

Facility Maintenance Management Practice of Condominium Buildings in Addis Ababa: The Case of Five Condominium Sites



Helen Tafesse Cheriye

A Thesis Submitted to

The Department of Construction Engineering and Management

School of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in
Civil Engineering (Construction Engineering and Management)

Office of Graduate Studies

Adama Science and Technology University

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Adama, Ethiopia

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in Addis Ababa: The Case of Five Condominium Sites

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Approval Page

I, the advisor of the thesis entitled “**Facility Maintenance Management Practice of Condominium Buildings in Addis Ababa: The Case of Five Condominium Sites**” and developed by Helen Tafesse, hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

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We, the undersigned, members of the Board of Examiners of the thesis by Helen Tafesse have read and evaluated the thesis entitled “**Facility Maintenance Management Practice of Condominium Buildings in Addis Ababa: The Case of Five Condominium Sites**” and examined the candidate during the open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in Civil Engineering (Specialization in Construction Engineering and Management).

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Declaration

I hereby declare that this Master Thesis entitled “**Facility Maintenance Management Practice of Condominium Buildings in Addis Ababa: The Case of Five Condominium Sites**” is my original work. That is, it has not been submitted for the award of any academic degree, diploma, or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation.

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Recommendation

I, the advisor of this thesis, hereby certify that I have read the revised version of the thesis entitled “**Facility Maintenance Management Practice of Condominium Buildings in Addis Ababa: The Case of Five Condominium Sites**” prepared under my guidance by Helen Tafesse submitted in partial fulfillment of the requirements for the degree of Master’s of Science in Civil Engineering (Specialization in Construction Engineering and Management).

Therefore, I recommend the submission of a revised version of the thesis to the department following the application procedures.

Major Advisor

Signature

Date

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ABSTRACT

Building maintenance is a fundamental practice in facility management. It is an essential practice to sustain the performance of building within required standards. This research aims to evaluate the facility maintenance management practice of condominium buildings. The objectives are discussed under the sub-topics of assessment of the current facility maintenance management practices of condominium buildings in Addis Ababa, identification of the cause of defects in condominium buildings, evaluation of the failure factors affecting the application of facility maintenance management, evaluation of the maintenance management strategies and finally facility maintenance management format is developed to improve the facility maintenance practice of condominium buildings. Addis Ababa Housing Development Project Office, the five district housing development offices and five condominium sites that give service for morethan eiht years were target group for the study. Questionnaires, interview and physical observation were data collection techniques. Data analysis is conducted to assess the overall operational state of condominium buildings using root cause analysis and presented in a Fish bone diagram, convenient maintenance strategy for condominium buildings is selected using Analytical Hierarchical Process method and finally, a maintenance management framework is developed to record the status of a condominium building. The data analysis result showed that maintenance department is not available at all levels of condominium administration. Due to this, there is no regular inspection and preventive maintenance schedule. Unavailability of the maintenance department, lack of awareness on the importance of maintenance, and shortage of reserve funds are considered as the critical failure factors for the implementation of the facility maintenance management system.

Keywords: Condominium, Maintenance, Addis Ababa

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LIST OF ACRONYMS

IHDP	Integrated housing Development Program
SME	Small and Medium Enterprises
UN	United Nations
GTZ-IS	Deutsche Gesellschaft für Internationale Zusammenarbeit – International Services
LCH	Low-Cost Housing
AAHDP	Addis Ababa Housing Development Project
AAHDPO	Addis Ababa Housing Development Project Office
TBM	Time Based Maintenance
FFM	Failure Finding Maintenance
CBM	Condition Based Maintenance
RBM	Risk-Based Maintenance
BIFM	British Institute of Facilities Management
FM	Facility Management
SFM	Sustainable Facility Management
SL	Service Level
MMF	Maintenance Management Framework
UNECE	United Nations Economic Commission for Europe
RCA	Root Cause Analysis

1. INTRODUCTION

1.1 Background

Facility maintenance management is defined as the process of increasing the utility of a building by regularly servicing capital assets, commercial appliances, and areas inside or around a building. The development of facility maintenance management practice requires the active and integrated engagement of the facility management organization (Støre-valen & Buser, 2019).

Sustainable facility management (SFM) has a positive effect on the three main pillars of sustainable buildings: economic, environmental, and social benefits, thereby adding value to companies, organizations, and governments that integrate SFM into their vision (Alfalah & Zayed, 2020).

It is highly desirable but hardly feasible to produce maintenance-free buildings, although much can be done at the design stage to reduce the amount of subsequent maintenance work. All elements of buildings deteriorate at a greater or lesser rate dependent on materials and methods of construction, environmental conditions, and the use of the building (Allen, 1993).

Maintenance plays a vital role in the building lifecycle and, as the number of older buildings increases, is becoming a crucial issue in many countries. The functionality of any building indeed deteriorates over the usage period. The necessity for effective maintenance is now widely recognized to provide a satisfactory level of service and secure the inhabitants' wellbeing by ensuring the buildings' desired condition (Islam et al., 2021). Building facility maintenance increases the safety value of a building which can ensure the safety of occupants, visitors, and the general public and also presenting a good appearance. Investment in building maintenance is huge prevalent all over the world. The value of a building depends on the quality of the maintenance invested in the buildings.

Maintenance practices must be effective in aspects such as planning, organization, and supervision to maintain the building at a satisfactory level of performance all the time (Awg Husaini & Tabassi, 2014). Maintaining building premises is important to protect the building and the individuals inside. A poorly maintained building can lead to a big problem which is why building maintenance is vital for every business. It also can give a negative impression of

the residents and to the city. A well-maintained building will highlight that the business or residence is well managed, professional, and has a positive attitude towards the premises (Faremi, 2012).

Maintaining a building premise is important to protect the building and the individuals inside. A building is a financial investment that has the potential to serve comfort and safety for many years if it is well maintained. Poorly maintained buildings can lead to a big problem which is why building maintenance is vital for every business.

Facility Maintenance Management of Condominium Buildings:-

A condominium building is a special kind of multi-apartment building in which each residential unit is separately demarcated, assigned individual legal title, and can be legally owned separately from the whole. All associated land, common areas, and other real property are jointly owned in common by the individual unit owners (UNECE, 2019). Considering the economy of people and the sustainable land use of the city, Ethiopian government is experiencing the design and implementation of affordable low-cost housing programs since 2004. Addis Ababa City Administration in cooperation with GTZ-IS and MH Engineering plans to design and construct Low-Cost Housing (LCH) termed as ‘condominium house’ (French & Hegab, 2011).

Condominium houses constructed under Addis Ababa housing development project are huge in number, but they didn’t get enough attention regarding the facility management practice. There is also no maintenance department to undertake maintenance-related issues. For example; the buildings giving service for the past 10 years didn’t get satisfactory facility maintenance. According to condominium proclamation 370/2003, the responsibility of building facility administration and keeping its values is given to the residents’ associations which are assigned by households. These associations consist of representatives of condominium residents to manage the condominium compound through a board of directors. But, the facility maintenance practices of associations are at minor scale and are limited to the correction of critically failed facility component. Usually, maintenance works on the roof, wall, drainage, and supply lines are undertaken at a low level by the condominium associations. This minor and corrective maintenance work is not satisfactory to upkeep the

building values, whereas regular inspection and maintenance are required to keep the planned service life of the building, its comfort, and aesthetics.

Residents of condominium houses are from different places with a variety of living habits and experiences. They may treat the building well or bad that affects the planned service life of the building component. Together with the poor construction quality, the users' negative treatment reduces the building values. Considering the residents' requirements and to achieve durable and serviceable building regular inspection and maintenance of building facility is vital.

According to the research performed on Jimma town condominium buildings, several defects are noticed on them. Major contributing factors for the defects are weakness in design, poor workmanship during construction and, low quality of construction material. The defects are also due to a lack of awareness by occupants about the maintenance of their houses (Awol et al., 2016)

Condominium buildings have similar features & purposes, but there is no organized plan for facility maintenance management. There are many responsible factors for the in-advancement of building facility maintenance management of low-cost buildings such as low budget cost, lack of technical personnel, non-availability of maintenance guidelines and policy, lack of maintenance culture, non-availability of materials and equipment.

All facilities of condominium buildings require maintenance as they age. Good maintenance is a rational choice as it helps to retain the value of a building and makes it more enjoyable to live in. Poor maintenance or neglect can lead to serious damage and safety hazards. It may also trigger municipalities, in their attempt to prevent neighborhood blight to pursue planning enforcement or building rectification work orders against the homeowners association or even against all lot owners (Mualam et al., 2018).

In most countries, the board/association, guided by unit owner voting as appropriate, makes decisions about the use, operation, rehabilitation/reconstruction, improvement, and reorganization of the common property, while the manager undertakes to support such decisions as required. The maintenance department manager is also responsible for general and routine maintenance, repair, and operation of the common property as well as the purchase of equipment and other supplies if appropriate. In some cases, the manager's activities may be

guided by a formal maintenance and operation manual or may fall under the purview of the manager's professional experience (UNECE, 2019).

Condominium owners are known low/medium income groups of the society to expend more money for sustainable facility maintenance. But, regarding the maintenance work and its cost Condominium Proclamation 370/2003 states that the unit owners' association to establish a reserve fund for repair and maintenance and may use it where necessary (Federal Negarit Gazeta, 2003).

1.2 Problem Statement

All condominium houses have similar features and purposes, a facility maintenance department can prepare and organize a standard maintenance/repair guideline, but due to the lack of a centralized system, there is no maintenance guideline and maintenance schedule at all levels of condominium administration. Based on the field survey of the researcher, Addis Ababa Housing Development project Office (AAHDPO) and unit owners associations have no maintenance department and organized system for facility maintenance management. Also, there is no available maintenance manual and policy to undertake scheduled maintenance rather the associations try to rectify failed building components only when the case is critical. Normally, building facility maintenance guideline and schedule needs to be prepared by the architect during the design stage. But, the researcher couldn't find maintenance-related documents at all offices of Addis Ababa Housing Development Project (AAHDP). There is also no responsible team to prepare maintenance manual and schedule which helps to conduct regular inspection and to control the maintenance activities.

