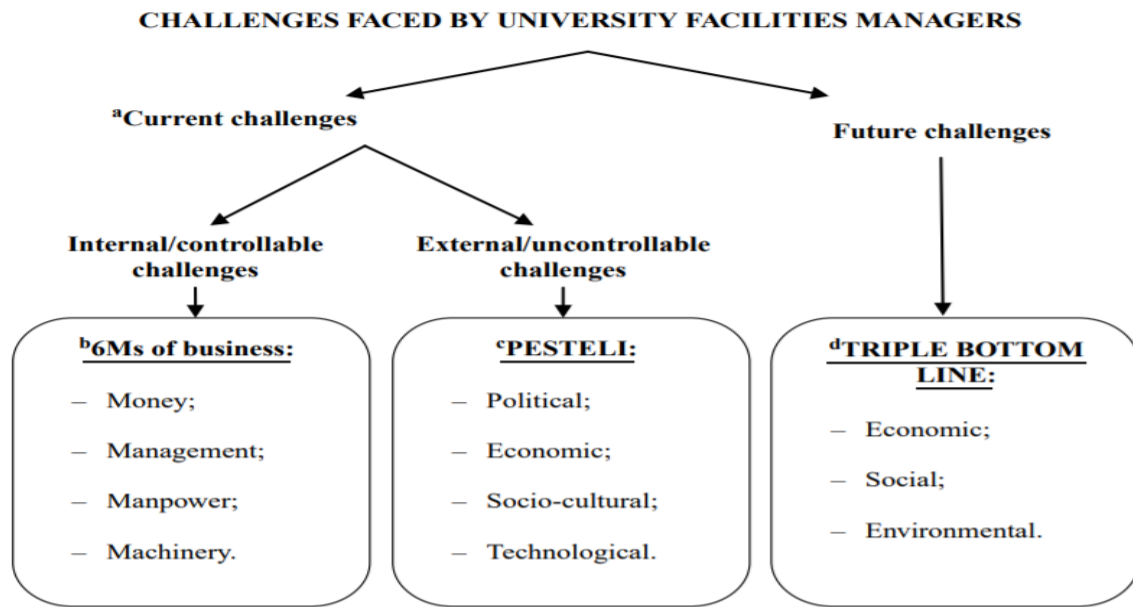
<p>Saudi Arabia</p>	<p>4. Shortage of material</p>	<p>structure of the government department was unclear. Where this has resulted in poor implementation of maintenance works as roles aren't clear on to whom are they assigned to.</p>	<p>Alshehri, et al. (2015: 235)</p>
	<p>5. Lack of maintenance software tool</p>	<p>The absence of suitable material in the local markets of Saudi Arabia often complicate the process of maintenance works (Alshehri, et al., 2015: 235). This may lead to maintenance works and operation of a facility stopping completely or delaying repair works and increase the cost of material.</p>	
	<p>6. Lack of awareness</p>	<p>Alshehri, et al. (2015: 235) suggests that the maintenance department needs an effective software system to help facility managers determine how to allocate and use budgets throughout the life cycle of the system. However, they mentioned that in Saudi Arabia there is no renewing or upgrading for the old system available which affects them in tracking required maintenance works and thus a challenge and manual system is implemented which is time-consuming.</p>	
	<p>7. Lack of supervision</p>	<p>Lack of awareness on importance of facility maintenance has resulted in poor planning and budget of maintenance works (Alshehri, et al., 2015: 235). And thus, what they have found in Saudi Arabia as a challenge as government employees usually do not maintain their facilities periodically and also leave their equipment to a stage of emergency when it breaks down which will cost them much more than if they had use planned maintenance.</p>	
	<p>8. Poor management</p>	<p>In the study of Alshehri, et al., 2015: 235) they found that most government sectors in Saudi Arabia do not have efficient maintenance staff including supervisors. They mentioned that their supervisors also lack technical skills and they rely on receiving maintenance reports from the contractor to sign it only. For instance, in an actual activity where maintenance work is being carried out, lack of or poor supervision can lead to an avoidable injury to maintenance personnel and not only that but poor workmanship too.</p>	
	<p></p>	<p>Management is an effective role of leadership in order to achieve high standard of work and in the absence of such, it often leads to: time-consuming/delay, wrong execution of maintenance work and increases cost, and therefore, leads to failure in maintenance works. Failure in execution of maintenance works leads to having to replace the contractor and such processes within the government is lengthy (it will need months to have a contract in place) and thus more time loss with a high chance of never being recontracted (Alshehri, et al., 2015: 235). Therefore, a great management team is thus crucial for success of the maintenance management system.</p>	
	<p></p>	<p></p>	

	<p>9. Government legislations</p>	<p>According to Alshehri, et al. (2015: 235), the policy of the Saudi Arabian government tends to award the contract to the highest bidder, as long as the value of the new contract does not exceed the value of the previous contract. However, this implies that they do not take fluctuations of prices as facilities require more maintenance when it gets older (Alshehri, et al., 2015: 235). These become a challenge as some of the maintenance works are neglected when prices of maintenance fluctuate.</p>	
<p>Malaysia</p>	<p>1. Development of new technologies</p> <p>2. Stakeholder communication</p> <p>3. Lack of participation from the whole organization due to lack of understanding the importance of facility maintenance</p> <p>4. Lack of technical knowledge and expertise</p> <p>5. The lack of proper facility maintenance guidelines and requirements i.e. policy</p>	<p>Ali, et al. (2016:13) cited Baek (2007:317) and indicated that the rapid growth of modern technologies has led to complexity of the product required to better quality and higher reliability of facility maintenance. Thus, the Malaysian government does not adopt new technologies and relies on old methods that are still not effective.</p> <p>In every maintenance work, communication is crucial as good communication will ensure the department's goal, objectives and plans are carried out as intended. Unfortunately, this does not happen in the Malaysian government and thus provides enough reason why facilities are dilapidated (Ali et al., 2016:13; Baek, 2007: 317)</p>	<p>Ali, et al. (2016:13) cited Baek (2007:317)</p>

UK	1. Resource allocation		
	2. Inadequate funding		
	3. Emergency management and business continuity planning		Kamaraza Ly, et al. (2013:138)
	4. Statutory compliance		
	5. Keeping up with rapid changes in technology		
	6. Sustainability and environmental stewardship		
	7. Maintenance and manpower		

The above Table 9 stipulated the challenges faced by other countries which reflects similarities. This continues to show that these challenges it's indeed a common problem that need to be addressed in order to improve the maintenance management system. Similarly, the study of Kamarazaly, et al. (2013:138), who studied challenges faced by facility managers in the Australasian university, had also indicated similar settings. However, they identified challenges in terms of controllable and uncontrollable categories. Controllable challenges include managerial issues, while uncontrollable challenges are related to PEST (political, environmental, social and technological) issues. According to Kamarazaly, et al. (2013:138), the rapid change of technology creates pressure on maintenance team and the lack of continuous training of upgraded technologies leads to maintenance personnel only being comfortable with traditional methods. From an economic perspective, challenges such as inadequate funding, high legislative compliance costs and constraints and the ceiling or limitation on capital expenditures were identified as some of the uncontrollable challenges (Kamarazaly et al., 2013:138). Figure 11 presents the challenges faced by facility managers in maintaining universities; Kamarazaly, et al. (2013:138) believe that economic, social and environmental are likely to persist as challenges in the future.





**Figure 11:** Challenges faced by university facility managers

**Source:** Kamarazaly et al. (2013)

## 2.6 CHALLENGES OF MAINTENANCE MANAGEMENT SYSTEM (SA perspective)

There are many maintenance/facility management studies conducted in South Africa that also reveal similar challenges to those in other countries. According to Veld and Van De Voorde (2014:856), government faces a serious shortage of maintenance personnel in the public facilities. This is mainly due to insufficient production, insufficient recruitment (especially in rural areas), low retention rate and poor staff management. These challenges have also been highlighted as global challenges (Veld & Van De Voorde 2014:856). It was also indicated in Dunjwa (2016:1) that routine maintenance such as general housekeeping is not implemented fully in the hospitals. Poor waste management, lack of cleanliness and poor maintenance of grounds and equipment are considered the most worrying problems (Dunjwa, 2016:1).

Studies done specifically on government and municipal facilities also point to these challenges. For example, Mojela (2015:84) conducted a study to assess the effectiveness of the public school infrastructure maintenance system in Gauteng Province. The study found that apartheid which deepened inequalities is one of the reasons why some school

facilities were in an unacceptable condition. Mojela (2015:86) further mentioned other challenges which contributes to public schools or facilities dilapidation such as:

- Budget cuts whereby the provincial education budget often gets cut when other departments are under pressure.
- Failure to conduct a condition assessment, therefore the lack of accurate information about the condition of buildings and maintenance requirements, making it difficult to perform proper maintenance.
- Lack of skills and abilities.
- Inefficient professional services acquisition processes.
- Poor relationships within the department and lack of communication.

Likewise, a study conducted by Boshof (2017:1) entitled “Challenges of asset management in municipalities” also broadly indicated that the public works in South Africa provide a wide range of facilities and services for businesses, government sectors, social institutions and families to ensure social health, well-being and support economic growth. Boshof (2017:1) further added that facilities have dilapidated, and services have failed due to several challenges including:

- Political preference for new facility creation
- Lack of knowledge
- Asset overloading and/or underutilization
- Inability to properly assess maintenance needs, funding requirements and implement maintenance plan and budgets
- Maintenance budget provisions that are treated as discretionary items
- Weak technical and financial skills
- Absence of asset lifecycle planning
- Selection of inappropriate maintenance practices
- Unrealistic development planning practices
- Inadequate revenue base and/or cost recovery
- Vandalism and theft

- Explosions in local economic growth and shrinking local economies.

On the other hand, a study conducted by Ngobeni et al. (2015:53) titled “Management of government properties in Mpumalanga province, South Africa: a service quality perspective” also added common maintenance challenges presented by government properties:

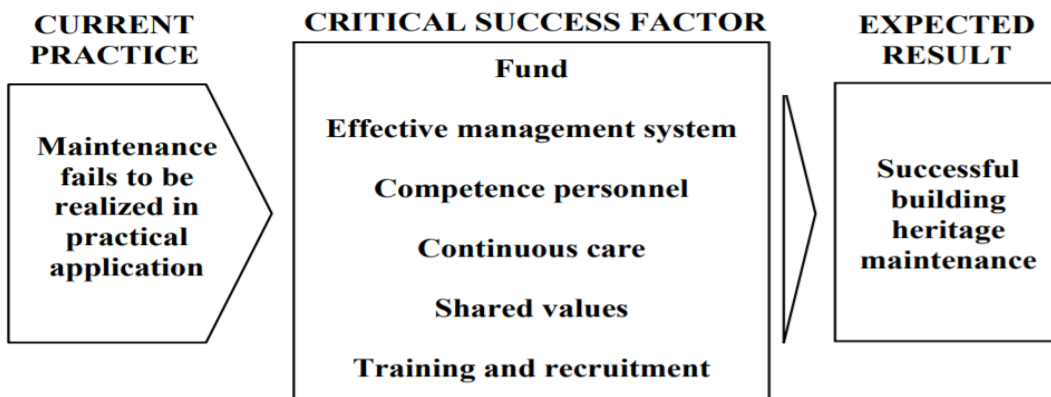
- Poor budget and planning contributing towards the increase of the maintenance backlogs in which a non-existent facility plan contributes to the ill-informed budget planning decisions.
- Skills shortages that continue to affect the provision of quality services.
- Inadequate rent collection and registration by tenants living in government shelters have a negative impact on the amount of funds that can be used to participate in property maintenance activities.
- Inadequate operation management

Therefore, based on the challenges stipulated above for both global and South Africa as a whole, it is safe to conclude that the implementation of maintenance managements system in public sector suffers similar challenges that continues to hampers the effectiveness of the system.

## **2.7 MAINTENANCE MANAGEMENT SYSTEM SUCCESS FACTORS**

According to Akasah, Abdul and Zuraidi (2011:656), the gap between current practices and best practices should be seen as the key to successfully maintaining the management system. In their study “Maintenance success factors of heritage buildings”, they identified six key factors that play huge role in the success of heritage building maintenance, namely funds, effective maintenance system, skilled personnel, continuous care, shared values and recruitment and training. Akasah et al. (2011:656) further emphasize that, “the key to success of facility maintenance hinges on funds, which should be put aside for maintenance expenditure”. Additionally, having a competent and skilled management that will ensure that the maintenance management system remains effective, assist in allocating resources, monitor works and always be aware of every problem/challenge that

may hinder the maintenance work from being done is also crucial. Figure 12 presents a conceptual framework of maintenance success factors developed by Akasah et al. (2011).



**Figure 12:** The critical success factor framework of building heritage maintenance management

**Source:** Akasah et al. (2011)

There are six critical factors mentioned by Pakrudin et al. (2017: 75-76) that can be applicable for maintenance management system success:

- Efficiency of teamwork
- Contract management
- Strategic decisions
- Resources and training
- Commitment and support from senior management
- Equipment and facilities improvements

In addition, Pakrudin et al. (2017:76) believe that establishing the best maintenance management practice and its critical success factors will bring an opportunity for facility managers to play a leading role in organization change and development efforts. Other success factors that play key roles in the improvement of maintenance management systems are indicated in Table 10 below.

**Table 10:** Maintenance management system success factors

No.	Elements	Items
1.	Monitoring and supervision	Maintenance work complying standard specification, internal audit International organization for standardization (ISO)
2.	Task planning and scheduling	Get a proper work, completed ppm and contingency plan
3.	Computerized maintenance management system (CMMS)	CMMS used, CMMS information sharing tool or CMIS
4.	Maintenance approach	Maintenance method, problem analysis (root cause analysis)
5.	Spare part management	Spare part stock, cost value comparison, spare part stock control
6.	Outsource strategy	Outsourcing vendor and third party
7.	Policy deployment and organisation	Maintenance policy, application, policy review frequency, policy review responsibility, maintenance responsibility, maintenance organisation
8.	Human resources	Human resource management, staff competency, continuous training program, attend training, job scope and duty list, spirit of working, staff performance, a total of balanced staff
9.	Financial	Financial planning, annual budget, achievement of expenses, analysis damage cost
10.	Continuous improvement	Improvement implementation, improvement form, analysis performance measurement, involvement of the upper management, maintenance objective achievement

**Source:** Pakrudin, et al. (2017:76)

Other success factors indicated by various authors in relation to building maintenance management system are presented below in Table 11.

**Table 11:** Success factors of maintenance management system – previous studies

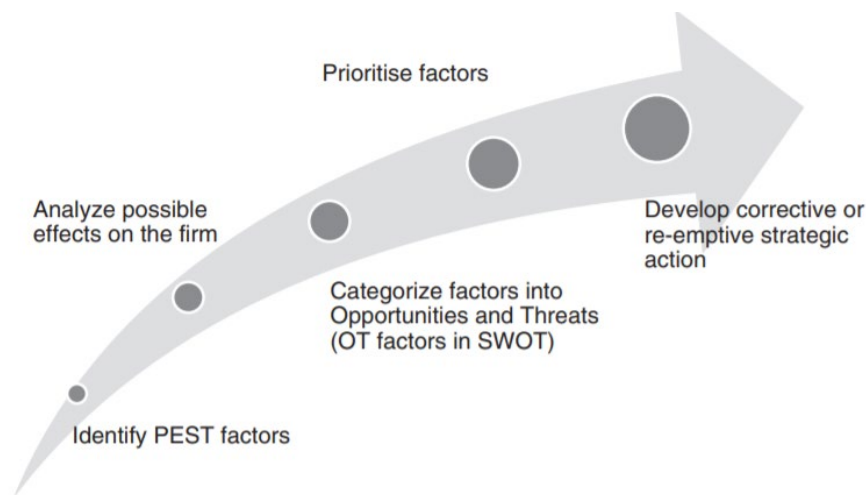
Author	Building	Area/scope	Critical Success Factors
Yau,Chi Wing Ho & Li, (2017)	Residential House	Property Management Agent	Staff training
Kalumba, Mutingi, Mbohwa (2016)	Local Government Building	Building Maintenance	Top management support, familiarity with the local building maintenance practice, familiarity with the maintenance related plans. maintenance policy, quality standards & resources, employee training, computerized maintenance management systems.
Tan,Shen, Langston, Lu,Yam (2014)	General Building	Building Maintenance	Quality of maintenance services and management, certification, people & relationship
Tucker, Turley, Holgate (2014)	Social Housing	Building	Stakeholder opinion, value for money, service standards, performance, continuous improvement
Ganisen, Mohammed ,Jawahr Nesan, Kanniyapan (2015)	Low Cost House	Maintenance	Workforce development and training, clear, goals and objectives, effective monitoring and feedback, project team competence, dedicated resources, management planning, taking account past experience, good interdepartmental communication, education on new technologies, clients expectations

**Source:** Dahlan and Zainuddin (2018:738)

### 2.7.1 PEST analysis

According to Sammut-Bonnici and Galea (2015:1), PEST is an acronym consisting of four sources of change: political, economic, social and technological factors. Koumparoulis (2013:32) describes PEST as an analytical tool that can help facility managers determine the key external and internal factors that must be considered to overcome the challenges of a project or plan. When analyzing the macro-environmental challenges of an organization, it is important to identify factors that may affect the maintenance and management system. The results can be used to seize opportunities when developing strategic plans and contingency plans for threats (Koumparoulis, 2013:32). Sammut-Bonnici and Galea (2015:7) developed a 5 stage PEST analysis process that can be explored in an organizational macro-environment, namely:

- Identify current and future factors in the organization's PEST;
- Analyze the possible impact of each factor on the competitive position of the organization;
- Classify each factor as an opportunity or threat to the organization;
- Prioritize the strategic importance of each set of PEST opportunities and threats; and,
- Develop strategic actions to correct negative impacts and take advantage of positive impacts.



**Figure 13:** Process and stages of PEST analysis

**Source:** Sammut-Bonnici and Galea (2017:7)

In this study, to efficiently and successfully develop an improvement of strategies for maintenance management system, PEST analysis would be adopted as a tool to analyze challenges that may hamper the effectiveness of the maintenance management system of an organization by providing strategies with a framework as an aid to increase awareness of the external environment.

## **2.8 CHAPTER SUMMARY**

This chapter reviewed papers related to the research. It also pointed out gaps in the literature. It outlined a wide range of ideas and concepts related to research from previous research, trying to provide obvious missing links to provide information for the research concepts. The literature discussed generic overview of maintenance management system, its importance and what the system should comprise. This study noted that maintenance management system should consist of maintenance policy, maintenance prioritization, performance or condition standards, maintenance condition assessment, budgeting, asset inventory/register, maintenance strategies, maintenance scheduling and planning of activities within the budgeted program to utilize resources in the most efficient manner and maintenance execution. The review further highlighted the importance of adopting the use of computerized maintenance management system to improve maintenance efficiency, time, and cost.

The review further broadly discussed the issues or challenges that impact the effectiveness of maintenance management systems in public facilities globally and South Africa. Globally, challenges faced by public facilities in Ghana, Kenya, Saudi Arabia, UK and Malaysia were outlined. The five most common challenges found were inadequacy of funds, inadequacy of maintenance personnel, inadequacy of resources, lack of a CMMS/software system and poor maintenance awareness.

Success factors were also outlined. Training staff, support structure, appointment of skilled personnel, increase of maintenance budget and resources, utilization of software tools, efficient transport system and improved security systems were identified as most critical success factors. PEST analysis was determined to be an effective tool of continuous

improvement of a system as it creates awareness of external challenges that may hamper the maintenance management system and allows organizations to create contingency plans and improve strategies. A conceptual framework to improve strategies of maintenance management system in public facilities was developed.

The next chapter will discuss the methods adopted for this study. Firstly, research methodology and the research design adopted will be discussed. Moreover, population selection, sampling technique, process of data collection, data analysis technique adopted, trustworthiness and ethical consideration of the data will be discussed.



## **CHAPTER THREE**

### **RESEARCH METHODOLOGY**

#### **3. INTRODUCTION**

This chapter outlines methodological methods and procedures, data collection and presentation techniques, data analysis and tools, and the methods and procedures used in this study. It further discusses the research methodology and the methods used to obtain the desired results, taking into consideration the research problem, aim and objectives. The justification for the choices made is also provided in this chapter. The methods adopted for the study are presented under the following subheadings: research design, research approach, population of the study, sample and sampling technique, validation and reliability of the instrument, method of data collection, and analysis.

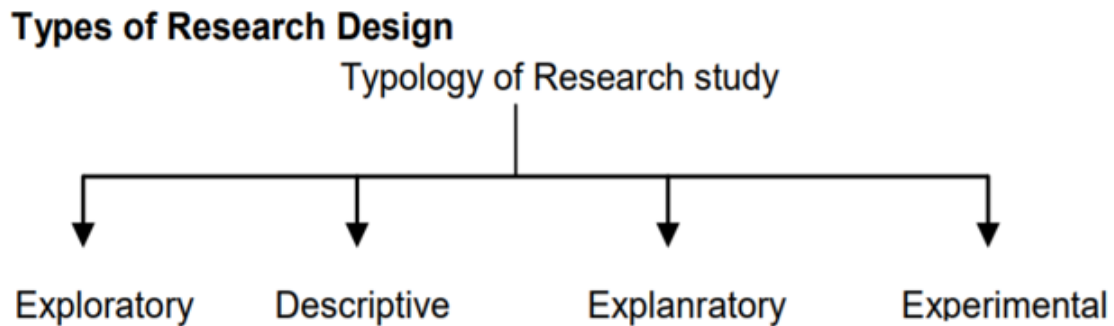
#### **3.1 RESEARCH METHODOLOGY**

According to Rajasekar, Philominathan and Chinnathambi (2013:5), research methodology is a systematic approach to problem solving. Basically, it is a science that studies how to conduct research. Therefore, the process by which researchers describe, explain, and predict phenomena is called research methodology (Rajasekar et al., 2013:5). Other authors such as Mohajan (2018:1) also define it as the study of knowledge acquisition methods, the purpose of which is to give a work plan for the study. Therefore, the research format used in the survey should be a tool to answer research questions (Mohajan, 2018:1).

#### **3.2 RESEARCH DESIGN**

According to Akhtar (2016:68), research design can be viewed as the structure of research, which manifests itself as the “glue” that holds all the elements of the research project together. In short, it is a plan of proposed research work. The research design establishes the procedures for the required data, the methods used to collect and analyze this data, and how all these will answer the research questions (Grey, 2014:11). There are 4 types of research design, namely: exploratory, descriptive, explanatory design and experimental design. Appropriate design depends on the research problem, the aim and

objectives of the research (Simpheh, 2013:42). Figure 14 illustrates the four types of research designs. All of these designs are discussed below.



**Figure 14:** Types of research design

**Source:** Akhtar (2016:73)

### **3.2.1 Exploratory design**

According to Squires and Dorsen (2018:2), exploratory design is mainly used to solve a project that has a high degree of uncertainty and ignorance on the subject, and when the problem is not very clear (that is, it rarely exists with regard to the subject matter). Its purpose is to determine the environmental limits where problems, opportunities or situations of interest may exist, and to identify important factors or variables that may be found and that are relevant to the research (Squires & Dorsen, 2018:2). However, it is not intended to provide final and conclusive answers to research questions, but only to explore research topics at different levels of depth (Boru, 2018:99). Three methods that can be useful for exploratory research are literature surveys, empirical surveys, and case studies (Akhtar, 2016:75).

### **3.2.2 Descriptive design**

Descriptive design is also called statistical research design, which describes existing phenomena (Akhtar, 2016:75). It aims to provide pictures of situations, people, or events, or to show the relationship between things and how they naturally occur (Boru, 2018:98). However, the descriptive design cannot explain the reason for the occurrence of the event and is well suited for relatively new or unexplored fields of research (Boru, 2018:98).

Therefore, when descriptive information is abundant, alternative research designs, such as explanatory or exploratory methods, are recommended.

### **3.2.3 Explanatory design**

According to Boru (2018:98), an explanatory study sets out to explain and account for the descriptive information. So, while descriptive research may ask "what" questions, explanatory research attempts to ask "why" and "how" questions (Grey, 2014:11). Explanatory research searches for causes and provides evidence to support or refute the explanation or prediction (Boru, 2018:98). The main purpose of explanatory research design is to explore the unknown; when little is known about the phenomenon, researchers will try to explore and discover more relevant information (Green & Thorogood, 2018:18).

### **3.2.4 Experimental design**

According to Akhtar (2016:78), research design used to test relationships or variables under controlled conditions is called an experimental design. Controlling conditions means that the phenomenon or conditions should not be allowed to change during the experiment (Akhtar, 2016:78). In other words, the control condition keeps the factor constant once, while other conditions can be changed freely in the experiment. The purpose of this type of design is to test the hypothesis of causality between variables (Akhtar, 2016:78).

## **3.3 RESEARCH DESIGN FOR THIS STUDY**

This study intends to explore and explain the factors hindering the implementation of effective maintenance management systems in the Limpopo district. Thus, exploratory designs will be employed to explore and explain the challenges in depth. The purpose of adopting this research design is to allow the researcher to gain familiarity in unknown areas, and to identify the causes and reasons for such issues to provide enough evidence to support and explain the problem.

## **3.4 TYPES OF RESEARCH METHODS**

Research can be conducted in three type of methods which are qualitative, quantitative and mixed methods design. The three methods are discussed below.

### **3.4.1 Qualitative research**

According to Moore (2016:3), qualitative research method is an exploratory method that aims to explain the "what", "how" and "why" questions that need to collect qualitative data to answer the research questions. Qualitative research is inductive in nature, and researchers usually explore meaning and perspectives in any given situation (Levitt et al., 2017:6). Teherani et al. (2015:669) describe qualitative research as a systematic investigation of social phenomena in the natural environment. These phenomena may include, but are not limited to, how people experience all aspects of life, how individuals and/or groups behave, how organizations operate, and how organizational interactions are formed.

Generally, there are seven types of qualitative research, namely: narrative, phenomenology, grounded theory, case study, ethnography, historical research, and content analysis (Mohajan, 2018:7). It is used to explore people's behaviours, opinions, feelings and experiences, and the center of their lives (Gopaldas, 2016:117). The researcher is the primary instrument for data collection and analysis. It usually involves fieldwork (Mohajan, 2018:2). According to Elkatawneh (2016:2), the tools used in qualitative approach include the use of interviews, diaries, journals, classroom observations and immersions, and open-ended questionnaires, visual and textual materials, and oral history to collect data. Similarly, the researchers must go to the people, setting, site, and institutions to observe behaviour in its natural setting (Mohajan, 2018:2).

As mentioned above, the purpose of qualitative research is to explore the meaning of people's experiences, the meaning of people's culture, and how people perceive specific issues or cases (Elkatawneh, 2016:2). Thus, qualitative research does not include statistical or empirical calculations (Mohajan, 2018:2). Table 12 shows the advantages and disadvantages of using qualitative research.

**Table 12:** Advantages and disadvantages of qualitative research

Advantages	Disadvantages
Open-ended questions reveal new or unexpected phenomena and raise more questions through broad and open investigation.	It is difficult to demonstrate the scientific rigor of the data collection
It is rich in content and provides detailed information on the affected population	As it is generally open-ended, the participants have more control over the content of the data collected.
It enables researchers to explore the points of view of homogeneous and different groups of people, and helps to unravel these different points of view within the community.	It can be difficult to replicate results.
It can play an important role in suggesting possible relationships, causes, effects, and dynamic processes.	Collection of the data can be time-consuming and costly.
It allows people to open up, and allows new evidence that was not initially considered	It requires labour intensive analysis processes, such as recording, classification, etc.

