FACTORS AFFECTING MAINTENANCE COST OF PUBLIC BUILDINGS: THE CASE OF TANZANIA BUILDINGS AGENCY AND NATIONAL HOUSING CORPORATION

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By

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A Dissertation submitted in Partial Fulfilment of the Requirements for the Degree of Master of Science in Construction Economics and Management of Ardhi University

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for examination by Ardhi University a dissertation entitled “Factors affecting maintenance cost of Public Building: The Case of Tanzania Building Agency and National Housing Corporation” in partial fulfilment of the requirements for the degree of Master of Construction, Economics and Management of Ardhi University.

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Dr. Geraldine Kikwasi

Supervisor

Date: _____

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AND

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DEDICATION

To my parents Mr and Mrs Zeni Slim

ABSTRACT

Despite efforts to raise the performance of public buildings, little emphasis is placed on maintenance works and related factors affecting maintenance costs of public buildings, which are often high. This study seeks to examine factors and areas affecting maintenance costs of public buildings in Tanzania. This was a cross-sectional study involving a total of 387 tenants and 29 employees (experts) from public buildings agencies. Data were collected using questionnaires and analyzed using Stata version 16 – descriptive statistics feature reporting absolute numbers and frequencies. Findings: Findings from tenants and experts, the identification and ranking of factors affecting maintenance costs were similar whereby four out of the six most dominant factors were the same and these were; building age, poor quality control, building material used, and inadequate financial resources. However, findings from areas contributing to high maintenance cost showed wide variation between tenants and experts with only plumbing and engineering installation which was common: Findings of this study provide an insight on identification and ranking of factors affecting maintenance cost and providing a framework which will inform stakeholders on minimizing maintenance cost. Further research is needed to assess actual costs of various maintenance works conducted in public buildings including analysis of timeliness and completeness of maintenance works.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATION

DSM	Dar es Salaam
NHC	National Housing Cooperation
TBA	Tanzania Building Agency

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Public buildings are a type of buildings for rent or sale which are generally owned by the government through various established government agencies. Key activities overseen by the government building agencies to ensure operations of public buildings are functional at optimal level include general administration, project management, finance and accounting, purchasing and inventory, rental and occupancy, personnel and training, and maintenance management (U.S Department of Buildings and Urban Development, 1983). Maintenance is a crucial component of the overall public buildings management that ensures the value of the house remains high and maximizes efficiency by saving costs and time through avoidance of performing more expensive fixes rather than prevent them from happening through regular maintained activities (U.S. Department of Housing and Urban Developmet, 1983).

According to Stanford (2010), the main objective of maintenance is to prevent or at least minimize the deterioration of the building and its various sections or a component over its life span. Additionally, a well maintained building or buildings unit elevates its physical appearance and functionality which enables the community or potential tenants to positively judge the services being offered and become more willing to buy or rent at a competitive market price (Stanford, 2010). Additional advantages of having adequate maintenance management include: preservation of initial investment value; keeping public houses in an acceptable condition; maintaining a good appearance of public houses; and generating income for the government building agencies (Nyayiemi, 2013).

Despite the documented benefits of maintenance management, evidence around the world has shown that majority of public houses have poor maintenance record compared to private sector houses. A study in Ghana reported that 83 percent of public buildings that were assessed had maintenance problems such as structural defects and utility deterioration (Cobbinah, 2010). Other studies in Hong Kong (Lau, 2002) and Malaysia (Talib et al., 2014) also reported maintenance issues in public buildings. Additionally, another study in Kenya reported a general lack of maintenance prioritization whereby majority of urban public houses are characterized by a poor state of maintenance leading a drastic decrease of economic value of these houses and some buildings units reaching a stage of non-repair (Matindi, 2013). The observed maintenance challenges are also reported in Tanzania.

In 2020, Tanzania was classified as a lower-middle income country from low-income country by the World Bank due to consistent increases in gross national income per capital. This positive milestone has been contributed by strong economic performance and has been achieved in parallel with improvements in infrastructure and urbanization (World Bank, 2020). With increased urbanization and standard of living, demand for public buildings also increase which entails the need for government building agencies to scale up new building projects but also to maintain the existing houses in terms of aesthetical, structural and architectural functions. The physical appearance of public houses constitutes the basis upon which the society makes their initial judgment of the quality of services to be offered. However, in spite of the heavy investment in building public houses in Tanzania, there has been minimum budget on a sustainable maintenance plan to preserve the quality of existing buildings (Kanuti and Alananga, 2017).

The state of public houses in Tanzania exhibits evidence of lack of maintenance and repair on different building elements and facilities including physical appearances and other structural building components (Kanuti and Alananga, 2017). This observation cuts across both residential and commercial public houses. Furthermore, some public houses have not seen significant maintenance or show little signs of maintenance since they were constructed, even those dating back to the colonial era (Komu, 2011). Therefore, making it very difficult for government building agencies to hold on to these unmaintained and unrepaired buildings leading to unwanted consequences of having public houses with reduced lifespans and others to the extent of abandonment (Komu, 2011). Furthermore, the study demonstrated a significant neglect of public buildings repair and maintenance run by the National Housing Corporation in Dar es Salaam due to low levels of rent and insufficient collection of rent driven by existing government policies (Komu, 2011). Additionally, government building agencies fail to take into account factors affecting maintenance costs by understanding different ranks of these factors to the total expenditure, as indicated by the study conducted in Dar es Salaam on impact of maintenance type on costs to the Tanzania Building Agency especially in the initial phase where costs seem to be high (Shenyagwa, 2015). Despite efforts to raise the performance of public buildings, little emphasis is placed on public buildings maintenance and the related maintenance costs are often high for government building agencies to accommodate and properly implement standard maintenance and repair activities (Kanuti and Alananga, 2017).

In this regard, evidence from the literature has reported several factors affecting public buildings maintenance cost such as: 1) building characteristics (building age, building materials, building function, building height, building area etc.); 2) tenant factors (expectation of tenants, misuse of property, delay or failure in reporting maintenance issue etc.); 3) maintenance factors (poor workmanship, poor material selection during maintenance, budget constraints, poor maintenance plan, failure to identify true cause of the defects etc.); 4) political factors (changes in political policies, health and safety regulations); 5) other factors (lack of trained personnel and vandalism) (Nyayiemi, 2013). However, there is limited evidence in Tanzania on factors affecting maintenance costs of public buildings.

1.2 Research Gap

General common maintenance challenges include: physical building deterioration; breakdown of mechanical and structural systems; inadequate government support; lack of competent of workforce; in availability of materials, supplies and equipment; and issues related to handling of emergencies, reducing backlogs, scheduling systematic maintenance etc. (U.S. Department of Housing and Urban Developmet, 1983). Evidence from the literature has reported more specific factors which may be affecting maintenance performance of public buildings such as choice of materials used and their strength, safety measures put in place, skilled maintenance personnel, environmental factors, usage factors, and quality control factors (Adejimi, 2005). Another study indicated that the level of maintenance of public buildings may be specifically affected by variables such as structural components condition, roof components, toilet facilities, discharge of waste water component, exterior wall condition, electrical wire and switches conditions etc. (Olagunju, 2012). Additionally, building defects which may require specified maintenance and repair might be contributed by construction errors, lack of supportive supervisor and oversight, lack of care of those people who design, construct and maintain buildings and lack of capacity to perform maintenance duties to the required standard (Addleson, 1977).

For public houses to be properly functional with competitive market value, then maintenance has to be considered a top priority to ensure maximum utilization of the services for maintaining optimal conditions of public houses. Generally, the successful operation of the government building agencies is measured by financial, physical and functional indicators. Financial indicators are related to cost and expenditure associated with operations, implementation and maintenance; while physical indicators are related to physical shape and condition of the houses and supportive systems; and functional indicators are related to the

way building and facility function (De Marco and Mangano, 2012). Building maintenance management is often considered as a cost burden to the government building agencies. However, this viewpoint on maintenance management should not be considered as a cost burden but rather a way of saving extra cost in the future. Furthermore, government building agencies with clear understanding for strategic planning on maintenance can optimize the return on investment of their maintenance expenditure (De Marco and Mangano, 2012).

The above-mentioned maintenance requirements and challenges has led to increased budget and expenditures which far exceeds the capacity for government building agencies and tenants to support. This high maintenance cost may be a result of various factors such as managerial factors, building characteristics, maintenance factors, political factors, and tenants factors. Although these factors have been identified in the literature, evidence from Tanzania is limited. The current study is designed to add to the knowledge base the factors that affect the maintenance cost of public houses overseen by the government building agencies in Tanzania. Having a better understanding of these factors will assist the government building agencies to propose measures that would mitigate high maintenance costs.

In Tanzania, two regions – Dar es Salaam and Dodoma – have been experiencing increased demand for public buildings due to population growth and migration in Dar es Salaam and the shifting of all government offices to Dodoma. Thus, this has put pressure on government building agencies to deliver well maintained buildings to potential tenants. Therefore, to ensure the maintenance cost for public houses are reduced, it is crucial to investigate factors that affect the maintenance cost of public houses in Dar es Salaam and Dodoma.

1.3 Problem Statement

Government building agencies are faced with challenges of adequately maintaining buildings, partly due to lack of maintenance prioritization and scarcity of resources. Evidence from the literature has indicated that maintenance planning and execution has been given lower priority leading to loss of value of public buildings. Additionally, government building agencies fail to consider factors affecting maintenance costs by understanding different ranks of these factors to the total expenditure. However, evidence of factors affecting maintenance of costs among public buildings in Tanzania is limited. Therefore, the current study aims to systematically provide decision makers with evidence-based findings and recommendations on factors affecting maintenance costs.

1.4 Objectives of the Study

1.4.1 Main objective

To assess factors affecting maintenance cost of public buildings with the view of developing a framework that will inform stakeholder on minimizing maintenance costs of public buildings.

1.4.2 Specific objectives

i. To identify factors affecting maintenance costs of public buildings.
ii. To examine areas that contribute to high maintenance costs in public buildings.
iii. To develop a framework that will inform the stakeholders on minimizing maintenance costs in public buildings

1.5 Research Questions

i. What are factors affecting maintenance cost of public buildings?
ii. Which areas contribute to high maintenance costs in public buildings?
iii. How can maintenance costs in public buildings be minimized?