It is inevitable that to keep the values of building facilities, regular inspection and maintenance are required. During the physical observation, there is no organized department of facility maintenance management to undertake a regular inspection and to follow up maintenance-related issues.

Some of the observed building components which require maintenance work are; external wall painting, cracks on walls, stair and hand rails, gutters, downpipes, and windowsill. For example; it is suggested to renew external paint within three to five years, but they are not renewed for the past 10 years. As indicated on pictures attached in the annex, some

associations try to repaint with different colors; this practice may affect the aesthetics of the city in the future.

The research problem arises from the lack of an organized condominium building maintenance management system and the necessity of a facility maintenance management system to keep the building values. Unavailability of standard facility maintenance management and centralized controlling system causes two major obstacles on the condominium management; associations prefer corrective maintenance to solve problems, which may solve problems temporarily but may degrade the building quality, and there are numerous residents' associations in the city with different levels of understanding on the maintenance requirement; some may keep the buildings good but some may not.

Several local and international research works are available on the topic of building maintenance. There are also available local journals and research theses on condominium building facilities, but they didn't address on the requirement of facility maintenance management.

1.3 Objectives

1.3.1 General Objective

The main objective of this thesis is to evaluate the facility maintenance management practice of condominium buildings.

1.3.2 Specific Objective

- , To assess the current facility maintenance management practices of condominium buildings in Addis Ababa
- , To identify the cause of defects in condominium buildings
- , To evaluate failure factors affecting the application of facility maintenance management
- , To evaluate the convenient maintenance strategy for condominium buildings
- , To develop the facility maintenance management framework to improve the building maintenance practice of condominium buildings

1.4 Research Question

The research questions are developed based on the actual conditions of condominium building maintenance management system. The research is intended to answer the following questions through the research objectives.

1. What does the current facility maintenance practice of condominium buildings looks like?
2. What are the possible causes of defects?
3. What is the failure factor affecting the application of maintenance management?
4. Which maintenance strategy is convenient for condominium buildings?
5. Is there any maintenance management framework that assures sustainable facility maintenance management?

1.5 Relevance of the Study

Condominium buildings are constructed by the principle of low-cost construction technique; hence high quality of construction is not expected. This drawback of construction can be enhanced by performing regular inspections and maintenance. facility maintenance management practice is essential for AAHDPO projects in the implementation of uniform maintenance works as per the standard which keeps the building serviceability and city aesthetics.

Condominium buildings are supposed to accommodate low-income residents of the city. The buildings are huge in number and hold thousands' of residents. Failure of these numerous buildings may lead to uncontrolled and severe housing problems. Therefore it is important to keep the values of buildings and also to improve their function.

This study is essential to contribute knowledge on the necessity of facility maintenance management. Types of maintenance, components and the importance of facility maintenance are also discussed in the study. Hence, it has significance for AAHDPO and owners associations in creating awareness on the current state of the condominium buildings, solving problems related to condominium maintenance, in understanding the importance of facility maintenance management and in selecting appropriate maintenance strategy. The relevance of the study is assured by the specific objectives achieved through the study.

1.6 Scope of the Study

From the broad category of facility management, facility maintenance management is discussed in the study. Facility maintenance management practice of condominium buildings located in Addis Ababa is evaluated based on the set of objectives. Due to the similarity of buildings in form and function; information gathering focused on the five condominium sites and AAHDPO. The facility maintenance management practice of condominium buildings, cause of defects, failure factors of the facility maintenance management system and suitable maintenance strategies for condominium facility management are studied.

1.7 Limitation of the Study

Lack of prepared maintenance document by AAHDPO and residents associations limits the researcher to investigate satisfactory information.

There is no facility management department at AAHDPO and residents associations, hence gathering information on previously conducted maintenance activities was difficult.

2. LITERATURE REVIEW

2.1 Facility Maintenance Management

2.1.1 Facility Management

The development of the construction industry from a traditional crafting industry to a service-based industry requires a more structured and effective process of developing and designing facility management (Ogunbile & Oke, 2015). The British Institute of Facilities Management (BIFM) defined Facility Management (FM) as the practice of coordinating the physical workplace with the people and work of an organization. Facilities management encompasses a range of disciplines and services to ensure the functionality, comfort, safety, and efficiency of a built environment i.e. buildings and grounds, infrastructure, and real estate. It includes operations and maintenance.

Facility Management is an activity carried out to manage and maintain the facility including its functional parts at the level that will retain or enhance the value of the facility; create a safe, functional, and conducive living environment for occupants; keep or restore every part in efficient working order and good state of repair; and project a good appearance or image for the facility (Ogunbile & Oke, 2015).

FM services are categorized into several sub-sections. One of the subdivisions of FM services is listed in table 2.1 (Kaplan & Norton, 2000).

Table 2-1 Facility management services

Facility Management Services	Building management control system
	Building code and regulatory compliance
	Building repairs and maintenance
	Cleaning and general maintenance
	Concierge (a resident caretaker), mail, and other soft services
	Conserving asset value

The development of FM practices requires the active and integrated engagement of the FM organization (Støre-valen & Buser, 2019). Sustainable facility management is an emerging field within FM through which to achieve the building's high performance and safety, low resource utilization, as well as other adaptations to climate change such as energy management, waste, and recycling. (Alfalah & Zayed, 2020).

The study focuses on one of the categories of facility maintenance management services, building repair, and maintenance. The following sub-topics mainly explain building maintenance.

2.2 Maintenance Management

The maintenance management of buildings and allied infrastructures is an integral aspect of the overall management responsibility in any organization or institution irrespective of the nature and scope of the core business activities of such organization or institution (Faremi O., Adenuga O., 2017).

Maintenance management involves obtaining optimum benefit from the investment made in the maintenance activities. According to European Standard, maintenance management is described as all activities of the management that determine the maintenance objectives, strategies, and responsibilities, and implementation of them by such means as maintenance planning, maintenance control, and the improvement of maintenance activities and economics. According to British Standard, maintenance management is defined as all activities of the management that determine the maintenance objectives, strategies, and responsibilities, and implementation of them by such means as maintenance planning, maintenance control, and the improvement of maintenance activities and economics (BS-EN-13306, 2010)

Building maintenance management has always been seen as the "Cinderella" of the construction industry and has never been recognized in its own right. It has always been seen and carried out as part of another function, or discipline, i.e. architects, surveyors, engineers, or, in more recent times facilities managers (Allen, 1993). Maintenance management involves making use of resources for the sustenance of the building performance optimally. It makes certain that buildings are in high performance during their operation phase (Abdul-aziz, 2015).

Building maintenance practices must be taken into consideration by building facility managers or building owners. They involve daily operations to ensure that end users can work or live

comfortably and safely. Through effective maintenance practices, the functions of the existing building facilities can be maintained and meet the needs of the building users. Maintenance practices must be effective in aspects such as planning, organization, and supervision to maintain the building at a satisfactory level of performance all the time (Husaini & Tabassi, 2018).

Building maintenance management is important for the well-functioning and preservation of building components. It is important for the following reason; reduced the long-term cost, deliver timely maintenance, reduce consumption of all categories of resources, reduce the number and severity of environmental events, and promotes fire, health, and safety (Levitt, 1952).

A study by Lateef under the topic of building maintenance management in Malaysia describes as maintenance management involves maximum benefit from the investment made on the maintenance activities. Building maintenance is conditionally driven and is usually carried out only when there is money, even if the needs are obvious until such a situation when the building becomes unattractive or even unsuitable for its users and the populace. As such, building maintenance is not regarded as part of the production processes, that is, not as a factor of production. There is no doubt that the government is consistently increasing its allocation to the maintenance sector, but the allocation is grossly inadequate to meet the ever-growing demand for the maintenance backlog. Therefore, there is a need for a broad and systematic value-based procedure related to building maintenance that puts the building users at the center of maintenance planning, control, and implementation. A maintenance management system that is value-based provides a clear definition of the goals of the maintenance programs and policies as well as establishing the problems the maintenance is expected to solve.

Maintenance of buildings in Malaysia is on the increase regardless of size, type, location, and ownership. The current maintenance management procedures in Malaysia are, however, condition and reactive-based (Lateef, 2009).

2.2.1 Maintenance Management Process

The maintenance management process is a generic process that can assist departments to establish appropriate practices for the maintenance of buildings. Its objective is to facilitate consistency in the planning and implementation of building maintenance. The maintenance

management process is part of the overall asset management process. (Queensland Department of Housing, 2017b). the overall maintenance management process is presented in chart 2.1.

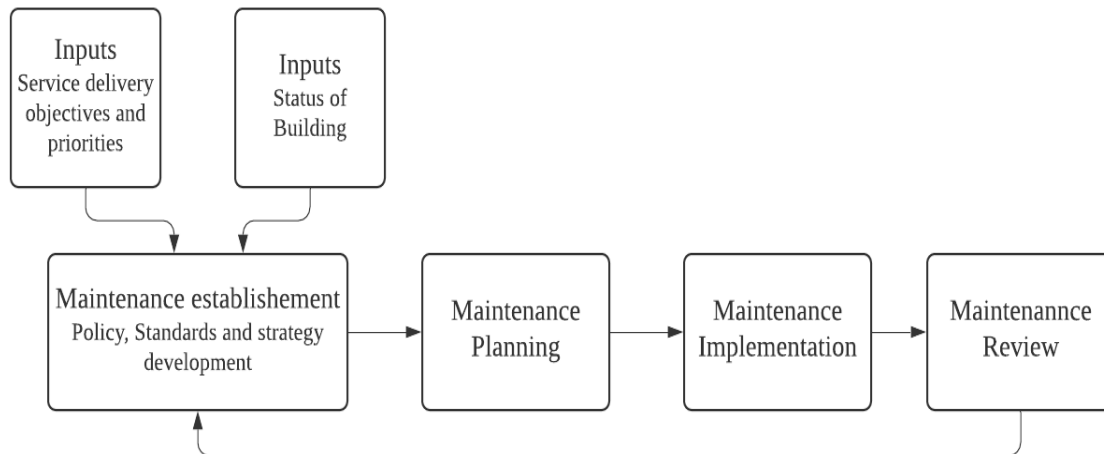


Figure 2-1 Maintenance management process

Source: Building maintenance policy, standards and strategy development, queensland department of housing and publicworks, 2017, page 4.