**Source:** Creswell (2014:11)

### 3.4.2 Quantitative research

According to Apuke (2017:41), quantitative research is a method of quantification and analysis of variables to obtain results. It involves the use and analysis of numerical data using specific statistical techniques to answer questions such as "who", "how much", "what", "where", "when", "how much" and "how" (Apuke, 2017:41). Moore (2016:4) states that quantitative methods use mathematical and statistical models for analysis and provide numerical results that are considered more objective. In addition, it uses research strategies such as experiments and surveys, and collects data using predetermined tools that generate statistics (Williams, 2011:18).

The advantage of using quantitative methods is that the results may be generalized to the entire population or sub-populations because it is a larger sample selected at random (Williams, 2011:18). Conversely, quantitative methods overlook and limit the respondent's experiences and perspectives in a highly controlled setting (Williams, 2011:18). Table 13 broadly shows the advantages and disadvantages of quantitative research. Whilst, Table

4 shows a vivid description of the comparison between qualitative and quantitative research.

**Table 13:** Advantages and disadvantages of quantitative research

Advantages	Disadvantages
Can be tested and checked	False focus on numbers
Straightforward analysis	Difficulty setting up a research model
Prestige	Can be misleading
Data analysis is less time consuming	It fails to ascertain deeper underlying meanings and explanations

**Source:** Rahman (2017:104)

**Table 14:** Comparison of qualitative vs quantitative research method

Criteria	Qualitative Research	Quantitative Research
<b>Purpose</b>	To understand & interpret social interactions.	To test hypotheses, look at cause & effect, & make predictions.
<b>Group Studied</b>	Smaller & not randomly selected.	Larger & randomly selected.
<b>Variables</b>	Study of the whole, not variables.	Specific variables studied
<b>Type of Data Collected</b>	Words, images, or objects.	Numbers and statistics.
<b>Form of Data Collected</b>	Qualitative data such as open- ended responses, interviews, participant observations, field notes, & reflections.	Quantitative data based on precise measurements using structured & validated data-collection instruments.
<b>Type of Data Analysis</b>	Identify patterns, features, themes.	Identify statistical relationships.
<b>Objectivity and Subjectivity</b>	Subjectivity is expected.	Objectivity is critical.
<b>Role of Researcher</b>	Researcher & their biases may be known to participants in the study, & participant characteristics may be known to the researcher.	Researcher & their biases are not known to participants in the study, & participant characteristics are deliberately hidden from the researcher (double blind studies).
<b>Results</b>	Particular or specialized findings that is less generalizable.	Generalizable findings that can be applied to other populations.
<b>Scientific Method</b>	Exploratory or bottom-up: the researcher generates a new hypothesis and theory from the data collected.	Confirmatory or top-down: the researcher tests the hypothesis and theory with the data.
<b>View of Human Behavior</b>	Dynamic, situational, social, & personal.	Regular & predictable.
<b>Most Common Research Objectives</b>	Explore, discover, & construct.	Describe, explain, & predict.
<b>Focus</b>	Wide-angle lens; examines the breadth & depth of phenomena.	Narrow-angle lens; tests a specific hypotheses.
<b>Nature of Observation</b>	Study behavior in a natural environment.	Study behavior under controlled conditions; isolate causal effects.
<b>Nature of Reality</b>	Multiple realities; subjective.	Single reality; objective.
<b>Final Report</b>	Narrative report with contextual description & direct quotations from research participants.	Statistical report with correlations, comparisons of means, & statistical significance of findings.

**Source:** Johnson and Christensen (2008:34)

### 3.4.3 Mixed method research

According to Moore (2016:5), mixed research method combines both quantitative and qualitative research. Mixed methods research can be used to compensate for weaknesses in research using only one method and, due to the depth of the review, can lead to better and more accurate inferences (Moore, 2016:5). Creswell and Clark (2011:17) hold that this method can provide a greater degree of understanding than a single method for specific research. In addition, researchers collect and analyze qualitative and quantitative data in a sequential and/or simultaneous and rigorous manner, integrating both forms of data (Creswell & Clark, 2011:18). The way in which this data is combined will depend upon the nature of the inquiry and the philosophical outlook of the person conducting the research (Almalki, 2016:291).

According to Almalki (2016:291), any researcher who decides to use mixed methods for research will face some challenges. The biggest challenge is deciding which mixed method research design is best for the particular study (Almalki, 2016:291). Moreover, Creswell and Clark (2011:21) emphasize the fact that mixed methods studies may require a good deal of time, effort and resources on the part of researchers and it is important that they are aware of this, particularly if they are working alone. Using a mixed methods study has several advantages and disadvantages, which are stipulated in the Table 15 below.

**Table 15:** Advantages and disadvantages of using mixed method research

Advantages	Disadvantages
Compares quantitative and qualitative data	Increase the complexity of the evaluation
Reflects participants' point of view	Relies on a team of multidisciplinary researchers
Fosters scholarly interaction	Requires increased resources
Provides methodological flexibility	
Collects rich, comprehensive data	

**Source:** Wisdom and Creswell (2013:3-4)

### **3.5 RESEARCH METHOD FOR THIS STUDY**

A qualitative research design was adopted to achieve the aim and objectives of this study. The study aims at identifying the maintenance management system currently adopted in public facilities of Limpopo, South Africa and its challenges associated with implementation of the systems. This research method was selected because of the nature of this study. The researcher found adopting qualitative research method more favorable as the data is more natural than artificial and the findings could lead to theory generation.

Additionally, qualitative research allowed the researcher to explore the views of diverse groups of people, thus helping identify the challenges from different perspectives. Creswell (2014:11) also mentioned that qualitative research allows participants to take an interest and give more insights or data which forms new evidence that was not initially considered. Therefore, new evidence that may be found will assist the researcher develop better strategies for implementing the maintenance management system under study.

### **3.6 RESEARCH STRATEGY**

According to Kakulu (2014:56), several strategies can be adopted in qualitative research, namely phenomenology, biography, grounded theory, ethnography, and case study. The strategies are discussed below. Moreover, justification is provided for the strategy adopted for this study.

#### **3.6.1 Phenomenology**

According to Kakulu (2014:56), phenomenology is a study that describes the meaning of the life experiences of various people with regard to a concept or phenomenon. It is about obtaining data from various people who have experienced this phenomenon. Its purpose is to gain a deeper understanding of the nature or meaning of our daily experience (Kakulu, 2014:56).

#### **3.6.2 Biography**

Wolgemuth and Agosto (2019:1) describe biography as a narrative research strategy, pointing out that narrative strategy is a tradition that evokes and analyzes stories to understand people, culture, and society. They also mention that the knowledge acquired through narrative research about individuals or society is constructed and understood



narratively through the study of the content and structure of the story (i.e. scripts, texts, and visual images) (Wolgemuth & Agosto, 2019:1). This type of a strategy provides the researcher an opportunity to access the personal experiences of the participant (the storyteller) (Elçi & Devran, 2014:38).

### **3.6.3 Grounded theory**

Noble and Mitchell (2016:1) cite Glaser and Strauss (1987:3) who describe grounded theory (GT) as a research method concerned with the generation of theory. It is basically a general method of developing theory that is grounded in data which is systematically gathered and analyzed (Noble & Mitchell, 2016:1). It is used to uncover things such as social relationships and behaviours of groups, known as social processes (Noble & Mitchell, 2016:1). They further describe the features or determining factors of GT:

- Data collection and analysis are carried out at the same time
- Analysis categories and code are developed from the data
- Pre-existing concepts that should not be used, which is called theoretical sensitivity
- Theoretical sampling is used to refine categories
- Abstract categories are constructed inductively
- Social processes are discovered in the data
- Analytical memoranda are used between coding and writing
- Integration of categories into theoretical frameworks

### **3.6.4 Ethnography**

Ethnography is defined as the study of social interactions and cultural groups such as society, communities, organizations, or teams (Reeves, Peller, Goldman & Kitto, 2013:1366). The aim of ethnography is to provide a rich and comprehensive view of people's worldview and behaviour and the nature of where they live (Reeves et al., 2013:1366). In other words, the aim is to “get inside” the way each group of people sees the world.

### **3.6.5 Case study**

The case study is defined as "an empirical research method used to investigate contemporary phenomena, focusing on the dynamics of the case in the context of real life"

(Baškarada, 2014:1). It is a flexible, applicable, and easy-to-use qualitative research method that can be applied to various research designs, such as exploratory, descriptive, or explanatory (Baškarada, 2014:1).

### **3.7 RESEARCH STRATEGY FOR THIS STUDY**

For this study, the researcher adopted the case study method to collect data and contextual information. This approach gave the researcher an opportunity to search through one aspect of a problem in more detail within a limited timeframe. It has enabled researcher to closely examine the data within a specific context. As said by Starman (2013:31), “case study research has a great potential to achieve high conceptual validity, it can provide concrete and context-dependent experience”. Thus, the case study approach is suitable to achieve the objectives of this study.

### **3.8 POPULATION**

According to Denzin and Lincoln (2011:12), there is a difference between three types of population, namely, general, target and accessible population, which often confuses many researchers and accounts for issues relating to poor population specification and sampling biases. The types of populations are described below.

#### **3.8.1 General population**

Banerjee and Chaudhury (2010:61) defined the general population as "... the whole group that needs certain information". Therefore, participants from the general population must have at least one attribute of common interest (Creswell, 2003:8).

#### **3.8.2 Target population**

According to Creswell (2003:11), the target population is defined as "... individuals or groups of participants with specific attributes of interest and relevance". Since it does not contain attributes that contradict the hypothesis, background, or objectives of the research, the target population is more refined than the general population (Asiamah, Mensah & Oteng-Abayie, 2017:1613). Therefore, target population corresponds to the entire set of subjects whose characteristics are of interest to the researcher.

### **3.8.3 Accessible population**

According to Bartlett et al. (2001:1), after removing all individuals who will or will not participate or who will not be accessed during the study period from the target population, the accessible population is reached. Basically, it is the final group of participants, from which data is collected by surveying all of its members or drawing samples from them (Asiamah et al., 2017:1613). It represents the sampling frame if the intention is to draw a sample from it (Bartlett et al., 2001:2). Therefore, for a large research population, the researcher must determine whether the population is the target population or the accessible population after determining the general population (Asiamah et al., 2017:1611).

As for this study, a target population was adopted. The target population allowed the researcher to avoid unnecessarily data collection delay, but instead sort for individuals who could provide quality information under more convenient conditions.

## **3.9 SAMPLING METHOD AND TECHNIQUE**

According to Taherdoost (2016:18), in order to answer research questions, it is not practical for researchers to be able to collect data from all cases. Therefore, it is necessary to select samples. Since researchers do not have the time or resources to analyze the entire population, they apply sampling techniques to reduce the number of cases (Taherdoost, 2016:18). According to Alvi (2016:12), sampling techniques can be broadly categorized in two major classes:

- Probability or random sampling
- Non-probability or non-random sampling

### **3.9.1 Probability sampling**

Alvi (2016:12) states that probability sampling involves techniques such as random sampling or unbiased sampling, and uses some form of random selection. In probability sampling, each member of the population has a known (non-zero) probability of being included in the sample (Alvi, 2016:12). It involves selecting items from the sample to ensure that all members of the total population have an equal chance of being selected. Random sampling is the most often used by researchers (Taherdoost, 2016:21). However,

there are also other probability techniques such as stratified, random, cluster, systematic, and multi-stage sampling. Table 16 below shows the advantages and disadvantages of adopting probability sampling techniques.

**Table 16:** Advantages and disadvantages of probability sampling techniques

Advantages	Disadvantages
This sampling technique reduces the possibility of systematic errors.	The technique needs a lot of effort.
The method minimizes the possibility of sampling bias.	Time-consuming.
The best representative sample is generated using probability sampling techniques.	They are expensive.
The calculations extracted from the sample can be generalized to the population.	

**Source:** Alvi (2016:12)

### 3.9.2 Non-probability sampling

According to Taherdoost (2016:22), the non-probability sampling technique is also called the "judgment sampling technique" and, as the name suggests, it is based on the judgment of the researchers. Non-probability sampling is usually related to the design of case studies and qualitative research, the objective of which is to determine if a problem or problem exists in a quick and inexpensive way (Taherdoost, 2016:22). A sample of participants or cases does not need to be representative, or random, but a clear rationale is needed for the inclusion of some cases or individuals rather than others (Taherdoost, 2016:22). Types of non-probability sampling are quota, snowball, convenience and purposive, which are defined below.

#### 3.9.2.1 Snowball sampling

Snowball sampling uses some cases to help encourage other cases to participate in the research, thereby increasing the sample size (Taherdoost, 2016:22). This method is most suitable for small groups that are difficult to enter due to closeness, such as secret societies and inaccessible occupations (Taherdoost, 2016:22).

### **3.9.2.2 Convenience sampling**

According to Alvi (2016:29), convenience sampling is also called incidental sampling or opportunity sampling. Researchers include participants who are easily or conveniently accessible (Taherdoost, 2016:22; Alvi, 2016:29). This technique is useful when the target population is defined as a very broad category, such as girls or boys, rich or poor, etc. (Alvi, 2016:29).

### **3.9.2.3 Purposive or judgmental sampling**

Purposive sampling methods are based on the judgment of the researcher, that is, who will provide the best information to achieve the research objectives of the study (Etikan & Bala, 2017:215). The sampling criteria of the elements to be included in the study are predefined. Therefore, this technique does not include all available people, but includes those who are available and meet the defined criteria (Alvi, 2016:29).

### **3.9.2.4 Quota sampling**

Quota sampling is a technique that selects participants based on predetermined characteristics so that the total sample has the same characteristic distribution as the general population (Taherdoost, 2016:22). It is basically an extension of purposive sampling in trying to intuitively reproduce probability sampling (Edgar & Manz, 2017:98). With quota sampling, a researcher can subdivide the population around different and relevant characteristics, such as job category, age, education level, and so on (Edgar & Manz, 2017:98).

Table 17 below shows the advantages and disadvantages of non-probability sampling whereas Table 18 shows the comparison of probability and non-probability sampling technique.

**Table 17:** Advantages and disadvantages of non-probability sampling

Advantages	Disadvantages
The technology requires less effort.	Sampling techniques are subject to systematic errors and sampling deviations.
Less time-consuming.	It cannot be said that the sample is a good representative of the population.
Less costly.	The conclusion drawn from the sample cannot be generalized to the population.
Provides methodological flexibility.	
Collects rich, comprehensive data.	

**Source:** Alvi (2016:22)

**Table 18:** Comparison between probability and non-probability sampling techniques

Probability sampling	Non-probability sampling
Probability sampling is also called random or representative sampling.	Non-probability sampling is also called judgmental or non-random sampling.
Random selection is used.	No random selection is used.
This technique requires a very precise definition of the population.	This technique does not need to define the population very precisely.
Probability sampling is very suitable for research aimed at deepening the knowledge of the population.	Non-probability sampling is well suited for exploratory research aimed at generating new ideas, which will be systematically tested in the future.

**Source:** Alvi (2016:22)

Rolfe (2006:307) mentions that, in order for researchers to determine the correct sampling technique to use, they must use the following guideline to identify sufficient sample sizes:

- For small groups (less than 100 people): sampling techniques are not required;
- If the population size is approximately 500, then 50% of the population should be used as a sample;
- If the population size is approximately 1500, then sampling should be done at 20% of the population, and

- Beyond a certain point (approximately 5,000 people or more), a sample of 400 people is sufficient.

### **3.9.3 Sampling method for this study**

In this study, the researcher adopted the quota sampling technique, mainly because it ensures that the sample generated is representative of the population. Furthermore, the researchers found that this method can be used to generate samples quickly because it is easy to administer and does not require a sampling frame. The researcher selected three cases (Local municipality, district public works and provincial public works). These selection was based on acceptance of researcher's data collection permit after the researcher has applied for permission to several municipalities and public works in the province, but only three accepted. Considering the number of employees within each cases, this was then sufficient cases for this study. This also allowed the researcher to simplify the representation of the population of study and to be able to analyze data accurately and fairly.

## **3.10 METHOD OF DATA COLLECTION**

To fulfil the intended objectives of the study, primary and secondary data collection methods were both employed in this study. The two are discussed below:

### **3.10.1 Primary data**

Primary data is collected with an aim of finding solutions to the problem at first hand. These data are collected by researchers for the first time (Ajayi, 2017:2). The primary data collection method used was the interview. The interview method and how the interview was piloted and scheduled is discussed below.

#### **3.10.1.1 Pilot interview**

According to Harding (2013:12), there is a need for qualitative interviews to be piloted in order to improve the quality of the interview guide. Piloting can help the researcher to identify errors and inconsistencies in the study design and therefore allow the researcher to make adjustments (Harding, 2013:12). Based on the above recommendation, the researcher decided to pilot the interview before embarking on the major study. The pilot

interviews were conducted with a few government employees, where five voluntarily participated. The pilot interview helped the researcher to improve the questions, determine appropriate time, test recording instruments, and do other necessary adjustment to the interview guide.

### 3.10.1.2 Interviews

According to Ajayi (2017:4), interviewing is a technique mainly used to understand the underlying causes and motivations of people's attitudes, experiences, preferences, or behaviours. Interviews can be conducted individually or in groups (Ajayi, 2017:4).

For this study the interview was conducted telephonically due to the restrictions in place to curb the Covid-19 virus, and it allowed participants to feel at ease, safe and be more open. Semi-structured interviews are used to allow interviewers to explore the views of interviewees. All interviews were recorded with a tape recorder. Interview guidelines were used to avoid deviating from the subject of the survey (see Appendix B). The interview questions were based on the aim and objectives of the research and the information collected during the literature review. The structure of the interview questions is shown in Table 19 below.

**Table 19:** Interview questions design

Section	Section title	Objectives	Research questions
A	General information	-	-
B	<ul style="list-style-type: none"> <li>○ Identification of current maintenance management system factors adopted in public facilities of Limpopo Province, South Africa.</li> </ul>	1	1
C	<ul style="list-style-type: none"> <li>○ Challenges faced in the implementation of the maintenance management system.</li> <li>○ To establish the critical success factors in the maintenance management process that can contribute to an effective maintenance management system for public facilities.</li> <li>○ To recommend strategies that can assist to improve the current maintenance system of public facilities.</li> </ul>	3	3

The researcher interviewed a total of 25 participants, where case A = 9 participants, case B= 8 participants and case C = 8 participants. The selection of participants was based on



the cases's (municipality, district public works and provincial public works) choice based on staff capacity. However, they were guided by the researcher on the quality of individual to fit the purpose of the study i.e junior, middle and seniors within the engineering or maintainance department. The list of participant's name, their position and relavant contacts were emailed to the researcher. After the arragement with participants, a briefing session was held to inform the participants about the nature of the research and what the interview entailed. Participants were also given the opportunity to ask any questions for clarification and as well given an opportunity to refrain from answering questions they were not comfortable with.

The participants were told that the interview would last 30 to 40 minutes. All participants agreed to this time frame. To ensure confidentiality during the interview, participants were required not to mention their names in recorded interviews. The name of the participant was not asked during the interview; the researcher gave each participant a number based on the sequence of their interview. Participant **1** was the first person to be interviewed, then Participant **2** ... until Participant **25**.

### **3.10.2 Secondary data**

According to Ajayi (2017:5), secondary data is data that has been collected beforehand by other researchers. If the researcher uses this data type, it becomes the secondary data of the current user and must be quoted or referenced (Ajayi, 2017:5). In this study, secondary data was mainly drawn from the literature review in chapter two and discussion of methodology in chapter three. The sources of data were mainly journal articles, theses, books, newspapers, websites, conference papers and reports.

## **3.11 PROCESS OF DATA COLLECTION**

As mentioned earlier, the research was conducted in Limpopo Province. It was necessary for the researcher to obtain permission from the respective government departments prior to beginning data collection. An application to conduct research was submitted to the government departments such as the municipality and Public Works within the province. As part of this application, the researcher also submitted a personal letter and an institutional letter in requesting permission for data collection which played role in

indemnity as well (see Appendix D). The application was successful, and permission was granted (see Appendix C). Copies of the questionnaire were sent before interviews were scheduled.

The data collection process started with interview questions management and piloting. The interview questions was accompanied by a cover letter detailing the ongoing research and a consent form for participants to fill in. The interview was conducted in private to ensure confidentiality and was recorded for later transcription. The researcher obtained permission to record the interview before the start of each one.

### **3.11.1 Interview scheduling**

According to Ryan, Coughlan and Cronin (2009:311), establishing an interview schedule is the first step in structuring the interview process. The timeline or guidelines depend on the nature of the research, the structure of the interview and the aims and objective of the study (Ryan et al., 2009:311). In this study, the researcher contacted the participants to schedule dates and times that were suitable for them and therefore developed a schedule that can could the researcher in keeping up with times and dates. The participants chose the most suitable time (it was mostly early morning before work at 07:00am, tea break at 10:00am, lunch break at 13:00pm and after work at 16:00pm), to allow them not to infringe on their working time.

Upon scheduling, the researcher issued a consent form related to the interview that needed to be signed and sent back. Interview were then conducted; however, some were rescheduled and others declined due to unavailability. A total of 30 interviews were scheduled, but only 25 were successful as 6 participants could not avail themselves for reasons such as poor network connection (no coverage) in the area whilst some reported sick (hospital admission due to Covid-19). However, the 25 number of participants were still sufficient/adequate for the study.

### **3.11.2 Recording of interviews**

According to Al-Yateem (2013:31), the data obtained from qualitative interviews is usually recorded, transcribed, and then examined for obvious themes. Recording is usually done using audio or video technology (Al-Yateem, 2013:31). In this study, the researcher had a

separate permission consent page (refer to Appendix A) that explained the purpose of the study. The researcher explained to the participants the purpose of the audio recording, as it would be impossible for the researcher to remember everything or to note overlaps. Furthermore, it enables researchers to repeatedly check or listen when in doubt during data analysis, and provides a basis for reliability and validity. It was also made clear to the participants that if they were uncomfortable with any question, they could omit the questions, and the researcher would respect such decisions by continuing to the next. The participants read and signed the interview consent form.

Al-Yateem (2013:31) further adds that it is important to ensure that the interview is effective and that the data collected is as rich as possible to reflect the true phenomenon of the research, so that the conclusions drawn are as accurate as possible. Therefore, in order to obtain data of the highest possible quality during the interview, the researcher adopted a strategy of controlling for all influencing factors, such as reiterating questions during the interview. Table 20 below shows other strategies that can be applied when recording interviews.

**Table 20:** Strategies that can be used during audio and video recording of interviews

Box 1 Strategies that can be used during audio and video recording of interviews	
<ul style="list-style-type: none"> <li>■ Use an appropriate study schedule.</li> <li>■ Prepare a schedule or guide of the interview with the aim of making the questions feel spontaneous to the participant.</li> <li>■ Organise appropriate technology for recording.</li> <li>■ Use a highly sensitive recorder, preferably as small as possible, so that it will be unobtrusive during the interview.</li> <li>■ Avoid anything that provides a visual indication that you are recording the participant, such as external microphones, clip microphones, and recorders that need frequent checks or changes of tapes or batteries.</li> <li>■ Prepare for the interview. Arrive early to arrange the setting and to fit and check the recorder ahead of the participant. This is not to hide the recording process, of which the participant should already be aware, but to allow interviewer and the participant to focus on the interview and have a less formal conversation.</li> </ul>	<ul style="list-style-type: none"> <li>■ Explain the research study. The interviewer should also obtain consent to participate before carrying out the main interview. This can help the interviewer and participant become more familiar with each other, break down barriers, build trust and ease the interview process for both parties. It also avoids including these formal procedures in the main interview, which might otherwise distract the interviewer and participant.</li> <li>■ Explain research goals and procedures carefully to participants during the initial contact when they sign the consent form. Subsequently, reminding the participants about their voluntary participation and interview recording can make the interview formal and less informative, so this reminder should be avoided.</li> <li>■ Select an appropriate setting for the interview. It should be chosen to make the interview look like everyday social conversation is taking place.</li> </ul>

**Source:** Al-Yateem (2013:31)

The researcher used a cellphone audio recorder to record the interviews. The data for this study were collected between 11 May 2020 and 6 June 2020. The collected data were transcribed by the researcher. The researcher asked an external person to listen to the recordings, comparing them with the transcripts. This was done to check for any inconsistencies that might have emerged or any interruptions that might have occurred during the interview. Necessary corrections were then performed.

### **3.12 DATA ANALYSIS**

Ashirwadam (2014:1) defines data analysis as a method of using facts and figures to solve research problems. He also emphasises that it is crucial to find answers to the research questions (Ashirwadam, 2014:1). For data to be analyzed, it is firstly transcribed, managed, organized and developed (Akinyode & Khan, 2018:164). However, the first important step taken by the researcher before analysis or after an interview was transcribing data. The transcribing of data is explained below.

#### **3.12.1 Transcribing data**

According to Simon and Goes (2013:2), in order to analyze data collected from interview, a form of transcription process is involved. Transcribing data can be a tedious process, as each interview takes several hours (Simon & Goes, 2013:2). There are transcription services that can help researchers to transcribe data at a fee, however, they tend to be costly. In this study, the researcher transcribed data by herself as it allowed the researcher to recall the tenour of the interview and helped in adding meaningful content. On average, transcribing data of a 30–40minute interview took 1.5-3 hours to type.

After transcribing, the researcher sent out the transcript to the participants allowing them to make corrections if required. This is called “member checking” which helps improve validity, accuracy, credibility and transferability of the research (Simon & Goes, 2013:2).

#### **3.12.2 Data analysis process for this study**

After transcribing data, Braun and Clarke’s six simple steps (2012:1) were adopted as a thematic process of analyzing data collected from the participants. The purpose of adopting these six steps is because it provides such a clear and usable framework for thematic analysis. Braun and Clark’s six simple steps are:

- Step 1: Familiarize yourself with data
- Step 2: Generate initial codes
- Step 3: Search for themes
- Step 4: Review themes
- Step 5: Define and name themes
- Step 6: Prepare a report

**a) Step 1: Familiarize yourself with data**

According to Braun and Clarke (2012:5), the first step in qualitative data analysis is to familiarize researchers with the data. This step requires researchers to delve into the data by thoroughly reading and rereading the text data (for example, interview records, qualitative survey responses, if applicable) and re-listening to recordings or reviewing video data or highlighting the text and taking notes (Braun & Clarke, 2012:5). In this study, the researcher achieved this through engaging with the transcribed data numerous times and listening to interview recordings repeatedly. The researcher compared all the information collected and performed a member check to make sure that all the data recorded matched what the participants had said.

**b) Step 2: Generate initial codes**

Creswell (2012a:112) defines coding as the process of fragmenting and categorizing text to form interpretation and integral themes in the data. Similarly, Akinyode and Khan (2018:166) describe coding as assigning labels or codes to different sections of text that are related to different problems. Its purpose is to reduce data by classifying information transcripts into manageable and meaningful transcript fragments with the help of coding frameworks (Akinyode & Khan, 2018:166). There are two different methods of coding namely, open or axial codings method. Open coding aims to identify discrete concepts, while axial coding mainly specifies ways to establish connections between groups and subgroups in new ways (Khan, 2014:21). Coding helps to divide data into categories (nodes) or themes so that data from different sources can be easily organized and compared.

In this study, both open and axial methods were employed. This was to order, organize, manage, develop and modify data. The researcher adopted manual coding, using a Microsoft Word document, and highlighting significant words and sentences with different themes in order to identify and classify the codes (see Appendix F).