1.6 Significance of the Study

Findings from this study assist decision makers, government building agencies officers and other stakeholders to make informed decision about building maintenance management. By having a better understanding of different factors which may be affecting maintenance costs, appropriate decisions and actions may be taken to plan, implement and evaluate maintenance activities in order to achieve high performance at minimum costs. Furthermore, findings from study will provide recommendations which are grounded on results from Dar es Salaam and Dodoma on how to conduct maintenance activities for improving efficiency. Ultimately, findings from this study will inform a wide range of stakeholders including government building agencies provision of proper maintenance management and minimization of costs to ensure quality of services. Specifically, by having a better understanding of factors affecting maintenance costs and identifying particular areas contributing to high cost will enable the government building agencies to provide proper maintenance management. Finally, the study will develop a framework and if adopted will minimize the maintenance cost in public buildings. Additionally, the study findings will provide an opportunity for further research on the subject matter

1.7 Research Methodology

This study utilized quantitative approach where two government building agencies – Tanzania Building Agency (TBA) and National Buildings Corporation (NHC) provided data for this study. All occupied public buildings in Dar es Salaam and Dodoma managed by TBA and NHC provided the population of interest in this study and act as the sampling frame. The sample from this population was given questionnaires whereby one tenant from each household was recruited. Another population of interest in this study was experts in maintenance works for TBA and NHC. The population units of public houses are 11,208 units which provided a sample of 387. Data management and analyses were conducted and reporting descriptive statistics in a way of absolute numbers and frequencies.

1.8 Scope and Limitation of the Study

This study involved an assessment of factors affecting the maintenance cost of public houses. The findings help decision makers better understand the specific factors which contribute to maintenance cost. Furthermore, the application of quantitative methods also provides information which is credible. However, the study has some limitations such as geographical coverage which is limited to Dar es Salaam and Dodoma regions, hence missing important information from other regions which may have different experiences. Another limitation is the design of the study which collects information in a snapshot manner therefore unable to assess causality.

1.9 Organization of the Study

This dissertation about factors affecting maintenance cost of public buildings in Tanzania is organized with respect to the approved format. It utilized the following layout: abstract; chapter one – introduction; chapter two – literature review; chapter three – methodology; chapter four – data collection, analysis and discussion; chapter five – conclusion and recommendation; references; and appendices.

1.10 Chapter Summary

In summary, this chapter details the background information of the study and identifying the research gap which the study intends to understand systematically better. Additionally, the chapter described the problem being studied and stipulated objectives which guide the study design and getting appropriate outcomes through selected methodology which will provide the desired results in a credible and valid scientific approach. The next chapter is literature review.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter looks at the review of relevant literatures that give a background on the concept of maintenance cost for public houses. It identifies factors affecting maintenance cost, examines areas that contribute to high maintenance costs in public housing and propose/recommended a framework that will minimize maintenance costs in public housing.

2.2 Importance of Maintenance Management

Maintenance management involves activities which ensure the housing unit or building remains functional, aesthetically pleasing and can last as long as planned. In other words, maintenance management prevents deterioration of the housing units and promotes optimal performance of the unit. Without having proper maintenance management, the housing units will be affected by issues related to efficiency, convenience, life span, economic viability and appearance (Ofori et al., 2015). Although it is highly desirable to build a housing unit with minimal maintenance requirement, this is neither practical nor feasible. Maintenance is necessary and plays an important role for the sustainability of the housing unit. Generally, maintenance management should commence immediately when the housing unit or building is completed (Ofori *et al*., 2015). Not all housing units require the same amount of resources and effort to conduct maintenance activities (Kanuti and Alananga, 2017). The level of effort for maintenance will depend on factors such as materials used during construction, design of the housing unit, technical knowhow of contractors, the daily use of the housing unit and the interrelations of these factors (Olagunju, 2012).

Maintenance management can be conducted at different stages of housing unit or building development from conception to completion. At each stage, there are different characteristics and qualities for consideration. The three stages are as follows: 1) planning and design stage – this stage emphasizes having a proper plan and design of a housing unit or building based on the identified function and be as maintenance free as possible. Therefore, it is crucial for developers to consult with maintenance specialists and managers during the early stages of the building design; 2) construction stage – this stage emphasizes the importance of contractors and construction workers to perform their work to the highest level so that the completed building does not require too much maintenance work during the building life. As a result, expert contractors should be selected to perform the building development and construction; 3) maintenance stage – this stage is normally conducted after the housing unit or

building has been constructed and occupied (Ofori et al., 2015). Nevertheless, the level of effort for maintenance activities vary according to age of the structure and also depends on the quality of the original building components and workmanship (Olagunju, 2012).

2.3 Factors of Maintenance Management

Different factors or variables may bring about the need for maintenance work. A clear understanding of factors which cause building deterioration will assist to avoid unnecessary maintenance work and save costs. Causes of maintenance can be grouped as common factors deterioration, agents of deterioration and other factors (Ogunmakinde et al., 2013).

Common factors deterioration

Aging stock of the housing unit or building may be influenced by several factors such as control of materials used, control of work on site, change of use of housing unit or building, and lack of maintenance (Ogunmakinde et al., 2013). Another factor is obsolescence of building which is a condition whereby the housing unit becomes obsolete prior to the end of their physical life. Additionally, emergence of new technology may contribute to the need to perform maintenance (Ogunmakinde et al., 2013).

Agents of deteriorations

There are several agents which may cause deteriorations to house units or building such as mechanical agents, biological agents, chemical agents, weathering agents, and design deficiencies (Ogunmakinde et al., 2013). Examples of chemical agents include sulphate and salt exposures. Examples of weathering agents include moisture, wind and atmospheric gases. Examples of design deficiencies include materials selection, design approach and design maintainability.

Other factors influencing maintenance management

There are several other factors apart from the above-mentioned factors. Some of these factors include: faulty design and complexities; lack of prioritization for future maintenance work; unfamiliarity with site conditions; unavailability of skilled labor; unqualified maintenance contractors; lack of housing unit or building manuals; not using the housing unit after completion; misuse of housing after completion of construction; lack of awareness on the importance of maintenance work; not using preventive maintenance; and poor financial support for maintenance work (Ofori et al., 2015).

2.4 Factors Affecting Maintenance Costs

Evidence from the literature has reported several of these factors including: building materials; building age; building services; expectation of tenants; and failure to perform maintenance work in a timely manner (Ali et al., 2010). A study by (El‐Haram and Horner, 2002) categorized these factors as: building characteristics; tenants factors; maintenance factors; political factors; and other factors

Building characteristics

Building characteristics influence maintenance costs through factors such as building age, building materials used, type of building structure and height of the building, building finishing work, building function and services (Cheung and Kyle, 1996). For example, maintenance costs increase when building age increases. Also, the higher the building, the higher the maintenance costs, for instance with tall buildings, extra cost may be required in hiring equipment and plants such as scaffolds (Skinner, 1982). Moreover, another study noted that material selections chosen over the life of a housing unit or building element can influence the maintenance costs. This may be due to wear and tear of selected materials whereby materials with short lifespan have high maintenance cost because of frequent need for replacement. Also, poor selection of building materials such as inferior materials during construction phase may cause more failure during operation phase of the building and requiring more maintenance works (Al-Khatam, 2003).

Tenants Factors

Housing unit or building maintenance cost may be affected by tenants occupying the houses. Evidence has suggested some of these factors including: the expectation of tenants; how tenants use the housing unit; vandalism by the tenants; and delay in reporting failures by tenants (El‐Haram and Horner, 2002). In terms of percentage of the total maintenance costs, a study by (Olubodun, 2001) reports that tenant influence could reach up to 25 per cent. High expectations from tenants drives maintenance costs up. Likewise, maintenance and repair cost will increase gradually because of improper use of the property.

Maintenance factors

Evidence from the literature has reported that maintenance costs may be affected by some of the factors arising the maintenance department itself and its functionality (El‐Haram and

Horner, 2002). Examples of these maintenance factors include: poor workmanship; poor quality of materials used; poor maintenance management; failure to identify true cause of defect; failure to perform timely maintenance activities; and poor budgetary control. Additionally, the selection of the maintenance management team and staff is closely related to the maintenance factors that affect maintenance cost including issues related to resource management such as procurement of materials and equipment, utilization of human resource, skilled and unskilled labor in achieving the expected quality of maintenance works

Political factors

Political conditions may affect maintenance cost in some circumstances, especially when there are changes of political policies through government or local authority (Haram and Horner, 2002). Policies such as right to buy policy, health and safety regulations and poor management may impact maintenance costs as government building agencies might be required to follow the stipulated guidelines or policy (El‐Haram and Horner, 2002). Moreover, inadequate financial resources allocated to maintenance activities may result in these activities are not carried out based on the actual need. Therefore, it is vital for public building management to allocate enough financial resources for maintenance work (Talib et al., 2014).

Other factors

Apart from the above-mentioned factors which may affect maintenance costs such as third‐party vandalism, poor or lack of training, and adaptation of new maintenance technique. For third-party vandalism, it is generally conducted by people who have no relationship or interest to a housing unit. As for the lack of maintenance personnel training, this normally leads to poor operating practices in maintenance management (El‐Haram and Horner, 2002). Furthermore, there are environmental factors which may increase maintenance cost due to lack of conducive working environment and other external factors such harsh climatic conditions related to chemical agents and atmospheric pollution associated with rain leading to deterioration of some building materials. For example, pilling off of painting as a result of temperature variations hence the cost of maintenance is incurred before the expected time in maintenance plan (Ofori et al., 2015).

2.5 Areas Affecting Maintenance Cost

Evidence from the literature has also pointed out several areas affecting maintenance costs. For example, a study in Korea identified plumbing works due to leakages, walling and painting as a result of weather events, and lightning as major areas contributing to maintenance costs (Kim et al., 2018). Specifically, for water leaks, the consequences are beyond the cost implications alone, but also on structural damages of the buildings which may significantly reduce the building life span. Additionally, water leaks may have impact on safety and health of the tenants due to development of moulds and respiratory concerns (Tokar et al., 2021). Therefore, plumbing works and engineering during design and maintenance phases are vital to ensure costs are minimized and impact on health issues are avoided. The impact of weather events such as heavy rains and wind has also been reported to cause building element failure which may occur more frequently and require costly maintenance works (Orr et al., 2018). Other studies have indicated electrical engineering contributing to high maintenance costs and affecting the procurement procedure of buildings (Alolote Ibim and Dimkpa, 2020).

2.4 Conceptual Framework

It is crucial to consider the cost aspect of maintenance management during planning and implementation of maintenance activities. To reduce the maintenance costs, building managers or maintenance manager of public buildings should adapt strategies that minimize maintenance costs by understanding factors affecting these costs. As explained in the previous section, factors can be described as: building characteristics, tenant factors, maintenance factors, political and others factor. These are illustrated in the conceptual framework below (Figure 2.1).