2.3 Components of Building Maintenance

Maintenance involves a considerable amount of work that has been categorized into three components namely; servicing, rectification, and replacement.

Servicing: is essentially a clearing operation undertaken at regular intervals of varying frequency and is sometimes termed day-to-day maintenance. Daily sweeping of floors, monthly washing, and cleaning of windows, and regular painting for decoration and protection every four years are some examples of services. Servicing becomes necessary because of the constant use of facilities, the effect of the weather and atmospheric conditions on the components of the building (Twumasi-Ampofo et al., 2017).

Rectification: usually occurs fairly early in the life of a building, but it can also occur sometime within the life span of the building. It arises from a shortcoming in design, inherent fault in or unsuitability of components, damage of goods in transit or installation, and incorrect assembly. Rectification represents a fruitful point at which to reduce the costs of maintenance because it is available. All that is necessary at any rate, in theory, is to ensure that components

and materials are suitable for their purpose and are correctly installed. Rectification work could be reduced by the development and use of performance specifications and codes of installation (Fobiri G., Adjei K., 2014).

Replacement: occur at all costs in buildings. It is inevitable because service conditions cause materials to decay at different rates. Much replacement work stems not so much from the physical breakdown of the materials or element as from deterioration of the appearance (Seeley, 1987).

2.3.1 Maintenance-Related Concepts and Definitions

According to David Albrice, terms maintenance, repair, renewals, renovation, rehabilitation, and refurbishment are explained as follows:

Maintenance is an activity that continues to be focused on all critical assets such as sump pumps, elevators, fire alarm systems, and roofs. In addition, particular attention must be paid to exterior sealants and the various service penetrations through the walls and roofs.

Repair is the stage at which different types of obsolescence start to occur. For example, some assets, particularly electronic components, may be prone to technological obsolescence and are no longer manufactured, making it difficult to find replacement parts. The different forms of obsolescence and how to manage them will be discussed in a future information bulletin.

Renewals: Many assets are designed with a 20-25 year useful service life and are therefore considered to be mid-life assets. This is one of the primary reasons why reserve fund studies include a 30-year planning horizon (i.e. the window into the future). This enables the owners to anticipate and prepare for the majority of the asset replacement projects. The ability of owners to fund these capital expenditures can have a significant impact on the future lifespan of the building.

Merriam Webster defines renovation as restoration of a former better state either by cleaning, repairing, or rebuilding.

Rehabilitation is the modernization of aged buildings with or without adaptive alteration for use. It means the introduction of modern services into the building without changing its original use.

Refurbishment means in an architectural sense, involving replacement of missing parts or introduction of new decorative elements into a structure. In addition, it involves working on housing to make it bright, clean, and fresh again.

2.3.2 Importance of Building Maintenance

Maintenance includes all activities necessary to maintain the original standard and quality of the building and its installations. This includes all planned and unforeseen activities related to the repair of damage to buildings and installations, and replacements because of wear and tear. Repair work and replacements arising from routine service inspections and service agreements are also classified as maintenance activities. Generally, all activities related to improving the standard and quality of the building and its installations are defined as improvements and should not be classified as maintenance (UNECE, 2019).

Building maintenance makes economic sense as it may reduce or potentially eliminate the need for repairing projects. Repairs and maintenance can be disruptive and costly in terms of fabric and finances, hence carrying out maintenance places less of a burden on community resources can be extending the period between repair campaigns.

There are three main reasons for the importance of building maintenance:

- , Health and Safety of Employees
- , Cost-Effective
- , Improves the Appearance

Health and Safety of Employees: Damaged or poorly maintained buildings and premises can increase the risk of an individual getting injured because of damage to your building.

Cost-Effective: Regular maintenance on a building is much more cost-effective because precaution is always easier and more economical than fixing a problem. Emergency repairs are more expensive than regular maintenance. Regular and proper maintenance of a building ensures that it is maintained properly, free from damage, costly repair bills, and the need for urgent repairs.

Improves the Appearance: A poorly maintained building can give a negative impression of the business to a client which is why maintenance is important to a business. A well-maintained

building will highlight that the business is well managed, professional, and has a positive attitude towards the premises.

2.3.3 Building maintenance criteria

Building maintenance is a fundamental practice in facility management, which supports the longevity of a building. Building maintenance constitutes essential practices to sustain the performance of buildings within required standards as well as decrease the impact of equipment and system failures. Therefore, building maintenance practices have a remarkable effect on the longevity of a building.

Effective FM strategies are essential to an organization's ability to achieve its business objectives. FM is a multi-disciplinary process that provides the necessary services for the built environment to support an organization's missions and improve occupant comfort (Besiktepe et al., 2020). Building maintenance includes cleaning common areas, removing trash regularly, and repairing items that are broken. It also involves inspecting, repairing, and maintaining electrical systems, supply and drainage systems, and other utility services.

In Indonesia, public-rented residential buildings are residential buildings that are constructed by the government, either central and/or regional government, for low-income people to rent, especially for low-income people who live in slum areas. Public-rented residential building aim is to accommodate livable place that is decent to live and affordable, to utilize space effectively and efficiently, to decrease slum areas, to improve the welfare of low-income people, to develop the urban area and to meet the social and economic needs of low-income people. According to the preliminary observation, a lot of units experience leakage, especially in the bathroom and kitchen. The leakage causes the wall to become mossy, and eventually, after some time the building looks dirty.

According to the Ministry of Public Housing (2007), the public-rented residential building maintenance is under the responsibility of governing body. There are 2 types of activities in maintenance according to the Ministry of Public Housing (2007), which are maintenance and treatment. The maintenance of a building is all the activities to ensure the reliability of the building and its facilities to function well. The treatment of a building is all the activities to repair and/or replace building elements and/or components, building material, and/or building facility to maintain the feasibility of the building. The treatment of public-rented residential

buildings is classified according to their urgency and level of damages. According to its urgency, the building treatment is classified into routine treatment, periodic treatment, urgent treatment, and emergency treatment.

Based on the Ministry of Public Housing (2007), routine treatments are operational activities, small repairs on utility equipment, and building security. Periodic treatments are activities that are planned according to the time and should be managed according to a specific schedule to avoid damage. Periodic treatment covers the replacement of building components, the replacement of spare parts, building painting, and mechanical and electrical equipment services. Urgent treatments are activities that are done unplanned and based on the building inspection that needs to be urgently treated. Emergency treatments are activities that need to be done right away to avoid endangering others (Arumsari & Rarasati, 2017).

2.4 Facility Maintenance Management

Facility maintenance is the process of increasing the utility of a building by regularly servicing capital assets, commercial appliances, and areas inside or around a building. Capital assets include machinery, robotics, research equipment, and medical devices; commercial appliances include boilers and HVAC units; and areas include rooms, hallways, parking lots, and garages. Facility maintenance is applied to commercial buildings where no manufacturing is involved (Wood, 2005).

Facilities Maintenance Management (FMM) is a professional management discipline focused on the efficient and effective delivery of support services for the organizations that it serves.

The importance of facility maintenance management has gradually been recognized in the life cycle of a building. Both new and existing buildings require a more efficient approach and advanced technology to improve the efficiency of the FM. Proper policies and advanced technologies are needed to enhance the efficiency of FM for new and existing buildings. Proper maintenance management is one of the key factors to extend the life cycle of buildings. As time goes on, deterioration will reduce buildings' functions and values, and severe problems may arise if prompt repair and renovation are not conducted (Pan & Chen, 2020).

In German Condominium facility maintenance management, the challenges of property management are technical defects of building or lack of technical knowledge of the property managers. The current situation of condominium buildings is unsatisfactory regarding

maintenance planning due to lack of legal provisions and appropriate strategy (Andreas & Mariam, 2021).

The new maintenance management system is suggested because aging buildings and rising construction costs lead to reconsideration of maintenance planning, maintenance managements systems need to react at an early stage to pending costs & repairs and Proactive maintenance planning can not only be seen as a refurbishment but also as a possibility to enhance property values. Proactive maintenance planning also enables to reduce the financial burden for the owners and gradually fewer maintenance backlogs (Andreas & Mariam, 2021). The study identifies that based on the calculations of Peters' formula (Peters' sche Formel) and Calculation Regulation (II. BV); annual maintenance reserve is sufficient to cover all maintenance measures Construction (Andreas & Mariam, 2021).

2.4.1 Building Facility Maintenance

According to the Oxford dictionary, maintenance is defined as the act of keeping something in good condition by checking or repairing it regularly.

European Standard defines maintenance as a combination of all technical, administrative, and managerial actions during the life cycle of an item intended to retain it in or restore it to, a state in which it can perform the required function (BS-EN-13306, 2010).

Maintenance is an activity taken while the buildings are in use to keep the building performance at a level acceptable to the users, including repairs, replacement, retrofit, etc. The performance of buildings decreases over time and without effective maintenance, their vulnerability to extreme events will increase (Pham et al., 2018).

Building maintenance has been considered a crucial part of the life cycle of a building as the number of aged buildings is increasing globally. Several maintenance-related problems are known to occur in aged buildings, particularly in urban areas. Thus, great importance should be given to maintenance as it preserves the original function of the buildings and maintains the quality of residents' lives. The degradation incurred by the aging of the building can not only lead to excessive repair costs but also affect its usability and resident safety negatively (Kwon et al., 2020).