**c) Step 3: Search for themes**

In this step, data analysis process starts to take shape by shifting from codes to themes. According to Braun and Clarke (2012:7), this basically means to "capture the important content of the data related to the research question, and express a certain degree of response or meaning through the patterns in the data set." In other words, the theme based on the code is mainly established according to the responses of the participants' meaningful universal codes (Akinyode & Khan, 2018:170). In this study, the researcher traversed each node to display the coded text and checked its compatibility with the responses of all other participants (see Appendix F). Identification of themes to interpret codes that were significant and those that were less significant were taken into consideration.

**d) Step 4: Review themes**

The fourth step of data analysis involves a recursive process by which researchers review the developed themes related to the coded data and the entire data set (Braun & Clarke (2012:9). If selective or inappropriate coding (step 2) is performed, or if the coding is evolved on the data set and the data is not re-coded using the final code set, a mismatch is most likely (Braun and Clarke, 2012: 9). In the case of such a mismatch in this study, the researcher engaged in creating other themes, sometimes modifying or discarding existing themes. The researcher at this stage was more interested in the prevalence of themes, that is, how often the themes occurred. This was a useful stage for the researcher to gather all the data and review each theme.

**e) Step 5: Define and name themes**

According to Braun and Clarke (2012:10), defining themes may require researchers to be able to clearly explain the uniqueness and specificity of each theme, though while naming them they may seem trivial, and short titles can and should send many signals. A good theme name should be informative, concise, and engaging (Braun & Clarke, 2012:9). This

step basically involves the final definition and refining of the themes and potential subthemes within the data collected. This is aimed at identifying the importance of each theme regarding the subject of the study.

#### **f) Step 6: Prepare a report**

According to Caulfield (2019:60), this final step requires the researcher to transform the analysis into a written report for easy comprehension. The report should be logical and interpretable and should use exact and persuasive extracts from transcriptions that correlate with the themes, research question, and literature (Caulfield, 2019:60). A report of the current data analysis is presented in chapter four below.

### **3.13 CHECKING FOR TRUSTWORTHINES**

According to Ogunbanjo, Mabuza, Govender and Mash (2014:3), qualitative research must be clear enough about the process used so that readers can evaluate the scientific rigour of the research and thus be able to accept or disprove the research results. Rigour refers to various strategies used in qualitative research to protect against biases and enhance the reliability of the study findings (Noble & Smith, 2015:34). The concepts and terminology used to describe the trustworthiness of qualitative research results are different from those of quantitative research (Ogunbanjo et al., 2014:3). The criteria for trustworthiness (verification) are credibility (for internal validity), transferability (external validity), dependability (reliability) and confirmability (objectivity) (Huberman & Miles, 2000:181). These criteria were applied in this study to ensure that its findings were trustworthy.

#### **3.13.1 Credibility and validity**

According to Ogunbanjo et al. (2014:3), credibility is more related to the validity of the conclusions drawn from the data and how these conclusions match the reported reality. Validity explains the extent to which the collected data covers the actual research field. Simply put, it basically means "measure what you want to measure" (Ogunbanjo et al., 2014:3).

For this study, to ensure participants' validation, the interview was transcribed, and content validity were adopted. The data was provided to the participants to verify and resolve any

discrepancies that might have arisen, eliminating misunderstandings or biases on the part of the interviewer. Also, the interview questions were piloted first to test the validity of the content. This helped the researcher to ensure that the data collected were credible and trustworthy.

### **3.13.2 Transferability**

According to Ogunbanjo et al. (2014:3), transferability refers to the degree to which the research findings can be applied to other similar settings. The ability of others to judge whether research results can be transferred depends on the detailed description of the research setting, the choice of participants, and the research results. This is often referred to as a thick description.

In this study, the researcher provided evidence that the study results could be applied to other backgrounds, situations, times, and populations, thus ensuring transferability. The researcher achieved this goal by providing rich descriptive data narratives, such as the research background, environment, sample size, sample strategy, demographics, interview procedures, and changes in questioning of research process and excerpts from the interview guide.

### **3.13.3 Dependability**

Dependability refers to the degree to which similar results will be obtained if the research is repeated. Taherdoost (2016:33) defines dependability as the consistency of measurement, or the degree to which the instrument measures in the same way each time it is used with the same object under the same conditions. In short, it is the repeatability of measurement (Taherdoost, 2016:33). Dependability testing is very important because it involves consistency between the various parts of the measuring instrument (Huck, 2007:2). Thus, consistency is viewed as the extent to which variation can be tracked or explained.

To ensure the dependability of this research, a slightly different form of reformulation tool was used in the interview process. Also, repeating the interview at other times can provide another estimate of the consistency of the response. However, due to time constraints, the researchers only used the first tool to repeat the question in a slightly different way.



### **3.13.4 Confirmability**

According to Ogunbanjo et al. (2014:3), confirmability refers to the degree of objectivity of researchers in collecting and presenting data. Readers want to make sure that the results are actually based on data and not on the characteristics, preferences, or assumptions of the researcher (Ogunbanjo et al., 2014:3).

In this study, confirmability was achieved by associating the objectives with the interview questions. The results of this study were confirmed through audio recordings, transcripts, and participant verification through member checking.

### **3.14 ETHICAL CONSIDERATIONS**

Before data collection, the researcher obtained ethical approval from the CPUT Ethics Committee. The researcher also sent a consent form to each participant for approval to participate in the study. During this process, participants were informed of the purpose of the research and confirmed that their answers were confidential. This included briefings that did not disclose personal identities and exempted participants from any liability or risk arising from the research or response. The interview schedule was prepared by the researcher to avoid any psychological distress to the participants. If necessary, participants were encouraged to ask for clarification. The researcher guaranteed that the appointment time for the interview would not interfere with their work schedules in any way. The researcher gave and explained to the participants the right to withdraw at any time if they felt uncomfortable participating. Efforts were also made to protect the study from bias, abuse, misconduct and fraudulent practices. The researcher explained the format of linking the responses of the questions to the participants, and participants' names were not used during the data-collection process. The format of this link was to allocate each participant a number e.g. Participant 1, participant 2...to participant 25, to ensure anonymity and confidentiality of the participants.

Permission to record interviews of participants was also obtained, and no participants objected. At the end of the interview, both participants and the researcher reported on the interview process itself and the impact of the interview. The purpose of debriefing was to

ensure that participants understood the purpose of the research and felt comfortable afterwards.

### **3.15 CHAPTER SUMMARY**

This chapter provided an overview of the research methodology adopted for this study. A qualitative research approach was adopted. The approach allowed the researcher to explore the views of diverse groups of people and helped to unpack the challenges from different perspectives in order to meet the objectives of the study. Exploratory design was adopted. This design was employed to allow the researcher to explore and gain more insight in unknown areas and to provide enough evidence to support and explain the problem.

Population and sampling technique adopted were explained. A target population was adopted which allowed the researcher to avoid unnecessarily data collection delay, but instead sort for individuals who could provide quality information under more convenient conditions. Quota sampling was also adopted to categorize the target population into relevant strata such as managerial level.

Data collection and tools employed to analyze qualitative data were discussed. To fulfill the intended objectives of the study, both primary and secondary data collection methods were employed. Primary data was collected with an aim of finding solutions to the problem at first hand. Interviews were used as a method of collecting primary data for the study. Interviews were firstly piloted in order to improve the research settings, and therefore were recorded for transcription purpose. Secondary data was mainly used to find relative information of this study from past authors, articles or online news to form part of the literature and such data was referenced.

Braun and Clarke's Six Simple Steps were used as an approach to analyzing the data. These steps allowed the researcher to adopt a thematic process by analyzing data collected from the participants. Validity and creditability, dependability, transferability and confirmability were employed to ensure that the findings were trustworthy and rigorous, thus, eliminating any form of bias.

Finally, the ethical considerations applied in this study were described. The following were the ethical keys to this study:

- The researcher obtained ethical approval from the CPUT Ethics Committee.
- The confidentiality of personal identities and their exemption from any responsibility or risk derived from investigations or responses was affirmed.
- The participants' right to withdraw at any time if they felt uncomfortable participating was provided.
- Participants' permission was also obtained to record the interviews.

The next chapter deals with the findings, analysis and interpretation of the results of this study.

## **CHAPTER FOUR**

### **FINDINGS**

#### **4. INTRODUCTION**

This chapter presents the findings of the semi-structured interviews in four sections. The chapter further discusses the findings within each section of the study. The findings and discussions are presented in sections, namely:

- Section A: Profile of participants
- Section B: Current maintenance management system adopted
- Section C: Challenging factors in implementing a maintenance management system.
- Section D: Success factors that can be adopted to improve a maintenance management system for public facilities.

#### **4.1 DESCRIPTION OF CASES**

This study identified three cases in order to solve the research problem and meet the objectives of the study. Case A was a local municipality in the district of Mopane in the small town of Giyani within the Limpopo Province. The municipality structure consisted of all municipal departments i.e. infrastructure, solid works, accounting, maintenance, etc. Case B was a public works department located within the same district, town and province as case A. The public works department oversees the municipality and is responsible to share resources when required. Case C was the provincial public works department of the entire Limpopo Province located in the city of Polokwane. The provincial public works department is responsible to oversee all district public works departments and municipalities, and to assist with resources where required.

In all cases, the researcher selected the management level to constitute of 3 levels (senior, middle and junior). The reasons for these cases and selection of management levels was for the researcher to investigate, compare and draw parallels in the results obtained across or among all cases of participants.

A total of 25 participants were interviewed from three cases. Case A was represented by 9 participants whilst case B and C were each represented by 8 participants. The results from the interviews and the findings for each case are presented and interpreted in this chapter. The combined summary of all the cases is also presented and discussed

## 4.2 SECTION A: PROFILE OF PARTICIPANTS

During the interviews, each participant gave his or her position, experience in the position, highest qualification and professional registration. Management level of participants ranged from junior to senior and their highest qualifications ranged from N6 (Diploma) to MSc in different fields, but all within the engineering industry. The experience in years of participants in their current positions ranged from 1 year to 20+ years. However, the majority of the participants were not registered with any professional body due to registration not being a mandatory requirement in their institutions. The tables and figures below summarise the profile and demographic details of the participants.

### 4.2.1 Management level of the participants

Table 21 below represents the number/percentage of top, middle and junior level participants of each case as well as the combined (total) cases. It is evident from Table 20 that most of the participants occupied top and junior level management. The findings show that 66.7% of participants in case A occupied senior management level. In case B, only 25% of participants occupied senior management level whilst the majority of participants (i.e. 50%) were juniors. Similarly, 62.5% of participants in case C occupied junior management level whereas 25% occupied senior management level. The total indicates that there are equal large minorities at senior and junior managerial level consisting of 40% of participants each.

**Table 21:** Management level of participants

Management level	Case A		Case B		Case C		Total	
	No.	%	No.	%	No.	%	No.	%
Senior	6	66.7	2	25	2	25	10	40
Middle	2	22.2	2	25	1	12.5	5	20
Junior	1	11.1	4	50	5	62.5	10	40
<b>Total</b>	<b>9</b>	<b>100</b>	<b>8</b>	<b>100</b>	<b>8</b>	<b>100</b>	<b>25</b>	<b>100</b>

#### 4.2.2 Position/title of the participants

Table 22 below presents the number and percentage of participants' positions. The findings reveal that there was an equal percentage of 33.33% of participants in case A who occupied the positions of control work inspector and construction project manager, whilst in case B an equal percentage of 25% of participants held the positions of control work inspector, construction project manager, maintenance/building inspector and engineer. In case C, the largest group (i.e. 37.5%) were maintenance/building inspectors. For the total percentage of all cases of participants' position, the findings show that the largest group (i.e. 28%) of participants were construction project managers whilst 25% were control work inspectors and maintenance/building inspectors respectively.

**Table 22:** Position/Title of participants

Position/Title	Case A		Case B		Case C		Total	
	No.	%	No.	%	No.	%	No.	%
Control Work Inspector	3	33.33	2	25	1	11.11	6	24
Construction Project Manager	3	33.33	2	25	2	25	7	28
Maintenance Manager	1	11.11	0	0	0	0	1	4
Maintenance/building Inspector	1	11.11	2	25	3	37.5	6	24
Engineer	1	11.11	2	25	0	0	3	12
Supervisor	0	0	0	0	2	25	2	8
<b>Total</b>	<b>9</b>	<b>100</b>	<b>8</b>	<b>100</b>	<b>8</b>	<b>100</b>	<b>25</b>	<b>100</b>

#### 4.2.3 Experience of management level within the position

Table 23 below presents the number and percentage of participants' experience in their positions. The findings indicate that, in case A, most of participants (55.56%) had been working in management level from 10-14 years. In case B, the majority of participants (75%) had less than 4 years of experience at management level. Similarly, the majority of participants (i.e. 50%) in case C, had fewer than 4 years of experience at management level. The combined total in percentage for all cases reveals that most participants (48%)

had less than 4 years of experience in management level whilst 44% had been in management level for between 5 and 14 years.

**Table 23:** Experience of management level

Management level (in years)	Case A		Case B		Case C		Total	
	No.	%	No.	%	No.	%	No.	%
0-4	2	22.22	6	75	4	50	12	48
5-9	1	11.11	1	12.5	3	37.5	5	20
10-14	5	55.56	0	0	1	12.5	6	24
15-19	0	0	1	12.5	0	0	1	4
20+	1	11.11	0	0	0	0	1	4
<b>Total</b>	<b>9</b>	<b>100</b>	<b>8</b>	<b>100</b>	<b>8</b>	<b>100</b>	<b>25</b>	<b>100</b>

#### 4.2.4 Qualifications of participants

Table 24 below presents the number and percentage of participants' qualification levels. The findings show that both case A and B had the highest percentage of participants with BSc/BTech degrees. On the other hand, for case C, the majority of participants (50%) held N6 (Diploma). The total of all cases reveals that most of the participants (48%) had BSc/BTech degrees followed by the National Diploma (24%).

**Table 24:** Qualification level of participants

Qualification level	Case A		Case B		Case C		Total	
	No.	%	No.	%	No.	%	No.	%
N6 (Diploma)	0	0	1	12.5	4	50	5	20
ND (National Diploma)	3	33.33	2	25	1	12.5	6	24
BSc/BTech Degree	5	55.56	4	50	3	37.5	12	48
MSc Degree	0	0	1	12.5	0	0	1	4
Other	1	11.11	0	0	0	0	1	4
<b>Total</b>	<b>9</b>	<b>100</b>	<b>8</b>	<b>100</b>	<b>8</b>	<b>100</b>	<b>25</b>	<b>100</b>

#### 4.2.5 Registration status

Table 25 below presents the number and percentage (%) of participants with professional registration. The findings indicate that 33.33% of participants in case A and 75% of participants in both case B and C were not registered with any professional body. The total (%) of all cases show that majority of participants (60%) were not registered with any professional body.

**Table 25:** Registration status

Professional registration	Case A		Case B		Case C		Total	
	No.	%	No.	%	No.	%	No.	%
Candidate Engineer	2	22.22	1	12.5	1	12.5	4	16
Professional Engineer	1	11.11	1	12.5	0	0	2	8
Candidate Construction Project Manager	1	11.11	0	0	1	12.5	2	8
Professional Construction Project Manager	1	11.11	0	0	0	0	1	4
Inactive Candidate	1	11.11	0	0	0	0	1	4
Non-registered	3	33.33	6	75	6	75	15	60
<b>Total</b>	<b>9</b>	<b>100</b>	<b>8</b>	<b>100</b>	<b>8</b>	<b>100</b>	<b>25</b>	<b>100</b>

#### 4.2.6 Summary of participants' profile

The Table 26 below presents the summary of the participants' profile.



**Table 26:** Summary of participants' profile

No.	Management level	Position/ title	Experience (years)	Qualification level	Registration status
1	Junior	Control work inspector	2	ND (National Diploma)	N/A
2	Senior	Construction project manager	12	BTech Degree	Professional engineer (ECSA)
3	Senior	Engineer	10	BSc Degree	Candidate engineer (ECSA)
4	Middle	Maintenance/building inspector	4	ND (National Diploma)	Inactive CANDIDATE Construction project manager (SACPCMP)
5	Middle	Control work inspector	5	ND (National Diploma)	N/A
6	Senior	Construction project manager	11	BSc Degree	Candidate construction project manager (SACPCMP)
7	Senior	Maintenance Manager	20	BSc Degree	Professional Construction project manager (SACPCMP)
8	Senior	Control Work Inspector	10	Building Certificate (N4)	N/A
9	Senior	Construction project manager	12	BTech Degree	Candidate engineer (ECSA)
10	Junior	Engineer	3	MSc Degree	Professional engineer (ECSA)
11	Junior	Maintenance/building inspector	1	Diploma (N6)	N/A
12	Senior	Construction project manager	15	BTech Degree	N/A

13	Senior	Engineer	7	BTech Degree	Candidate engineer (ECSA)
14	Middle	Maintenance/building inspector	4	ND (National Diploma)	N/A
15	Middle	Construction project manager	4	BTech Degree	N/A
16	Junior	Control Work Inspector	3	ND (National Diploma)	N/A
17	Junior	Control Work Inspector	1	BTech Degree	N/A
18	Senior	Construction project manager	12	BTech Degree	Candidate construction project manager (SACPCMP)
19	Junior	Control Work Inspector	2	Diploma (N6)	N/A
20	Junior	Supervisor	4	Diploma (N6)	N/A
21	Junior	Maintenance/building inspector	1	ND (National Diploma)	N/A
22	Junior	Maintenance/building inspector	1	BTech Degree	Candidate engineer (ECSA)
23	Junior	Supervisor	5	Diploma (N6)	N/A
24	Middle	Maintenance/building inspector	6	Diploma (N6)	N/A
25	Senior	Construction project manager	8	BTech Degree	N/A

### 4.3 PERCEPTION ABOUT CONDITION OF FACILITIES

At this stage of the interview, the researcher's aim was to meet the first objective of the study. Most of the participants perceived the facilities to be in bad condition. Participants justified their opinions and their selected responses are presented below.

#### 4.3.1 Case A

The following are some of the selected responses from participants in case A regarding the conditions of the public facilities. Participants 1, 2, 6 and 9 stated that the condition of the facilities had not improved in the last 5 years whilst participant 3 believed that the condition of the facilities had somewhat improved.

*“Even though I’ve been here for a year, there are facilities that have deteriorated so badly even though they were maintained. So, I wouldn’t say they have improved you know. Also based on the act that we have to maintain every 5 years by the time the maintenance is due, the facilities are badly vandalized by community. Like, you may find there are government facilities that are not occupied/vacant, when community notice them, they just vandalize them. So, if you’ll maintain, install new windows, paint, replace lights ... then within 6 months it’s vandalized again, so how will it look when you come back 5 years later? Definitely terrible” (P1).*

*“No. It hasn’t. It gets worse each year” (P2).*

*“I wouldn’t say it has improved. The thing is Public Works now doesn’t have much control in all public facilities. Like Department of Education now do their own maintenance, Department of Health do their own, Department of Sports same, so what happens is Public Works will have an inspectorate who will go there and inspect, do BOQ which will go for next financial budget proposal. So, these departments receive way low budget than what Public Works receives. So clearly, they won’t have outstanding maintenance. It’s going to be poor. However, Public Works is required to help the departments. But funds they receive won’t be enough to help all departments. With these being said, we end up sitting with huge backlog. So, it’s hard to see what we have progressed” (P6).*

*“Noooo, it hasn’t. it’s even tough to check progress, you can’t tell that we are moving forward or backward. It’s bad” (P9).*

Participant 3 believed some facilities had improved:

*“They have, though sometimes it might not be clearly visible because of the backlog. You know, sometimes the work becomes too much due to backlog which has resulted from most government building for not being maintained for a very long time. So, with the work being too much, you can hardly see progress. But those that were managed to be maintained have improved its condition to date”.*

#### **4.3.2 Case B**

As in case A, most of the participants in case B indicated that the condition of the facilities had not improved in the last 5 years. Examples of the responses are provided:

*“To my observations I wouldn’t say they have improved. Remember you can only say things have improved if the backlog is less. But if the backlog is increasing you can’t say you’re improving. So no, we have not improved. It’s getting worse day by day” (P10).*

*“Um.... I can’t really say they have improved. It’s just bad. Every year we are sitting with same conditions of some facilities. Yes, some we do maintain but they get vandalized within months” (P15).*

*“No, they haven’t, but they are progressive” (P11).*

However, participant 13 perceived that the condition of facilities had lately been improving. The response was:

*“Honestly, If I am to revert back to 5 years then no. But past 2 years there’s been improvement”.*

#### **4.3.3 Case C**

The following are some of the responses from participants in case C regarding the conditions of the facilities:

*“No - no improvement..., we need a facility or maintenance department that will look after all our facilities” (P18).*

*“No, it hasn’t. Reason is facilities that are not occupied or not in use we don’t maintain them due to fear of it getting vandalized. So, we leave them to deteriorate. And today we have high number of facilities that has been left off and no one cares about them. And we cannot be proud about that obviously as it defeats the purpose of the mandate that municipality should adhere to”. (P23).*

*“No, they haven’t. Problem is that the quality is always poor when work has been completed. Also, routine maintenance doesn’t take place thereafter. So, facilities deteriorate faster than they should” (P25).*

#### 4.3.4 Summary

Table 27 present the summary of the responses from each case regarding how participants perceived the condition of public facilities.

**Table 27:** Summary of public facilities condition

	CASE A	CASE B	CASE C
CONDITION OF FACILITIES	Most of the participants perceived the condition of the facilities to have not improved in the past 5 years due to constant vandalism, lack of skilled staff, poor leadership and budget. Whilst a few perceived improvement, it was not noticeable due to backlogs.	The majority of participants perceived the condition of the facilities to have not improved in the past 5 years due to constant increases in the backlog. However, two participants perceived that the condition had somewhat progressed.	All participants perceived the condition of the facilities had not improved in the past 5 years due to poor workmanship, neglect, constant vandalism, lack of a maintenance department.

#### 4.4 CURRENT MAINTENANCE MANAGEMENT SYSTEMS

In this section, the researcher interviewed participants to determined how they perceived the importance of maintenance management systems and their perceptions/ratings of the current maintenance system of their department. This section met the second objective of the study. The majority of the participants provided reasons or justifications for their ratings.

Therefore, the findings of this section are presented quantitatively, indicating percentage of the rating and qualitatively justifying the ratings. Discussion of the findings is then presented at the end of the presentation.

#### 4.5 IMPORTANCE OF A MAINTENANCE MANAGEMENT SYSTEM

Table 28 below presents the findings of how participants rated the importance of an effective maintenance management system. Ratings of each case as well as the total of all the cases are presented. It is evident from the table that all participants believe that it is important for facility or maintenance department to have an effective maintenance management system in place.

**Table 28:** Importance of maintenance management system

Maintenance management system	Case A				Case B				Case C				Total			
	Yes	%	No	%	Yes	%	No	%	Yes	%	No	%	Yes	%	No	%
<b>Participants</b>	9	100	0	0	8	100	0	0	8	100	0	0	25	100	0	0
<b>Total</b>	<b>9</b>	<b>100</b>	<b>0</b>	<b>0</b>	<b>8</b>	<b>100</b>	<b>0</b>	<b>0</b>	<b>8</b>	<b>100</b>	<b>0</b>	<b>0</b>	<b>25</b>	<b>100</b>	<b>0</b>	<b>0</b>

Some participants provided explanations to justify their ratings. Some of the justification or reasons provided in Case A were:

*“Yes, reason is that the environment must be safe, user friendly and be habitable. So, it’s quite important to have maintenance system in place” (P2).*

*“Yes, it is important, it is important to have maintenance management systems in the department, because it will tell you when to maintain and when not to. Also, to know the condition of the building, so ja, it is important” (P5).*

Some justification from case B participants follow:

*“It is very important to have a maintenance management system in place. For any development made by contractors on handover, it is a responsibility of maintenance department to keep the development [in] its state through maintenance” (P14).*

*“Yes, it is. And not just to have it, but it must be enforceable. Today, we are sitting down with good system on paper/files but practically we are doing the opposite of what the system requires us to do” (P15).*

For case C, no explanations or justification were provided. However, a few participants confirmed their rating. For example, participant 18 stated, *“Yes, it is very important.”* Similarly, participant 24 stated, *“Yes, it is”*.

#### 4.5.1 Participant’s rating of their current maintenance management system

After determining perceptions regarding the importance of maintenance management systems, participants, the participants were further asked to rate the overall maintenance management system currently adopted or practiced in their organizations on a scale of 1 to 10. The ratings were presented to participants as: 1 & 2 = Very poor; 3 & 4= Poor; 5 & 6= Fair; 7 & 8 = good; and 9 &10 = Excellent. Table 27 below presents the ratings provided by the participants. It is evident from Table 27 below that all participants across the cases rated their maintenance management system in the range of “very poor’ to ‘fair”. More than 50% in all cases (case A = 55.55%, case B = 62.5%, case C =100%) rated the maintenance management system of their department as “poor”. Table 29 below presents the findings of participants’ ratings.

**Table 29:** Participant’s rating of their current maintenance management system

Cases		Maintenance management system rating (%)										Total
		1	2	3	4	5	6	7	8	9	10	
	Unsure	Very poor		Poor		Fair		Good		Excellent		
<b>Case A</b>		22,22	22,22	11,11	44,44	22,22						<b>100</b>
<b>Case B</b>				12,5	50	37,5						<b>100</b>
<b>Case C</b>				50	50							<b>100</b>

The reasons for such a poor rating were provided by a few participants. For example, one participant from Case A stated:

*“You know what, I want to be very honest with your questions. Our government is dead, there’s no people here, some are already in pension some are due for it, and no open posts. How will work be conducted when there’s no people to carry it out? So, for that reason, I’ll rate it very low because we don’t have workers. It’s really bad” (P9).*

This is what participant 18 from case B stated,

*“I can tell you one thing; our maintenance system is not good because one; we don’t have maintenance department, more especially in municipalities like ours which are located in the far north with no city, just small towns”.*

Similar to the point of participant 18, participant 24 from case C indicated,

*“Our one, it’s very poor honestly. Reason we do not have a department that’s specifically for maintenance and, we do not have people with relevant skills”.*

#### **4.6 MAINTENANCE MANAGEMENT SYSTEM COMPONENT RATING**

To allow for a better understanding of the current maintenance management systems adopted, participants were asked to rate each of the maintenance management system components of their institutions on a scale of 1 to 10. The ratings are presented as: 1 & 2 = Very poor; 3 & 4= Poor; 5 & 6= Fair; 7 & 8 = good; and 9 &10 = Excellent. The findings of each case are presented separately. Both the quantitative data (indicating the ratings) and qualitative data (justifying the ratings) are presented.

##### **4.6.1 Case A**

It can be deduced from Table 30 that participants from case A rated all the components of the maintenance management system in the range of ‘absent’ to ‘fair’. The asset register was rated by the majority of participants (77.8%) as absent. Moreover, all the other maintenance management components were either rated “very poor” or “poor” by most of the respondents. This clearly correlate with the overall rating provide earlier.