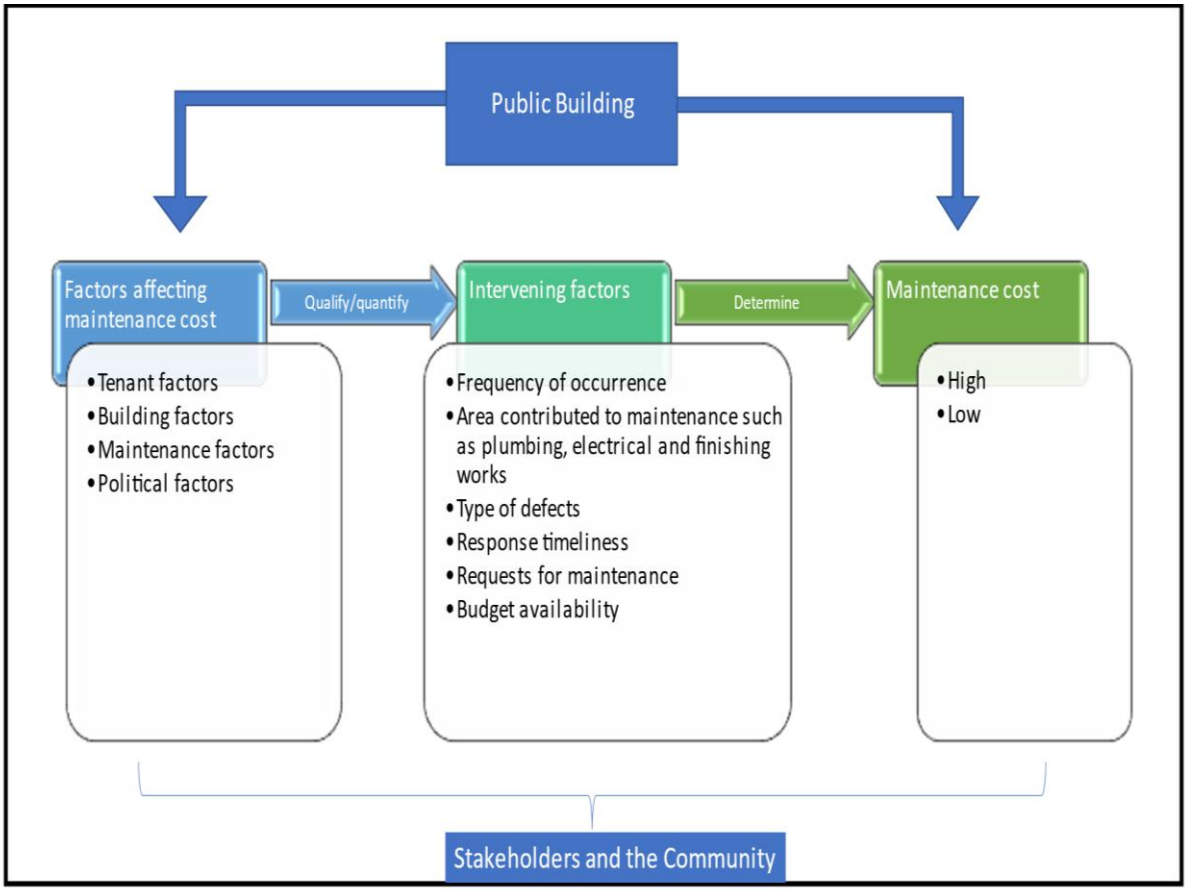

Figure 2.1: Conceptual framework

The conceptual framework is used as a means of showcasing relationships of various factors and how they relate to the research study. In this case, a framework is a visual tool adopted to illustrate the expected relationships between study inputs and outputs. In Figure 2.1 above, across public building, inputs are factors affecting maintenance cost which are categorized into groups – building factors, tenant factors, political factors, and maintenance factors. These factors are related to maintenance costs either contributing to determination of high or low costs. Maintenance costs categorization of high or low are outputs of the study. Furthermore, the output – maintenance cost – is affected by intervening factors which are describe the frequency and intensity of the input factors such as frequency of occurrence and type of defects. Additionally, areas contributing to maintenance cost such as plumbing and electrical engineering are intervening factors which are impacted by the input factors. Finally, in the conceptual framework, stakeholders and the community form an important part of the entire framework. These are the decision makers and end users who are associated with all aspects of the framework from inputs to outputs.

CHAPTER THREE
METHODOLOGY

3.1 Introduction

This chapter describes the methodology used in this study to systematically answer the study objectives in a scientifically sound approach. This entails appropriate selection of the study design and technique used to address the study objectives. This covers different sub-sections such as research type, study population, sampling procedure, data collection, and data analysis.

3.2 Study Design

This study utilized quantitative approach. A cross-sectional study design was used. The obtained quantitative data provided the necessary information to answer the research questions through the analytical cross-sectional design whereby certain factors are hypothesized to contribute to the outcome of interest. Although, cross-sectional design cannot establish causation, it estimates associations between independent and outcome variables (Setia, 2016). Furthermore, a cross-sectional study design provides a snapshot of findings without using many resources and time. These characteristics are important especially in a setting of limited financial resources (Setia, 2016). Two government building agencies – Tanzania Building Agency (TBA) and National Buildings Corporation (NHC) provided data for this study. TBA and NHC are the largest government agencies responsible to manage and provide buildings for public and private workers.

3.3 Study Population

A study population is defined as a complete set of individual and objects with some observable characteristics of interest (Majid, 2018). Studies have indicated that it is crucial to identify the population parameters being investigated prior to conducting sample size calculations (Singh and Masuku, 2014). This is an important step which ensures the sample is representative of the population. Criteria for selection of study participants involved all functional public buildings in Dar es Salaam and Dodoma managed by TBA and NHC. Houses for rent or sale managed by private buildings companies and their tenants were excluded. This was the population of interest in the study and act as the sampling frame. Non-functional or non-occupied buildings/households were excluded. Thereafter, selected occupied households from the sampling frame were given a quantitative questionnaire whereby one tenant from each household who is aged 18 years or older will be recruited. Tenants under 18 years are excluded. Additionally, only the registered tenants or their

spouses were eligible to complete the questionnaire. Other members of the households such as visiting relatives or housekeepers were excluded. Another population of interest in this study was maintenance officers working for TBA and NHC. The selection criteria for these officers were to include all current officers working in the maintenance department.

As mentioned, the sampling frame for this study involves respondents from two regions of Tanzania, Dar es Salaam and Dodoma. Dar es Salaam is the largest city and economic hub of the country with a population of 5.3 million people as of 2019 (Todd et al., 2019). It is the former capital city that started the transition in 1974 and transition in 1996. Dodoma city has a population of 411,000 people, as of the 2012 census is the capital city of Tanzania (United Republic of Tanzania, 2013). These two cities have the largest number of public houses in the country managed by TBA and NHC which provided data for this study. Records indicate that TBA has a total of 1,447 housing units comprising of 964 in Dodoma and 483 in Dar es Salaam and NHC has a total of 9,761 housing comprising of 230 in Dodoma and 9,531 in Dar es Salaam. Table 1 provides more information about the study population.

Table 3.1: Number of houses from TBA and NHC

NO.	REGIONS	TANZANIA BUILDING AGENCY (TBA)	NATIONAL HOUSING COOPERATION (NHC)
1	Dar es Salaam	483	9,531
2	Dodoma	964	230
	Sub -Total	1,447	9761
	Total number of household units for the study is 11,208 units		

3.4 Sample Size

The sampling frame for this study involved 1,447 housing units from TBA and 9,761 housing units from NHC. These numbers represent the total population size for this study. This study considers all units are managed by the maintenance department at headquarters offices of TBA and NHC. To get a representative sample from the above-mentioned sampling frame, the following formula below (equation 1) as devised by (Sharma et al., 2020) was applied to achieve the required sample size.

The used formula:

$$S = N / (1 + N (e2)) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{ Equation (1)}$$

Where;

S- Size of sample

N- Size of the population

e -Level of precision

Manipulations were conducted to calculate the sample size, as shown below:

S_{TBA} = N/ (1+N (e2))	S_{NHC} = N/ (1+N (e2))
S_{TBA} = 1447/(1+1447(0.05)2)	S_{NHC} = 9761/(1+9761(0.05)2)
S_{TBA} = 313	S_{NHC} = 384

By using (Sharma et al., 2020) formula S= N/ (1+N (e2)), the total sample size of the study is 697 building units from TBA and NHC combined.

3.5 Sampling Procedure

A sample is the sub-group of the population which is an ideal representative of the entire population and is utilized when time and resources do not allow reaching the overall population (Taherdoost, 2016). This study covered two regions, Dar es Salaam and Dodoma, and involved housing units from TBA and NHC. All functional houses with tenants were included in the sampling frame. Then, a stratified random sampling approach was utilized to ensure representation by region and districts. In this sampling approach, the housing units are first divided into subgroups (or strata) by region, Dar es Salaam and Dodoma and then by districts from those two regions.

Population parameters and sampling procedure are of paramount importance which will give the successful project (Taherdoost, 2016). The nature of research required that sample should be free from bias to have accurate results during data collection and analysis. The population units of public houses are 11,208 units which provide a sample of 697. The sample was carefully chosen to capture all characteristics of the population. Sampling was given from the maintenance department of TBA and NHC in which are tested to avoid distortion in the conclusion. Stratification of the population was used to minimize errors in which a researcher narrowed down from population as indicated in Table 3.2.

Table 3.2: The sample population obtained from the sampling frame

TBA sample	NHC sample
= (1447/11208) x 697	= (9761/11208) x 697
= 90	= 607

Therefore, the sample population of the research selected from the sample procedure was 90 units from TBA and 607 units from NHC. Furthermore, the number of corresponding samples of building per respective regions was obtained and presented in Table 3 below.

Table 3.3: Number of corresponding buildings per respective regions

TBA sample in respective regions	NHC sample in respective regions
Dar es Salaam = (483/1447) x 90 = 30	Dar es Salaam = (9531/9761) x 607= 593
Dodoma = (964/1447) x 90 = 60	Dodoma = (230/9761) x 607 = 14

3.6 Data Collection

Structured questionnaires with closed-ended questions were used. A questionnaire is a written list of questions to be answered by participants. A good questionnaire must be designed to suit the study's aim and nature of its participants by being simple and clear. Questionnaire survey is an effective approach because of the relative ease of obtaining appropriate data for achieving the study objectives. Data were collected using the questionnaires for tenants (appendix 2) and for experts who are current workers of TBA and NHC maintenance departments (appendix 1).

3.7 Data Analysis

In this study, descriptive statistics reporting absolute numbers and frequencies were presented separately for tenants and experts, including demographic and perception characteristics. Other measures of central tendencies and dispersion were not utilized due to the nature of the questionnaire which included questions with discrete categories. Furthermore, rating on factors and areas associated with maintenance costs were also categorical with five options ranging from: 1=not significant; 2=less significant; 3=significant; 4=very significant; 5=extremely significant. For analysis purposes, the five rating options were categorized into three groups: those who responded not significant and less significant were grouped in the low group; those who responded significant were grouped in the average group; and those who responded very significant and extremely significant were grouped in the high group. Top factors and areas percentage-wise which affected maintenance costs are reported. To allow for statistical comparisons, chi-squared tests are utilized to show differences between the selected top factors and areas affecting maintenance cost by socio-demographic characteristics and perception factors. Statistically significant level set at $p<0.05$. All data management and analysis were conducted by the statistical package, Stata version 16.