Maintenance can also be explained as it is an avoidable task that is perceived as adding little to the quality of the working environment and expending scarce resources which would be better utilized. Management of any process involves assessing performance, and maintenance management of buildings is no exception. For any maintenance manager to measure performance and set priorities, the organizational needs have to be considered i.e. the function and performance of buildings and their appropriate standards will be dependent on the user's perception and their primary needs (Faremi, 2012).

Buildings are expected to exist for a long time, regardless of whether or not they have actually been designed and constructed properly to do so. The building industry is responsible for maintaining, improving, and adapting the existing stock of buildings in addition to the production of new buildings. The maintenance and retrofitting market has grown rapidly and is bound to continue growing. The standard and level of maintenance of buildings in any country are invariably directly related to the strength of its economy. As countries become more developed, they are disposed to require higher standards from buildings, as with other aspects of life (Son & Yuen, 1993).

2.5 Cause of Building Defects

There are major causes such as design defects, inadequate contractor and construction supervision, use of low-quality materials and workmanship, unavailability of qualified human resources and quality materials, poor maintenance management, insufficient maintenance fund but high and unexpected cost, age of the building, natural disaster and earth settlement and so on. Lack of proper maintenance department, programs, plans, and policies are the critical issues of improvement by public institutions (Chandra & Dahal, 2020).

The research by awol on Jimma town identified the cause of defect and maintenance management of condominium buildings. The result summarized as the building maintenance management is a medium provider and operator that oversee the components related to building condition and services installation to ensure the optimum capacity.

Existing condominium buildings in Jimma Town lacks adequate maintenance attention. Most condominium buildings are in very poor and deplorable conditions of structural and decorative disrepair. Most condominium buildings in Jimma town are in very poor and deplorable conditions of structural and decorative disrepair.

The findings of the research show that most low-cost housing (Jimma town condominium) defects are caused by leaking pipes, cracking, peeling paint, dampness, timber decay, sagging, fungi, termites, broken tiles, and electrical faults. It is widely accepted that the contributing causes of these defects include weak designs, poor workmanship, and the quality of materials (Awol et al., 2016).

According to a research by Dahal & Dahal, Public buildings of any nation are too valuable assets and maintaining them at a regular functional state is becoming a challenging job for developing countries like Nepal. The most significant building maintenance problems are plumbing and w/s, toilet, bathroom and sanitary, electrical problems, poor maintenance management & practices, peeling off paint, dampness, surface cracking, growth of fungi or small plants, and decay or breaking of floor/tile. Decay, deterioration, and failure of the fabric and finishing of a building due to negligence of maintenance have harmful effects on the contents and occupants.

Causes of maintenance problems can be grouped as managerial, technical, building user-related and natural causes. There are major causes such as design defects, inadequate contractor and construction supervision, use of low-quality materials & workmanship, unavailability of qualified human resources and quality materials, poor maintenance management, insufficient maintenance fund but high and unexpected cost, age of the building, natural disaster and earth settlement and so on (Dahal & Dahal, 2020)..

Lack of proper maintenance department, programs, plan, and policy are the critical issues of improvement by public institutions. Patent and latent defects in buildings are serious issues and failure to address them would contribute to additional rectification costs, hamper the smooth operation of the building and reduce its service life. Buildings and facilities that are not properly maintained can cause discomfort and lead to accidents and injury to the users (Dahal & Dahal, 2020).

2.6 Factors Affecting Maintenance Management

According to the research by Faremi and Adenuga, the attitude of users, lack of discernable maintenance culture, and misuse of facilities are the most significant factors affecting maintenance ranked by maintenance officers. Lack of discernable maintenance culture and lack of funds was the most significant factor affecting building maintenance, is also the highest factor affecting maintenance by users. These results proved that maintenance management has not got the chance to use the narrow span of control, which could lead to better performance and coordination of the maintenance department (Faremi, 2012).

There are also financial factors affecting maintenance management in government offices. Their unit of analysis targeted the maintenance employees and the government office employees. Results showed that the maintenance management had recognized its responsibility to offer the necessary budget for each maintenance plan (Jandali & Sweis, 2018).

A research by Chima, shows as there are so many problems associated with the maintenance of buildings and infrastructural facilities in the Nigeria. One of the serious problems is finance; government financing as regards to maintenance of buildings (both public and private) is minimal. The grant towards the maintenance of infrastructural facilities is at its lowest ebb. Most buildings and infrastructures have been neglected by subsequent tenures of government while the private sectors; the individual property owners have little or nothing to contribute towards effective maintenance of their buildings (Chima, 2021).

As long as the buildings afford the owner annual income, the government would not care for the maintenance and so long the interior of the building is conducive for the occupants they could not care for outward appearance or other necessary maintenance activity. Another serious impediment to maintenance of building in Nigeria is the state of the economy, according to the United Nation research on profitability index as regards income per capita of nations of the world; Nigeria is rated as a fifth poorest country (UN 2010), which implies that the average Nigerian lives below one dollar per day. Because of this economic hardship, residents and citizens have little or nothing to contribute in terms of effective maintenance of their abode thus leading to neglected effects visualized in our cities and metropolis (Chima, 2021).

The other factor is lack of preventive maintenance, the use of substandard materials, design resolution factors, and faulty workmanship were the most significant factors affecting maintenance. These factors are a real threat to the structural and functional state of the building and consequently, this would lead to rapid deterioration. Whereas technological change, lack of understanding of the benefits of maintenance, non-availability of replacement parts and components, and lack of communication between maintenance contractors and clients were the least significant factors (Waziri & Vanduhe, 2013).

The issue of design defects and their effect on maintenance was studied by Ali. The result showed that the building facade and missing slots underneath the floor slab were the most significant defects leading to complexity in carrying out maintenance tasks. Their solution was to benefit from the maintenance inputs during the design phase for the ease of maintenance to decrease design defects (A. S. Ali et al., 2013). Assaf also studied and discussed that most of the buildings' defects were the result of faulty design and construction and this led to increasing maintenance work. He concluded that maintenance experts should be involved in the planning phase (Assaf et al., 1996). Faulty designs, misuse of building after completion, and unavailability of skilled labor to undertake maintenance operations, and poor financial support for maintenance work were the most significant factors influencing the decision to carry out maintenance work. Based on that, maintenance should be taken into consideration within the design phase, high-quality materials should be used during the construction phase, and governments should take actions toward the awareness of the importance of maintenance (Ofori, I., Duodu, P. and Bonney, 2015).

The utilize of untested or inferior materials such as cement, aggregate, and water was the most significant factor causing defects, as these materials are being used in the construction and they will result in a poor building condition which will lead to more maintenance work. Thus, the involvement of construction professionals in the design phase could help to avoid such problems (Olanrewaju & Anifowose, 2015)

Talib assessed the factors affecting the building maintenance and the results showed that insufficient funds to maintain the building, not responding to a maintenance request, lack of preventive maintenance, non-availability of replacement parts and components, and lack of building maintenance standard were the most significant factors affecting maintenance. Based

on these results there should be an increased demand for effectiveness and efficiency from the maintenance department staff (Talib et al., 2014).

Environmental factors, design and proper workmanship, low quality of original construction, alterations and modifications, construction supervision, the value of buildings, gradual depreciation, wear and tear, detailing of working drawings, material specifications, cash flow analysis, users activities, shifting values and modernizations, solar radiation, social factors, aging, inadequate waste management plan, inadequate housing stock, accidents, and preservation of historical background. They revealed that the most significant factors affecting maintenance were: material specifications, design, and proper workmanship, detailing of working drawings, and construction supervision. Therefore, a relationship between construction supervision and material specifications is needed (Ajetomobi & Olanrewaju, 2015). The cause factors that affect maintenance management are summarized in table 2.2.

Under the current Law on Construction in Vietnam, building facility owners are obliged to conduct maintenance after facility construction is completed. However, facility owners are in general said to be nonprofessional in building facility maintenance, so that the regulation stipulates the measure that design consultants develop maintenance procedure manuals and then project owners implement facility maintenance following procedures as per the manual (Guideline by JICA Project Team).

Table 2-2 Factors affecting maintenance management

Causes Affecting Maintenance Management	
Factors	Author
Lack of maintenance culture Misuse of facilities Lack of funds	(Faremi, 2012)
Lack of offering the necessary budget for each maintenance plan	(Jandali & Sweis, 2018)
Lack of preventive maintenance The use of substandard materials Faulty workmanship	(Waziri & Vandehe, 2013)

Technological change Lack of understanding of the benefits of maintenance Non-availability of replacement parts and components Lack of communication between maintenance contractors and clients	
Faulty design and construction Misuse of buildings after completion Unavailability of skilled labor to undertake maintenance operations and Poor financial support for maintenance work	(A. S. Ali et al., 2013), (Assaf et al., 1996), (Ofori, I., Duodu, P. and Bonney, 2015), (Olanrewaju & Anifowose, 2015)
Insufficient funds to maintain the building Not responding to a maintenance request Lack of preventive maintenance Non-availability of replacement part and components Lack of building maintenance standard	(Talib et al., 2014).
Material specifications Design and proper workmanship Detailing of working drawings Construction supervision and aging	(Ajetomobi & Olanrewaju, 2015)

2.7 Maintenance Management Strategies and Selection Criteria

There are numerous classifications of maintenance strategies. Horner classifies maintenance strategies into three main categories;

Planned maintenance:- This refers to any maintenance activity that is planned, documented, and scheduled. Planned maintenance aims to reduce downtime by having all necessary resources on hand, like labor and parts, and a strategy to use these resources.

Corrective maintenance:- The simplest type of maintenance strategy, where an element in a building is used until it breaks down. It covers all activities, including replacement or repair of an element that has failed to a point at which it cannot perform its required function.

Corrective maintenance sometimes referred to as failure-based or unplanned maintenance. It is extremely expensive for two reasons:

1. The failure of an item can cause a large amount of consequential damage to other elements in the building. For example, failure of the roof could cause damage to the ceiling and the interior of the building.
2. Failure of an item can occur at a time which is inconvenient to both the user and the maintaining authority. This can make manpower and spare parts planning extremely difficult (Horner et al., 1997).