**Table 30:** Rating of components of maintenance management system

Factors	Ratings										Total	
		1	2	3	4	5	6	7	8	9		10
	Absent	Very poor	Poor	Fair	Good	Excellent						
Maintenance policy		11.1	33.3	44.4	11.1							100
Maintenance prioritization	11.1		44.4	11.1	11.1	22.2						100
Maintenance condition standards		33.3	11.1	22.2	22.2	11.1						100
Condition assessment		11.1	33.3	22.2	33.3							100
Asset register	77.8			11.1	11.1							100
Maintenance budget			33.3	44.4	22.2							100
Maintenance strategy	33.3		11.1	55.6								100
Maintenance plan			44.4	33.3	11.1	11.1						100
Maintenance schedule	11.1	22.2	22.2	11.1	22.2	11.1						100
Maintenance execution			22.2	55.6	22.2							100

Most of the participants (77.7%) rated the maintenance policy as poor. Although most participants mentioned that the department make use of DIAMA (Departmental Immovable Asset Management Act), the responses suggest that the implementation of the Act was poor. The following are some of the responses provided by participants to justify their ratings.

*“Yes, maintenance policy we do have and it’s approved. But it is not implemented 100%. For example, there’s a clause from DIAMA that says the testing of the equipment like generator, our people are required to test it weekly, and fire equipment on quarterly basis, the air conditioners/ HVAC on monthly basis must be checked. But none of this is being done. No one is putting effort to ensure that the policy is adhered to” (P4).*

*“Yes, let me tell you upfront. You are required to do what we call condition assessment by DIAMA. DIAMA is an Immovable Asset Management Act that requires you to do CA once every 5 years..., like now you know school A will need this, and school B will need this, but where is the budget? So, you end up doing what you call emergency maintenance. There is no budget for routine maintenance so, government rather wait for that particular thing to break then respond to it. So, policy is there yes, but we respond based on budget” (P5).*

*“Yes, it is there. Like I said people here are due for pension. No one cares about these policies or even bother to look at them. So, they are not practically implemented but yes they are there” (P9).*

However, there is a policy as can be inferred from the responses. Participants rated it as poor due issues such as lack of implementation, lack of funds, and retention of old staff approaching the age of pension.

Regarding maintenance prioritization, most of the participants (55.5%) rated it as poor. One participant (P4) indicated that there was no maintenance prioritization system in their department. Below are some of the responses:

*“No, we don’t” (P4).*

*“Yes, but it’s based on what hasn’t been maintained the previous year not what should actually be maintained. Like, if the previous year something wasn’t maintained, on the following year they use that as a priority. But during the time there are also current facilities that are due for maintenance. So, every year the current due maintenance will be maintained the following year. So, it’s a year dragged thing due to backlog” (P2).*

*“Yes, we do have. Yearly we look at the backlog. We have then list facilities that were due for maintenance but never maintained. Then also look at the following year needs. Then we decide which facilities within our backlog are we going to*

*maintain first. And list of activities that needs to take place before the other. So yes, we do have prioritization system” (P7).*

*“Ja... we do have priority system but not implemented. Changes of MECs results in every time changing priorities, so this causes confusion. As I speak, I don't know how our priority system works” (P1).*

Although there seem to be a prioritization system, the implementation of this factor is lacking. It appears that the implementation is more reactive resulting in maintenance backlogs. Moreover, unstable leadership (i.e. constant change of leadership) affected the necessary direction that was needed to implement an effective prioritization system.

Condition standards was rated by 33.3% participants as very poor, 33.3% as poor, and 33.3% as fair. Participants revealed that the factor exists but perceived the implementation to be poor. Some participants explained how their condition standards were adopted.

*“Yes, we do. Our standards are based on our budget. Like what we can afford, as long as it appears functional and safe for use then it's an acceptable standard for us fine” (P2).*

*“Yes, we do. For every facility it has its own condition standards as it serves different purposes. These standards help us what to accept or consider unacceptable. Although it may not be high class standards, but as other person may perceive it but it's acceptable” (P3).*

*“Umh... we used to have standards that we used to stick to. Like, when we maintain buildings, we would know that this building needs to be of this standard and the other of this. Now, we don't know. It's terrible the way things operate” (P9).*

The findings from participants' responses suggests that the maintenance standard adopted is merely based on acceptability which is driven by budget and functionality, whilst

participant 2 expressed how unclear the standard implementation is. These are clear indication of why the standard was rated as poor.

For the condition assessment, the majority of the participants (55.5%) perceived the implementation to be poor. Some participants explained how their condition assessment was adopted and justified the rating. These are some of the responses:

*“Ja... that’s the first thing our act/policy want us to do. The performance is poor because doing condition assessment (CA) every 5 years can’t be effective. By not being effective I mean, some components need CA to be done every 6 months, like equipment such as air conditioners or lifts. One can’t wait that long to find defect or assess the condition, by then it’s already broken and needs replacement, not maintenance” (P1).*

*“Yes, we do. We are supposed to do CA every 5 years. We assess the situation whether the condition has collapsed or not. But even so, they ignore, they completely ignore it. They’ll even go far and say, nooo... this thing is new or recently build so it’s still in a good condition to require maintenance. Then they leave it up until it collapses” (P2).*

*“Yes, we do. The DIAMA document wants every facility to be condition assessed every 5 years. However, we are not consistent in this or do as per requirement. Because there’s always interventions in the government. Lots of changes, lots of plans so everyone ends up being confused on whether we are still operating as per what DIAMA requires us to operate or we operate as per what leaders say. So, it’s a mess. It’s really not being implemented as it should be” (P6).*

Although condition assessment is adopted as part of their maintenance management system, the findings suggest that the approach seems ineffective due to issues such as lengthy time frame, inconsistency and non-compliance or ignorance.

An asset register was rated absent by 77.8% of participants. However, 2 participants mentioned that the factor exists. Participant 3 noted that:

*“We do have asset register which it follows along with our priority system. We have a log that we use to register our assets and record what has been done and left out to allow us to be on track. The only problem we face is keeping on track or updated with the register, you know. Sometimes you have to beg people to do their job”.*

Although the majority rated the factor absent, participant 3 highlighted issues such as incompetent personnel and lack of keeping track as factors that hinder the implementation of an asset register.

Regarding the maintenance budget, participants indicated that budgeting was done. However, most of the participants (77.7%) perceived it to be poorly done. Participants justified their rating and explained how this factor was implemented. These are some of the responses:

*“Yes, we do budget for works. We do budget for planned and unplanned works every financial year. But the budget is not enough for planned works, so what we do we use the money for planned works to cater for unplanned works. So, we are more active on unplanned maintenance...” (P6).*

*“We do, but it very poor. After setting out our priorities, we then determine the cost of the financial year and then the funds will be allocated. Although, it’s not going to be what will be looking for based on the needs or demand. In most cases we get less than we require. So sometimes or in these cases some of the things won’t be [maintained] due to insufficient funds” (P3).*

*“You know, let me tell you... Public Works is the custodian of facilities. So we are supposed to do maintenance for the whole province. So, in each department they’ve got their own budget for maintenance which is very little. In our department (facility) when we budget, the budget which we get from treasury. In the same breath, we are required to assist other departments with our own resources but it’s not enough. Budget it is available yes, but it is not equivalent to the backlog. It’s like a drop in the ocean. So being mandate[d] to assist other departments it’s not practical” (P4).*

*“Yes, we do have. Our budget honestly is not enough based on our backlog. And the more backlog we have we end up sitting with billions set of maintenance work. Like the budget we receive is enough for maintenance if all is well. But since we have to cater for backlog so we end up in a situation where ourselves we decide what we should do and leave out. Even though everything is important” (P7).*

Although the majority of the participants mentioned that there is a budget, participants rated this factor as poor due to insufficient funds, increased backlogs and unrealistic performance expectations.

It can be deduced from Table 28 that the majority of participants (66.7%) perceived maintenance strategy as poor whereas others indicated that it was absent. Participants justified their rating.

*“Yes, we do. Ehhh..., I can’t say much about it. It’s there but with environment operational at most we don’t stick [to] or implement our strategies, we just work as to what has been said by our leaders” (P3).*

*“Yes, we do. But the strategy we use now it’s not the same and effective as the one before. The issue of no human resources is the cause of that, government needs to employ people. And not just people but young people with qualifications and full of energy and not to forget fresh minds or ideas. This thing of only having old people, they use strategy that was implemented years ago. Things [are] different now and ways of maintaining change over time” (P9).*

Participants 1 and 2 indicated that they do not have strategy at all:

*“No...I can’t say we have a strategy, you know. I haven’t seen one, we just rely of the leader’s word of mouth for approach on projects” (P1).*

*“No..., I wouldn’t say we have. You know, things are complex here. It’ll take us the whole day to explain this operation” (P2).*

Whilst other participants rated this factor absent, It is evident from the other participants' responses that issues such as lack of implementation, lack of human resources, retention of old staff who are approaching pension age and stuck in outdated strategy are major challenges that hamper the implementation of the maintenance strategy.

Respondents indicated that maintenance planning was done. However, the majority of participants (77.7%) perceived maintenance planning as poor. Participants explained how poorly their maintenance plan was implemented.

*“Yes, we do planned maintenance which [is] our day to day maintenance. For our day to day, we have system that responds to it. For example, a broken window, or leak water burst, housekeeping we are able to respond to that. And the planned maintenance are ones that are budgeted for. Our plan is always failing you know. Our main problem is just finance which breaks our plan” (P3).*

*“... most maintenance plan that is implemented is the reactive one. Just because its emergency so we are able to react on it but also depends if what type of emergency it is. Like if it's in relation to water or electricity we can respond but structurally no we cannot...” (P4).*

*“...Our approach is always unplanned like basically ones that requires emergency responds or if a certain component breaks down. We mostly focus on these as budget for planned works is always not enough. So, we rather wait for something to completely be not functional then we maintain or replace. It's not helping but it's our approach” (P6).*

*“Yes, we do plan[ned] and unplanned. But mainly unplanned due to failure to plan and strategize internally. Also, budget constraints. So, we wait for components to break down so we can maintain. So do not perform routine maintenance, its costly and government always says they don't have money” (P9).*

Although the factor is adopted, the majority of participants rated the implementation as poor. The findings from participants' responses suggest that their maintenance plan only reacts to emergency maintenance (unplanned maintenance) due to budget constraints which militate against implementing a routine maintenance protocol.

Maintenance scheduling was perceived to be between very poor and fair. Participants justified their ratings. These are some of the responses:

*"I'd say so...but no one follows it or update[s] the schedule. Work just come[s] out of the blue. So, it's as good as we don't have one" (P1).*

*"Yes, we do have. This follows after having a plan in place. But implementation of it is poor. Because we only implement emergency works only" (P5).*

*"Yes, we do. We scheduled approved maintenance works based on whether funds are allocated to it or not. If no funds, we discard it even though it needs to be maintained. So, it's really not effective as we don't much maintenance in a year (P8).*

Participant 7 perceived it to be fair and justified the rating. The response was:

*"We do have maintenance schedule. We schedule for what we need to maintain. Effectiveness maybe yes on emergencies of activities mentioned earlier, water and electricity. We only schedule activities of these items if only they have broken down or faulty, not routine maintenance".*

The majority of the participants rated the implementation of maintenance schedule poor. It can be inferred from participants' responses that issues such as inconsistent updates, improper scheduling such as scheduling only emergency maintenance works obstructed effective implementation of this factor.

Maintenance execution was rated to be an existing factor. However, it can be deduced from Table 28 that most of the participants (77.8%) perceived it to be poor. Reasons for such ratings were provided by the respondents.



*“... We do both in-house and outsource. Our in-house team who are our technicians do minor works like renovations that doesn't require specialists. So outsourcing is based mainly on specialist work. Before it used to be any project of above R2 million should outsourced, but today even if R500 thousands it can be outsourced. For example, installation of air conditioners, our in-house team don't have such expertise. The performance is honestly poor for many reasons. Maybe if government can increase budget to consequently increase our resources we can perform better (P4).*

*“We mostly do maintenance on a day to day bases just to cool in the fire. But we do combination of both in-house and outsourcing approach. Let me tell you something, remember if we don't do maintenance the building will deteriorate faster and lead to refurbishments not maintenance. Some facilities do reach that stage as we fail to do day to day on them. Then we advertise to contractors that this block of flats or offices needs refurbishment then when they do it, we again to maintain it and the circle continues” (P5).*

*“Ehhhh, our in-house has no more labour[er]s like before. Today we don't have plumbers, electricians and all technical workmanship. If we do, our labour[er]s don't have tools or materials to work with. Some of those who are more passion with their jobs buy their own tools. Government isn't providing them anymore like before and I don't know why. So now our maintenance team will just come to work and sit and not being bored because they are getting paid and they have valid facts to say we don't have tools or material” (P6).*

*“As I've mentioned earlier, we outsource projects which goes through tendering process. And our internal projects we use our own labour which they maintain minor works. Our tendering process for outsourcing is a nightmare and also our internal projects our own labour do not have enough equipment to perform works” (P1).*

*“You know what, there has been huge failure in execution because of outsourcing. The people who were or are put in place for maintenance they don’t have expertise, they are just in a “tender entrepreneurship”. So, the standard that is required is never reached” (P9).*

It can be inferred from responses the both in-house and outsourcing approach was adopted to execute maintenance work. However, participants rated it as poor due to issues such as lack of human resources (e.g. specialized labour), lack of equipment or material for in-house teams, outsourcing processes that are not transparent, poor selection of maintenance contractors with no expertise which consequently results in poor workmanship and performance.

#### 4.6.2 Case B

It can be deduced from Table 30 that participants rated all the component factors of the maintenance management system in the range of “absent” to “fair”. Fifty percent (50%) or more respondents rated four factors absent, whilst the other maintenance management system factors were rated as either “very poor” and “poor”. The factor rating is presented in Table 31 below. Participant’s responses are also presented.

**Table 31:** Rating of components of maintenance management system

Factors	Ratings										Total	
	Absent	1 Very poor	2 Poor	3 Fair	4 Good	5 Excellent	6	7	8	9		10
Maintenance policy		12,5	12,5	62,5	12,5							100
Maintenance prioritization	37,5		37,5	25,0								100
Maintenance condition standards	50,0	37,5	12,5	12,5								100
Condition assessment		37,5	25,0	25,0	12,5							100
Asset register	87,5		12,5									100
Maintenance budget			37,5	62,5								100

Maintenance strategy	75,0	12,5	12,5				<b>100</b>
Maintenance plan			75,0	12,5	12,5		<b>100</b>
Maintenance schedule	87,5		12,5				<b>100</b>
Maintenance execution			37,5	37,5	25,0		<b>100</b>

The majority of the participants (75%) rated maintenance policy as poor. Most participants mentioned however that the DIAMA (Departmental Immovable Asset Management Act) was applied. The following are some of the responses provided by participants to justify their ratings.

*“Yes, we do have. The performance of our maintenance policy is bad. People don’t follow the policies properly or maybe know what the policy says. That’s why we end up failing our priority system” (P10).*

*“No, we don’t have. We actually do not even have a maintenance department. Like, for example, the schools that we managing (the schools itself) do not have maintenance department or personnel. The teachers report maintenance themselves or replace something if broken for example a window. There is no one who assess the facilities that can do reporting to state if the facilities are safe or not. Like no one. I have come in board, I did maintenance policy for these schools, they got approved but they were never implemented, for one, there are no people to implement them. So they are good as they are not there. There are no maintenance plans, no budget even, just nothing. They only do replacements of components with maybe stationery budget” (P12).*

*Government needs to employ people; the facilities are dilapidated. Me alone I cannot assist government in these areas, I need support from people that we don’t have. It’s tough and sad. The only type of maintenance is done is housekeeping. Which actually this doesn’t even fall under maintenance” (P13).*

*“Maintenance policy, it’s there. We do have one from DIAMA. Um, yes the policy it’s good but within the department it’s not implemented correctly” (P15).*

Although policy exists, the majority of participants rated it poor due issues such as lack of implementation, lack of personnel in the department, retention of staff approaching pension, and lack of skills.

It can be deduced from Table 30 above that 37.5% of participants (i.e. participants 10, 14, 16 & 17) indicated that there was no maintenance prioritization system, whilst the others perceived it to be poorly implemented. The following are some of the responses from participants to justify their rating:

*“We don’t have clear priorities as we wait for breakdowns so to react. So whatever breaks down first that’s what we attend do” (P12).*

*“Yes, it is there. But our priority systems are based on broken down components. Like what’s damaged and which one is important over the other. So, this is where we exercise our maintenance priority system. Having to replace components is more expensive than doing routine maintenance, where sometimes we leave it completely as it is costly” (P13).*

*“Yes, we do. But not implemented” (P15).*

It appears the system is more reactive to broken down components which is thus the reason that they do not have a priority system. The findings suggest that the implementation of this factor is based on the failure of a component which is then prioritized as emergency maintenance provided funds are available. Another issue indicated by participants was the lack of implementation.

Regarding maintenance condition standard, 50% of the participants (i.e. participants 10, 12, 14, 16 and 17) indicated that it was absent whilst others rated it as either poor or very poor. Participants justified their ratings:

*“Um, you know what, that is difficult to say. But all I can say we don’t have condition standards like in our policy that we can follow. For example, having paperwork/guidance that says sports facilities as per government should look like*

*this, buildings like this, no... we don't have that. We just have acceptable standards which we judge by functionality. If its functional then it's acceptable standard. Even when quality is low, we accept. Then 6 months later it's dilapidated again" (P11).*

*"Our standards are not clear. We basically just work based on our budget. If our budget doesn't fit the actual standard we still go ahead, maintain and accept any related standard to our budget" (P15).*

Participants expressed that the approach is based on acceptability where it is driven by budget and functionality but not quality or properly determined standards.

For condition assessment, 37.5% perceived it to be very poor whilst 50% rated it as poor. Participants justified their rating and detailed how the factor was adopted.

*"We have inspectorate who does assessments every 5 years and writes report to HOD on what they find and what needs to be done to keep the facilities at good conducive environment. This is not effective. I mean the time period, like if you look at it, if you do assessment every 5 years how much of damage are you going to find? Definitely a lot, and the question is, will the department have finances to maintain and repair all that? Definitely no. So, if it was done yearly maybe we could be having a different conversation. Do you understand?" (P10).*

*"Yes, we do our condition assessment every 5 years. Ah, the performance I'm not sure if I should complain or what. However, even when condition assessment is done, if nothing is done after it is carried out then what's the point of doing condition assessment? Government will always say there's not enough budget, today we are sitting with a huge backlog and what do we do about it? Nothing" (P11).*

*"Our condition assessment is done every 5 years as per DIAMA policy. The performance is not up to good standard. We do not do our assessment based on technical aspects, like equipment to be fully tested, lifts to be tested and so forth. But we do not do any of these" (P12).*

Although there seem to be condition assessment in the maintenance system, the findings suggest that the approach adopted is not effective, because the implementation is insufficiently technical, inconsistent and the period adopted is too long.

Maintenance budget was rated by all participants as poor. The participants justified their rating and detailed how the budget was allocated. The following are some of the responses:

*“Yes, of course we do have budget. But the downfall of our budget is not based on the needs (current or future) but it’s based on what they want to offer us. And in most cases, it’ll be relatively low. And I understand why they do so, as sometimes money can end up in wrong hands... what we call corruption or maybe our needs are way too extreme as we have a huge backlog and obviously that’s costly” (P12).*

*“Yes, of course we do have. The districts allocate funds to us and we have to do planning based on it. In most cases our budget allocation is fixed every year, just an appreciation of 10% due to inflation. However, yearly things get expensive by more than 10%, so imagine how tough things gets on us. So, at the end of the day the funds become really low that we basically cannot afford to do routine maintenance” (P13).*

*“Yes, we do. Our budget that’s allocated for us is very poor compared with facilities that need to be maintained and the backlog that we have. How can one maintain works when there’s no financial support? It’s difficult” (P16).*

Although there is a budget as can be inferred from participants’ responses, insufficient funds resulting in huge backlogs, poor allocation of funds, lack of transparency and corruption were identified as major challenges.

The majority of participants (87.5%) rated maintenance planning as poor. Participants explained how the maintenance plan was adopted and justified their rating.

*“...you know what, the policy says we must do unplanned and planned maintenance. But the issue with planned maintenance requires more money as one*

*has to continuously do routine maintenance, testing equipment and all. Which our in-house team have no skills in performing such works and hiring a contractor for routine works is expensive. So hence we don't do it..." (P12).*

*"Yes. Ideally, we are supposed to do preventative maintenance and routine maintenance. However, we do not have in-house team with the right skills to perform daily maintenance works and hiring a contractor or outsourcing is expensive. Therefore, we now do breakdown maintenance. And for these types of maintenance we outsource them. Um, honestly if one understands what maintenance is, this shouldn't be an approved manner of doing things. It ends up not being maintenance but something else" (P13).*

*"Yes, we do reactive maintenance. On cases where you find there's sewage blockage or something. Our reactive maintenance it is effective. However, its costly as now you have to replace whole thing. If we were doing routine maintenance, we would not need to replace anything but just continue maintaining the component" (P11).*

Although some form of maintenance planning was done, the implementation was reactive due to issues such as budget constraints and lack of expertise within the in-house team.

Most participants (75%) perceived maintenance execution as poor. Participants justified their rating and explained how the factor was adopted. Here are some of the responses:

*"We usually tender out most if not all works. Reason being we don't have internal staff that can carry out works even if it's minor works. So, we just outsource. In terms of performance honestly contractors are just in it for cashing in money. The quality of works is always poor but ... they accept it" (P10).*

*"We've got in-house teams that do general maintenance. For example, cleaning our facilities, changing lights and so forth. Then we outsource for specialized works that requires skills. The outsourcing approach is really expensive as I believe some of the works being outsource could be done internally if we employ artisans. But now we get double rated (taken advantage of us because we are government). So, I*

*believe some of the work is unnecessary to outsource and government should focus on employing people” (P15).*

*“We do outsource and in-house. But our in-house team has no sufficient personnel. This makes our system to not be as effective as it should be. Outsources, we only do in cases where things are beyond our control and rehabilitation is now required” (P17).*

Participants rated maintenance execution as poor due to issues such as lack of skilled human resources and lack of equipment or material for in-house teams. With regard to outsourcing, there was poor selection of maintenance contractors with poor workmanship, and unnecessary outsourcing of work.

The remaining factors (asset register, maintenance strategy and maintenance schedule) were perceived by most of the participants as absent, although one participant explained that asset register and maintenance strategy were part of the maintenance system.

*Yes, we do. We obviously do have register of our facilities or assets and records of their conditions. But what does that help with? (P15)*

*“Yes, but not implemented. We just hear from our leaders how they want us to approach works”. (P15)*

Although the majority of participants rated these factors as absent, one respondent indicated that lack of implementation was the challenge to the implementation of both the asset register and maintenance strategy.

#### **4.6.3 Case C**

It can be deduced from Table 32 that the majority of participants in case C rated six of maintenance management system component factors as absent. Moreover, participants rated the other maintenance management system factors as either ‘very poor’ or ‘poor’.



**Table 32:** Rating of components of maintenance management system

Factors	Ratings										Total	
	Absent	1 Very poor	2	3 Poor	4	5 Fair	6	7 Good	8	9 Excellent		10
Maintenance policy	87,5	12,5										100
Maintenance prioritization	62,5		37,5									100
Maintenance condition standards	87,5		12,5									100
Condition assessment	12,5		37,5	12,5	25,0	12,5						100
Asset register	100											100
Maintenance budget	12,5			37,5	50							100
Maintenance strategy	87,5				12,5							100
Maintenance plan	25,0			37,5	37,5							100
Maintenance schedule	87,5			12,5								100
Maintenance execution			50,0	37,5	12,5							100

Maintenance policy was rated by 87.5% of participants as absent. Participants justified their reasons, and these are some of the responses:

*“Yes, we do have policies but they are not implemented fully. That’s why, if they were implemented fully we wouldn’t be facing what we actually facing now with our roads and buildings” (P18).*

*“Yes, we do. But it is not clear on what it requires us to do. So I think we need to revise this internally but the problem is we do not have right people with the right knowledge that knows what a maintenance policy consist of. So this is where the problem of many starts” (P20).*

*“We do have one, which was drafted years ago like more than 20 years. Surely it has dust at the moment (giggles). Like if you were to ask employees who are*

*appointed under maintenance what our policy says, I don't think you'll get answers. Here in this municipality what we do, we normally just rely on what community complains about. For example, if the community complains about bad road infrastructure, then that's when we sit and discuss the way forward. Just routine maintenance, that's just a dream for everyone" (P23).*

Issues such as lack of a maintenance department, lack of staff, and old policies that serve no purpose have been expressed as major challenges to implementing maintenance policy. This explain the high number of dilapidated facilities in Limpopo province.

Most of the participants (62.5%) mentioned that a priority system is absent, whilst others (37.5%) rated it very poor. Participants justified their ratings.

*"yes, we do prioritize based on the community outcry as mentioned. So, if there's school or road or water burst being reported to not being at good condition then we do prioritize on which should come first" (P19).*

*"Um... I think our priority is only on electrical and water. These are things that's attended to mostly. If its related to structure or building or sport centers, there's no maintenance that's done unless its cleaning or it has been reported that there's no water or electricity" (P20).*

Although some participants said that prioritization was implemented, it is evident from the responses that it was not, because they relied on the community to tell them what to maintain, and if they did, it was restricted to selected problems such as water or electricity.

The following factors (maintenance strategy, maintenance schedule, asset register, and condition standards) were also rated absent by participants.

Regarding condition assessment, 37.5% perceived it as very poor whilst another 37.5% rated it as poor. Participants justified their rating and detailed how the factor was adopted.

*"Um... not really. We do assessment but it's not a planned one, ...like I said, we listen to outcry, then that's when will go do assessment and assess the condition" (P19).*

*“Um.... Yes, we do assess if there's issues that has been reported faulty like on water or electricity. We basically assess when we want to maintain not just for records, no” (P20).*

*“Yes, we do. We do this when we have identified facilities that we need to maintain for that particular year or following year and in most cases, this would have been brought forward by the community. Which helps us to know how much of a budget are we looking at” (P24).*

Although condition assessment is done to an extent, the approach adopted is ineffective. It appears it is not planned at all; thus, conditions are only assessed when the community reports an issue then that's when assessment or maintenance will be done.

A total of 87.5% of participants perceived maintenance budgeting to be poor. Some of the responses to justify this rating are provided below:

*“Yes, we do have. But you know, with the backlog we have, we can never have enough budget for it. And, sometimes we don't receive the funds in time. Like funds can even delay by 6 months for maintenance. Sometimes even a year or 2” (P19).*

*“Yes, we do. Just that it's not consistent. Like we not sure how it is calculated” (P20).*

Although budgeting was done, it was ineffective due to issues such as inconsistent funds allocation, insufficient funds, and delay in funding allocation

For maintenance planning, 75.5% of the participants rated it as poor. The reasons for the ratings were provided by respondents.

*“Yes, we do. We do unplanned maintenance. The only thing we do often is housekeeping and basic stuff like changing lights etc. As for unplanned maintenance, this is where most of our budget goes to. Even though the department believes that this is a low-cost type of maintenance but it's actually the one that cost us most of money. Reason is when we react to breakdown maintenance, it is highly likely that we are going to need to replace not to maintain. But if we were to do routine maintenance, we would highly likely not to reach this stage” (P20).*

*“Yes, we do routine maintenance which it is conducted by in-house team. We also do reactive maintenance for obvious reasons if for example there has been a blockage of pipe. Um, for rating the performance, I’ll say poor because our in-house team do not have full capacity to carry out works. Like for example, do not have tools, they don’t train them on how to maintain machinery, so even if the work is minor...let say a bolt was just loose that’s causing loud noise in the building, instead of them detecting the [fault] they leave it because they don’t know what to do...Also, our in-house team is old and do not have enough energy to perform works. They are just waiting to retire” (P22).*

*“...But we only act on unplanned maintenance for obvious reason. Like we don’t have money and skills to carry out planned maintenance works” (P23).*

Although some form of planning was done, it was not well thought out. Reasons for the lack or poor planning were lack capacity of in-house maintenance team, aged staff members, lack of funds and lack of tools.