3.8 Ethical Consideration

This study was approved by the ethical review board of Ardhi University and received permission from TBA and NHC management. Ethical considerations are vital to avoid harm to participants. This study ensured there is voluntary participation among all participants with no room for coercion or deception. Each participant fully understood what she/he was being asked to do and that she/he was informed of any potential negative consequences of participation and finally provided informed consent. The study did not collect personal identifiable information to ensure confidentiality. The concept of confidentiality is another vital ethical consideration which ensures the known identity of the participant is not revealed in any way in the resulting report. This is important in the following ways: 1) protect the privacy of study participants; 2) build trust with study participants; and 3) uphold ethical standards and the integrity of the study. This study maintained all the ethical considerations throughout the research cycle.

3.9 Validity and Reliability

Validity and reliability are two fundamental concepts in the evaluation of a measurement instrument. Validity is concerned with the extent to which an instrument measures what it is intended to measure. Reliability is concerned with the ability of an instrument to measure consistently (Tavakol and Dennick, 2011). A validated questionnaire was used in this study which indicate that the questions have been tried-and-tested and allows comparisons with other studies (Nardi, 2018). A Cronbach Alpha test was conducted for this study using STATA to provide a measure of the internal consistency of a construct, expressed as a number between 0 and 1. For factors affecting maintenance cost, the scale reliability coefficient was 0.84 across 34 items. For areas affecting maintenance cost, the scale reliability coefficient was 0.63 across 13 items. The performed Cronbach Alpha tests indicated that the utilized instrument achieved desired reliability.

3.10 Chapter Summary

This chapter details the key information about the need for conducting the study and the methodology used. Quantitative methods were utilized to collect data and provided evidence which may be used to make informed decisions to improve maintenance. The next chapter ‘data collection and analysis’ describe how the study data were collected, managed, and analyzed, and presented in tabular format. Additionally, the chapter described ranking of factors affecting maintenance cost of public buildings.

CHAPTER FOUR
DATA COLLECTION AND ANALYSIS

4.1 Introduction

This chapter describes the results obtained from the collected data. This covers different sub-sections such as demographic and perceptions of maintenance cost, description of various factors affecting maintenance cost, and areas that contribute to maintenance cost. The analysis was stratified by two groups namely; tenants who currently occupy the public buildings and experts involved in maintenance activities. The study sample comprised of tenants and experts from NHC and TBA in Dar es Salaam and Dodoma regions.

4.2 Data collection

In total 697 questionnaires were sent to tenants. Out of those, 387 were filled, returned, and were analyzed. The response rate for tenants was 56%. For experts, 35 questionnaires were sent. Out of those, 29 were filled, returned, and were analyzed. The response rate for experts was 83%. For both tenants and experts, the questionnaires were delivered and filled independently, and after several days, they were collected back.

4.3 Data Analysis and Results

This section presents results of the data analysis in tabular and chart formats. Data were analyzed using STATA 16 software. From both the tenant and expert questionnaire, the utilized sections were sections A and B which included close-ended questions for quantitative analysis. The short answer questions of section C from the questionnaires were not utilized in study due to data limitation of incompleteness.

4.3.1 Demographic description and perceptions of tenant and experts

Table 4 presents description and perceptions of tenant and expert. Results indicate that slight majority of respondents were males (55%) and mostly occupied public buildings from NHC (87%). Furthermore, approximately 90% of respondents were residing from Dar es Salaam. With regards to duration of occupancy at the public buildings, majority of tenants (74%) have been living for 1-5 years, followed by those living less than 1 year (19%). Almost half of the respondents (48%) reported that the landlords (NHC and TBA) performed zero maintenance in the past 3 years while 24% of respondents reported annual maintenance work performed. Two-thirds (65%) of respondents reported untimely response to maintenance requests (Table 4.1).

Table 4.1: Study characteristics of tenant and experts from NHC and TBA

Tenants: Demographics and Perceptions			
		n (387)	%
Gender	Male	213	55%
	Female	174	45%
Landlord	TBA	50	13%
	NHC	337	87%
Region	DSM	346	89%
	Dodoma	41	11%
Tenant stay	Less than 1 year	74	19%
	1-5 years	286	74%
	More than 5 years	27	7%
Frequency of maintenance	None	187	48%
	Monthly	12	3%
	Every 6 months	34	9%
	Annually	94	24%
	Every 3 years	60	16%
Maintenance response	Yes	135	35%
	No	252	65%
Expert: Demographics and Perceptions		n (29)	%
Designation	Facility manager	4	14%
	Architect	3	10%
	Quantity surveyor	16	55%
	Engineer	3	10%
	Valuer	1	4%
	Other	2	7%
Institution	TBA	11	37%
	NHC	19	63%
Region	DSM	20	69%
	Dodoma	9	31%
Experience	Less than 5 years	7	24%
	5-10 years	17	59%
	More than 10 years	5	17%
Project executed	Less than 5 projects	2	7%
	5-10 projects	6	21%
	11-15 projects	6	21%
	More than 15 projects	15	51%
Funding used	Less than 50 M	8	27%
	50-100 M	6	21%
	More than 100 M	15	52%
Government policy	Budget plan	15	52%
	Taxation	1	4%
	Interest rate	3	10%
	Economic confidence	3	10%

Tenants: Demographics and Perceptions			
	Rental payment and policy	7	24%
Frequency of maintenance	Weekly	1	4%
	Monthly	3	10%
	Every 6 months	5	17%
	Annually	17	59%
	Every 3 years	3	10%

For experts, more than a half (55%) of respondents were quantity surveyors, followed by facility managers (14%) and least proportion was 4% made up valuers. Almost two-thirds (63%) of respondents worked for NHC. Furthermore, approximately 70% of respondents were residing from Dar es Salaam. With regards to working experience at the public building agencies, majority of experts (59%) had 5-10 year of experience, followed by those with less than 5 years of experience (24%). Half of the respondents (51%) reported to execute more than 15 maintenance projects in the last three years while only 7% reported executing less than 5 maintenance projects in the last 3 years. Furthermore, around half of the respondents (52%) reported more than 100 million used for maintenance works in the last three years. Additionally, approximately half (52%) of the respondents reported that policies on budget plans have large effect on maintenance cost. About 60% of respondents reported that they performed maintenance works annually followed by those (17%) who reported conducting maintenance works after every six months (Table 4.1 above).

4.3.2 Factors affecting maintenance cost reported by tenants

Table 5 presents factors affecting maintenance cost categorized into five groups which are: 1) building factors; 2) maintenance factors; 3) political factors; 4) tenant factors; and 5) other factors. Among building factors, over 76% of tenants reported building age as the leading factor affecting maintenance cost compared to the rest of the factors. The second leading factor affecting maintenance cost was building material used during maintenance works (63%). The third leading factor was building design problems (43%). The least reported factor affecting maintenance cost was non-availability of replacement parts (19%).

Among maintenance factors, over two-thirds (67%) of tenants reported poor quality control as the leading factor affecting maintenance cost compared to the rest of the factors. The second leading factor affecting maintenance cost was execution of maintenance works when it is urgent (61%). The third leading factor was faulty maintenance works (54%). The least

reported factor affecting maintenance cost was unavailability of skilled and unskilled labor (29%).

Among political factors, majority (61%) of tenants reported inadequate financial allocation as the leading factor affecting maintenance cost. The second leading factor affecting maintenance cost was resource management problems (58%). The least reported factor affecting maintenance cost was change the use of the building (28%).

Among tenant factors, half (50%) of the tenants reported poor communication structure as the leading factor affecting maintenance cost. The second leading factor affecting maintenance cost was rising of the social expectations (35%). The least reported factors affecting maintenance cost were vandalism and misuse of the buildings (both factors 22%).

Among other factors, 36% of the tenants reported new maintenance techniques as high impact to maintenance cost while 50% of tenants reported advent of new technologies as having average impact to maintenance cost.

Table 4.2: Factors affecting maintenance cost reported by tenants

Factors affecting maintenance cost		**Maintenance cost**		
		Low	Average	High
		n(%)	n(%)	n(%)
Building factors	Design problem	80(21%)	140(36%)	167(43%)
	Design complexity	119(31%)	107(28%)	161(41%)
	Design faults	120(31%)	119(31%)	148(38%)
	Building materials used	34(9%)	107(28%)	246(63%)
	Ignorance about property of materials	167(43%)	103(27%)	117(30%)
	Building height and structures	174(45%)	120(31%)	93(24%)
	Building age	33(9%)	60(15%)	294(76%)
	Inadequate standard and specifications	114(29%)	127(33%)	146(38%)
	Non-availability of replacement parts	194(50%)	119(31%)	74(19%)
	Obsolete of the building	73(19%)	146(38%)	168(43%)
Maintenance factors	Fault maintenance	40(10%)	139(36%)	208(54%)
	Poor quality control	47(12%)	80(21%)	260(67%)
	Low concern to future maintenance	73(19%)	133(34%)	181(47%)
	Failure to identify true cause of defect	119(31%)	73(19%)	195(50%)
	Site conditions	117(30%)	151(39%)	119(31%)
	Unqualified and unavailability of maintenance contractors	174(45%)	81(21%)	132(34%)
	Harsh climate conditions	120(31%)	146(38%)	121(31%)
	Unavailability of skilled and unskilled labor	94(24%)	180(47%)	113(29%)
	Lack of maintenance manual	80(21%)	112(29%)	195(50%)

Factors affecting maintenance cost		Maintenance cost		
	Execution of maintenance work when it is urgent	80(21%)	72(18%)	235(61%)
	Control of work on site	81(21%)	134(35%)	172(44%)
Political factors	Resource management problems	86(22%)	78(20%)	223(58%)
	Poor management by maintenance unit	93(24%)	139(36%)	155(40%)
	Inadequate financial allocation	13(3%)	140(36%)	134(61%)
	Poor financial control	53(14%)	126(33%)	208(53%)
	Change of the use of the building	157(40%)	123(32%)	107(28%)
Tenant Factors	Poor communication structure	101(26%)	94(24%)	192(50%)
	User does not understand importance of maintenance	101(26%)	165(43%)	121(31%)
	Miss use of buildings	201(52%)	100(26%)	86(22%)
	Cultural practice	114(29%)	159(42%)	114(29%)
	Rising social expectations	114(29%)	139(36%)	134(35%)
	Vandalism	80(21%)	220(57%)	87(22%)
Other factors	New maintenance techniques	127(33%)	120(31%)	140(36%)
	Advent of new technologies	108(28%)	192(50%)	87(22%)

4.3.3 Factors affecting maintenance cost reported by experts

Table 4.2 presents factors affecting maintenance cost among building factors, 79% of experts reported building age as the leading factor affecting maintenance cost. The second leading factor affecting maintenance cost was building material used during maintenance works (69%). The third leading factor was ignorance about properties of material (62%). The least reported factors affecting maintenance cost were non-availability of replacement parts and design complexity (34%).