Emergency Maintenance/ breakdown maintenance:- Maintenance required when an asset or piece of equipment suffers an unexpected breakdown or change in condition that results in an immediate threat to health and safety. (Horner et al., 1997)

In addition to Horner, several studies categorize maintenance in different groups. The major categories are preventive maintenance and corrective maintenance. Preventive and corrective types of maintenance are further classified into immediate maintenance, and routine maintenance.

2.7.1 Preventive Maintenance

Preventive maintenance is an effective maintenance strategy to ensure the constant and efficient usage of building systems and their components (Jin & Chua, 2018). Well-planned preventive maintenance is advocated for its effects on improving equipment's operating efficiency, preventing premature replacement of components, and avoiding interruptions for building occupants. Preventive maintenance is widely thought to reduce long-term costs by maximizing the operating capacities of equipment, minimizing downtime, and avoiding breakdowns that would otherwise lead to higher repair costs later (Sahelu, 2015).

In terms of preventive maintenance interval, it can be categorized into periodic preventive maintenance and non-periodic preventive maintenance. periodic preventive maintenance is when the maintenance cycle is fixed whereas non-periodic preventive maintenance can be regarded as dynamic preventive maintenance, and preventive maintenance period in different time periods is different, but the period of the same time period is constant (Li et al., 2021).

Preventive maintenance was introduced to overcome the disadvantages of corrective maintenance, by reducing the probability of occurrence of failure and avoiding sudden failure (Horner et al., 1997). Well-planned preventive maintenance is advocated for its effects on improving equipment's operating efficiency, preventing premature replacement of components, and avoiding interruptions for building occupants. Preventive maintenance is widely thought to reduce long-term costs by maximizing the operating capacities of equipment, minimizing downtime, and avoiding breakdowns that would otherwise lead to higher repair costs later (Sahelu, 2015).

Time-based preventive maintenance is most likely to be the appropriate maintenance strategy for health, safety, and environmentally significant items whose condition cannot be monitored, but for which the online condition monitoring techniques either are not available or are not cost-effective; and utility significant items whose condition cannot be monitored and for which the cost of applying time-based preventive maintenance is less than the cost of applying corrective maintenance (Horner & Munns, 1997).

Benefits of Preventive Maintenance:- Preventive maintenance was introduced to overcome the disadvantages of corrective maintenance, by reducing the probability of occurrence of failure and avoiding sudden failure. This strategy is referred to as time-based maintenance, planned maintenance, or cyclic maintenance. Preventive maintenance tasks are performed under a predetermined plan at regular, fixed intervals, which may be based for example on operating time. Such a strategy is frequently applied to external or internal paintwork (Horner & Munns, 1997).

According to Raymond and Joan, the advantages of preventive maintenance over corrective maintenance are summarized in table 2.3.

Table 2-3 Advantage and disadvantages of preventive maintenance

Advantages (Raymond & Joan, 1991)	Disadvantages (Horner & Munns, 1997)
Planned and performed when it is convenient to the building's user	Performed irrespective of the condition of the building elements. A large number of unnecessary tasks will be carried out on elements that could have remained in a safe and acceptable operating condition for a much longer time

Costs can be reduced by avoiding the cost of consequential damage	The condition of an element may end up worse than it was before, as a result of human error during the execution of the maintenance task
The time that an element of the building or the whole building is out of service, can be minimized so the habitability of the building can be increased	Usually very demanding in terms of spare parts and labor
Improved health & safety of the user	

Importance of preventive maintenance:- Imaginers Spring Newsletter 2010 states the following under the topic of “Why a Preventative Maintenance Schedule is Important”. Scheduling of routine and preventative maintenance is important for several reasons as summarized in table 2.4.

Table 2-4 Importance of preventive maintenance

Importance of Preventive maintenance	Eliminate unexpected expenses and breakdowns
	Keep costs down because repairs are not made on an emergency basis
	Extend the lives of common elements and reduces the amount needed for reserved funds
	Stop problems before they occur

Types of preventive maintenance:- Preventive Maintenance is done before a failure occurs and consists of maintenance types like Time Based Maintenance (TBM), Failure Finding Maintenance (FFM), Risk-Based Maintenance (RBM), Condition Based Maintenance (CBM), and Predictive Maintenance.

TBM refers to replacing or renewing an item to restore its reliability at a fixed time, interval or usage regardless of its condition. FFM tasks are aimed at detecting hidden failures typically associated with protective functions. RBM is when a risk assessment methodology is assigned for maintenance resources to those assets that carry the most risk in case of failure. CBM is carried out when certain indicators give the signal that the equipment is deteriorating and the failure probability is increasing (Hicks et al., 1999).

2.7.2 Corrective maintenance

Corrective maintenance is a maintenance task performed to identify, isolate, and rectify a fault so that the failed equipment, machine, or system can be restored to an operational condition within the tolerances or limits established for in-service operations.

This maintenance strategy is also named fire-fighting maintenance, failure-based maintenance, or breakdown maintenance. When corrective maintenance strategy is applied, maintenance is not implemented until failure occurs. It is the original maintenance strategy applied in the industry. It is considered a feasible strategy in the case where profit margins are large. However, such a fire-fighting mode of maintenance often causes serious damage to related facilities, personnel, and the environment (M. Pariazar, J. Shahrabi, 2008).

Corrective maintenance is most likely to be the appropriate maintenance strategy for non-significant items and utility significant items whose condition cannot be monitored and for which the cost of applying time-based preventive maintenance is less than the cost of applying corrective maintenance (Horner & Munns, 1997).

Corrective maintenance can be extremely expensive for two reasons:

1. The failure of an item can cause a large amount of consequential damage to other elements in the building. For example, failure of the roof could cause damage to the ceiling and the interior of the building.
2. Failure of an item can occur at a time which is inconvenient to both the user and the maintaining authority. This can make manpower and spare parts planning extremely difficult.

However, corrective maintenance is still an important part of any maintenance management strategy. It has its own pros and cons as summarized in table 2.5 (Horner & Munns, 1997).

Table 2-5 Advantage and disadvantage of corrective maintenance

Advantages	Disadvantages
Lower short-term costs	Failure is unpredictable
Minimal planning is required	Paused operations
Simpler process	Higher long-term costs

2.7.3 Immediate Maintenance

Immediate/ emergency maintenance/ breakdown maintenance is maintenance required when an asset or piece of equipment suffers an unexpected breakdown or change in condition that results in an immediate threat to health and safety or could cause serious property damage. Examples of emergency maintenance are fire outbreaks, leaking roofs, and electrical malfunction that's causing power surges. major flooding. Like preventive and corrective maintenance, immediate maintenance also has its own advantages and drawbacks and it is summarized in table 2.6.

Table 2-6 Advantages and disadvantages of immediate maintenance

Advantages	Disadvantages
Minimal planning is required	increased chances of accidents or injuries.
The process is very simple so it is easy to understand	Breakdown occurs at inappropriate times leading to poor and hurried maintenance
Few maintenance operators are required as less work is done day-to-day.	Longer repair time in comparison to any other maintenance types

2.7.4 Routine maintenance

Routine maintenance refers to any maintenance task that is done on a planned and ongoing basis to identify and prevent problems before they result in equipment failure. Some common routine maintenance includes regular inspections or service work. It involves the complete replacement of equipment based on time intervals without any inspections. This is also a

common maintenance strategy applied to industrial equipment, for example, for the replacement of filters and wearing components.

Routine maintenance comprises simple maintenance tasks that are done on a regular basis like lubrication, filter changes, parts replacements, etc. cleaning related tasks (mopping the floor, cleaning equipment, washing windows, mowing the lawn, etc.; which are more pronounced in property maintenance.

The benefits and drawbacks of routine maintenance are summarized in table 2.7.

Table 2-7 Advantages and disadvantages of routine maintenance

Advantages	Disadvantages
Less equipment downtime	Upfront costs - keeping equipment well-maintained requires investment
Longer asset life	More labor-intensive, so you'll need more staff on hand
Fewer interruptions to critical operations	Potential for over-maintenance

Several authors wrote on the topic of maintenance strategies, they have classified maintenance into different sections. Table 2.8 shows a summary of types of maintenance and authors on the area.

Table 2-8 Types of maintenance

Type of maintenance	Definition	Authors on the area
Preventive maintenance	Maintenance is carried out at predetermined intervals or according to prescribed criteria and intended to reduce the probability of failure or the degradation of the functioning of an item.	(Horner et al.), (BS-EN-13306, 2010), (M. Pariazar, J. Shahrabi, 2008)

Predetermined maintenance	Preventive maintenance is carried out under established intervals of time or number of units of use but without previous condition investigation. Intervals of times or number of units of use may be established from knowledge of the failure mechanisms of the item.	(BS-EN-13306, 2010)
Condition-based maintenance	Preventive maintenance includes a combination of condition monitoring and/or inspection and/or testing, analysis, and the ensuing maintenance action. The condition monitoring and/or inspection and/or testing may be scheduled, on request, or continuous.	(BS-EN-13306, 2010), (M. Pariazar, J. Shahrabi, 2008)
Predictive maintenance	Type of condition-based maintenance is carried out following a forecast derived from repeated analysis or known characteristics and evaluation of the significant parameters of the degradation of the item.	(BS-EN-13306, 2010), (M. Pariazar, J. Shahrabi, 2008)
Scheduled maintenance	Maintenance is carried out following an established schedule or established number of units of use. Note: Corrective deferred maintenance may also be scheduled.	(BS-EN-13306, 2010)
Corrective maintenance	Maintenance is carried out after fault recognition and intended to put an item into a state in which it can perform a required function	(BS-EN-13306, 2010), (Horner et al.), (M. Pariazar, J. Shahrabi, 2008)
Deferred corrective maintenance	Corrective maintenance that is not immediately carried out after fault detection but is delayed under given rules	(BS-EN-13306, 2010)
Immediate corrective maintenance	Corrective maintenance that is carried out without delay after a fault has been detected to avoid unacceptable consequences	(BS-EN-13306, 2010)
Emergency Maintenance	(also known as breakdown maintenance) is maintenance required when an asset or piece	(BS-EN-13306, 2010), (Horner et al.,)

	of equipment suffers an unexpected breakdown or change in condition that results in an immediate threat to health and safety	
Onsite maintenance	Maintenance carried out at the location where the item is normally located	(BS-EN-13306, 2010)
Operator maintenance	Maintenance action is carried out by an operator. Such maintenance actions should be clearly defined.	(BS-EN-13306, 2010)