Regarding maintenance execution, 50% rated it as poor whilst the other 50% rated it as very poor. Participants explained how the factor was adopted and justified their rating.

*“yes, we do in-house and outsourcing, we approach it when there’s a rehabilitation or renovation tender in place. Ah... in terms of outsourcing, I do not think we are looking at right contractors that can perform works at good and acceptable standard. The procurement system in selecting contractors is flawed and corrupt. Some contractors will go as far as doing zero works and no one will be held accountable” (P20).*

*“In-house and outsourcing. For projects or maintenance work over a million rand we outsource. Basic routine works we do in-house. Both ways are not effective as they should be. If it’s not in-house struggling and not being able to perform due to no full capability be it knowledge or lacking equipment, then it’s corruption that comes in selecting a contractor as an outsource to maintain works” (P24).*

*“We do both in-house and outsourcing. Downfall to our in-house team is shortage of skilled staff (like people who got technical skills). Also, they have insufficient tools or equipment” (P25).*

Maintenance execution was perceived as ineffective due to issues such as lack of capacity, lack of equipment, poor contractor’s selection, corruption, lack of skilled staff and accountability.

#### 4.6.4 Summary

This section presents the combined maintenance management system rating from all cases. Table 33 presents a summary of maintenance management system ratings. It is clear from the responses that public facilities are in a bad state due to poor implementation, as a result of retention of ageing staff and poor budget and/or absence of maintenance management system factors.

**Table 33:** Summary of maintenance management system rating

	CASE A	CASE B	CASE C
Maintenance management system factor rating	<p>Participants rated most of the factors as either “very poor” or “poor”. The main reasons for the ratings are:</p> <ul style="list-style-type: none"> <li>• Poor implementation of policy,</li> <li>• Insufficient budget,</li> <li>• Retention of old staff,</li> <li>• Constant changes of priority system due to changes of MECs,</li> <li>• Implementation of poor standards,</li> <li>• Poor timeline of implementing condition assessment,</li> <li>• Poor implementation of strategy,</li> <li>• Poor approach of maintenance plan,</li> <li>• Poor implementation of maintenance schedule (irregular updates),</li> <li>• Poor implementation of maintenance execution due to lack of resources (human and equipment) for in-house team and</li> </ul>	<p>Three factors were rated absent by participants which were asset register, condition standards, maintenance schedule and strategy, whilst the others were rated as either “very poor” or “poor” due to the following reasons:</p> <ul style="list-style-type: none"> <li>• Poor implementation of policy,</li> <li>• Insufficient budget,</li> <li>• Retention of old staff,</li> <li>• Unclear priority system,</li> <li>• Poor timeline of implementing condition assessment including non-technical assessment,</li> <li>• Poor approach of maintenance planning,</li> <li>• Poor implementation of maintenance execution due to lack of resources (human and equipment) for in-house team and poor</li> </ul>	<p>Participants rated almost factors “absent”, whilst the others were mainly rated as either “very poor” or “poor” due to issues such as:</p> <ul style="list-style-type: none"> <li>• Lack of maintenance department,</li> <li>• Lack of skilled staff,</li> <li>• Lack of equipment and/or tools,</li> <li>• Lack of funds,</li> <li>• Corruption,</li> <li>• Poor selection of contractors</li> <li>• No policy to guide how maintenance should be carried out.</li> </ul>

	poor selection of contracts when outsourcing.  Seemingly, only one factor, “asset register” was perceived as absent.	selection of contracts when outsourcing.	
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**4.7 SECTION C: CHALLENGES**

This section answered the third objective of the study. During the interview, the researcher asked participants to describe challenges that they faced that hindered the effectiveness or implementation of their maintenance management system. From the interviews conducted, it was found that the majority of the challenges faced in all the cases were common whilst a few were peculiar to the specific cases. Table 34 shows a summary of all the challenges identified in all the cases. The common challenges are presented together first, followed by those peculiar to the specific cases.

**Table 34:** Summary of challenges

	Case A	Case B	Case C
Challenges	<ul style="list-style-type: none"> <li>• Budget inadequacy</li> <li>• Lack of leadership</li> <li>• External interference</li> <li>• Maintenance contracts</li> <li>• Climatic conditions</li> <li>• Vandalism &amp; misuse of facilities</li> <li>• Traditional system</li> <li>• Lack of expertise</li> <li>• Theft</li> <li>• Retention of ageing staff</li> <li>• Shortage of water</li> <li>• Poor staff capacity</li> </ul>	<ul style="list-style-type: none"> <li>• Budget inadequacy</li> <li>• Change of leadership</li> <li>• External interference</li> <li>• Procurement</li> <li>• Recruitment process</li> <li>• Authority</li> <li>• Climatic conditions</li> <li>• Vandalism</li> <li>• Traditional system</li> <li>• Lack of expertise</li> <li>• Skills mismatch</li> <li>• Retention of ageing staff</li> <li>• Poor staff capacity</li> </ul>	<ul style="list-style-type: none"> <li>• Budget inadequacy</li> <li>• External interference</li> <li>• Maintenance contracts &amp; procurement system</li> <li>• Climatic conditions</li> <li>• Vandalism</li> <li>• Traditional system</li> <li>• Lack of expertise</li> <li>• Theft</li> <li>• Shortage of water</li> <li>• Lack of maintenance department</li> <li>• Corruption</li> </ul>

**4.7.1 Common challenges**

Most challenges found to be common across all cases included budget inadequacy, leadership, procurement, vandalism, theft, shortage of water, climatic conditions, external

interference, lack of staff capacity and traditional (manual) system. These challenges are presented in the following subsection.

#### **4.7.1.1 Budget inadequacy**

Inadequacy of funds is one of the main challenges faced by maintenance department in many parts of the world. This challenge was mentioned by most of the participants in all the cases. Example of responses are provided below.

*“You know, main challenge is lack of funds, resources are always limited because of funds. So, if budget can be increased then least to our problems can be reduced” (P3).*

*“Lack of funds is honestly an issue. The main reason why we mostly perform emergency maintenance is because we do not have enough funds for routine maintenance. Instead of constant maintaining equipment at periodic times, due to lack of funds, we wait for the equipment to break down then we replace. Similarly, to structural components e.g. roof, we wait for it to leak or fall off to replace it” (P6).*

*“Funds allocated to us is very little to what our facility maintenance requires. Thus, it makes it so difficult to maintain and keep up with the facility standards. Without funds, there’s nothing we can do really in terms of maintenance” (P15).*

*“You know what I can tell you, yes we may be lacking funds but even if we had who was to utilize the funds? Definitely no one. So before we first lay our outcry into lack of funding we need to first liaise an issue of lack of maintenance personnel. We do not have maintenance team to execute maintenance works, only after this then we can talk about budget allocation or it can be proposed. But we don’t have maintenance department at all so where can the funds be allocated to and utilize by whom?” (P21).*

#### 4.7.1.2 Leadership

Leadership was identified as a challenge in all the cases. Participants explained how lack of leadership and changes of leadership had negatively impacted on their maintenance management systems. Below are some responses from selected participants.

*“Ja... you see, let’s say there’s cabinet reshuffle ...any changes in the state, where you find there’s changes of HOD, works usually stops until the new HOD is fully assigned and this can take 3 months. You know, this impact the progress of the project. For example, in terms of procurement of resources and the supply chain of it, when needing approval from HOD in order to progress with works, then you find there’s no HOD because of politics that transpired due to cabernet reshuffle. Then the work has to stand still, and time is money.” (P1).*

*“Leadership challenges caused by everything that has to do with political interference. There’s poor selection of leadership and this rises because of political intervention. We lack leadership, we lack expertise on jobs from our leaders...” (P7).*

*“In our situation politics plays a very important role. Let me give you an example; in our department where I am working, for the past 3 years we had more than 4 MECs. Remember when they change MECs they bring in new staff, like his/her new HOD and many more. And not only do staff change but plans too. I do not know how many times we have changed our 5-year plan. Like the 5-year plan has never worked even once, always changed. So, it doesn’t really help at all. It really affects us. We have policy from DIAMA which is an immovable asset act which says that each and every 5 years we have to do CA. So, we plan for that including budget for every financial year of that 5 years. So, these get changed during the process and ends up 5 years later nothing was done. This impacts us financially, and being labelled as incompetent” (P10).*

*“Yes, honestly we cannot yield political interference. Changes of MECs and politics interfering on what we need to do and leave out. Even if you had plans, MECs come and change everything. Basically, forced decisions, no one will bother to explain why we are changing plans and all that. You just have to keep quiet and do what*



*they say. It's really a challenge. Of course, this impacts us in not performing works. We waste time" (P11).*

*"The issue with constant changes of leaders goes back to recruitment processes where employees are recruited via back doors and more often than not, they employ their friends or families even though they don't have the skills the department needs. That impacts us badly as instead of me doing my job then I have to use my time teaching my so-called supervisor on how to do their job" (P14).*

*"You know what, we do not have leadership here. Obviously for reasons mentioned earlier that the issue starts with lack of maintenance workers. So we absolutely have no one to lead us nor [represent us]. Our maintenance just generally relies when facility has fully collapsed and not usable or safe" (P19).*

Similarly, P22 resonated with P19 and said, *"We do not have leadership for one, we have no maintenance team nor department."*

It can be deduced from participants' responses that the issue of constant changes of leadership is a challenge. It can also be inferred from participants' response that this challenge is caused by political interference. The findings also show that changes of leadership are prevalent because most institutions/departments do not have comprehensive management guides to regulate the conduct of leadership appointments, the skillset required, and capability, as indicated by Participant 14. Further, Participants 19 and 22 indicated that lack of leadership was mainly due to the absence of maintenance teams and departments. Thus, there is no one accountable or responsible to care about maintenance works.

#### **4.7.1.3 Procurement (maintenance contracts)**

Participants from all the cases mentioned maintenance contracts or procurement as one of their challenge. They explained how this challenge affected their implementation of the maintenance management system. These were some of the responses:

*"...also, the issue of maintenance contracts for non-compliance it comes at handy and it is motivated by politicians. This impact us in a way that we are known or labeled as constant poor service delivery" (P7).*

*“Um...the issue of contractors selected. They usually don't finish their work. These types of contractors are awarded tenders because of political intervention. These people only want money. Their interest it's really not about work. And this impact on budget and time. Imagine the process of having to advertise, quotation, appointing new contractor it's too much” (P9).*

*“As mentioned earlier the selection of contractors, decisions are based on politics not on inability to perform works. This affects us again on budget as we have to fund same project for same works over and over again” (P21).*

*“The political part determining who gets the tender and who doesn't and who it should benefit amongst stakeholders is not working for us. They do not care about the actual work but care about who must get tender money. Hence works end up not being performed. This obviously impacts us on failing to perform works and having to plan for same works over and over” (25).*

*“... I think the maintenance procurement system is as well a huge challenge. It is a lengthy procedure and even if you only need materials for our in-house team it can take months to get processed. And during that time, obviously maintenance is delayed” (P11).*

*“Procurement system. The system of tender awarding or even just to procure maintenance equipment is just flawed. The system is long and complex this needs to be changed and needs more transparency too...” (P24).*

It is evident from participants' responses that the procurement system is indeed a challenge faced by all cases and that results in delays of execution of maintenance work. It can be inferred from participants' responses that contractors selected through the opaque recruitment system are non-complaint. The main reason for the non-compliance was identified as political interference which plays a huge role in awarding of the contracts

and also in acceptance of non-performance, which consequently results in contractors not putting any effort into the scope of works, and thus poor performance.

#### **4.7.1.4 Shortage of water**

Lack of water was one of the challenges mentioned by participants in all cases. Participants explained how this challenge impacts their maintenance management system. These are some of the responses from all cases:

*“Um... here in our district, there’s shortage of water due to drought. So, what I’ve noticed is that shortage of water leads to...geyser damage. When there’s no water and the geyser is on, it burns the elements in it. Where now you have to keep replacing because some burns completely that you cannot maintain them. Also, blockage of public toilets as there’s no water to flush the waste. This goes back to straining budget” (P1).*

Similarly, Participants 4 and 21 expressed the same problem in different terms .

*“We only experience dryness. Limpopo it’s a very hot province and we face drought every single time. So, some functions in a building gets badly affected because there’s no water. For example, toilets easy block because people in public space end up not flushing toilets that results in a blockage. So weekly there’s blockage of toilets. Constant maintenance for weekly blockage is a lot of money that was never budgeted for. That impacts us really bad financially” (P4).*

*“Um, lack of water due to dams drying out as the temperature is extremely hot. The impact on this is not able to work as people will need to use bathrooms and there’s no water. So, if we don’t have water, we don’t work at all. And sometimes we can go 2 weeks without water that means no work” (P21).*

*“...you know what...as you also from Limpopo you know that there is water crisis. Our dams are very small and dries out quickly due to hot temperature. So water challenge does affects us hugely more especially in facilities like public hospitals. These facilities need water to be fully hygienic ... and functional. Even in schools or offices, we cannot work as there is no water and bathrooms aren’t working. Lawns*

*or landscape deteriorates faster and so many effects as results to no water. So yes, it is a challenge” (P17).*

It is evident from participants’ responses that shortage of water is an immense challenge. The findings suggest that shortage of water is a result of drought and the effects on maintenance of facilities is huge. Participants indicated that shortage of water can result in constant blockage of building components such as toilets (which are not flushed after use), public hospitals are not in hygienic condition, air-conditioning elements are affected and gardens deteriorate quickly. In sum, this increases the deterioration of facilities to the point of being dysfunctional or unfit for purpose.

#### **4.7.1.5 Climatic conditions**

Weather effects were one of the challenges mentioned by participants in all cases. Participants explained how this challenge impacted their maintenance management system. Participants 10 and 22 expressed how physical temperature affects the implementation of the maintenance management system.

*“I can say rain damages. Sometimes weather can be a challenge. Like if there’s heavy storms, it can happen that roofs of structures gets damaged. And obviously, one has to react to that immediately. So, this comes down and affects the budget. Because this was never catered for when planning for maintenance” (P10).*

*“Obviously rain damages. Like our facilities have already dilapidated. Like roof structures aren’t strong anymore. So, come light rain there’s leaks or damages. And it impacts us on budget as we will have to replace most of the things” (P22).*

*“I’ll say it’s weather issue. People cannot work when temperature is above 40 degrees. And in Limpopo this can be a temperature for 3 days a week. So, the amount of work delayed due to this, result in us Public Works delaying to deliver” (P15).*

Similarly, Participants 20 stated that *“Limpopo is a very hot province and thus affect us in terms of production or the ability to work. We sometimes cannot work when the weather is extremely hot and thus contributes to non-performance of maintenance”*.

It can be inferred from participants’ response that environmental factors are indeed a challenge. Issues such as drought, extremely hot temperatures and unpredicted rain effects were raised as major contributors to this challenge.

#### **4.7.1.6 Vandalism**

Vandalism was identified as one of the biggest challenges. Participants expressed the root cause of this challenge and how it impacted their maintenance management system. These are some of the findings from some of the participants’ responses:

*“Vandalism, vandalism... as I’m speaking with you now, there is one of the facility in the village that has just been vandalized by the community because the royal family is having conflicts with the municipality and ordered people to vandalize government office. They broke everything, air conditioners, lights, windows, gates, boreholes JoJo tanks and many more. This will take us back in terms of progress and obviously this impact us financially. The cost of replacing this is higher than maintenance cost” (P2).*

*“We experience vandalism a lot. You find that there were properties that were not fully utilized. So, 3 years ago, the department decided that they will only maintain properties that are fully utilized and neglect the ones that are not. The reason being to avoid vandalism, as they have found that if they maintain these unutilized properties, three months down the line vandalism takes place. So, this was a departmental decision to say no...we can’t carry on like this. We will rather maintain when it wants to be occupied. So, our strategy is the property must be fully utilized to maintain. It impacts on us financially in the long run as the facility will dilapidate” (P3).*

*“We experience vandalism. We have what we call civil unrest. What you call it? Um, protest (that’s the word I was looking for). Where you find people protesting because*

*they feel we are not providing them with what they need, like tar road or they want sub-contracting. So, they'll go vandalize and burn one of the facilities. Of course, this affects us badly, because remember we are sitting with a backlog, so if you burn what we have just maintained then will never get rid of our backlog" (P5).*

*"Changes of MECs brings huge impact in the community unrest. Imagine if this community was told that we are going to do this in this area, for example, bring water, fix sports ground and all that. Then MEC comes and say noooo, leave this community let's do the other one. Definitely there's going to be strike, and strike leads to damages. And all these can be avoided if MECs wouldn't come and change plans. But pride allows them to make bad decisions. Not wanting to carry over and continue but start afresh with a fresh idea. It's not right" (P10).*

*"Once we promise our community to deliver certain services and we don't do so, definitely it'll leads to community unrest. People are going to strike, and strikes within our community are never peaceful, there has to be vandalism of some sort. Budget will always be strained and impacted for as long as this behaviour continues. But we also can't blame them. The only way to stop this is to deliver what's due to them and we don't." (P11).*

*"...we have what we call community unrest. This is triggered by so many factors. Government not delivering services, or them striking to have new mayor over the other, want employment. So many things, and it never ends well as the facilities gets damaged. This impacts on budget obviously" (P21).*

*"...users not caring about the facilities. Polluting, drawing up in walls creating arts. You see, you'll find a lot of these. You paint wall today, tomorrow there's an art drawing on the wall...They damage them more to a point where the government cannot have funds to maintain it. So, it's tough and affects budget very big time". (P7)*

It can be inferred from participants' responses that vandalism is a huge challenge. Participants mentioned that vandalism occurs through pollution, graffiti, and community unrest due government's failure to provide required services to the community.

#### **4.7.1.7 Theft**

Participants in all cases revealed theft as one of the major challenges affecting the implementation of maintenance. These are some of the responses:

*“We experience theft. Once there’s new air conditioners installed or anything, people break in and steal. And worse, there’s no security, if there is, it’s not a tight security system. Obviously, this goes and burdens our budget. Can you imagine replacing something that will be stolen in a week. So, maintaining things has become a liability” (P9).*

*“We experience a lot of theft. The issue of theft occurs for many reasons. Reasons such as youth wanting to make a living since there is high rise of unemployment. So they target facilities that are vacant mostly and steal sort of furniture, lights etc. sometimes even those facilities that are occupied e.g. schools they also steal as there is poor security. Sometimes stealing occurs coz it’s a norm within the community. And this will obviously impact and challenge us as it comes back to our pockets” (P13).*

*“People steal stuff, the moment they see that oh, government has brought new cleaning stuff for facilities they’ll go steal them. So, it gets tough budget-wise because now we have to do same thing over again. And who knows they won’t steal again?” (P20).*

*“People just break in and take whatever they need and even break doors or windows if they feel like” (P21).*

*“Stealing: For example, in schools, people will steal furniture and cleaning materials and sell them at black market. This is always not good to us as will be bound to buying same stuff again and again” (P23).*

The findings suggest that theft results mainly from poor security in government facilities. It can also be inferred that theft always impacts negatively on the already insufficient maintenance budget as moneys budgeted for other projects have to be redirected to fix stolen items.

#### **4.7.1.8 Traditional (manual) system**

A traditional or manual system was revealed as one of the challenges by participant in all cases. The following are some of the responses:

*“There’s lack of software that can be used to track all maintenance needed to be done or done. You know, everything is manual. And this prolong the process. Like time, we take long to process...how much more in actual implementation? This impact us on time. A 3-month maintenance will take a whole year...” (P1).*

*“... our system is very old and never upgraded. We use manual system where you call or come personally, and it takes some days for that request to be attended to because of lack of technological system. This impact us on time and money. Prices of things increases while we are still fighting to get approval on a certain price. By the time is approved now again we are short of money” (P3).*

*“Manual system is a problem. It prolongs the process. Our RCC (Request Call Center) system never worked for us, we tried to improve it but with low budget we are not getting anywhere. So, this is a really huge challenge” (P6).*

*“The paper base system is not sustainable as work gets lost and not easy to follow up on requested work that has missing documents. And time consuming” (P14).*

*“Our systems are very poor. We do not have a computerized system and that’s tough. Imagine having to report local repairs or maintenance you have to drive down to nearest municipality or public works and report. It would have been nice if there was a system where community people can easily log in to and log a request. So, this is really a challenge” (P20).*

It can be inferred from participants’ responses that the maintenance departments do not make use of new technologies to manage their maintenance work. It is mentioned that there is no renewing or upgrading or changing the old system because of the perception that it may require more maintenance and cost.



#### **4.7.1.9 External interference**

Interference was a challenge across all cases. This is not only limited to political interference, but also from local chieftaincies. These are some of the responses:

*Politics it's really a major delaying problem towards leadership within the organization...it's too much... Things here, you won't understand. There's lack of leadership" (P1).*

*"Leadership challenges caused by everything that has to do with political interference. There's poor selection of leadership and this rises because of political intervention. We lack leadership, we lack expertise on jobs from our leaders..." (P7).*

*"Yes, people appointed to wrong positions due to their connections" (P13).*

*"...Our challenges are mainly due to counselors and mayor's intervention. And in most cases these people are politically affiliated. So whatever decisions they make to us, it's not only for our best interest in the maintenance department but it's for political too. This impact us badly because we neglect what we were supposed to do and do what the mayor has asked us to do for their own interest" (P20).*

*"Yes, we do. The involvement of chieftaincies and politicians in municipality decisions. It ends up creating confusions amongst us the lower level within the municipality. In fact, our main decisions are influenced by what chiefs want or need, not what we want. This impact us on understanding the purpose who are we actually serving, the community or chief?" (P22).*

It can be inferred from participants' responses that external intervention is a problem. Participants revealed that the involvement of politicians and chiefs also a major impact on decisions of maintenance works.

#### **4.7.1.10 Lack of expertise**

Participants from all the cases mentioned lack of expertise as a challenge their maintenance department is facing. They explained how politics affects recruitment processes where unskilled leaders will be recruited with little to no expertise.

*“... I can say, lack of expertise in the high position. Like you will find directors in civil engineering for example, does not necessarily have the qualifications you know. But is being put in that position for political reasons. Like they’ll say that person doesn’t needs qualification because they are just overseeing the works, like how do you oversee something you don’t understand...I mean, these politics is something else. If it’s not about qualifications, then its positions located to wrong people. Like an admin person given a civil engineering position...” (P1).*

It can be inferred from participant’s 1 response that senior management in governmental departments lack expertise and are unqualified for the positions they hold.

#### **4.7.1.11 Retention of ageing staff**

Participants across all cases mentioned retention of ageing staff as an issue. These are some of the responses:

*“Retention of staff is an issue: like I said, people here are due for pension. Most of them they do not have energy to still work. They are just waiting to retire, and they are no longer committed....they do not have such courage or dedication. There’s absolutely no leadership at all” (P9).*

*“...Also, other challenges that I can mention is ageing of employees. People are retiring and no replacement...” (P10).*

The responses from participants clearly indicate that retention of ageing staff is an issue. The findings suggest that the issues with retention of ageing staff are lower motivation and less courage regarding maintenance work and transferring of skills to lower management.

#### **4.7.1.12 Lack of skills transfer**

Skills transfer is very important; however, it was identified as one of the main challenges in the cases. These are some of the responses:

*“...and these are supposed to be our leaders to transfer skills to the junior and middle levels but there’s no...” (P9).*

*“...Imagine what happens when someone with all experience leaves the department without transferring the knowledge to the next person? What is the department left with? Definitely nothing...” (P10).*

*“...what can one learn from someone who is a leader but clueless? Definitely nothing. So, it’s that bad” (P15).*

*“no maintenance department, means no skills transfer nor personnel. Here in our areas our facilities are neglected by our government. No one cares as these areas are economic burden not a builder. So government does not bother about our facilities or infrastructure. They get build and never maintained until they collapse and they build new buildings and the same cycle continues” (P21).*

#### **4.7.1.13 Lack of capacity**

Lack of capacity, in terms of human resources, tools, and equipment is a general challenge to the effective implementation of maintenance. Participants across all cases identified lack of capacity as a challenge.

*“We don’t have personnel in this department to enforce what’s required by our policy...” (P4)*

*“The team is not enough within the department. We don’t have artisans for example and many things” (P7).*

*“One of the major factors is people. Government doesn’t have people. the maintenance department is empty. So, tell me, how will maintenance be effective with only two personnel?” (P10).*

*“we do not have staff or maintenance department. So definitely, without a maintenance department that means we suffer a great challenge in maintenance personnel or capacity and it is a huge challenge for us” (P12).*

*“we do not have a maintenance department to begin with, so definitely we do not have human resources” (P19).*

It can be inferred from participants' responses that lack of staff capacity to carry out maintenance work is a challenge. Participants indicated that they do not have enough skilled in-house staff, particularly artisans.

#### **4.7.2 Other challenges**

##### **4.7.2.1 Nepotism**

Nepotism was mainly mentioned in case B. The responses from some participants on how this challenge comes into effect and how it impacts them are as follows:

*“Yes, people appointed to wrong positions due to their connections. That affects the lower level as they do not see leadership role or understand the path they need to go into. I mean if one can just be connected to get position, why should the next person work hard to get that position instead of them looking for connection too” (P13).*

*“Having leaders in wrong positions. This impact us in a way that there's no transferable skills” (P15).*

##### **4.7.2.2 Authority (poor organizational structure)**

Authority is another problem highlighted in case B. Participant 11 mentioned authority as one of the challenges. The participant expressed how it impacted the organization.

*“Authority: Like the issue of who does what it's really a problem. And this problem impacts us on when things goes wrong no one is accountable as they step back to say it was not their responsibility even though they were part of the decisions. This obviously has money involved, so budget wise we are always not winning”.*

It can be deduced from Participant 11's response that issues of authority or poor organizational structure can have a negative impact on maintenance work. It has been noted throughout the interviews that the structures of maintenance departments are unclear in the government sector and people are not sure what their positions actually require them to do.

#### **4.7.2.3 Corruption**

Corruption was mentioned in case C as one of the challenges. Participants expressed how corruption impacts their work.

*"Corruption is one of the things. Like, already we cry over lack of funds, but there's people who are supposed to be public servants to improve facilities, but they want these funds for themselves and politics is their backbone. Normally when we receive funds, we receive it after we have sent out claims for situations that are like life-threatening. For example, when the roof looks like it's going to fall off, so we send claims for funding in replacement of it but then again, some leaders will take those funds to enrich themselves" (P18).*

*"Corruption which are backed by politicians and covered. I think government shouldn't allow anyone to be part of political parties publicly or shouldn't allow politicians to make decisions over employees. We should operate like private sectors. Everyone's remains anonymous on which political party they are for. Or also they do not use any political related laws in decisions made internally. And here in government is allowing all that, hence so much corruption" (P25).*

It is evident that corruption is a challenge. The findings suggest that corruption is a result of political influence which eventually leads to looting of monies allocated for maintenance.

#### **4.7.2.4 Lack of maintenance department**

All participants from case C mentioned indicated that the absence of a maintenance department was a huge challenge. The response as follow:

*“...you know what, let me be honest with you...we do not have maintenance department and that means no maintenance funding is allocated to us. With schools that I am working on, we make use of learners to clean their own classes, and also make use of some donation or stationary budget towards maintenance. We do not have a maintenance plan or policy to follow we just do what we can” (P19).*

*“We do not have maintenance department. How will work get executed with no departmental structure and personnel? Government needs to employ people; facilities are dilapidated” (P18).*

Similar sentiments were shared by other respondents (P20, P22, P23, P24, P25).