Among maintenance factors, majority (72%) of experts reported poor quality control as the leading factor affecting maintenance cost compared to the rest of the factors. The second leading factor affecting maintenance cost was faulty maintenance works (65%). The third leading factor was execution of maintenance works when it is urgent (62%). The least reported factor affecting maintenance cost was control of work on site (28%).

Among political factors, majority (69%) of experts reported inadequate financial allocation as the leading factor affecting maintenance cost. The second leading factor affecting maintenance cost was change of the use of the building (52%). The least reported factor affecting maintenance cost was resource management problems (41%).

Among tenant factors, 62% of the experts reported misuse of the building as the leading factor affecting maintenance cost. The second leading factor affecting maintenance cost was

vandalism (52%). The least reported factor affecting maintenance cost was poor communication structure (34%).

Among other factors, 38% of the experts reported new maintenance techniques as high impact to maintenance cost while 52% of experts reported advent of new technologies as having average impact to maintenance cost.

Table 4.3: Factors affecting maintenance cost reported by experts

Factors affecting maintenance cost		**Maintenance cost**		
		Low	Average	High
		n(%)	n(%)	n(%)
Building factors	Design problem	8(28%)	6(21%)	15(51%)
	Design complexity	6(21%)	13(45%)	10(34%)
	Design faults	7(24%)	8(28%)	14 (48%)
	Building materials used	1(3%)	8(28%)	20(69%)
	Ignorance about property of materials	5(17%)	6(21%)	18(62%)
	Building height and structures	9(31%)	8(28%)	12(41%)
	Building age	2(7%)	4(14%)	23(79%)
	Inadequate standard and specifications	7(24%)	9(31%)	13(45%)
	Non-availability of replacement parts	8(28%)	11 (38%)	10(34%)
	Obsolete of the building	7(24%)	7(24%)	15(52%)
Maintenance factors	Fault maintenance	2(7%)	8(28%)	19(65%)
	Poor quality control	4(14%)	4(14%)	21(72%)
	Low concern to future maintenance	4(14%)	8(28%)	17(58%)
	Failure to identify true cause of defect	2(7%)	11(38%)	16(55%)
	Site conditions	6(21%)	17(24%)	16(55%)
	Unqualified and unavailability of maintenance contractors	10(34%)	6(21%)	13(45%)
	Harsh climate conditions	12(41%)	6(21%)	11 (38%)
	Unavailability of skilled and unskilled labor	8(28%)	8(28%)	13(44%)
	Lack of maintenance manual	6(21%)	9(31%)	14(48%)
	Execution of maintenance work when it is urgent	5(17%)	6(21%)	18(62%)
	Control of work on site	11(38%)	10(34%)	8(28%)
Political factors	Resource management problems	9(31%)	8(28%)	12(41%)
	Poor management by maintenance unit	9(31%)	7(24%)	13(45%)
	Inadequate financial allocation	3(10%)	6(21%)	20(69%)
	Poor financial control	6(21%)	10(34%)	13(45%)
	Change of the use of the building	4(14%)	10(34%)	15(52%)
Tenant Factors	Poor communication structure	6(21%)	13(45%)	10(34%)
	User does not understand importance of maintenance	7(24%)	8(28%)	14(48%)
	Miss use of buildings	5(17%)	6(21%)	18(62%)
	Cultural practice	8(28%)	10(34%)	11 (38%)

Factors affecting maintenance cost		**Maintenance cost**		
	Rising social expectations	10(34%)	7(24%)	12(42%)
	Vandalism	4(14%)	10(34%)	15(52%)
Other factors	New maintenance techniques	11(38%)	7(24%)	11(38%)
	Advent of new technologies	7(24%)	15(52%)	7(24%)

4.3.4 Areas contributing to maintenance cost as reported by tenants

Among the listed thirteen elements covering areas contributing to maintenance cost, majority (74%) of tenants reported plumbing and engineering installation as the leading element affecting maintenance cost. Specifically, tenants mentioned sanitary wares. The second leading element affecting maintenance cost was electrical installation (67%), contributed largely by electrical accessories. The third leading element affecting maintenance cost was roof structures (50%), contributed largely by roof coverage (iron sheet). The least reported element affecting maintenance cost was fire detection devices (20%).

Table 4.4: Areas contributing to maintenance cost as reported by tenants

Area contributing to maintenance cost	Maintenance cost		
	Low	Average	High
	n(%)	n(%)	n(%)
Frame	146(38%)	107(28%)	134(34%)
Walling cracks	79(20%)	209(54%)	99(26%)
Doors	41(11%)	185(48%)	161(41%)
Windows	28(7%)	184(48%)	175(45%)
Roof structure	46(12%)	147(38%)	194(50%)
Finishes	78(20%)	118(31%)	191(49%)
Painting and decoration	121(31%)	100(26%)	166(43%)
Plumbing and engineering installation	40(10%)	61(16%)	286(74%)
Fire detection devices	233(60%)	78(20%)	76(20%)
Electrical installation	53(14%)	73(19%)	261(67%)
Fitting and fixture	93(24%)	139(36%)	155(40%)
Mechanical works	40(10%)	214(55%)	133(35%)
External works	55(14%)	179(46%)	153(40%)

4.3.5 Areas contributing to maintenance cost as reported by expert

Among the listed thirteen elements covering areas contributing to maintenance cost, majority (83%) of experts reported finishes as the leading element affecting maintenance cost. Specifically, experts mentioned floor work and ceiling. The second leading element affecting maintenance cost was plumbing and engineering installation (72%), contributed largely by sanitary wares. The third leading element affecting maintenance cost was walling cracks

(62%). The least reported element affecting maintenance cost was fire detection devices (41%).

Table 4.5: Areas contributing to maintenance cost as reported by experts

Area contributing to maintenance cost	**Maintenance cost**		
	Low	Average	High
	n(%)	n(%)	n(%)
Frame	11(40%)	4(14%)	14(48%)
Walling cracks	3(10%)	8(28%)	18(62%)
Doors	3(10%)	10(34%)	16(55%)
Windows	3(10%)	13(45%)	13(45%)
Roof structure	2(7%)	12(41%)	15(52%)
Finishes	0(0%)	5(17%)	24(83%)
Painting and decoration	8(28%)	7(24%)	14(48%)
Plumbing and engineering installation	2(7%)	6(21%)	21(72%)
Fire detection devices	7(24%)	10(35%)	12(41%)
Electrical installation	4(14%)	10(34%)	15(52%)
Fitting and fixture	5(17%)	11(38%)	13(45%)
Mechanical works	3(10%)	9(31%)	17(59%)
External works	4(14%)	11(38%)	14(48%)

4.3.6 Summarized findings on factors and areas of high maintenance cost by tenants and experts

Table 4.5 presents a summary of findings reported in the above-mentioned sub-sections. Results indicate top six factors affecting maintenance cost ranked by both experts and tenants and the top 5 areas of high maintenance cost ranked by both tenants and experts.

Table 4.6: Findings on factors and areas of high maintenance cost by tenants and experts

Factors affecting maintenance cost		**Area contributing to high maintenance cost**	
Tenants	Experts	Tenants	Experts
Building age	Building age	Plumbing and engineering	Finishes
Poor quality control	Poor quality control	Electrical installation	Plumbing and engineering
Building materials used	Building materials used	Roof structure	Walling cracks
Execution of work when it is urgent	Inadequate financial allocation	Windows	Mechanical works
Inadequate financial allocation	Faults maintenance	Paint and decoration	Doors
Resource management	Misuse of building		

4.3.7 Description of select building factors by demographic and perception characteristics

Table 4.6 presents relationship between two building factors – building age and building material used – by demographic characteristics and perception variables among tenant respondents.

For the variable building age, statistically significant differences were found with variables tenant stay (p=0.000) and frequency of maintenance (p=0.000). Respondents who reported building age to have high maintenance cost, majority (72%) were living for 1-5 years compared to 23% and 5% who were living less than 1 year and more than six years respectively. Additionally, among respondents who reported building age to have high maintenance cost, half (50%) reported zero maintenance works in the last 3 years while 20% reported annual maintenance works.

For the variable building material used, statistically significant differences were found with variables, gender (p=0.008), tenant stay (0.000), frequency of maintenance (p=0.000), and timely maintenance response (0.016). About 54% of male respondents reported building material used to have high maintenance cost compared to 46% of female respondents. Also, those who reported building material used to have high maintenance cost, majority (81%) were living for 1-5 years compared to 16% and 3% who were living less than 1 year and more than six years respectively. Additionally, among respondents who reported high maintenance cost on building material used, about half (46%) reported zero maintenance works in the last 3 years while 25% reported annual maintenance works. Finally, among respondents who reported high maintenance cost on building material used, 70% reported untimely maintenance response compared to 30% who reported timely maintenance response.

Table 4.7: Description of select building factors by demographic and perception factors

	Building age				Building material used			
	Low	Average	High		Low	Average	High	
	n(%)	n(%)	n(%)	p-value	n(%)	n(%)	n(%)	p-value
Gender								
Male	19(58%)	27(45%)	167(57%)	0.235	27(79%)	53(50%)	133(54%)	0.008
Female	14(42%)	33(55%)	127(43%)		7(21%)	54(50%)	113(46%)	
Agency								
TBA	3(9%)	9(15%)	38(13%)	0.719	5(15%)	16(15%)	29(12%)	0.681
NHC	30(91%)	51(85%)	256(87%)		29(85%)	91(85%)	217(88%)	
Region								
DSM	29(88%)	54(90%)	263(89%)	0.949	32(94%)	96(90%)	218(89%)	0.616
Dodoma	4(12%)	6(10%)	31(11%)		2(6%)	11(10%)	28(11%)	
Tenant stay								
Less than 1 year	7(22%)	0(0%)	67(23%)	0.000	0(0%)	34(31%)	40(16%)	0.000
1-5 years	13(39%)	60(100%)	213(72%)		34(100%)	53(50%)	199(81%)	
More than 6 years	13(39%)	0(0%)	14(5%)		0(0%)	20(19%)	7(3%)	
Frequency of maintenance								
None	8(24%)	32(53%)	147(50%)	0.000	20(59%)	53(49%)	114(46%)	0.000
Monthly	0(0%)	0(0%)	12(4%)		2(6%)	2(2%)	8(3%)	
Every 6 months	0(0%)	0(0%)	34(12%)		0(0%)	24(22%)	10(4%)	
Annually	25(76%)	8(14%)	61(20%)		5(15%)	28(26%)	61(25%)	
Every 3 years	0(0%)	20(33%)	40(14%)		7(21%)	0(0%)	53(21%)	
Timely maintenance response								
Yes	7(21%)	21(35%)	107(36%)	0.222	14(41%)	48(45%)	73(30%)	0.016
No	26(79%)	39(65%)	187(64%)		20(59%)	59(55%)	173(70%)	

4.3.8 Description of select maintenance factors by demographic and perception characteristics

Table 4.7 presents relationship between two maintenance factors – poor quality control and execution of work when it is urgent – by demographic characteristics and perception variables among tenant respondents.