The maintenance strategies are also summarized in the figure presented below in Figure 2.1. (BS-EN-13306, 2010):

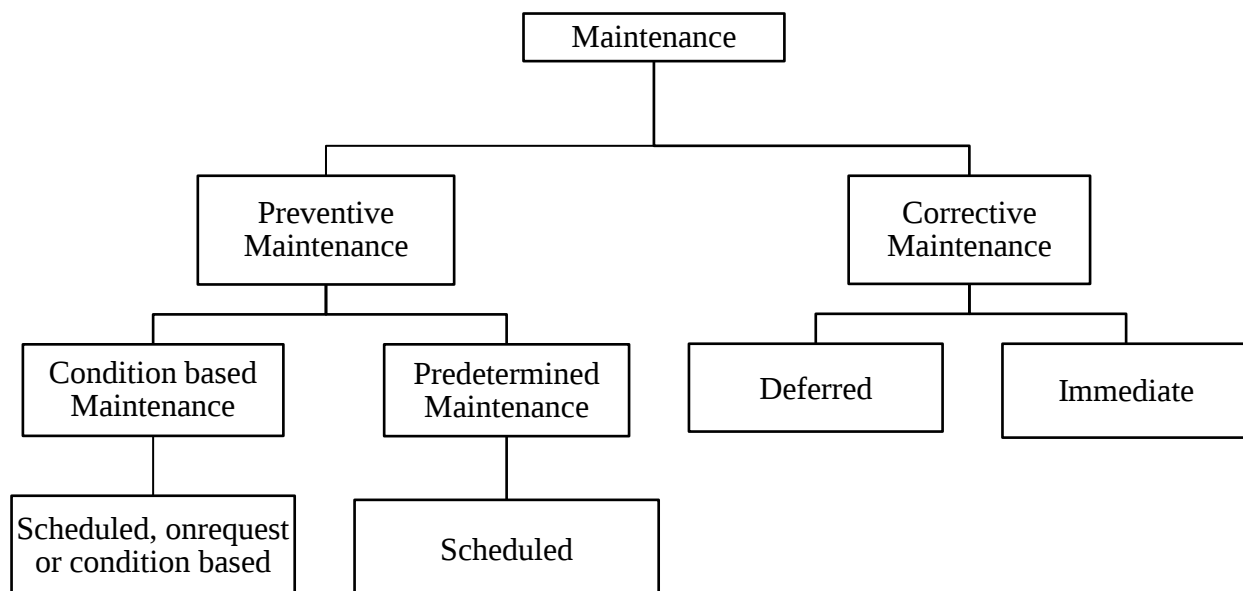


Figure 2-2 Types of maintenance

Source: BS-EN-13306, 2010

2.8 Selection criteria of maintenance strategy

Selection of maintenance strategy depends on many criteria. The decision on the appropriate type of maintenance for condominium buildings affects how to allocate resources, management, and organization process (M. Pariazar, J. Shahrabi, 2008).

Identifying relevant selection criteria comprises an essential part of any decision-making process. Building maintenance decision-making often must consider complex, conflicting, and competing criteria, as well as to identify the relative importance of the criteria (Besiktepe et al., 2020).

Several authors studied and suggested identification criterias. Table 2.9 shows few of criterias suggested by the authors.

Table 2-9 Identification Criteria

Identification criteria	Study area	Author
Breakdown consequences - Safety - Operation - Secondary damage Cost - Loss of production - Repair cost in man-hours - Repair cost of material Importance - Ease of failure detection - Bottleneck - Complexity of the system - Redundancy	Airport facilities maintenance policy section	(Chien-Chang, 2012)
- The costs of maintenance - Fulfillment of building user needs and expectations - The quality of maintenance of building structures and equipment - The efficiency of the maintenance process	Maintenance strategy selection for municipal buildings	(Reichelt et al., 2008)
- Mean time between failure - Downtime - Maintenance cost - Type of maintenance task (planned vs. unplanned) - Health and safety - Security and environment	The performance measurement criteria for the building maintenance activities	(Parida & Chattopadhyay, 2007)

- Employee satisfaction		
- Legal, safety, cost, condition, and operational considerations - Building status - Physical condition - Importance of building occupation, the effect on occupants - Cost implications - Effects on service provision	Prioritizing major items of maintenance and maintenance programs	(Besiktepe et al., 2020)
- Building materials - Building services - Building age and condition - Type of structure - Use of property - Failure to execute maintenance at the right time - New health and safety regulations - Budget constraints	Factors affecting housing maintenance costs in Malaysia	(Azlan Shah Ali et al., 2010)

2.9 Regular inspection of building facilities

To keep the building values, it is required to conduct regular inspections and maintenance. Regular inspection helps to identify existing/potential hazards in the building. It is also required to take corrective remedy actions before the appearance of risk. As a standard, regular inspection interval is presented in table 2.10.

Table 2-10 Building inspection frequency

Building Component	Activity to do	Frequency
Building Exterior	check the condition of the paint and walls	Every 3 years
	check the condition of windows and window sill	
	clean drains and gutters on the roof, test downspouts and drains by flushing them with water	
	make sure gutters are appropriately anchored	
	remove any plant life growing on the roof	
	examine the condition of the sidewalk and parking lots	
	examine the condition of the fencing	
Roof	inspect the roof, clean if necessary	Every 1 year
	continuity of roof covering	

	deterioration of fascia	
	gutters and soffits	
	performance of flashings	
	structural deformation	
Staircase and handrail	check the condition of the stairs	Every 5 years
	make sure handrails are anchored proper	
	ensure there is no obstacle on the corridor and stairs	
Electric and Telecommunication line/ lines (outside the building)	inspect the conditions of electric lines	Every 5 years
	make sure the electrical panel is accessible	
	clean and re-check electrical connections	
	inspect electrical connections and boxes for overheating	
Drainage lines/ lines outside the buildings	check drain connections to the sanitary sewer	Every 6 month
	inspect and clean manhole	
Water supply	inspect plumbing for any leaks or unusual noises	Every 2 years
General home inspection and maintenance is recommended to take place every 3-5 years.		

In the case of condominium buildings, a single building accommodates an average of 30 house owners. Each house owner has a diverse number of family members. Hence the number of occupants in one block is huge. These condominium houses are also assisting the government in accommodating large number of people which reduces the housing problems of the city. This indicates condominium buildings are very sensitive buildings that need more attention.

3. MATERIALS AND METHODS

3.1 Introduction

This chapter covers the methodology used for the study. It presented the study area, research design, the process of sampling, data collection methods & instruments, and analysis technique.

To address the key research objectives, the study used both qualitative and quantitative methods of data gathering and a combination of primary and secondary sources. The qualitative data support the quantitative data analysis and results.

3.2 Study Area

The study is on the assessment of facility maintenance management practices of condominium buildings in Addis Ababa. Due to the huge number of condominium building blocks and their scattered arrangement in the city; considering all the condominium buildings is time taking and difficult. Buildings that give service for more than eight years are taken for the study. Considering their similar feature and purpose, of the existing numerous condominium sites, five lots are recommended by AAHDP officers due to their extended service year. The selected site information is summarized in table 3.2.

This research evaluates the maintenance management practice of condominium buildings located under Addis Ababa Housing Development Project Offices. The study covers the assessment of maintenance behavior of AAHDPO and condominium owners associations. The five condominium buildings are found in Jemo 1, Gofa Mebrat hail, Gerji Mebrat Hail, Mikililand, and Bole Summit. The building location of the study area is indicated in pictures and is summarized in a table 3.1.

Table 3-1 Condominium building location

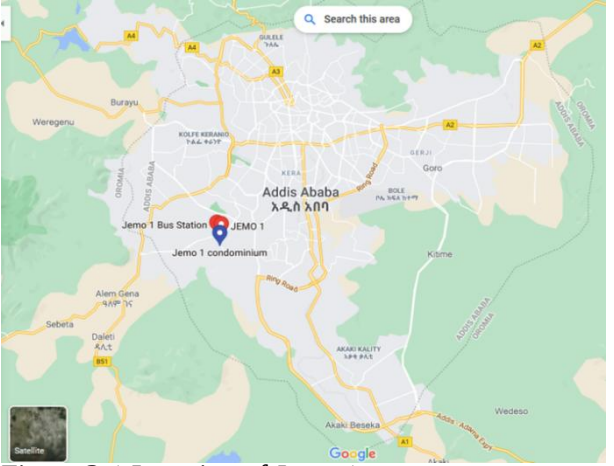
 Figure 3-1 Location of Jemo 1	 Figure 3-2 Location of Bole Summit
 Figure 3-3 Location of Gofa Mebrat Hail	 Figure 3-4 Location of Mikililand
 Figure 3-5 Location of Gerji Mebrat Hail	

Table 3-2 Condominium building service year

SN	Condominium name	Location	Number of Building Blocks	Service Year
1	Mikililand	Kolfe keranio S/C wereda 14	123	10 years
2	Bole Summit	Lemi Kura S/C Wereda 15	400	8 years
3	Gofa Mebrat Hail	Nifas Silk Lafto S/C Wereda 06	180	10 years
4	Gerji Mebrat Hail	Bole S/C Wereda 13	5	10 years
5	Jemo 1	Nifasilk Lafto S/C Wereda 01	350	9 years

3.3 Research Design

The research design is intended to provide an appropriate framework for a study. The significant decision in the research design process is the choice to be made regarding the research approach since it determines how relevant information for a study is obtained. It also refers to the overall strategy that is chosen to integrate the different components of the study coherently and logically to address the research problem effectively.