#### **4.8 SECTION D: MAINTENANCE MANAGEMENT SYSTEM SUCCESS FACTORS**

This section presents maintenance management system success factors. This section meets the third objective of the study and guides the development of improvement strategies (i.e. the fourth objective of the study). Several factors can be implemented to ensure the effectiveness and efficiency of a maintenance management system. Some of these factors were mentioned in all cases, whilst other were mentioned in two cases or one case. Therefore, the common factors are presented first, before those identified in two cases and finally those mentioned in only one case. The summary of all cases is also presented.

##### **4.8.1 Employment of skilled workers**

The majority of participants indicated that government needs to employ people with expertise that can assist with in-house maintenance work. These are some of the responses:

*“You know, government employees most of them are old. Our artisans are very old and close to retirement. So, they don't have the energy to carry out the works. So, government should employ youth as they are full of energy and are able to execute” (P3).*

*“Government need to employ people; we don’t have people anymore. All our staff are old and due for retirement. And not just anybody, but someone with a skill and expertise and train them often” (P6).*

The above sentiment was shared by respondents 7, 10, 12, 18, 17 and 25.

The findings suggest that government needs to appoint more skilled people. This is based on the emphasis laid by participants on the fact that the departments are understaffed or have people due for retirement.

#### **4.8.2 Training of staff**

Participants emphasised that training of staff would have a positive impact on the maintenance management system:

*“Training of more people who are qualified will have a positive impact in our system as they will constantly learn new skills and consequently will accelerate the repairs. Like we need trained artisans that can perform works, instead of relying to contractors” (P5).*

*“Enforce leadership development including trainings” (P18).*

*“Workshops between municipalities and districts should be considered which can help the two to discuss the challenges the currently facing and way forward. And obviously developing and learning new skills” (P22).*

The need for staff training and changing old systems was highlighted by participants 13, 15, 17, and 20).

Participants raised the need for more training and development to enhance the skills of employees. Participants revealed that with improved skills, the maintenance management system can be better implemented and therefore accelerate maintenance works.

#### **4.8.3 Need for a computerized maintenance system**

Participants mentioned that government needs to utilize an effective computerized maintenance management system (CMMS):

*“A computerized system would help. But not something complex but user-friendly system. This will help employees to follow all process required and keep up the record of works” (P9).*

*“Having a sound and effective computerized system that can help in making the work easier and keeping reports and records on cloud system” (P16).*

*“We need a reliable computerized system where we can log queries, submit work that is completed and so forth. I believe if these are done, our maintenance is bound to improve” (P17).*

Other respondents indicated that the call center and manual system do not work, and that government need to provide good software system (P10, P20, P24 and P25).

The findings suggest that government should make use of a CMMS. Participants indicated that a CMMS could be cost effective, help achieve faster responses to maintenance defects requests, and reduce time, which would ultimately help to improve overall maintenance performance.

#### **4.8.4 Amendment of procurement system**

Participants argued that government should scrap the lengthy procurement system as it is time-consuming. These are some of the responses:

*“Basically, I think what should be done is to cut the process of procurement and have maintenance contracts in place. Having a maintenance contract in place it’s easier to get materials as everything needed it’s in a contract. All resources it’s already in the contract. Procurement system prolong things. A mere material order like cleaning material has to go through lots of approvals” (P2).*

*“Another thing it’s our procurement system in government is very poor. If the government can revise the procurement system and create a better one that doesn’t*



*prolong things and cut off unnecessary admin, maintenance system can improve.”*  
**(P3).**

*“Change the procurement plan or system”* **(P18).**

*“Improve procurement system and allow it to be transparent, easy to apply for us to bring better performance”* **(P24).**

The findings are that government should improve procurement system and processes to allow resources to be easily accessible such as material for in-house team usage. Additionally, the system should be more transparent regarding the process of outsourcing maintenance works and external skills personnel recruitment. This will improve government efficiency with regard to access to resources, and consequently improve the maintenance management system.

#### **4.8.5 Efficient transport system**

Participants have recommended government to provide an efficient transport system to improve maintenance works. These are some of the responses:

*“Sustainable transport should be offered to employees who needs to move from one site to the next (facilities). It is hot here in Limpopo and you can’t expect such person to still work at their level best. So, providing transport to all labour[er]s will have great positive performance”* **(P8).**

*“Transport system: we have lots of facilities under public works. There is no sufficient transport that takes our in-house team to them. Government needs to either buy bakkies that our artisans can use from one facility to another or hire a permanent reliable transport. I am saying this because we find that our in-house team comes to work to sit. They can’t go to facilities and perform works due to no transport...”* **(P11).**

The findings suggest that government should make provision for vehicles to transport artisans. Participants expressed the difficulty of the in-house team, especially artisans, not

being able to work as they cannot move from one facility to the next due to the cost of transportation. This has resulted in most facilities being neglected and not maintained.

#### **4.8.6 Provision of resources**

Participants revealed that government should increase their resources in order to effectively carry out maintenance works. These are some of the responses:

*“They need to provide resources for these employees. Like laptops, tools and other materials they need. I believe this is the only way to begin execution of work” (P6).*

*“...Also providing equipment. Our in-house team lacks tools to work with. Government must provide these things if they want works to be carried out. I believe if this is done, our maintenance is bound to improve” (P17).*

*“Buy equipment and required materials for in-house team so they can perform works” (P23).*

The participants' responses suggest that government should increase resources for in-house maintenance teams. Participants revealed that resources would enable in-house teams to perform necessarily duties for maintenance. Important resources mentioned are laptops, tools, equipment and relevant materials.

#### **4.8.7 Adequate budget provision**

Most participants have suggested that government should increase the budget allocated for maintenance to reduce the backlogs, and to improve the quality of facility maintenance as well. Participant's responses are as follows:

*“Increase budget or merge budget based on assessment done. Not the other way around. Like, the department just locate funds to say R2 million is for this facility without any facts” (P2).*

*“Have clear budget allocations” (P5).*

*“increase budget in other for facility or maintenance team to increase resources. This will enable the departments to maintain facilities efficiently” (P11).*

Although the government institutions allocate money to maintain the facilities, participants indicated that it is not enough and not allocated according to maintenance requirements. Participants in case C did not indicate lack of funding as their major concern, as the main issue was the absence of a maintenance department. They syndicated earlier during the interviews that it would be much easier to have a structure in place with maintenance personnel to determine how much funding would be required for particular facilities.

#### **4.8.8 Amendment of maintenance policies**

Participants from case B and C suggested that government needs to amend policies:

*“Amending policies that were approved by the apartheid regime. Tick what may be relevant and phase out the rest” (P10).*

*“Policy in place that is revised annually and that can be implemented with clear standards” (P19).*

*“Have clear maintenance policy and priority that are implementable” (P20).*

*“The government need come up with a clear maintenance policy for us or employ a right person that can do it internally then submit for approval. This will help us in many ways as you know a policy is a guideline. Now we don’t have one that’s why everything is just a mess” (P21).*

The participants’ responses suggest that government should amend policy to allow them to implement a maintenance management system effectively. Participants indicated that the use of effective policy would provide them with proper maintenance guidelines.

#### **4.8.9 Human resource structure**

Participant 7 (case A) mentioned that revising the organogram based on skills of human resources would be an important success factor:

*“Government needs to revise organogram. These thing of having wrong people at wrong positions with wrong expertise is killing us”.*

It can be deduced from participants’ response that government must implement a proper human resource structure (organogram) to avoid a skills mismatch of employees.

#### **4.8.10 Security system**

Participant 16 (case B) believes that theft and vandalism could be minimized if government would invest in an effective security system.

*“Have great security system within the facilities to prevent theft. This could be a great way in having to capture these hooligans on camera for example. So, they can be held accountable instead of us having to suffer the cost”.* (R16)

It can be inferred from participant’s 16 response that government needs to prioritize the security system. The participant indicated that the lack of or poor security system leads to the vandalism and theft.

#### **4.8.11 Support structure**

Participant 11 (also from case B) believed that having a strong support structure from top level will have positive impact on the maintenance management system.

*“Have a great support structure from top management down to lower management. People need someone to look up to, not being discouraged all times. So, if the management support all staff equally, the behavioural norms will automatically change”.*

The findings indicated that government should have support structure within the department. The participant revealed this would have a strong impact on the behaviours of staff and consequently improve performance.

#### 4.8.12 Corruption law

Participant 23 (case C) suggests government needs to have corruption laws in place to prevent unethical behaviour.

*“Have law in place on how to deal with corruption. This way people will account and take responsibility for all action or decision made by them”.*

Participant 23 suggests that formulating laws to deal with corruption towards unethical officials could be valuable in improving the maintenance management system particularly with the budget.

#### 4.9 Summary

Table 35 presents a summary of maintenance management system success factors mentioned by participants in all cases. Most success factors were found to be common across all cases. The summary of the success factors are as follows.

**Table 35:** Summary of maintenance management system success factors

	Case A	Case B	Case C
<b>Maintenance management system success factors</b>	<ul style="list-style-type: none"> <li>• Employment of skilled workers</li> <li>• Training of staff</li> <li>• Utilizing computerized maintenance system</li> <li>• Procurement system</li> <li>• Human resource structure</li> <li>• Efficient transport system</li> <li>• Resources</li> <li>• Budget</li> </ul>	<ul style="list-style-type: none"> <li>• Amending policies</li> <li>• Training of staff</li> <li>• Utilizing computerized maintenance system</li> <li>• Security system</li> <li>• Support structure</li> <li>• Efficient transport system</li> <li>• Resources</li> <li>• Increased staff allocations</li> </ul>	<ul style="list-style-type: none"> <li>• Amending policies</li> <li>• Training of staff</li> <li>• Utilizing computerized maintenance system</li> <li>• Efficient transport system</li> <li>• Resources</li> <li>• Appointing of skilled personnel</li> <li>• Procurement system</li> <li>• Corruption law</li> </ul>

#### 4.10 CHAPTER SUMMARY

This chapter presented the findings obtained through the semi-structured interviews. Thematic analysis was utilized in this chapter. The findings were presented in sections as per study objectives which were as follows: Section A: profile of participants; Section B: current maintenance management system adopted; Section C: challenging factors in implementing maintenance management system; Section D: success factors that can be

adopted for maintenance management system of public facilities to improve. With regard to the profile of participants, their management levels ranged from junior to senior and their highest qualification ranged from N6 (Diploma) to MSc in different fields, all within the engineering industry. The experience of participants in their current positions ranged from 1 year to 20+ years. However, the majority of the participants were not registered with any professional body as it was not mandatory in their institutions.

The condition of facilities was found to be poor due to the maintenance management system being poorly implemented and factors such as policy, budget, priority, scheduling and planning, etc., were found to be absent or not implemented in their systems.

Findings were presented indicated the challenges faced by facility managers in implementing the maintenance management system efficiently. The challenges found to be common across all cases included budget inadequacy, leadership, procurement, vandalism, theft, shortage of water, climatic conditions, external interference, lack of staff capacity and a traditional (manual) system, lack of expertise, retention of ageing staff, and lack of skills transfer. Peculiar challenges to the specific cases were found to be nepotism, corruption and no maintenance department.

Success factors for the maintenance management system were presented. Employment of skilled workers, training of staff, utilization of a computerized maintenance system, transparent procurement system, clear and concise human resource structure, efficient transport system, availability of resources, budget adequacy, amendment of policies, availability of security system, support structure and corruption law were found to be the success factors. The next chapter will broadly discuss the findings of this study.

## **CHAPTER FIVE**

### **DISCUSSION**

#### **5. PROFILE OF PARTICIPANTS**

The participants' profile consisted of stratified groups, namely management level, current title/position, experience within the current position, highest qualification level and professional registration. These strata groups were to enable the researcher to understand the management level present in public institutions and its structure. A total of 60% of participants from all cases were not registered with any professional body. This finding correlates with Gibson's findings. Gibson (2004:47) reports that only 13 out of the 47 district municipalities (28%) and 42 out of the 231 local municipalities (18%) have members of the Institute of Municipal Engineering of Southern Africa (IMESA) among their senior management, which is an indicator that crucial management skills and experience are not available in many government institutions.

#### **5.1 CURRENT MAINTENANCE MANAGEMENT SYSTEMS**

##### **5.1.1 Perception of facilities' condition**

The participants were first asked whether the condition of public facilities under their care had improved in the past five years. The findings from all the cases suggest that the conditions of public facilities had not improved in the past 5 years. This finding collaborates with Mojela (2013). Mojela's study focused on public schools and found that there were a significant number of public-school facilities that were in terrible condition. Mojela (2013:77) further notes that it is impossible for condition of school facilities to improve when there are no maintenance offices or departments within these schools. This further explains why the conditions of facilities are not improving. Additionally, the South African government admit that the condition of public facilities is deteriorating, and that the backlog maintenance is increasing rapidly (Department of Public Works & Construction Industry Development Board, 2017:15). Additionally, the majority of participants emphasized that neglecting facility maintenance increases the backlog and significantly increases cost which then becomes a burden on the government and results in maintenance of facilities

not being affordable. Therefore, it is crucial for government to prioritize maintenance of its facilities from handover onwards. This will constantly improve the efficiency and sustain the functionality of the facility to continue to serve its purpose while reduce maintenance cost as unnecessary equipment or component replacement will be avoided through proactive maintenance.

### **5.1.2 Importance of an effective maintenance system**

When asked about the importance of maintenance management systems, all the participants indicated that instituting an effective maintenance system was important. The findings of this study align with other studies done previously. Mong, Mohamed and Misnan (2019:119) emphasized that maintenance management system is a crucial tool for ensuring delivery of a better built environment to customers or users. Similarly, Olanrewaju and Abdul-Aziz (2015:79) indicated that successful maintenance management depends on effective maintenance management systems. Thus, it is important to firstly develop and institute a maintenance management system and secondly, to ensure that the system developed is well implemented.

## **5.2 RATING OF THEIR CURRENT MAINTENANCE MANAGEMENT SYSTEM**

To obtain an overall understanding of the maintenance management system, participants were asked to rate the maintenance management system of their organization. The findings as presented in the previous chapter suggest that the maintenance management system of public facilities is poor. Participants revealed several factors that hindered the implementation of the system. The main contributor to the poor maintenance management system of public facilities is lack of capacity or a dedicated maintenance department equipped with resources to care for facilities (Mong et al., 2019:121). The study also established that maintenance teams have very little or no knowledge of facilities maintenance management systems and therefore, carrying out of maintenance inspection periodically, and the preparation of maintenance reports and schedules to regulate and regularize facilities maintenance was completely absent. A number of factors that contribute to the effectiveness of maintenance management systems are further discussed below, based on the findings in this study.



### **5.2.1 Rating of specific factors that make up maintenance management systems**

The last question in this section helped to determine the rating of the specific maintenance management factors that make up the overall maintenance system. Respondents were asked to rate each maintenance factor and provide reasons for their ratings. The factors were maintenance policy, prioritization system, maintenance standard, condition assessment, asset register, budget, strategy, maintenance planning and execution of maintenance work. Each factor is discussed as a paragraph.

The first factor is the maintenance policy. The findings indicate that respondents from case A and B believe that the main problem is implementation whilst most of the participants from case C pointed out that the department had no policy. Participants rated the policy as poor due to issues such as lack of implementation, lack of funds, and retention of ageing staff who were expected to go for pension. Also, most of the participants from case A and B were aware of the Government Immovable Asset Management Act (GIAMA) (Wall, 2009). A study by Ngobeni et al. (2015:52) also confirms that government does have a national policy framework known as GIAMA. Although the national policy framework exists, DPW has argued all government departments such as the departments of health, education and many more must have their internal policy that will serve the interest of each facility, which is referred to as DIAMA (Ngobeni et al., 2015:52). Unfortunately, the National Infrastructure Maintenance Strategy (Construction Industry Development Board, 2016:12) revealed that many government departments have failed to establish standardized policy nor adopted the national policy aimed at addressing the backlog. This study also demonstrates that departments have failed to adapt the GIAMA or to develop their own policy to guide maintenance. Ngobeni et al. (2015:52) further supports the response of Participant 9 by stating that most personnel have retired from most government departments without replacement or skills transfer to young people, which contributes to non-implementation of any policy framework. Lee and Scott (2008:79) argue that policy plays an essential role in maintenance management systems as it contains the standards and guidelines to implement all the management tasks and describes the responsibilities of maintenance personnel. Therefore, for government to effectively manage and

implement maintenance management systems, maintenance policy must be developed and implemented.

The second factor is the maintenance prioritization system. The findings indicate that the prioritization system is poor. Issue(s) identified were unstable leadership (the constant change of leadership) and the reactive approach to maintenance due to backlogs. The findings correlate with a study conducted by Yusof et al. (2012:510) and Wing et al. (2016:3). Yusof et al. (2012:510) state that facility managers face difficulties in setting or implementing maintenance priorities. Some of the reasons for the difficulty were identified as pressure due to the backlog to prioritize the limited resources to address current and backlog maintenance, poor leadership, and lack of capital (Wing et al, 2016:3). These challenges are similar to those identified in this study. Bad prioritization often results in unscheduled facility maintenance, system unavailability, and additional costs to repair or replace failed components or systems due to short notice (Wing et al., 2016:3). It is therefore crucial for government maintenance departments to develop and implement an effective prioritization system to reduce the maintenance backlog and manage budget allocations effectively.

The maintenance standard is the third factor to discuss. The participants' responses indicate that the maintenance standard in public facilities is unclear and implementation is merely based on acceptability which is driven by budget and functionality. In general, standard can be defined as minimal level of performance to be achieved (Ganisen et al., 2014:35). It has therefore, been established that public facilities are not meeting the minimum level of performance, and budget restrictions have been highlighted as the major factor militating against the implementation of the factor. Therefore, it is crucial for government to set acceptable condition standards for all facilities that will enable facility managers to gauge its performance/condition. This will enable managers to plan and maintain facilities efficiently based on the required standard and consequently mitigate facilities being more prone to incur defects and underperform.

The fourth factor closely related to condition standards is condition assessment. Although condition assessment is part of the maintenance management system, the findings suggest that the approach is ineffective due to issues such as lengthy time frames, inconsistency, non-compliance or ignorance (as in case A & B). Participants from case C indicated that condition assessment was only done when the community reported an issue or when maintenance was due. A study conducted in South Africa by Majela (2013:86) also found that condition assessments were not carried out on most of the public schools except when the community requested a certain facility be assessed. This very much correlates with the findings from case C. Yacob et al. (2016:1) revealed that the inefficiencies and inconsistency of implementation of condition assessment can subsequently increase maintenance work due to defects and damage to the building or facility. Thus, the need to conduct condition assessments is crucial for government departments charged with the responsibility of managing facilities.

Another important factor is an asset register. The absence of an asset register could lead to lack of accurate and consistent information on facilities, which according to Madikizela, (2010:84) makes it impossible to carry out effective maintenance. Additionally, Ngobeni et al. (2019:52) observe that the lack of an accurate asset register becomes a problem when having to ascertain assets/facilities that belong to the DPW, and also which facilities require maintenance. The findings of this current study suggest that maintenance departments do not have an up-to-date asset register. This problem is also noted in Ngobeni et al. (2019:52). The study findings also indicate that issues such as incompetent personnel and failure to keep track of facilities aggravated the problem. These are issues which have been identified by other studies (Yahaya, 2016:9). The inability to identify assets/facilities results in departments being unable to properly categorize their facilities (Ngobeni et al., 2019:52). Therefore, government departments should have asset registers as part of their maintenance system to keep records of all assets/facilities.

The maintenance budget is one of the biggest challenges facing maintenance departments. The findings of the current study indicate that departments prepare maintenance budgets; however, participants rated maintenance budgeting as poor due to

insufficient provision of funds, increases in backlogs, and unrealistic performance expectations. The challenge of insufficient funding provision has been highlighted by many researchers (Buys and Nkado, 2006; Xaba, 2012:221; Simpeh, 2013; Ngobeni et al., 2015; Wing et al., 2016:3). Xaba (2012:221) indicated that, although the Department of Basic Education allocates money to schools, it is not enough as the overall financial allocation to schools is 12% for maintenance; however, it is obviously ringfenced, which implies that even if maintenance needs exceeded the allocated percentage, schools could not use funds allocated for other functions. The insufficient provision of funds eventually leads to more backlogs, as participants revealed. Ngobeni et al. (2015:53) similarly argued that inadequate or inefficient funds allocations for maintenance work leads to an increase in maintenance backlogs. Therefore, it is crucial for government to allocate a maintenance budget based on facility needs, and sufficient to reduce the backlog.

The strategy adopted for maintenance was also rated by participants. The findings indicate that the implementation of maintenance strategy was poor. The main reasons for the poor rating were lack of implementation, lack of human resources, retention of ageing staff nearing retirement and stuck on outdated strategy. These findings are supported by Velmurugan and Dhingra (2015:1629), who indicated that implementation of maintenance strategy is a great challenge for maintenance managers in the public sector. They further reveal that lack of resources such as manpower, equipment (spares, tools, etc.), deploying the manpower, and managing all the resources efficiently has a huge impact on carrying out maintenance effectively (Velmurugan & Dhingra, 2015:1629). There is need for government maintenance departments to re-evaluate and establish effective maintenance strategies that can help them perform maintenance work effectively.

Maintenance planning was also rated by participants. Their responses indicate that maintenance was poorly planned, resulting in a reactive approach. The underlying problem was budget constraints. Thus, the study found that a reactive approach to maintenance was adopted due to inadequate funding provision. This finding correlates with a study conducted by Yahaya (2016:9), who found that most maintenance departments adopted a reactive maintenance approach due to poor planning. According to Owusu and Aigbavboa

(2016:558), lack of effective planning may lead to re-occurrence of faults or defects and thus subsequent recurrence of maintenance work and eventual exhaustion of the initial budget. The recurrence of defects or faults may lead to disruption of service delivery through equipment breakdowns or building element/component failures and increases in the capital burden. To avoid recurrence of defects, it will be necessary for every government maintenance department to proactively develop a concise facilities maintenance plan to deal with facility maintenance demands efficiently.

The next factor is scheduling of maintenance work, which correlates with maintenance planning. The findings suggest that most of the participants rated the implementation of maintenance scheduling as poor. Issues such as inconsistent updates, and improper schedules such as scheduling only emergency maintenance works were identified. Velmurugan and Dhingra (2014:1629) also mention poor scheduling, and updating maintenance work often results in poor maintenance execution. Although maintenance can be scheduled properly, lack of budget allocations for particular scheduled work remains problematic. Therefore, if government does not allocate adequate funding for maintenance works that is planned and scheduled, or the budget is cut mid-year, an increase in deferred maintenance is inevitable (Hamid, Alexander & Baldry, 2010:82). Therefore, it is crucial to have adequate funds for maintenance to be implementable and government should then prioritize it.

The last factor is maintenance execution. The findings suggest that both in-house and outsourcing approaches were adopted to execute maintenance work. However, participants rated it as poor due to issues such as lack of human resources (e.g. specialized labour), lack of equipment or material for in-house teams, lack of transparency in the outsourcing process, and poor selection of maintenance contractors with no expertise further resulted in poor workmanship and performance. Ganisen et al. (2014:35) found similar deficits and described the consequences. They found that these issues delayed maintenance processes and increased the severity of the problems and even could result in facility services failure (Ganisen et al., 2014:35). Therefore, government should hire and train in-house teams and provide them with the required resources, or

outsourced selected, reputable contractors with resources and expertise to ensure that maintenance work is carried out effectively.

### **5.3 CHALLENGES**

This section discusses the challenges reported in the previous chapter. Each challenge is discussed separately.

#### **A) Inadequate budget provision**

Inadequacy of funds is one of the main challenges faced by government facility management or maintenance departments in many parts of the world. Participants indicated that the resources are limited due to lack of funds, which makes it impossible for them to perform routine maintenance and keep up the standard of their facilities. Hamid et al. (2016:81) also indicated that if funds allocated for maintenance works is insufficient and diverted to pay for only emergencies, then the risk of equipment failure and building deterioration increases. Additionally, when facilities are not maintained, there is an increase in backlogs, which can result in maintenance costs rising to the value of new facilities (Hamid et al., 2016:81). Thus, government might end up building new facilities instead of maintaining the current deteriorated facilities due to the cost of maintenance exceeding the cost of a new facility. Therefore, it is crucial for government to consistently allocate funds for maintenance of facilities. This will allow facility managers to preserve facilities and ensure that they perform their function, remain safe for users, while minimizing major repairs.

#### **B) Leadership**

Participants indicated that government institutions lack leadership. The findings suggest that this challenge is as a result of political interference. Similarly, Wangwe (2012) found that political interference is a challenge for the implementation of an effective maintenance management system. According to Mfuru, Sarwatt and Kanire (2013:21), political interference occurs when political leader(s) interfere with decision making in public administrative matters such as planning, organizing, staffing, directing, coordinating,

reporting, and budgeting as well as allocation and use of public funds. Therefore, it is advisable for government to develop a plan to mitigate external interference in the best interest of quality service delivery and improvement of the maintenance management systems.

### **C) Maintenance contract/procurement system**

The findings reveal that procurement is a major issue. This finding is supported by Ali et al. (2016:17), who also found that maintenance contracts are problematic. The underlying cause was identified as a complex procurement system with resource or tender allocations or processes and requirements not being transparent (Ali et al., 2016:17). Alshehri et al. (2015:235) attributed the challenge to government policy-mandated awarding of maintenance contracts to the lowest bidder, without considering the capability of the contractor or reputation in terms of the company profile, resources and quality policy, etc. On the other hand, Muhakanizi (2015:12) found that the poor procurement system is a factor, due to failure to prepare adequate specifications, leading to cost overruns and delays in maintenance work. Additionally, the implication of inadequate or poor procurement systems results in arrears as the department has to spend resources that have not been budgeted for, which may also lead to deviation of resources meant for other projects or facilities (Joseph, 2016:12).

The government therefore needs to prioritize a transparent procurement system to effect decisions of resource allocations such as materials, equipment and the selection of maintenance contractors; further, to ensure that the contractors selected are capable of executing the work in terms of availability of resources to avoid wastage of time, effort, rework and costs. It is also important for government to ensure the efficiency of their procurement system as this would ensure development of specifications, identify wrong decisions taken about items to be procured, and consequently lead to better quality of maintenance works or goods being delivered.

### **D) Climatic conditions**

Climatic conditions present uncontrollable challenges faced by facility managers across the globe. From participants' responses, it can be inferred that harsh weather conditions

are indeed a challenge. Participants gave examples such as drought due to extremely hot temperature and sporadic rain. Okosun and Olagunju (2017:21) found that heavy rainstorms are likely to cause maintenance problems due to roofs leaking or being blown off. On the other hand, heat can reduce the quality of physical structure such as external wall paint, cause drought and damage lawns, and lead to blockages of toilets due to the absence of running water, etc. Therefore, government should ensure that high quality material is selected and used, as cheaper materials might require more frequent maintenance than high quality materials in the long run. Additionally, it should ensure that each facility is provided with boreholes to keep functions such as toilets operational and lawns cared for.