For the variable poor quality control, statistically significant differences were found with variables; tenant stay (p=0.000), frequency of maintenance (p=0.000), and timely maintenance response (p=0.000). Among respondents who reported poor quality control to have high maintenance cost, majority (79%) were living for 1-5 years compared to 21% and 0% who were living less than 1 year and more than six years respectively. Additionally,

among respondents who reported poor quality control to have high maintenance cost, about half (45%) reported zero maintenance works in the last 3 years while 25% reported annual maintenance works. Finally, among respondents who reported high maintenance cost on poor quality control, 79% reported untimely maintenance response compared to 21% who reported timely maintenance response.

For the variable execution of work when it us urgent, statistically significant differences were found with variables, gender (p=0.002), tenant stay (0.000), frequency of maintenance (p=0.000), and timely maintenance response (0.005). About 60% of male respondents reported execution of work when it is urgent to have high maintenance cost compared to 40% of female respondents. Also, those who reported execution of work when it is urgent to have high maintenance cost, majority (74%) were living for 1-5 years compared to 20% and 6% who were living less than 1 year and more than six years respectively. Additionally, among respondents who reported high maintenance cost on execution of work when it is urgent, slightly more than half (54%) reported zero maintenance works in the last 3 years while 21% reported annual maintenance works. Finally, among respondents who reported high maintenance cost on execution of work when it is urgent, 68% reported untimely maintenance response compared to 32% who reported timely maintenance response.

Table 4.8: Description of select maintenance factors by demographic and perception factors

	Poor quality control				**Execution of work when it is urgent**			
	Low	Average	High		Low	Average	High	
	n(%)	n(%)	n(%)	p-value	n(%)	n(%)	n(%)	p-value
Gender								
Male	20(43%)	46(58%)	147(57%)	0.183	46(58%)	26(36%)	141(60%)	0.002
Female	27(57%)	34(42%)	113(43%)		34(42%)	46(64%)	94(40%)	
Agency								
TBA	7(15%)	10(13%)	33(13%)	0.911	10(13%	9(13%)	31(13%)	0.981
NHC	40(85%)	70(87%)	227(87%)		70(87%)	63(87%)	214(87%)	
Region								
DSM	43(91%)	72(90%)	231(89%)	0.847	72(90%)	62(86%)	212(90%)	0.602
Dodoma	4(9%)	8(10%)	29(11%)		8(10%)	10(14%)	23(10%)	
Tenant stay								
Less than 1 year	7(15%)	13(16%)	54(21%)	0.000	20(25%)	7(10%)	47(20%)	0.000
1-5 years	20(42%)	60(75%)	206(79%)		60(75%)	52(72%)	174(74%)	
More than 6 years	20(43%)	7(9%)	0(0%)		0(0%)	13(18%)	14(6%)	

	Poor quality control				**Execution of work when it is urgent**			
Frequency of maintenance								
None	16(34%)	54(67%)	117(45%)	0.000	36(45%)	25(35%)	126(54%)	0.000
Monthly	2(4%)	2(3%)	8(3%)		0(0%)	2(3%)	10(4%)	
Every 6 months	11(23%)	13(16%)	10(4%)		11(14%)	0(0%)	23(10%)	
Annually	18(38%)	11(14%)	65(25%)		26(32%)	19(26%)	49(21%)	
Every 3 years	0(0%)	0(0%)	60(23%)		7(9%)	23(36%)	27(11%)	
Timely maintenance response								
Yes	27(57%)	54(68%)	54(21%)	0.000	40(50%)	20(28%)	75(32%)	0.005
No	20(43%)	26(32%)	206(79%)		40(50%)	52(72%)	168(68%)	

4.3.9 Description of select political factors by demographic and perception characteristics

Table 4.8 present the relationship between two political factors – inadequate financial allocation and resource management – by demographic characteristics and perception variables among tenant respondents.

For the variable inadequate financial allocation, statistically significant differences were found with variables; tenant stay (p=0.000), frequency of maintenance (p=0.000), and timely maintenance response (p=0.000). Among respondents who reported inadequate financial allocation to have high maintenance cost, majority (68%) were living for 1-5 years compared to 26% and 6% who were living less than 1 year and more than six years respectively. Additionally, among respondents who reported inadequate financial allocation to have high maintenance cost, more than half (57%) reported zero maintenance works in the last 3 years while 18% reported annual maintenance works. Finally, among respondents who reported high maintenance cost on inadequate financial allocation, 74% reported untimely maintenance response compared to 26% who reported timely maintenance response.

For the variable resource management, statistically significant differences were found with variables, gender (p=0.009), tenant stay (0.000), frequency of maintenance (p=0.000), and timely maintenance response (0.024). About 58% of male respondents reported resource management to have high maintenance cost compared to 42% of female respondents. Also, those who reported resource management to have high maintenance cost, majority (72%) were living for 1-5 years compared to 25% and 3% who were living less than 1 year and more than six years respectively. Additionally, among respondents who reported high maintenance cost on resource management, more than half (60%) reported zero maintenance works in the last 3 years while 22% reported annual maintenance works. Finally, among respondents who

reported high maintenance cost on resource management, 70% reported untimely maintenance response compared to 30% who reported timely maintenance response.

Table 4.9: Description of select political factors by demographic and perception factors

	Inadequate financial allocation				**Resource management**			
	Low	Average	High		Low	Average	High	
	n(%)	n(%)	n(%)	p-value	n(%)	n(%)	n(%)	p-value
Gender								
Male	6(46%)	74(53%)	133(57%)	0.610	52(60%)	31(40%)	130(58%)	0.009
Female	7(54%)	66(47%)	101(43%)		34(4%)	47(60%)	39(42%)	
Agency								
TBA	2(15%)	15(11%)	33(14%)	0.617	11(13%)	7(9%)	32(14%)	0.476
NHC	11(85%)	127(89%)	201(86%)		75(87%)	71(91%)	191(86%)	
Region								
DSM	11(85%)	124(89%)	211(90%)	0.755	77(90%)	74(95%)	195(87%)	0.186
Dodoma	2(15%)	16(11%)	23(10%)		9(10%)	4(5%)	28(13%)	
Tenant stay								
Less than 1 year	0(0%)	14(10%)	60(26%)	0.000	14(16%)	5(6%)	55(25%)	0.000
1-5 years	0(0%)	126(90%)	160(68%)		59(69%)	67(86%)	160(72%)	
More than 6 years	13(100%)	0(0%)	14(6%)		13(15%)	6(8%)	8(3%)	
Frequency of maintenance								
None	3(23%)	50(36%)	134(57%)	0.000	31(36%)	22(28%)	134(60%)	0.000
Monthly	0(0%)	8(6%)	4(2%)		2(2%)	1(1%)	9(4%)	
Every 6 months	0(0%)	21(15%)	13(6%)		10(12%)	10(13%)	14(6%)	
Annually	10(77%)	41(29%)	43(18%)		23(27%)	23(29%)	48(22%)	
Every 3 years	0(0%)	20(14%)	40(17%)		20(23%)	22(28%)	18(8%)	
Timely maintenance response								
Yes	0(0%)	74 (53%)	61(26%)	0.000	40(47%)	28(36%)	67(30%)	0.024
No	13(100%)	66(47%)	173(74%)		46(53%)	50(64%)	156(70%)	

4.3.10 Description of select areas contributing to maintenance cost by demographic and perception characteristics

Table 4.9 below describes relationship between two selected areas contributing to maintenance cost – plumbing and engineering installation and electrical installation – by demographic characteristics and perception variables among tenant respondents.

For the variable plumbing and engineering installation, statistically significant differences were found with variables; gender (p=0.023), tenant stay (p=0.000), frequency of

maintenance (p=0.000), and timely maintenance response (p=0.014). About 58% of male respondents reported that plumbing and engineering installation to have high maintenance cost compared to 42% females. Also, among those who reported plumbing and engineering installation to have high maintenance cost, majority (81%) were living for 1-5 years compared to 14% and 5% who were living less than 1 year and more than six years respectively. Additionally, among respondents who reported plumbing and engineering installation to have high maintenance cost, more than half (52%) reported zero maintenance works in the last 3 years while 25% reported annual maintenance works. Finally, among respondents who reported high maintenance cost on plumbing and engineering installation, 65% reported untimely maintenance response compared to 35% who reported timely maintenance response.

For the variable electrical installation, statistically significant differences were found with variables, tenant stay (0.000) and frequency of maintenance (p=0.000). Among respondents who reported high maintenance cost on electrical installation, majority (76%) were living for 1-5 years compared to 18% and 5% who were living less than 1 year and more than six years respectively. Additionally, among respondents who reported high maintenance cost on electrical installation, about half (48%) reported zero maintenance works in the last 3 years while 26% reported annual maintenance works.