A research design involves a critical review and articulation of the research questions that is tailored to the problem statement, the methodical design of the research and philosophical stand adopted the critical design of the research instrument, collection of the data needed, and critical analysis of the same to reach to the informed conclusion (Sahelu, 2015).

The research design of this study is summarized in the following steps.

Step 1: Initiation of the research idea and discussion on its applicability with the advisor.

Step 2: Gathering preliminary information about maintenance works of condominium houses

Step 3: Proposal writing and approval

Step 4: Survey in condominium sites selected as a case study, to overview the status of buildings and maintenance activities

Step 5: Design questionnaire & interview questions and get advisor's approval

Step 6: Intensive site investigation and data collection from the respective personnel

Step 7: Statistical analysis of data and extract results using root cause analysis, AHP method of analysis and Framework.

Step 8: Data interpretation and development of maintenance framework

Step 9: Based on the analysis result, development of conclusion and recommendation

3.4 Population and Sampling

The Population for this research is five condominium buildings in Addis Ababa that gives service for more than eight years. Condominium sites have scattered arrangements in the city, hence to assess all buildings having service years of more than eight years is very wide and difficult task. Considering their similarity in feature, function and their cluster arrangement, five clusters were selected for the study. The study areas are Jemo 1, Gofa Mebrat hail, Gerji Mebrat Hail, Mikililand, and Bole Summit. The condominium blocks are classified into several parcels for ease of administration. Each segment has its compound, a specified number of blocks, and residents association. For such kind of arrangement cluster sampling is highly compatible for this study.

3.4.1 Sample size

To get sufficient information and to reach a reasonable and substantiate conclusion, Addis Ababa Housing Development officers, the five wereda housing development office workers and condominium residents' associations were focus groups. They are considered in the study due to their direct involvement in condominium management.

To get essential information and to reach a reasonable conclusion, questionnaire were prepared and distributed for AAHDPO, wereda housing development office, and residents associations. The research covers all responsible officers from AAHDPO, the five wereda housing development project officers, and 15% of the condominium clusters. The population and cluster sample sizes of condominium clusters are summarized in table 3.3.

Table 3-3 Parcel size arrangement of condominium buildings

SN	Condominium Name	Location	Total number of clusters
1	Mikililand	Kolfe keranio S/C	13
2	Summit	Lemi Kura S/C Wereda 15	30
3	Gofa Mebrat Hahil	Nifas Silk Lafto S/C Wereda	14
4	Gerji Mebrat Hail	Bole S/C Wereda 13	1
5	Jemo 1	Nifasilk Lafto S/C Wereda 01	31
Total			89

Sample size is determined using the formula:

$$n = n' / [1 + (n' / N)]$$

where:

n = sample size from the finite population

N = total number of population

n' = sample size from infinite population = S^2 / V^2 , where S^2 is the variance of the variance of the population elements and V is a standard error of sampling population. (Usually $S = 0.5$ and $V = 0.05$). Hence, for 89 cluster population;

$$n = n' / [1 + (n' / N)]$$

$$n' = S^2 / V^2 = (0.5^2 / 0.05^2) = 100$$

$$N = 89$$

$$n = 100 / [1 + (100 / 89)] = 47.1 \text{ @} 48$$

This means the total questionnaire should be distributed to 48 directly participated stakeholders in order to achieve 95% confidence level. Questionnaire distribution rate is discussed in table 3.4.

From the 48 questionnaire, 20 is distributed for AAHDPO, 15 for the 5 wereda housing development office and 13 were distributed to the condominium clusters.

3.5 Data Collection Techniques

The study is descriptive by which information is gathered based on the actual status of the phenomena. Data collection was conducted from secondary data by which information were gathered through literature review, and primary data obtained from the interview, questionnaires, and physical observation.

After conducting an intensive literature review and preliminary site investigation on the situations of condominium buildings & their maintenance management system, tools used for necessary information gathering are decided to be the physical observation, interview, and questionnaire.

The response rate of questionnaire is summarized in table 3.4.

Table 3-4 Response rate

Respondents from	Distributed questionnaire	Response returned	Response rate (%)
AAHDPO	20	15	75%
Wereda officers	15	11	73.3%
Residents Associations	13	10	76.9%
Total	48	36	75%

3.5.1 Questionnaire Design

Based on the literature review and preliminary site investigation, questionnaires were designed to collect necessary information from the liable person. Questionnaires are prepared considering the stakeholders of condominium building management i.e. AAHDPO, werdea housing development offices, and condominium owners associations.

The questionnaires are designed to have 5 parts. The first two parts were to gather personal information and general information about the selected condominium sites. The last three parts are designed to achieve the three specific objectives of the study. The last two specific objectives are achieved based on the results of physical investigation of the researcher to give an insight on the better maintenance strategy and to provide inspection format.

Part 1 gives personal information of respondents

Part 2 is intended to get general information about the selected sample sites.

Part 3 is designed to obtain information that is required to meet specific objective 1 of the study.

Part 4 is planned to collect necessary information about the cause of defects on condominium buildings by which specific objective 2 is achieved.

The last part is about the factors that determine maintenance management. The third objective of the study is evaluated on this subtopic. The questionnaire part is summarized in table 3.5.

Table 3-5 Questionnaire questions and research objective

SN	Specific Objective	Questionnaire part
1	To assess the current facility maintenance management practices of a condominium in Addis Ababa	Part 3 Assessment of maintenance practices
2	To identify the cause of defects of condominium buildings	Part 4 Information on the cause of defects on condominium buildings
3	To evaluate failure factors affecting the application of facility maintenance management	Part 5 Factors that determine maintenance management

3.6 Data Analysis Techniques

3.6.1 Method of Analysis

Quantitative and qualitative types of research were extensively used because the data to be utilized should be in a concise format and need to test the relationships of variables among each other to generalize findings to a larger population.

Data collected through questionnaires and interviews are analyzed using descriptive statistical methods of analysis such as frequencies, percentages, and average. The analysis is conducted using Microsoft Excel and the findings are presented in a table and chart.

3.6.1.1 Root Cause Analysis (RCA)

Root Cause Analysis (RCA) is a process designed for use in investigating and categorizing the root causes of events with safety, health, environmental, quality, reliability and production impacts (Rooney & Hauvel, 2004). The cause and effects are presented in causal diagram that was created by Ishikawa in 1990 for the research field of management. The fishbone diagram or Ishikawa diagram is a cause-and-effect diagram that helps managers to track down the reasons for imperfections, variations, defects, or failures (Coccia, 2017). The diagram looks just like a fish's skeleton with the problem at its head and the causes for the problem feeding into the spine. Once all the causes that underlie the problem have been identified, managers can start looking for solutions to ensure that the problem doesn't become a recurring one.

RCA is used to assess the causes for condominium building defects and their effect is presented. Causing factors are basically classified in to two major categories. The above row of the diagram indicates causes that are happened after the building starts giving service and the lower row shows the cause happened during design and construction stage.

3.6.1.2 Analytic Hierarchy Process (AHP)

Analytic Hierarchy Process (AHP) is a method for organizing and analyzing complex decisions, using mathematics and psychology. It was developed by Thomas L. Saaty in the 1970s. Maintenance strategies are broadly classified in to planned and unplanned maintenance. They are further classified in to preventive, corrective, immediate and routine maintenance. To select convenient maintenance strategy of condominium buildings applying AHP method of analysis is suggested by different scholars.

The compatible maintenance strategy for condominium buildings is analyzed and discussed using AHP method. The method follows the following steps to reach the goal.

Step 1. Develop a hierarchical model for maintenance strategy selection criteria

Identification Criteria is presented in literature review table 2.9

There are different approaches to select criterias. For this study four criterias are selected based on the actual condition of condominium buildings. The criterias are cost, safety, ease of implementation and users satisfaction. AHP model presented in figure 3.6 is developed using selection criterias from the four alternative maintenance strategies to reach the goal of selecting convenient maintenance strategy for condominium buildings.

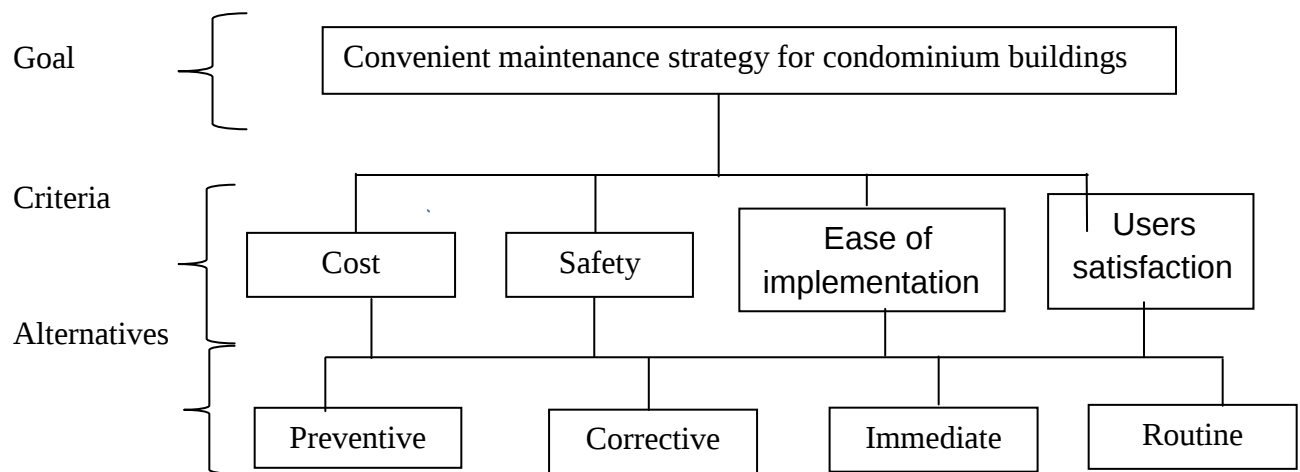


Figure 3-6 AHP model

Step 2. Drive weights (priorities) for the criteria

The importance rate of criterias are traced using the weight indicated in table 3.6.