### **E) Vandalism**

Vandalism is prevalent in South Africa. Thus, it is not a surprise that participants mentioned vandalism as a serious problem. Participants mentioned that vandalism occurs through community unrest due to government's failure to deliver the services required. Others mentioned that some vandalism and destruction of facilities occur for no apparent reason. Poor security also makes it easy for facilities within the communities to be vandalized. These findings are related to those found by Ngobeni et al. (201:52) and Farinloye et al. (2013:10). Ngobeni et al. (201:52) indicated that government facilities left unattended or unused create more space for vandalism. The acts of vandalism are normally motivated by anger, boredom, the need for catharsis, erosion of already damaged objects, or aesthetic factors (Farinloye et al., 2013:10). Therefore, it is crucial for government to ensure that occupied and unoccupied facilities are fully secured. This will prevent unnecessarily vandalism due to boredom and other causes, and it will allow the department to recover monies from culprits for damaged items if captured on cameras. This is the method most widely practiced in the private sector, thus private facilities are not damaged as frequently. The same can be implemented in government facilities.

### **F) Theft**

There are too many reports regarding theft in public facilities. Participants mentioned that theft results from several issues such as the poor security system in government facilities,



unemployment, and because it has become a community behavioural norm. Newly installed equipment and furniture are always stolen. Ikejamba and Schuur (2016:4) also found theft to be a problem, and found similar motives behind theft, such as failure of the government to effectively create jobs, lack of social security and other basic necessities, which arouses people's anger and leads to theft in order to sell equipment on the black market to survive. As mentioned earlier, government needs to provide employment opportunities to avoid unnecessarily theft in government facilities due to communities wanting to make a living.

### **G) Traditional (manual) system**

Manual administration is the most widely practiced system in public facilities. And it can be inferred from participants' responses that the government does not make use of new technologies to manage their maintenance work. It was mentioned by participants that there is no upgrading of systems available to maintenance staff due to government believing that it would cost a fortune and require higher maintenance costs to keep the system running efficiently. Thus, making use of a manual, paper-based system, or a request system through a call center comes out effectively cheaper, although both are lengthy and time-consuming processes. These findings also relate to the findings of Ngobeni et al. (2019:52) that issues arise with the use of a traditional or request maintenance system. Work orders are created manually for public schools, and not in order of priority by the inspectors in the regions. As a result, a maintenance backlog is then created (Ngobeni et al., 2019:52). Therefore, government must ensure that maintenance departments make use of an effective software system that will assist in operations, monitor maintenance work, modify the priorities of decision-making, improve time, and thus reduce cost.

### **H) Lack of expertise**

Lack of expertise is one of the challenges that cause poor implementation of the maintenance management system. It can be inferred from the response of Participant 1 that, "the senior management in governmental departments lack expertise and are unqualified for the positions they are in". The researcher found it most concerning how

knowledge is transferred from senior to junior management, and how the right maintenance guidelines cannot be ensured without the right knowledge and processes. According to Mustapa and Adnan (2010:83), lack of local expertise is a serious problem within the public sector in Malaysia. They found that the lack of local expertise leads to failure to provide responsive breakdown services, as well as failure to execute routine maintenance or implement an effective maintenance management system. Therefore, government needs to understand the importance of maintenance departments having personnel with the right expertise and competence for the full scope of maintenance works. This will allow maintenance works to be done efficiently and improve the condition of facilities.

#### **I) Retention of ageing staff**

Ageing of staff with no new recruitments and skills transferred is one of the most challenging issues faced in the public sector. These can also be seen from participants' responses. The findings suggest that the issues with retention of ageing staff have a strong effect on maintenance work being neglected due to lack of will or interest in maintenance work from leaders and ageing staff and no transfer of skills to lower management. This is supported by Alshehri et al. (2015: 236), who report that lack of encouragement from the senior management for workers to participate in maintenance and the operational field definitely leads to poor performance. Employing new senior management with the requisite skills in relation to maintenance management, with drive and motivation will improve the quality of work, minimize cost and reduce work timespan (Ofori et al., 2015:187). Government should therefore put protocols in place to measure the performance of all staff members and replace those who are not performing with people who have the relevant skills to carry out maintenance work efficiently.

#### **J) Lack of staff capacity and skill transfer**

The government sector in general faces a crisis of insufficient skilled staff. As participants have indicated, public facilities are also affected by this crisis. Participants indicated that they do not have enough skilled in-house staff, particularly artisans. The findings also suggest that there is lack of skills transfer from senior management. These findings are

supported by Ofori et al. (2015:187), who also indicated that it is important to have skilled workers for maintenance work and they should be available to perform the job, utilize equipment and transfer skills to new recruits. Similarly, Alshehri et al. (2015:235) note that the availability of a skilled maintenance work force is an important factor in the process of maintenance work. On the basis of the above literature, the government sector should prioritize employing more skilled workers to assist with maintenance work and outsource where necessary. It is also important that government implement training and development or workshops to transfer and enhance skills of its technical staff. This will effectively reduce maintenance costs as compared to the costs of outsourcing small maintenance works.

### **K) Nepotism**

Skills mismatch is one of the developing issues in governmental structures. The findings suggest that nepotism results from the appointment of well-connected people mainly influenced by politicians. Wuni et al. (2018:9) reported similar findings and indicated that the issue of skills mismatches is that people are appointed in positions to manage facilities who lack the knowledge or even the bare minimum skills for their position, and at worst do not know the erosive financial dimensions of accumulated neglect of maintenance. The poor facility management in public institutions can be blamed on the absence or wrong appointment of facility managers and lack of maintenance personnel with specialized knowledge in handling buildings and special facilities (Wuni et al., 2018:9). Therefore, it is important for government to ensure that all their maintenance personnel are appointed to positions that are in line with their core skills to ensure high standards of maintenance work.

### **L) Authority (poor organizational structure)**

Authority is a challenge similar to nepotism. The findings suggest that the issue with authority or poor organizational structure can have a negative impact on maintenance work. It was noted throughout the interviews that the structures of maintenance departments in the government sector are unclear and people are not sure of what their positions actually require them to do. Similar findings were reported by Alshehri et al. (2015:236), who note that the Saudi Arabian government sector has obscure and complex job roles and titles, rather than using well known terms such as service management and

support services. The result is confusion in management about what the authority of each one entails. In conclusion, government should have a clear and concise organizational structure with clear job descriptions for employees to provide clear indications of their authority and responsibilities, which is vital for maintenance performance. This will ensure that all maintenance management personnel remain accountable for all decisions and work executed by or under them.

### **M) Corruption**

Corruption is a prevalent challenge in the public sector. It is not a surprise that this came up as one of the findings in this study. The findings suggest that corruption is a result of political influence. This leads to funds allocated to maintenance being stolen. A study conducted by Hall (2012:4) titled “Corruption and public services” had similar findings. It concluded that corruption wastes public money by diverting it into the hands of corrupt politicians, businesses and their agents (Hall, 2012:4). The biggest concern is that there are strong corrupt networks of senior officials, politicians, and domestic and foreign businesses who divert public money for their own benefit. To end corruption will require public and political organizations to demand that political leaders represent public interests, not the interests of rich individuals and powerful companies, and to hold them accountable (Hall, 2012:4). Therefore, it is concluded in this study that government should commit to transparency, accountability and public participation as key elements to prevent corruption; there should be strong and independent auditing systems; and courts prepared to prosecute, fine and ban corrupt companies and officials in order to move forward with competent maintenance of facilities.

### **N) Lack of maintenance departments**

Lack of maintenance department was identified as a problem in Case C. The findings suggest that there is no maintenance department at all and that facilities are only maintained when parts of the structure have failed. It is then a huge challenge as maintenance work cannot be taken or monitored properly without appropriate resources, including a department to report works to. One of the participants also indicated that there was obviously no budget at all. In facilities such as schools, in case of emergency, funds

meant for stationary, feeding schemes, learners and staff contributions are diverted to fund such emergencies. A similar finding was made by Olanrewaju and Abdul-Aziz (2015). Maintenance is impossible to carry out without a maintenance department (Olanrewaju & Abdul-Aziz, 2015:81). The efficiency of maintenance depends on planning, design, and commissioning processes that require qualified and experienced personnel, proper equipment, and expertise (Olanrewaju & Abdul-Aziz, 2015:81). Therefore, government must prioritize setting up maintenance departments in all their institutions as they are an important factor with regard to the efficiency of the maintenance management system.

#### **5.4 CRITICAL SUCCESS FACTORS IN THE MAINTENANCE MANAGEMENT PROCESS**

##### **A) Employment of skilled workers**

The success of any system requires skilled personnel. Thus, it is not surprising that participants mentioned that government maintenance departments need to appoint more skilled personnel. The findings also suggest that most department had vacant positions. Akasah et al. (2011:665) observed that competent persons who have enough practical or theoretical knowledge and experience are needed to conduct maintenance work. Therefore, recruiting competent and skilled person is crucial for the successful implementation of a maintenance management system (Akasah et al., 2011:665). Ganisen et al, (2014:34) clarified that an adequate number of employees is important for an organization for continually provide effective performance. Therefore, it is important for government maintenance departments to prioritize the employment of competent persons who are skilled, competent and experienced.

##### **B) Training**

Training is crucial as even experience and skilled craftsmen may need to fill in gaps in their knowledge. Participants suggested that government maintenance departments need to ensure that workers are offered opportunities for more training and development programmes to enhance their skills. Participants indicated that with improved skills, maintenance management systems could be better implemented, and therefore accelerate maintenance work. Similarly, Yau, Ho, and Li, (2017:653) and Akasah et al.

(2011:665) identified staff training as a key area of success. Khan et al. (2011), explain that training is important as it enhances the capabilities of employees. Similarly, Noe (2010:5) believes that training imparts knowledge and skill to employees that can be applied to their day-to-day activities. Therefore, government should implement training programmes for their staff in order to enable organizations to achieve high performance.

### **C) Computerized maintenance systems**

Technology offers several benefits which easily outweigh the cost associated with the implementation of such technology. It is evident from the findings that a computerized maintenance system can offer great value to a maintenance department. In fact, participants mentioned that government maintenance departments need to make use of a computerized maintenance management system (CMMS). Participants indicated that utilization of a CMMS can be cost effective, help achieve faster response to maintenance defect requests, and reduce time, which ultimately helps to improve overall maintenance performance. This is supported by Akasah et al. (2011:665) who indicated that to ensure the success of maintenance management system it is necessary to direct and control it in a systematic manner using a software system. Government should therefore invest in an effective CMMS to increase the performance of maintenance work and reduce backlogs effectively.

### **D) Amendment of procurement system**

Procurement systems are meant to regulate departments but may also contribute to several problems. The findings show that the current procurement system creates unnecessarily administrative work that makes it difficult to procure equipment for in-house maintenance work and thus increases delays. According to Chua, Ali and Alias (2014:8), an appropriate selection of procurement strategy will have different effects on the time, quality and cost of the maintenance work. Therefore, there is a need to determine and develop appropriate procurement system to facilitate and allocate resources timeously to maintenance teams. Thus selecting an appropriate procurement method is essential to obtain optimum maintenance performance.

### **E) Provision of resources**

Resources are required in every organization. No organization can succeed without adequate resources. The findings suggest that government needs to increase resources for in-house maintenance teams. Participants indicated that resources would enable in-house teams to perform necessary duties for maintenance. Important resources mentioned are laptops, tools, equipment and relevant materials. Adequate and appropriate provisions of tools, equipment and materials need to be made so that the in-house personnel could execute their responsibilities. This finding is supported by Ganisen et al. (2015:36) who argued that an increase in resources will significantly increase the quality of maintenance work. Therefore, government should prioritize the availability of resources (manpower, material, transport, etc.) in order to increase the level of production within their facilities.

### **F) Adequate budget provision**

Sufficient provision of funds is acknowledged as one of the biggest success factors for maintenance department. It is therefore not surprising that all participants indicated that the budget allocated for maintenance should be increased to suit the needs of each particular facility. The findings of Mohd-Noor et al. (2011:438) also showed that maintenance should be carried out according to actual need, and budget allocations should be carefully evaluated based on the actual requirement for maintenance work (Mohd-Noor et al., 2011:438). It is believed that increasing maintenance funds in an organization will increase the efficiencies of the maintenance department and that the budget should be determined based on the type and strategy of maintenance (Ganisen et al., 2014:35). Government should therefore consider increasing maintenance funds, and allocations of funds should be based on the needs of a particular facility. This will increase facility resources and thus improve maintenance work.

### **G) Amendment of policies**

Maintenance policies were found to be old and not implementable. It is crucial for any maintenance department to have current approved policies that suit the needs of the facilities. The findings suggest that government should amend policy to allow the to

maintenance management system to be implemented effectively. Participants indicated that an effective policy would provide them with proper maintenance guideline. Similar findings were reported by Lee and Scott (2008:78). They indicated that policy is essential as it contains all the standard and guidelines to implement all the management tasks, and descriptions of the responsibilities of the maintenance personnel (Lee & Scott, 2008:78). Government should therefore amend policies to ensure that they suit the needs of each particular facility. It is a core component for effective implementation of a maintenance management system, as it provides clear guidelines, standards, budgets allocations, etc., for maintenance work.

#### **H) Organogram**

A clear departmental organogram plays a huge role in the success of a maintenance management system as it allocates the responsibilities of maintenance personnel. The findings suggest that government must implement a proper human resource structure (organogram) to avoid skills mismatches (nepotism) of employees. Kapur (2020:5) shared similar findings and indicated that it was important to have an organized and clear human resources structure to articulate the authority, relationships and responsibilities of maintenance personnel (Kapur, 2020:5). Similarly, Xaba (2012:117) cites Elghaffar (2007:60) and supports the creation of an organizational structure (organogram) for facility management, as it allows management to clearly define their roles and responsibilities. Therefore, government should consider having a concise resource structure for maintenance employees to understand their roles and responsibility in regard to maintenance work.

#### **I) Security system**

Vandalism and theft have been found to be challenges as of a result of the absence of security systems. Security systems play a huge role in the success of maintenance as it protects the facilities and prevents theft. The findings suggest that government need to prioritize the utilization of a security system (human and technological, i.e. cameras). It also indicated that the lack or poor security system leads to unnecessarily vandalism and theft. Sibanda (2015:12) shared similar findings and indicated that the South African government



spends over R380 million per year on security guards to curtail the issue of theft and vandalism. However, the problem of theft and vandalism still persists. This is due to the inefficiency and high cost of such security systems (Sibanda, 2015:12). Therefore, it is crucial for government to prioritize an effective and reliable security system to protect public facilities from equipment theft or damage, and ensure the safety of the users. This will also improve the condition of facilities in general.

#### **J) Support**

Support is one of the main contributors to the success of a maintenance management system. The findings suggest that government should have support structures within departments. Participants stated that this would have a great impact on the behaviours of staff and consequently improve performance. This was supported by Ganisen et al. (2014:36), which found that the success of maintenance management systems is often linked to the presence of senior management who perform the functions of leadership, facilitation and support for their maintenance personnel. Therefore, government should prioritize supporting their staff in carrying out maintenance works.

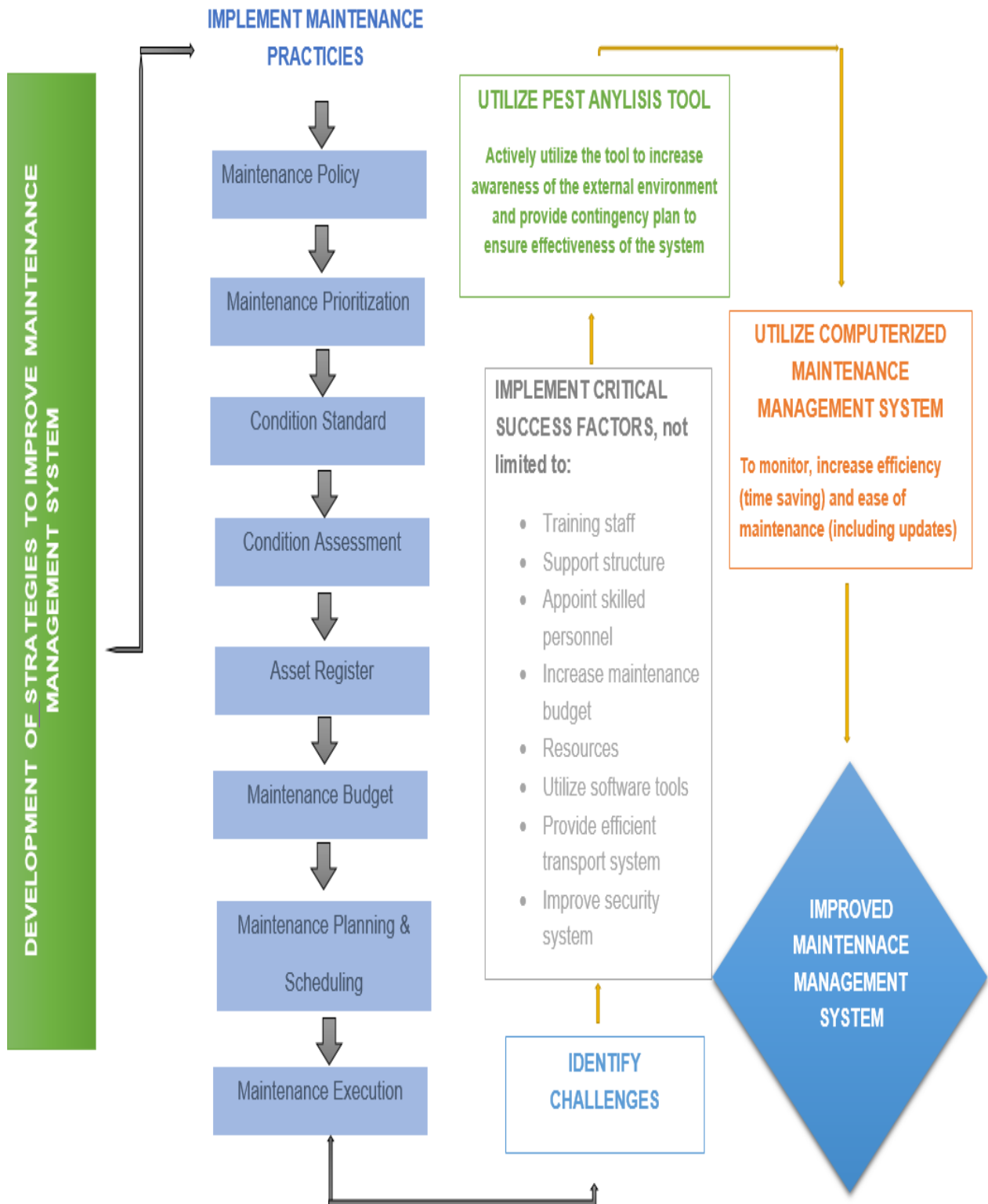
#### **K) Corruption law**

Although corruption is prevalent, the findings suggest that enforcing the law to deal with corruption amongst unethical officials could be valuable in improving a maintenance management system, particularly with regard to the budget. Garcia-Prado and Chawla (2016:94) mention that, although fighting corruption may seem to be a complex undertaking, but there are things policy makers and citizens can do to prevent corruption. They believe that enforcing a “corruption law” that will have jail consequences may reduce corruption tremendously (Garcia-Prado & Chawla, 2016:94). Vian (2008:29) attests to this and notes that using the law to make officials accountable for fraud can be a solution, as the impact on corruption in the public sector has negatively affected the quality of facility care and users’ safety. He further mentions that it will prevent resources being drained from public facility maintenance budgets through embezzlement and procurement fraud (Vian, 2008:29). Therefore, government can consider the above research as a solution to the issue of corruption.

### **5.1.1 Development of strategies to improve the current maintenance system of public facilities**

As indicated earlier in Figure 13, to meet the main objective of this study the following were developed; an improved maintenance management system should not be limited to maintenance management factors such as policy, maintenance prioritization, maintenance standards, an asset register, condition assessment, maintenance budget, maintenance planning and scheduling and maintenance execution. A policy should assist maintenance departments with guidelines on how, what and when to maintain facilities. A priority system will assist the department to prioritize maintenance work on which facilities or components should be attended to, while maintenance standards will give clear indications to maintenance personnel on acceptable levels of maintenance. An asset register will assist the departments to record facilities that have been or are to be maintained.

Although, challenges may still exist, it is the responsibility of a facility or maintenance department to identify them. However, it is crucial for a maintenance department to effectively utilize the top ten maintenance management system success factors, and to use the PEST analysis tool to analyse external or uncontrollable factors that may hamper or disrupt the system and in order to have a timeous contingency plan. Lastly, a computerized maintenance management system should be effectively utilized in order to monitor, plan and execute maintenance efficiently. This way a maintenance management system is bound to be improved. The figure below has been presented above, and it is a framework or strategy to improve a maintenance management system.



**Figure 15:** An improved maintenance management system for public facilities.

## **CHAPTER SIX**

### **CONCLUSION AND RECOMMENDATIONS**

#### **6. INTRODUCTION**

This chapter concludes the study. The conclusions were based on the purpose, research questions and results of the study. The implications of these findings and the resultant recommendations are also explained. The chapter further highlights the limitations of the study, and offers recommendations and further studies.

#### **6.1 OVERVIEW OF THE STUDY**

The aim of the study is to develop strategies that can assist to improve the maintenance management systems of public facilities to improve their current state or condition. To achieve this aim, these specific objectives were formulated:

- To evaluate the current maintenance management systems adopted for public facilities.
- To determine the challenges faced when implementing and executing the maintenance management system of public facilities.
- To establish the critical success factors in the maintenance management process that can contribute to effective maintenance management system of public facilities.
- To recommend strategies that can assist in improving the current maintenance system of public facilities.

#### **6.2 SUMMARY OF KEY FINDINGS**

The following are the key findings of the study:

- The current maintenance management systems adopted in public facilities are poor.
- The main reasons for the poor maintenance management systems are scarcity of resources (budget, skilled personnel, software systems, maintenance department etc.) and poor implementation of maintenance management system components.

- Several challenges are faced by facility managers that hamper the effectiveness of a maintenance management system. The main challenges were found to be inadequacy of funds, lack of skilled personnel, unavailability of a computerized maintenance management system, external interference, corruption, a poor procurement system, lack of leadership, nepotism, climate conditions and a lack of awareness.
- Maintenance management system success factors were identified. The factors that can promote the success of public facility maintenance management were indicated as training of staff, a support structure, appointment of skilled personnel, increased maintenance budget, provision of resources, utilization of software tools, provision of an efficient transport system, and improving security systems.

## **6.3 ACHIEVEMENT OF OBJECTIVES**

### **6.3.1 Current maintenance management systems adopted in public facilities**

The purpose of this objective was to aid the discussions of the study and help to understand the current maintenance management system adopted for managing public facilities. The objective was achieved by means of interviews. It was discovered that maintenance departments in the public sector do have maintenance management systems. However, the maintenance policy (DIAMA) is not efficiently implemented due to unclear guidelines of maintenance management practices. Although the departments under study use some integrated maintenance practices such as unplanned/reactive maintenance, reactive prioritization system, etc., this is not comprehensive. Additionally, the maintenance departments do not have capacitated staff or resources to enforce maintenance policy and practices.

### **6.3.2 Challenges faced in implementation of maintenance management system in public facilities**

From all case studies, participants revealed that there were challenges they faced that hampered the implementation of their maintenance management systems, which resulted in many public facilities being dilapidated. Challenges found to be common across all cases include budget inadequacy, poor leadership, procurement, vandalism, theft,

shortage of water, climatic condition, external interference, lack of staff capacity and a traditional (manual) system of administration, external interference, lack of expertise, retention of ageing staff, lack of skills transfer, and lack of capacity. Peculiar challenges to the specific cases were found to be nepotism, authority, corruption and lack of a maintenance department in one case. The lack of a computerized maintenance management system was found to be a serious challenge as maintenance work cannot be easily executed. Several studies reviewed in the literature also revealed that these challenges faced in public facilities do have an impact on the performance of maintenance management systems. Therefore, there is a link or correlation between these challenges and maintenance management systems. Resolving such challenges will significantly assist in the improvement of the maintenance management systems used for public facilities.

### **6.3.3 Critical success factors of maintenance management system**

It was highlighted in the literature review that there are critical success factors that can be implemented and used as strategies to improve maintenance management system. Participants also revealed that factors such as improving or amending maintenance policies would have a significance impact on the implementation of a maintenance management system. They revealed that policies would provide guidelines on what constitutes a maintenance management system, and how and when to implement its components or sub-systems. Participants also indicated that the employment of skilled staff, increasing the maintenance budget, support structures from senior management level, provision of resources for in-house teams to execute maintenance including transportation, constant and consistent staff training to enhance knowledge and develop more skills, clear job descriptions or lines of authority to avoid skills mismatches could help improve maintenance management systems and consequently improve the condition of public facilities.

### **6.3.4 Recommendation of strategies to improve the current maintenance system of public facilities**

The literature review indicated that the development of strategies to improve maintenance management of system could be achieved through the improvement of factors/practices

that constitute a maintenance management system. It was also indicated that a strategy for the maintenance management system should include a policy, a priority system, an asset register, condition standards and assessment, a maintenance strategy, budget, planning and scheduling, and execution. The findings through the participants' ratings suggest that many of these factors are currently not fully implemented in public facilities. This study formulated strategies for a maintenance management system in public facilities that can be followed. Figure 19 presents developed strategies for a maintenance management system.

## **6.4 RECOMMENDATIONS**

This study has presented recommendations from the outcome of the study based on the following three subsections:

### **6.4.1 Government**

Comprehensive research studies identified the importance of a maintenance management system. The importance of implementing the best practices or strategies of a maintenance management system will greatly improve the performance and condition of facilities. It was identified during the interviews that the current maintenance management system in public facilities is poor. The performance of facilities in terms of functionality depends on the maintenance to which they are exposed. Hence, the following are recommended for the government:

- it is highly recommended that government adopt the proposed strategies developed in this study.
- the government needs to take in account critical success factors to improve their maintenance management system, including but not limited to the following:
  - having a maintenance department for each facility.
  - employing skilled maintenance personnel.
  - amending policies that are enforceable and suit the needs of facilities.
  - increasing budget allocations for both planned and unplanned maintenance works.

- enforcing law(s) to deal with corruption amongst unethical officials misusing funds allocated for maintenance works.

#### **6.4.2 The department**

The following recommendations are made for the departments:

- A computerized maintenance management system is one of the tools that is gaining momentum and promoting effective maintenance management. However, the interview revealed that government maintenance or facility departments do not currently have a computerized maintenance management system in place and are making use of hard copy. It is therefore highly recommended that government help the maintenance department by investing in a CMMS tool that will assist with the planning, strategies, documentation and monitoring of maintenance works.
- Continuous training and development for maintenance personnel is highly recommended to continuously enhance the skills of maintenance personnel and increase the awareness of maintenance departments in order to be able to implement their mandate.
- It is highly recommended that departments ensure that there are high security systems in place to protect facilities from theft and vandalism.
- It is also recommended to support maintenance personnel in the form of leadership.

#### **6.4.3 Further studies**

The following recommendation are made for further studies:

- This study focused only on public facilities maintenance management system in one South African province. Further studies focusing on the private sector is highly recommended and would be of value. This will provide a broader perspective on improving strategies for a maintenance management system and extend knowledge not only limited to public institutions, but also to private institutions.
- Further studies might focus on the comparison of different maintenance management systems applied in public and private facilities within all provinces in South Africa. This may generally provide insightful outcomes, and explore both



practices by identifying the gap between public and private systems and establish a better system that could work for any sector and facility i.e. schools, hospitals, sports grounds, etc., in any province in South Africa.

#### **6.4.4 Practical Implications**

The findings of this study might alert maintenance personnel in the public sector to the significant advantages of implementing strategies for maintenance management systems. Findings from this study could also be useful to policy makers in setting benchmarks for the selection of competent contractors, and factors that constitute a maintenance management system (i.e. prioritization of maintenance, condition assessment and standards, planning and scheduling, asset management/register and budgeting) and performance monitoring.