Table 4.10: Description of select areas of maintenance cost by demographic and perception factors

	Plumbing and engineering installation				**Electrical installation**			
	Low	Average	High		Low	Average	High	
	n(%)	n(%)	n(%)	p-value	n(%)	n(%)	n(%)	p-value
Gender								
Male	14(35%)	33(54%)	166(58%)	0.023	26(49%)	39(53%)	148(57%)	0.567
Female	26(65%)	28(46%)	120(42%)		27(51%)	34(47%)	143(43%)	
Agency								
TBA	4(10%)	9(15%)	37(13%)	0.784	8(15%)	5(7%)	37(14%)	0.225
NHC	36(90%)	52(85%)	249(87%)		45(85%)	68(93%)	224(86%)	
Region								
DSM	36(90%)	57(93%)	253(88%)	0.513	47(89%)	69(95%)	230(887%)	0.287
Dodoma	4(10%)	4(7%)	33(12%)		6(11%)	4(5%)	31(12%)	
Tenant stay								
Less than 1 year	7(18%)	27(44%)	40(14%)	0.000	0(0%)	24(33%)	50(19%)	0.000
1-5 years	33(82%)	21(34%)	232(81%)		40(75%)	47(64%)	199(76%)	

	Plumbing and engineering installation				**Electrical installation**			
More than 6 years	0(0%)	13(21%)	14(5%)		13(25%)	2(3%)	12(5%)	
Frequency of maintenance								
None	19(47%)	19(31%)	149(52%)	0.000	18(34%)	43(59%)	126(48%)	0.000
Monthly	8(20%)	0(0%)	4(1%)		0(0%)	10(14%)	2(1%)	
Every 6 months	0(0%)	6(10%)	28(10%)		11(21%)	10(14%)	13(5%)	
Annually	0(0%)	22(36%)	72(25%)		24(45%)	3(4%)	67(26%)	
Every 3 years	13(33%)	14(23%)	33(12%)		0(0%)	7(10%)	53(20%)	
Timely maintenance response								
Yes	7(18%)	28 (46%)	100(35%)	0.014	20(38%)	21(29%)	94(36%)	0.463
No	33(82%)	33(54%)	186(65%)		33(62%)	52(71%)	167(64%)	

4.4 Proposed Framework to Minimize Maintenance Costs

This study proposes the following framework to inform stakeholders on minimizing maintenance costs of public buildings at different stages of maintenance works. This framework is developed based on the findings from the study and reflects the factors and areas affecting maintenance cost which were identified by tenants and experts as the most contributing to high maintenance cost. Further to identification of these factors, the framework defines the operationalization of the reported factors. For example, for the factor ‘building material used’, operational process added in the framework was ‘checking availability of material and durability’. Another example, for the factor ‘quality control assurance’, operational process added in the framework was ‘ensure appropriate specifications and standards’. Finally, another dimension added to the framework is categorization of the identified factors and their operationalizations into three phases which are planning stage, execution stage and evaluation stage. This ensured proper organization of these factors at different stages of maintenance cycle. The framework is reported in figure 2 below:

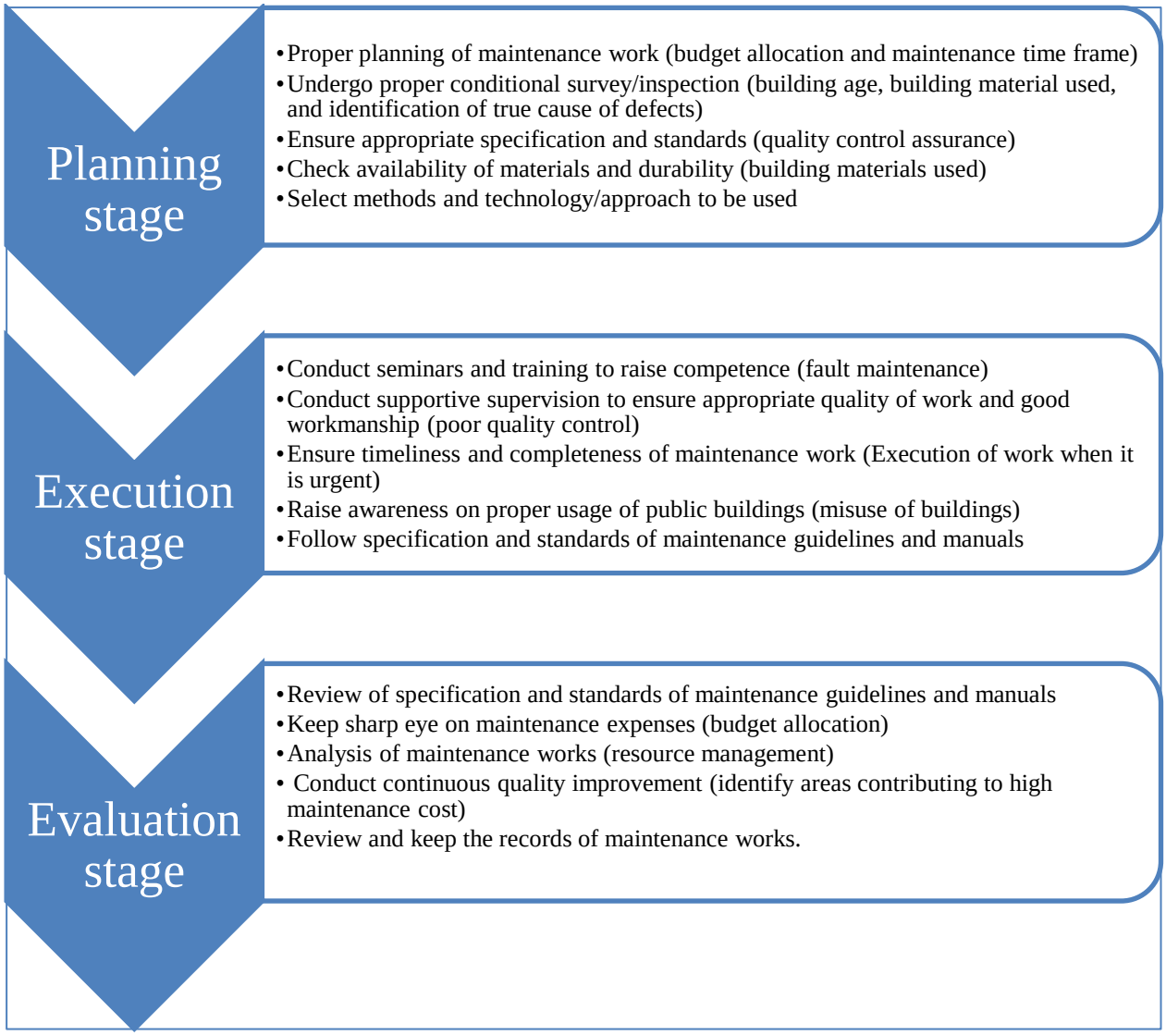

Figure 4.1: Proposed framework to minimize maintenance costs

4.5 Discussion

This study which assessed factors affecting maintenance cost on public buildings managed by TBA and NHC has two sets of important findings. The first is in relation to better understand and rank factors thought to have higher influence on maintenance cost from the perspective of tenants and experts. The second main finding relates to assessment of areas which are more attributed to affecting maintenance cost.

4.5.1 Building age as a factor affecting maintenance cost

This study identified building age as one of the main factors affecting maintenance cost whereby majority of participants reported building age having high effect of maintenance with over 76% of tenants and around 79% of experts. The longer the age of the building, the higher the maintenance cost since more maintenance work needs to be carried out for older

buildings. This finding is similar to other studies around the globe assessing the same objective. For example, a study in Malaysia reported building age as one of important factors affecting maintenance cost among respondents in metropolitan apartments (Salleh et al., 2016). Another study in Nigeria revealed predominant factors affecting maintenance costs of institution buildings including building age (Faremi et al., 2014).

4.5.2 Poor quality control as a factor affecting maintenance cost

This current study reported poor quality control as one of the main factors affecting maintenance cost whereby majority of participants self-reported poor quality control as having high effect on maintenance cost with over 67% of tenants and approximately 72% of experts. The reported poor quality control involved poor workmanship and inappropriate methods of maintenance work utilized by the maintenance team. This also involves lack of proper oversight and supervision during maintenance work leading to poor quality of the building. The finding from this study is similar to a study in Kenya which reported poor workmanship and poor management in having an increase of maintenance management cost (Nyayiemi, 2013). A similar study in Nigeria indicated use of poor quality components and materials during maintenance works by the maintenance department that highly contributed to maintenance costs (Adenuga, 2011).

4.5.3 Building material used as a factor affecting maintenance cost

Respondents of this study self-reported building material used as one of the main factors affecting maintenance cost whereby 63% and 69% of tenants and experts respectively indicated materials used having high maintenance costs. Choice of building materials during construction has a significant impact on maintenance costs whereby building materials with poor quality might require more maintenance works or large scale maintenance works. Similar studies in Tanzania and Malaysia reported similar findings as this current study. A Tanzanian study reported impact of cost of building materials in public buildings (Kishengere, 2013). A Malaysian study which aimed to determine and identify the factors contributing to rising maintenance costs reported building material used as one of the dominant factors (Ali et al., 2010), a similar finding to this current study.

4.5.4 Inadequate financial allocation as a factor affecting maintenance cost

Respondents of this study self-reported inadequate financial allocation as one of the main factors affecting maintenance cost whereby 61% and 69% of tenants and experts respectively indicated this factor having high maintenance costs. Generally, lack of enough budget or

funding have a negative impact on the ability to carry out maintenance works. A study in Taiwan reported a similar finding to this study whereby the authors indicated the importance of having plans for budgeting with regards to maintenance cost (Li and Guo, 2012). Furthermore, a study in Ghana concluded that poor financial support for maintenance work were also identified as the major factor affecting maintenance cost (Ofori et al., 2015).

4.5.5 Execution of work when it is urgent as a factor affecting maintenance cost

This study identified execution of work when it is urgent as one of the main factors affecting maintenance cost whereby majority of participants reported this factor having high effect of maintenance cost with approximately 61% of tenants. This finding is like other studies around the globe, for example a study in Malaysia concluded that one of the dominant factors affecting maintenance cost was failure to execute maintenance work at the right time (Ali et al., 2010). Additionally, another study in Saudi Arabia pointed out that timely execution of maintenance work is beneficial in reducing maintenance cost while delays in performing maintenance work might have high cost burden (Al-Khatam, 2003).

4.5.6 Faults maintenance as a factor affecting maintenance cost

Respondents of this study self-reported fault maintenance as one of the main factors affecting maintenance cost whereby 65% of experts indicated this factor having high maintenance costs. Generally, fault maintenance is attributed by failure to identify the true cause of defect and improper maintenance work by not following specifications material used and maintenance manuals. Additionally, this may lead to carrying out maintenance work incorrectly or failure to carry out maintenance at all. Similar to respondents of this study, a study in Portugal (Flores-Colen and de Brito, 2010) reported that faults maintenance contribute to high maintenance cost.

4.5.7 Misuse of public buildings as a factor affecting maintenance cost

This current study reported misuse of public buildings as one of the main factors affecting maintenance cost whereby majority of participants self-reported misuse of public buildings as having high effect on maintenance cost with approximately 62% of experts reporting it. The misuse of buildings involved aspects such as deliberate vandalism, blatant abuse of buildings, lack of awareness on proper use of buildings, and cultural practices. The finding from this study is similar to a study in Malaysia which reported the effect of improper use of property on maintenance costs and suggested improvements by introducing property - operating manuals and educating tenants (El - Haram and Horner, 2002).

4.5.8 Areas contributing to high maintenance cost

The second aim of this study was to identify and rank areas contributing to high maintenance cost. The study reported the following factors as being most dominant by respondents such as plumbing and engineering, electrical engineering, roof structure, windows and doors, roof and walling cracks, and paint and decorations. This finding is similar to another study conducted in Nepal (Dahal and Dahal, 2020) which determined that the most significant building maintenance areas were plumbing works such as toilet, bathroom and sanitary; and, electrical problems, peeling of paint, wall cracking, and breaking of floor/tile. Another study in Nigeria reported floor area as an area contributing to high maintenance costs (Faremi et al., 2014). Areas of the building and factors affecting maintenance cost are not mutually exclusive. These two concepts are related to each other to affect high maintenance cost. For example, if building material used were not of appropriate standard, then problems with plumbing and engineering will increase. This will eventually increase maintenance cost. Likewise, if fault maintenance works are performed to a building, then the likelihood of having electrical or wall cracks or roof structure problems are high. Again, this will increase maintenance cost. Therefore, it is important to consider both two concepts – factors and areas – to minimize maintenance costs.