### **6.5 LIMITATIONS**

The study was conducted in Limpopo Province, South Africa, and was limited to three public institutions of which one was the provincial public works department, and one local and one district municipality. One of the challenges faced during this research was to get government institution to allow their employees to participate in the study. For example, it took at least six months to get approval letters from government institutions, let alone another two months just to be provided with names and contact details to set up an appointment for interviews. Only three government institutions were used as case studies because many other institutions approached were not willing to provide access to the information, despite the assurance of confidentiality.

A sample size of 30 participants among government employees from senior to junior level in facility or maintenance department were targeted. Some participants declined the interview invitation and gave the reason that they had not been fully exposed to the issues under study. Others mentioned they could not spare the time due to busy schedules. While the findings may not be broadly generalizable, they are indicative of the impact of poor implementation of maintenance management systems in the public sector, particularly given that most of the key findings confirmed the findings of the literature review.

## **6.6 CONCLUDING REMARKS**

At present, maintenance of public facilities in some South African provinces is greatly neglected and are in unpleasant condition. The findings suggest that this is due to poor implementation of maintenance management systems. The factors that significantly influence the implementation of maintenance systems negatively include inadequate funds, poor policies, lack of maintenance personnel or appropriate skill sets, lack of a maintenance department and structure, and environmental factors. The implications of deteriorated facilities are that facilities cannot perform the functions for which they were intended or designed. The safety of users becomes an issue and the cost implications in replacing components becomes immensely huge and unaffordable. Therefore, it is important for government to implement effective strategies in maintenance management systems for public facilities. This will improve the condition of public facilities, promoting a safe environment for their users. Factors identified in the findings that would enhance the system were an adequate budget, increasing skilled personnel, increasing resources (material or equipment), training and development to enhance skills, etc. The study investigated the current maintenance management systems adopted in certain public facilities with the aim of improving them.

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## 8. APPENDICES

### 8.1 Appendix A: Consent form

**Research title:** Strategies to improve maintenance management system of public facilities in Limpopo Province, South Africa.

**Researcher:** Miller Glenrose Mavangwa, Masters candidate in Construction Management at Cape Peninsula University of Technology.

**Supervisor:** Mr Lance Wentzel, senior lecturer in the Department of Construction Management and Quantity Surveying at Cape Peninsula University of Technology.

**Co-Supervisor:** Dr. Fredrick Simpeh, senior lecturer in the Department of Construction Management and Quantity Surveying at Cape Peninsula University of Technology.

1. I understand that my participation in the above study will involve answering interview questions. \_\_\_\_\_ (Initials of participant)
2. I understand that the data from my interview will be used for academic purposes only and will NOT be disclosed for any other purpose. \_\_\_\_\_ (Initials of participant)
3. I understand that my participation is voluntary and that I am free to withdraw at any time without giving reasons. \_\_\_\_\_ (Initials of participant)
4. I understand that I do not have to answer all the questions and I may end the interview at any time, without giving a reason. \_\_\_\_\_ (Initials of participant)
5. I understand that the interview will NOT be audio recorded but the interviewer will note all answers down and I consent to this. \_\_\_\_\_ (Initials of participant)
6. I understand that I can withdraw any information given by me for the purpose of the study up until final analysis of the data. \_\_\_\_\_ (Initials of participant)
7. I agree/do not agree (delete as appropriate) to take part in the above study. \_\_\_\_\_ (Initials of participant)
8. I understand that my name will remain anonymous for this study. \_\_\_\_\_ (Initials of participant)

Name of Participant (optional) \_\_\_\_\_ Signature \_\_\_\_\_

Date \_\_\_\_\_

## 8.2 Appendix B: Interview questions

**Research title:** Strategies to improve maintenance management system of public facilities in Limpopo Province, South Africa.

**Aim of research study:** To develop strategies that can assist to improve the maintenance management systems of public facilities in Limpopo Province, South Africa.

The interview will be addressing maintenance or facility managers from junior to senior level. The aim of the interview is to achieve objective 1 and objective 2 which are:

1. To examine the current maintenance management systems adopted for public facilities;
2. To determine the challenges associated with the implementations of the maintenance systems set up for public facility;
3. To establish the critical success factors in the maintenance management process that would contribute to effective maintenance of public facility;
4. To develop strategies that can assist to improve the current maintenance system of public facilities.

### **SECTION A:** General information

This section attempts to obtain the general information about the participant and some background information about the organization.

1. What is the name of your organization (optional)?
2. At what level of management do you operate? Senior/Middle/Lower
3. What is your position/title?
4. How long have you been working in this position?
5. What is your highest qualification?
6. Are you registered with any professional body? If yes, which professional body are you registered with?

### **SECTION B:** Current maintenance management systems.

7. Do you perceive maintenance management system important in facility management?

If yes, out of 10 how do you rate your current maintenance management system?

8. Does your maintenance management system contain the following factors? If yes, out of 10, how would you rate the performance of it in your organization?

Factors	Yes(Y)/ No(N)	Rating
Maintenance policy		/10
Maintenance prioritization system		/10
Maintenance condition standards		/10
Condition assessment		/10
Asset register		/10
Maintenance budget		/10
Maintenance strategy		/10
Maintenance plan		/10
Maintenance scheduled		/10
Approach to maintenance execution		/10

9. Have the conditions of the facilities improved in last five years?

.....

.....

.....

.....

**SECTION C: Challenges**

10. What are the challenges that you are facing and its impact on your maintenance management system that affects the improvement of facility maintenance?

.....  
.....  
.....  
.....

**SECTION D: Success factors**

**11.**What success factors would you consider to have a huge influence on a maintenance management system for public facilities?

.....  
.....  
.....  
.....  
.....

**Thank for your time and effort!**

## 8.3 Appendix C: Approval letters for data collection



### GREATER GIYANI MUNICIPALITY

Tel: 015 811 5500

Fax: 015 812 2068

P/Bag X 9559

GIYANI

0826

#### OFFICE OF THE MUNICIPAL MANAGER

Ref: 4/4/R

Enq: Chauke H.D

Date: 05 December 2019

Ms Mavangwa Miller

P.O. Box 280

GIYANI

0826

PERMISSION TO CONDUCT RESEARCH ON STRATEGIES TO IMPROVE MAINTENANCE MANAGEMENT SYSTEMS IN PUBLIC FACILITIES IN SOUTH AFRICA: YOURSELF

Receipt of your letter dated 27<sup>th</sup> November 2019 regarding the matter mentioned above is hereby acknowledged.

Kindly be informed that your application has been approved. You are advised that the information obtained during the research should be confidentially and may not for any other purpose rather than for research purposes.

Your cooperation will be highly appreciated.

Regards,

  
MR CHAUKE H.D.  
MUNICIPAL MANAGER



**LIMPOPO**  
PROVINCIAL GOVERNMENT  
REPUBLIC OF SOUTH AFRICA

**DEPARTMENT OF  
PUBLIC WORKS, ROADS  
AND INFRASTRUCTURE**

Reference : 2/7/5/2  
Enquiry : Seboko MM  
Date : 06 December 2019

Ms. Miller Glenrose Mavangwa  
Cape Peninsula University of Technology  
PO Box 1906, Bellville  
7535

**PERMISSION TO CONDUCT RESEARCH STUDY AT LIMPOPO PUBLIC WORKS, ROADS AND INFRASTRUCTURE AS PART OF HER MASTERS OF CONSTRUCTION DEGREE REQUIREMENTS.**

1. Your application to conduct research in the department bears reference.
2. Your proposal was forwarded to the Monitoring, Evaluation and Research unit under Strategic Management for assessment and it was concluded that:
  - Your proposal complies with the departmental research and development term of reference.
  - Your research sample covers Construction Management and Quantity Surveying.
  - You should complete a departmental declaration form within 5 working days upon receipt of this letter.
3. To complete the whole process, contact Mr. Sithole Marcus at office No 6/4/11 during working hours between 07h30 to 16h30. (015-284 7423)

Regards,

  
HEAD OF DEPARTMENT  
Mr. DIKGOLE SEROKA

17 DECEMBER 2019  
DATE

43 Church Street, Polokwane, 0699, Private Bag X9490, POLOKWANE, 0700  
Tel: (015) 284 7301, (015) 284 7530 website: <http://www.dpw.limpopo.gov.za>

*The heartland of Southern Africa - development is about people!*



# LIMPOPO

PROVINCIAL GOVERNMENT  
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF  
**PUBLIC WORKS, ROADS  
AND INFRASTRUCTURE**


Ref: S.5/9/1  
Enq: Bila K.P

The Research Supervisor  
Cape Peninsula University of Technology  
Faculty of Engineering and the Built Environment  
Department of Construction Management and Quantity Surveying  
P.O. Box 1906  
Bellville  
7535

**Attention: Dr. Fredrick Simpeh**

**SUBJECT: REQUEST FOR PERMISSION TO OBTAIN DATA: FACULTY OF ENGINEERING  
AND THE BUILT ENVIRONMENT: MISS MAVANGWA GLENROSE MILLER.**

1. The Department acknowledge receipt of your email which was sent on the 16<sup>th</sup> March 2020.
2. This letter serves to confirm that the application for Miss. Mavangwa Glenrose Miller to obtain data from Department of Public Works Roads & Infrastructure has been approved.
3. The Department hope that the information will be kept as confidential and be used for research project only.

  
Mr. Baloy S.B.  
Director; Mopani District

2020/07/13.  
Date

579 Parliamentary Building, Giyani, Private Bag X576, GIYANI, 0826  
Tel: (015) 812 1972, Fax:(015) 812 4262/ 1526 Website: <http://www.Limpopo.gov.za>

**The heartland of Southern Africa - development is about people!**



## 8.4 Appendix D: Institution letter request for data collection



Faculty of Engineering and the Built Environment  
Department of Construction Management and  
Quantity Surveying  
P O Box 1906, Bellville, 7535  
Tel: (021) 959-6631/6527  
E-mail: [danielsch@cput.ac.za](mailto:danielsch@cput.ac.za)  
6<sup>th</sup> August 2019

Dear Sir/Madam

### **PERMISSION TO OBTAIN DATA**

This is to confirm that Miss Glenrose Miller Mavangwa student number (213295717) is a registered Masters student at Cape Peninsula University of Technology, in the Faculty of Engineering and the Built Environment, Department of Construction Management and Quantity Surveying.

Glenrose is conducting a research which focuses on the approach to the maintenance of public facilities. The aim of her research is to develop strategies that can assist to improve the maintenance management systems of municipalities in South Africa.

The above mentioned student is seeking for permission to collect data in the form of questionnaire and interview to gather necessary information needed for the research. The information will be treated confidential and solely used for academic purpose.

Your support is highly appreciated. Please, do not hesitate to contact me for further clarification.

Yours Sincerely



Dr Fredrick Simpeh  
Research supervisor  
Email: [simpehf@cput.ac.za](mailto:simpehf@cput.ac.za)  
Tel: 0219595866

## 8.5 Appendix E: Conference paper & presentation

			
CONFERENCE PROGRAMME - BUILDING SMART, RESILIENT AND SUSTAINABLE INFRASTRUCTURE IN DEVELOPING COUNTRIES			
DAY ONE (Wednesday, 6 <sup>th</sup> October 2021)			
<a href="https://ui02web.zoom.us/j/82699524292?pwd=SVFhblhlcUJlRFRGUVh0QVFnMEp0Z090">https://ui02web.zoom.us/j/82699524292?pwd=SVFhblhlcUJlRFRGUVh0QVFnMEp0Z090</a>			
09:00-09:05	Arrival and announcements- Prof Innocent Musonda – DII 2021 Scientific Chairperson		
09:05-09:10	Welcoming remarks: Prof. Yanxia Sun, Vice Dean of the Faculty of Engineering and the Built Environment- UJ		
09:10-09:30	Official opening of the conference and keynote: Prof Daniel Mashao, Executive Dean of the Faculty of Engineering and the Built Environment- UJ		
09:30-09:50	Keynote Address 1: Prof. Ephraim Munshifwa, Dean of the School of the Built Environment at the Copperbelt University		
09:50-10:15	Keynote Address 2: Mr Marios Ntaflou, Engineer   Mobility Analytics & Simulation   CUBE, LEGION, LumenRT		
10:15-10:15	Tea Break/Switching to Sessions		
Technical Sessions			
<a href="https://ui02web.zoom.us/j/87355044210">https://ui02web.zoom.us/j/87355044210</a>			
	Breakaway Session 1	Breakaway Session 2	Breakaway Session 3
	SUSTAINABILITY IN INFRASTRUCTURE DEVELOPMENT Session Chair: Dr Nuru Gambo	SMART INFRASTRUCTURE AND CITIES Session Chair: Dr Bupe G Mwanza	GENDER EQUITY, EMPOWERMENT, WELLNESS AND DEVELOPMENT Session Chair: Ms Kolosa Madikizela
10:15-10:30	Establishing a conceptual framework for developing sustainable building materials- A. Moghayedi, K. Le Jeune, M. Massyn, and P. Byron	People, People, everywhere; The Architectural Design Response for Enugu City, Nigeria- F. O. Okeke, F. O. Uzuogunam, R.C. Nnaemeka-Okeke, and E. C. Ezema	Socioeconomic Status, Gender and Outcome Expectations of Career Choices of Students in Construction Programs in South Africa- M. Akinlolu and T. C. Haupt
10:30-10:45	On-site Infrastructure for Sustainable Water Resource and Wastewater Management for New and Old Residential Areas - F. M. Kakana and E. M. Mwanaumo	Data sharing in the construction industry: exploring the willingness of industry stakeholders in South Africa- T. O. Ayodele and K. Kajimo-Shakantu	Skills Development in The Construction Industry Through Road Maintenance Activities- L. Matshidze, and A. Windapo
10:45-11:00	Sustainability awareness for architectural, engineering and construction professionals in Zimbabwe- T. Moyo and B. Chigara	Nigeria Public Transport System and The Global Smart City Crusade J. J. Dukiya	The Impact of an Industry Summit on Health and Safety (H&S) Practitioners' Industry 4.0 Perceptions- J. Smallwood and C. Allen
11:00-11:15	Influence of Team Integration and Adaptability in Project Team Cohesion in the Namibian Built Environment J. Engelbrecht and C. Ferreira	Renewable energy: the catalyst for a sustainable energy distribution sector in South Africa- M. Bukula, B. Botha, D. Els and W. de Beer	Effects of machine accidents on project delivery in the KwaZulu-Natal construction industry- A. Mall and A. O. Aiyetan
11:15-11:25	Tea Break/Switching to Sessions <a href="https://ui02web.zoom.us/j/87355044210">https://ui02web.zoom.us/j/87355044210</a>		
	Breakaway Session 4:	Breakaway Session 5:	Breakaway Session 6:
	INFRASTRUCTURE, INVESTMENT AND FINANCE- TRENDS AND FORECASTS Session Chair: Dr Chabota Kaliba	INFRASTRUCTURE: ECONOMIC SUSTAINABILITY Session Chair: Dr Peter M, Mukalula	INFRASTRUCTURE: SOCIAL/ENVIRONMENTAL SUSTAINABILITY Session Chair: Dr Neema Kavishe
11:25-11:40	Exploring The Impact of Asymmetric Lock-In on Cost Overruns in Megaprojects: The South African Energy Sector Projects- N. Khatleli	The Effect of Real Estate Obsolescence on Economic Sustainability- T. Mkhwe-Mafereka, B. Botha, D. Els and K. Ntakana	Evaluating the impact of leadership Styles and strategic decisions on the performance of contracting firms in South Africa A. Daworaz, D. Nooraully, K. Alade, L. Matshidze, and A. Windapo
11:40-11:55	Measuring Procurement Performance Using Sigma Level Metric- J. A. Ottou, B. K. Baiden, G. Nani and M. M. Tuuli	Handling financial implementation challenges of Public-Private Partnerships (PPPs) in Zambia- P. Mukalula	The Impact of Indoor Environmental Quality on Building Occupants Productivity and Human Health: A Literature Review- M. C. Mewomo
11:55-12:10	The Impact of Project Cost Management on Contractual Disputes in South Africa C. Amoah and C. van der Linde	A Framework for The Optimisation of Commercial Property Investment Opportunities in Africa- J. J. Gouws	Evaluation Of Current Maintenance Management Systems Adopted in South Africa: A Case Study of Public Facilities M. G Mavangwa, F. Simpeh and L. Wentzel
12:10-12:30	Session Chairs Report		
12:30-13:00	Lunch Break		
13:00-13:30	Panel Discussion <a href="https://ui02web.zoom.us/j/82699524292?pwd=SVFhblhlcUJlRFRGUVh0QVFnMEp0Z090">https://ui02web.zoom.us/j/82699524292?pwd=SVFhblhlcUJlRFRGUVh0QVFnMEp0Z090</a>		
	Discussants: Engr. Martin Manuhwa, Prof. Nuno Gil, Engr. Greshom Sichinga, Prof. Nthatsi Khatleli, Mr. Patrick Makape. Facilitator: Dr Sam Zulu		
13:30-15:45	Panel Discussion Outcome		
15:45	Closing for Day 1		



# EVALUATION OF CURRENT MAINTENANCE MANAGEMENT SYSTEMS ADOPTED IN SOUTH AFRICA: A CASE STUDY OF PUBLIC FACILITIES

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## ABSTRACT

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**Purpose:** Public facilities in most South African provinces are poorly managed due to several known and unknown factors. This paper seeks to evaluate the maintenance management system adopted by municipalities with the aim of identifying the underlying factors that militate against the implementation of developed maintenance system.

**Methodology:** An exploratory design and a case study research approach was adopted. Qualitative data was collected by means of a semi-structured interview from facilities or maintenance managers within the municipalities. A total of 30 participants were targeted and scheduled for interview. However, only 25 (i.e. 83.3%) availed themselves for the interview. thematic analysis was used to analyze the collected data.

**Findings:** The findings revealed that poor implementation of maintenance management system in public facilities leads to faster deterioration of facilities. Moreover, it became evident that deteriorated facilities increase cost burden, maintenance backlog and contribute to safety risk. The findings also show that the maintenance systems of the municipalities were poorly implemented. Lack of implementation results from lack of resources (manpower and equipment), inadequacy of funds, lack of expertise, lack of leadership, lack of staff training, lack of maintenance departments or poor maintenance structures and lack of security system.

**Originality:** No earlier research has thoroughly investigated the underlining factors hindering the implementation of maintenance system of municipalities in the South African context.

**Keywords:** Building maintenance, Facility management, Maintenance management system, Municipalities, South Africa

## 8.6 Appendix F: Coding and sub-themes of participants

Participant no.	6	
Position	Project Manager	
Experience in position	10- 15 years ( <i>Senior level</i> )	
Highest Qualification	BTech: Mech Eng.	
Professional registration	N/A	
Themes	Sub-Themes	
<b>1.Maintenance management system</b>	Descriptive purpose of maintenance management system's importance	
	Maintenance policy	
	Maintenance prioritization	
	Maintenance condition standards	
	Condition assessment	
	Asset register	
	Maintenance budget	
	Maintenance strategy	
	Maintenance plan	
	Maintenance schedule	
	Maintenance execution	
	<b>2.Condition of facilities</b>	Condition status
		Change of leadership
Recruitment process		
Authority		
Maintenance contracts		
Weather effects		
Vandalism		
Skills mismatch		
External intervention		
Procurement system		
Misusing facilities		
Lack of security systems		
Traditional system		
Theft		
<b>4. Maintenance management system success factors</b>	Amending policies	
	Employment of skilled workers	
	Training of staff	
	Utilize computerize maintenance system	
	Security system	
	Procurement system	
	Human resource structure	
	Support structure	
	Efficient transport system	
	Resources	
	Budget	
	Corruption law	

**Interviewer:** *Do you perceive a maintenance management system as important in facility management?*  YES/NO  and how will you rate it out of 10?

**P6:** It is very important. It's important in this way, most building or facilities that are newly constructed, immediately when its finished and in used one needs to start maintaining it from the beginning to keep it at its required standard or state and functionality for its use. However, the government will say, nooo...this building or facility is still new and doesn't need maintenance. They'll leave it for 3 years, or 4 years or 5 years or even more than 10. Sometimes they might be some minor problems which needs to be attended to, but they'll leave it. And this minor will result to huge problem which will then leads to spending more money to it. So it's very crucial to have maintenance system in place that can guide you how to maintain works from the beginning to retain its state. Our system I can say 4 out of 10.

**Interviewer:** *Does your maintenance management system contain of the following and if yes, out of 10, how would you rate the performance of it in your organization?*

**Interviewer:** *Do you have maintenance policy?*

**P6:** Maintenance policy...there is one. They use a document or act that it's called DIAMA that guide us on how to maintain buildings or facilities. I do not know much about the content of that policy as I have been moved to construction projects and not maintenance per se. However, even so, many people within the maintenance department they don't even know what that document contains and requires them to do. Even me then I did not know much about it. Or to understand the policy in general; no one will ever tell you what the policy says. People do things as they please and of course the excuse of saying we don't have funds to follow one, two, three.

**Interviewer:** *Do you have a maintenance prioritization system?*

**P6:** Prioritization...mmmh...no I don't think they have. But in government offices, the only thing they prioritize is electricity, sewage and water. These are the only things they look up too in terms of their maintenance. The ceiling can break; windows can break; they'll take years to fix it. So I wouldn't say this is a great prioritization system. So I can rate it 4 out of 10.

**Interviewer:** *Do you have maintenance condition standards (CS)?*

**P6:** Nooo, not really. Or maybe I can say we do. Our standards are basically on what we can afford on that particular year. We are not like private sector for example: Capitec Bank, where they insure year in year out that all their branches across the nation they look the same and have same standard. No. Us, we don't have a standard thing. We change every time. If there's money, we adjust requirements accordingly. It's just basically acceptance base on what we paid for. However, in most cases they are poor. So I can rate this 4 out of 10.

**Interviewer:** *Do you have condition assessment (CA)?*

**P6:** Yes, we do. The DIAMA document want every facility to be condition assessed every 5 years. However, we are not consistent in this or do as per requirement. Because there's always interventions in the government. Lots of changes, lots of plans so everyone end up being confused on whether are we still operating as per what DIAMA requires us to operate or we operate as per what leaders says. So it's a mess. But yes, we do have. So I can rate it 3 out of 10 because it's not being implemented as it should be.

**Interviewer:** *Do you have an asset register?*

**P6:** Noooo, we don't. Noo, we don't have.

**Interviewer:** *Do you have a maintenance budget?*

**P6:** Yes, we do budget for works. We do budget for planned and unplanned works every financial year. However, the budget is not enough for planned works, so what we do we use the money for planned works to cater for unplanned works. So we are more active on unplanned maintenance. Our budget is very poor so I can rate it 4 out of 10.

**Interviewer:** *Do you have a maintenance strategy?*

**P6:** The document from DIAMA does have strategies for us but it's not implemented. Like I said before, if it has nothing to do with water, sewage or electricity then we are not going to maintain that thing now. If our strategies were in place and implemented, then all facilities should be functional. So I can rate it 4 out of 10.

**Interviewer:** *Do you have a maintenance plan?*

**P6:** Yess, we do have. Like I mentioned we have planned works and unplanned. Unplanned are basically ones that requires emergency responds or if a certain component breaks down. We mostly focus on these as budget for planned works is always not enough. So we rather wait for something to completely be not functional then we maintain or replace. It's not helping but it's our approach. So I can give it 4 out of 10.

**Interviewer:** *Do you have a maintenance scheduled (MS)?*

**P6:** Yes, we do schedule what we need to maintain. Effectiveness...mmm, maybe yes on emergencies of activities mentioned earlier, water and mmm... the other two items mentioned earlier; the sewage and electricity. So in terms of these activities 6 out of 10. But in general maintenance schedule, it poor because out of 100 items we need to schedule and maintain, we only schedule 10 items. So in overall performance just 4.

**Interviewer:** *What approach do you have on maintenance execution?*

**P6:** ehhhh... sometimes we outsource for specialized work. Ehhhh, our in-house has no more labours like before. Today we don't have plumbers, electricians and all technical workmanship. If we do, our labours don't have tools or materials to work with. Some of those who are more passion with their jobs buy their own tools. Government isn't providing them anymore like before and I don't know why. So now our maintenance team will just come to work and sit and not being bored because they are getting paid and they have valid facts to say we don't have tools or material.

**Interviewer:** *Have the conditions of the facilities improved in last five years? What can you say about it based on your observations?*

**P6:** Ehhhh... I wouldn't say it has improved. The thing is public works now doesn't have much control in all public facilities. Like department of education now do their own maintenance, department of health do their own, department of sports same, so what happens is public works will have an inspectorate who will go there and inspect, do BOQ which will go for next financial budget proposal. So these departments receive way low budget than what public works receives. So clearly they won't have outstanding maintenance. It going to be poor. However, public works is required to help the departments. But funds they receive it won't be enough to help all departments. With these



being said, we end up sitting with huge backlog. So it's hard to see what we have progressed.

**Interviewer:** *What are the challenges that you are facing and their impact on your maintenance management system?*

**P6:** Eyyy, that one I will not answer because what happens at the top we don't know. But I can give you an example that may be relevant. Recently we needed to renovate two halls, we did everything required assessment, planning, BOQ, report you name them. We submitted this to the national department in Polokwane since here we are district. We were just waiting on positive feedback regarding dates to start and funds to be allocated.

But the feedback came to say leave the other hall A and only do hall B. reasons or motivations regarding such decisions till today we don't know.

**P6:** Also changes of MECs I would say it impacts us. This is normally caused when the government itself reshuffle the ministers, therefore, new ministers select its own MECs within the districts. And thus, changes everything. As you know, you know...MECs never want to take from where things were left. I don't know why (laughing...), but it's sort of tendency or believe that nothing was ever done right so they want to come and change everything. And thus, also causes confusion regarding authority. Like the battle of who is to what or what are my roles and MECs changes even people's duties.

**P6:** mmm, let me say weather issues also. It affects us in situations like hotness, in Limpopo weather can be extremely hot that work is postponed and we stay at home. And in most cases it's always above 36 degrees and for external works labourers do not cope executing works. and thus impact us in delay in time for completing works. another effect of hotness is that the area gets dry, till today we suffer drought. And you know, what obviously things like bathrooms are always out of order because of no water to flush toilets.

**P6:** Ehhhh... you know what, like in government hostels or residence you'll find that occupants or tenants when they complain about some elements that has broken down and needs to be maintained, when they report it and public works take time to rectify it causes anger in them and they'll go out strike and vandalize some of other facilities so they feel the pain they are feeling. In facilities that are well maintained, we experience theft due to lack of security system. Not only to forget that these residents are actually the one that are misusing the facilities. So they misuse, components get broken down then they strike



demanding service and damage more during the strike. So this will obviously have impact in budget as now instead of maintain what only broken down in those hostels, now you must as well have budget for the other vandalized facilities and the cost of replacing stolen stuff. It gets too much and it's a challenge really.

**P6:** Public works use call center system, where one needs to call, report their request, and manually procedures take place from there. By manual system, I mean by having to go through procurement steps of procuring labour, materials, budgets and so forth. This process is lengthy and some documents goes missing during the process. This is not effective and indeed a challenge. I think government needs to relook at this and come up with a better system.

**Interviewer:** *What are the 3 main factors would you consider to have a huge effluence on the success of the maintenance management system of public facilities?*

**P6:** Firstly, they need to employ people, we don't have people anymore. All our staff are old and due for retirement. And not just anybody, but someone with a skill. Secondly, they need to provide resources for these employees Like laptops, tools and other materials they need. 3rdly, train stuff regularly.