CHAPTER FIVE
CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter presents conclusion and recommendations of the study on factors affecting maintenance cost of public buildings; and areas contributing to high maintenance costs. Recommendation provides the practical implications of the study including suggesting a framework that will inform stakeholders on minimizing maintenance costs of public buildings.

5.2 Conclusion

This study reported key findings on factors affecting maintenance costs which were grouped into five categories; building factors, maintenance factors, tenants factors, political factors, and other factors. Additionally, the current study identified areas contributing to high maintenance cost as reported by tenants and experts. The analysis reported high impact factors affecting maintenance cost and areas contributing to high maintenance cost as follows:

5.2.1 Factors affecting maintenance costs

From the perspective of tenants, the following factors were reported to have high impact to maintenance cost. The reported factors were: 1) building age; 2) poor quality control; 3) building material used; 4) execution of work when it is urgent; 5) inadequate financial resources; and 6) resource management. These factors are ranked as being reported above.

From the perspective of experts, the following factors were reported to have high impact to maintenance cost. The reported factors were: 1) building age; 2) poor quality control; 3) building material used; 4) inadequate financial resources; 5) fault maintenance; and 6) misuse of the building. These factors are ranked as being reported above.

From both tenants and experts, the identification and ranking of factors affecting maintenance costs were similar from both perspectives. Four out of the six most dominant factors were the same and these were; building age, poor quality control, building material used, and inadequate financial allocation.

5.2.2 Areas of high maintenance costs

From the perspective of tenants, the following areas were reported to have high contribution to maintenance cost. The reported areas were: 1) plumbing and engineering works; 2)

electrical installation; 3) roof structure; 4) windows; and 5) paint and decoration. These factors are ranked as being reported above.

From the perspective of experts, the following areas were reported to have high maintenance cost. The reported areas were: 1) finishes; 2) plumbing and engineering works; 3) walling cracks; 4) mechanical works; and 5) doors. These factors are ranked as being reported above.

Findings from areas of high maintenance cost showed wide variation between tenants and experts, with only one area listed for both perspectives which was plumbing and engineering installation.

5.2 Recommendation

This study recommends the following actions to minimize maintenance costs of public buildings:

i. Conduct proper and timely inspection of the building by considering the building age, building material used and proper identification of defects during preparation of maintenance report.
ii. Ensure standard and specifications of maintenance works are attained by following standard operating procedures through provision of quality control assurance.
iii. Ensure timeliness and completeness of maintenance works when it is needed and urgent to hinder further damage.
iv. Conduct seminars and trainings to experts to improve their competences in maintenance works leading to deduction in maintenance cost.
v. Conduct routine awareness campaigns to tenants on proper usage of public buildings.
vi. Ensure proper planning on resource management and budgeting during preparation of maintenance budget.

5.3 Areas of Further Research

This study suggests the following areas for further research:

i. Assessment of costs for various maintenance works conducted in public buildings including analysis of timelines and completeness of maintenance works.
ii. Assessment of maintenance backlog on maintenance cost of public buildings.
iii. Evaluation of building age as a factor affecting maintenance cost in public buildings

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APPENDICES

Appendix 1: Questionnaire for maintenance department officers to understand factors affecting maintenance costs in public buildings

Instructions

Please circle your answers in the listed options provided.

Section A: General information

1. Designation of respondent
    a. Facility manager
    b. Architect
    c. Quantity surveyor
    d. Engineer
    e. Valuer
    f. Other

2. Which organization are you working for?
    a. TBA
    b. NHC

3. Which region is you currently stationed?
    a. DSM
    b. Dodoma

4. For how long have you practiced.....years?
    a. Less than 5 years
    b. 5-10 years
    c. More than 10 years

Section B: Specific questions on factors affecting maintenance cost of public buildings

1. The number of maintenance projects executed in the last 3 years
    a. Less than 5
    b. 5-10
    c. 11-15
    d. More than 15
2. Amount of funding used for maintenance work in the last three years (in millions Tanzanian shillings)
    a. Less than 50
    b. 50-100
    c. More than 100

3. In your opinion, dot the following government policies affect maintenance cost of public buildings
    a. Budget plan
    b. Taxation
    c. Interest rate
    d. Economic confidence
    e. Rental payment and policy

4. How often do you carry out maintenance works
    a. Weekly
    b. Monthly
    c. Every six months
    d. Annually
    e. Every after three years

Section C: From your experience in maintenance works of public buildings, please rate each of the following factors depending on the extent of its contribution to maintenance cost

Note: 1 – Not significant, 2 – Less significant, 3 – significant, 4 – very significant, 5 – extremely significant

A	Factors affecting maintenance cost	Score level				
		1	2	3	4	5
1	Design problems					
2	Design complexity					
3	Fault design					
4	Faulty maintenance					
5	Building materials used					
6	Ignorance about the properties of materials					
7	Building height and structure					
8	Building age					
9	Poor quality control					
10	Low concern to future maintenance					
11	Failure to identify the true cause of defect					
12	Site conditions					
13	New maintenance techniques					
14	Unqualified and unavailability of maintenance contractors					
15	Inadequate standard and specification					
16	Harsh climatic conditions					
17	Resource management problems					
18	Availability of skilled and unskilled labor					
19	Poor management by maintenance unit					
20	Lack of building maintenance manual					
21	Poor communication structure					
22	Inadequate finance allocation					
23	Poor financial control					
24	User does not understand importance of maintenance work					
25	Misuse of buildings					
26	Execution of maintenance works when it becomes a matter of urgency					
27	Cultural practice (way of living)					
28	Non availability of replacement parts					
29	Advent of new technologies					
30	Rising social expectations					
31	Change of use of building					
32	Vandalism					
33	Control of work on site					
34	Obsolescence of the building					

B	Areas with high maintenance cost buildings	Specific area	Score level				
			1	2	3	4	5
1	Frame(Specific area examples Column, beams, concrete ceiling)						
2	Walling cracks						
3	Doors(Specific area examples Door frame, door shutter, mortise lock, door glazing and metal grill)						
4	Window (Specific area examples Window lock, window glazing, window frame and window grill)						
5	Roof structure(Specific area examples Structure timber roof coverage and storm water drainage)						
6	Finishes (Specific area examples plaster wall, floor and gypsum ceiling, tiles works)						
7	Painting and decoration(Specific area examples wall painting, wood varnishes, grill painting)						
8	Plumbing and engineering installation (Specific area examples Pipes fitting Sanitary ware, Water storage tank)						
9	Fire detection(Specific area examples Fire detection points, alarm sound circuit, smoke detector portable extinguisher and fire hose pipe)						
10	Electrical installation(Specific area examples Equipment and control gear, electrical accessories i.e socket and switch and lighting fitting)						
11	Fitting and fixture(Specific area examples Wardrobe, kitchen cabinet)						
12	Mechanical works(Specific area examples Air conditioner, Generators etc)						
11	External works(Specific area examples Pavement, Septic tank, manhole Soak away pit)						

C. Short answer question

In your opinion, how can maintenance cost minimized?

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Appendix 2: Questionnaire for tenants to understand areas contributing to high maintenance costs in public buildings

Instructions

Please circle your answers in the listed options provided.

Section A: General information

1. Gender of respondent
    a. Male
    b. Female

2. Who is your landlord?
    a. TBA
    b. NHC

3. Which region are you currently living?
    a. DSM
    b. Dodoma

4. For how long have you been living in your current building (years)?
    a. Less than 1 year
    b. 1-5 years
    c. More than 6 years

Section B: Specific questions on factors affecting maintenance cost of public buildings

1. How many times have your landlord performed maintenance in the last three years?
    a. None
    b. Monthly
    c. Every six months
    d. Annually
    e. Every three years

2. From your opinion, do you think the landlord responds timely to maintenance requests?
    a. Yes
    b. No

Section C: From your experience in maintenance works of public buildings, please rate each of the following factors depending on the extent of its contribution to maintenance cost

Note: 1 – Not significant, 2 – Less significant, 3 – significant, 4 – very significant, 5 – extremely significant

A	Factors affecting maintenance cost	Score level				
		1	2	3	4	5
1	Design problems					
2	Design complexity					
3	Fault design					
4	Faulty maintenance					
5	Building materials used					
6	Ignorance about the properties of materials					
7	Building height and structure					
8	Building age					
9	Poor quality control					
10	Low concern to future maintenance					
11	Failure to identify the true cause of defect					
12	Site conditions					
13	New maintenance techniques					
14	Unqualified and unavailability of maintenance contractors					
15	Inadequate standard and specification					
16	Harsh climatic conditions					
17	Resource management problems					
18	Availability of skilled and unskilled labor					
19	Poor management by maintenance unit					
20	Lack of building maintenance manual					
21	Poor communication structure					
22	Inadequate finance allocation					
23	Poor financial control					
24	User does not understand importance of maintenance work					
25	Misuse of buildings					
26	Execution of maintenance works when it becomes a matter of urgency					
27	Cultural practice (way of living)					
28	Non availability of replacement parts					
29	Advent of new technologies					
30	Rising social expectations					
31	Change of use of building					
32	Vandalism					
33	Control of work on site					
34	Obsolescence of the building					

B	Areas with high maintenance cost buildings	Specific area	Score level				
			1	2	3	4	5
1	Frame(Specific area examples Column, beams, concrete ceiling)						
2	Walling cracks						
3	Doors(Specific area examples Door frame, door shutter, mortise lock, door glazing and metal grill)						
4	Window (Specific area examples Window lock, window glazing, window frame and window grill)						
5	Roof structure(Specific area examples Structure timber roof coverage and storm water drainage)						
6	Finishes (Specific area examples plaster wall, floor and gypsum ceiling, tiles works)						
7	Painting and decoration(Specific area examples wall painting, wood varnishes, grill painting)						
8	Plumbing and engineering installation (Specific area examples Pipes fitting Sanitary ware, Water storage tank)						
9	Fire detection(Specific area examples Fire detection points, alarm sound circuit, smoke detector portable extinguisher and fire hose pipe)						
10	Electrical installation(Specific area examples Equipment and control gear, electrical accessories i.e socket and switch and lighting fitting)						
11	Fitting and fixture(Specific area examples Wardrobe, kitchen cabinet)						
12	Mechanical works(Specific area examples Air conditioner, Generators etc)						
11	External works(Specific area examples Pavement, Septic tank, manhole Soak away pit)						

C. Short answer question

In your opinion, how can maintenance cost minimized?

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