Table 3-6 Importance rate

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one activity over the other
5	Essential importance	Experience and judgment strongly favor one activity over another
7	Very strong importance	An activity is favored very strongly over another; its dominance demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2,4,6,8,	Intermediate importance	When compromise is needed between two

Source: Fundamental criteria scale (Saaty, 1980)

Step 3. Consistency check

Check the assigned weights are correct or not using equations 3.1, 3.2, 3.2 and 3.4.

$$[C] = [A] * [B] \quad \text{Equation 3-1}$$

$$[D] = \frac{1}{n-1} \sum_{i=1}^{n-1} \sum_{j=1}^{n-1} |a_{ij} - a_{ji}| \quad \text{Equation 3-2}$$

[D] indicates the number of criteria, the calculated matrix D values should be similar with the number of criteria.

$$\text{Consistency index} = \frac{I}{n(n-1)} \quad \text{where: } I \text{ max is average value of } [D] \quad \text{Equation 3-3}$$

n is number of criterias

Consistency ration (CR):-

$$CR = \frac{\text{Consistency index}}{RI} \quad \text{Equation 3-4}$$

Random Index is obtained from random index table shown in table 3.7.

Table 3-7 Random index

Attributes	0	1	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Step 4. Derive overall priorities and final decision

Criteria weights are presented in percentage to set the proiority ceiteria.

3.6.1.3 Maintenance Management Framework:

The Maintenance Management Framework (MMF) states that “departments should decide on the appropriate interval in terms of criticality to service delivery and complexity of the building asset”. In addition, the MMF specifies the type of information that should result from the condition assessment process (Queensland Department of Housing, 2017a).

According to Republic of Namibia, the importance of MMF is described in brief and it is presented in table 3.8. (REPUBLIC OF NAMIBIA, MMF)

Table 3-8 Importance of maintenance management framework

Importance of MMF	continuous improvement in asset planning, maintenance procedures and risk management
	government buildings are adequately maintained
	the risks to the government are well managed
	ministries take a more strategic role in the maintenance of government buildings
	the Government has pertinent information for monitoring the maintenance, condition, and performance of buildings at a whole-of-Government level
	there is sufficient operational information to perform maintenance, including the ability to review policies and strategies, analyze life-cycle costs, assess environmental impact, plan for replacements and upgrades, and improve the efficiency and effectiveness of maintenance

Condition assessment:- According to Queensland Department of Housing and Public works, condition assessment is defined as the technical assessment of the physical condition of an asset, using a systematic method designed to produce consistent, relevant, and useful information. The condition assessment process for built assets should, as a minimum, rate asset condition, determine the risks associated with letting an asset remain in that condition, and identify maintenance work needed to restore to and retain an asset in its required condition.

It is an important aspect of effective maintenance planning. The incorporation of condition assessments as part of maintenance processes ensures that there is a structured, objective process for identifying the demand for condition-based maintenance works to meet strategic and operational priorities. Such works should form part of any comprehensive program of maintenance in conjunction with preventative, statutory, and reactive (unplanned) maintenance work, over the immediate, medium, and long term (Queensland Department of Housing, 2017a).

Condition Standard:- Table 3.9 shows conditions Standards Ratings to be determined for each building asset and periodically review and update the rating (Queensland Department of Housing, 2017a).

Table 3-9 Condition standard

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

Condition Index:- The general condition of buildings can be represented in the rating scale shown as follows: (Queensland Department of Housing, 2017a). This rating is applicable to be used by the assessor to represent the general condition of building assets. The condition index is presented in table 3.10.

Table 3-10 Condition index

Rating	Status	Condition of building asset
5	Excellent	, No defect , as new condition and appearance
4	Good	, Minor defects , superficial wear and tear , Some deterioration to finishes , Major maintenance not required

3	Fair	, Average condition , Significant defects are evident , Worn finishes require maintenance , Services are functional but need attention , Deferred maintenance work exists
2	Poor	, Badly deteriorated , Potential structural problems , Inferior appearance , Major defects , Components fail frequently
1	Very poor	, Building has failed

Cause code:- The cause of defects can be categorized into different factors. Major factors are summarized in table 3.11.

Table 3-11 Cause code

Cause of defect	Cause code
Design phase defect	A
Construction phase defect	B
Overload/ misuse of occupants	C
Age deterioration	D
Hostile environment	E

Priority ranking scale:- Table 3.12 sets out the rankings to be used by the assessor undertaking condition assessments to indicate recommended maintenance work (Queensland Department of Housing, 2017a).

Table 3-12 Priority rank

Priority ranking	Definition
1	Works needed to: , Meet maintenance-related statutory obligation and due diligence requirements

	- Ensure the health and safety of building occupants and users - Prevent serious disruption of building activities and /or may incur higher costs if not addressed within 1 year
2	Works that: - Affect the operational capacity of the building - Are likely to lead to serious deterioration and therefore higher future repair costs if not addressed between 1-2 years
3	Works that: - Have a minimal effect on the operational capacity of the building but are desirable to maintain the quality of the workplace - Are likely to require rectification within 3 years
4	Works that: Can be safely and economically deferred beyond 3 years and reassessed at a future date

3.6.2 Validity and Reliability

The research is conducted using reliable sources in data gathering. Primary and secondary data are used as data origins. Analysis and interpretations are also given based on the information gathered through data collection techniques. Questionnaires, interviews, and physical investigation were conducted to collect primary information, and the references used for the study are from reliable sources. Collection of data from different sources in the same area assures the reliability.

The research objectives are structured based on the real phenomenon of the maintenance behavior of condominium buildings. The result of the research work is valid for sectors in solving maintenance-related problems. The recommendations are also given considering the actual condition and its applicability in the facility maintenance management of condominium buildings.

4. RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the analysis of data collected through questionnaires, interviews, and physical observation. The main findings are summarized and discussed below based on the specific objectives of the study. The data was mainly collected from the questionnaires which were distributed to AAHDPO, wereda housing development project offices, and condominium owners associations. A total of 48 questionnaires were given while 36 respondents were filled and returned which accounts for 75%. In addition to the questionnaires, there were interviews conducted with a unit manager of AAHDPO. The researcher also carried out a physical investigation to study the actual status of condominium buildings. The reason for using different methods of information gathering is to increase the reliability and validity of data. This in addition enhances the quality of the research findings upon which the conclusion can be made.

4.2 Respondent Profile

Table 4-1 Respondent profile

	Respondent Profile	Number of respondents	Percentage
1	Organization		
1.1	AAHDPO Head Office	15	42
1.2	Wereda HDPO	11	31
1.3	Condominium owners association	10	27
	Total	36	100
2	Level of education		
2.1	Certificate and Diploma	8	22
2.2	First degree and above	28	78
	Total	36	100
3	Work experience		
3.1	0-2 years	11	31
3.2	3-5 years	16	44
3.3	6 years and above	9	25
	Total	36	100

4.3 Facility Maintenance Management Practice of Condominium Buildings

4.3.1 Number of building blocks

The selected sites have different numbers of building blocks; the research tries to assess locations with a massive number of buildings and also with a small number of buildings.

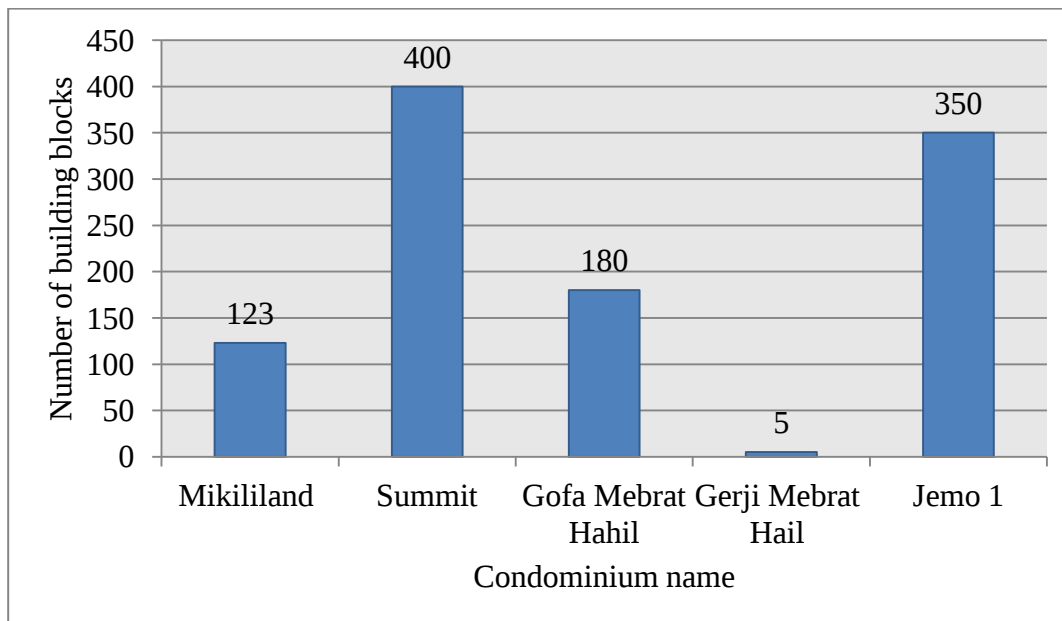


Figure 4-1 Number of building blocks in selected sites

Bole summit has 400 building blocks which is a huge number. The second largest number is 350 at Jemo 1. Gofa Mebrat Hail and Mikililand condominiums also have a large number of building blocks which are 180 and 123 respectively. From the sample condominium buildings, the compound with the least number of blocks is located at Gerji Menrat hail. The least number of building blocks is considered to see the behavior of wereda administration in supervising the status, but the result shows the same response as other sites.

4.3.2 The current maintenance strategy

As stated in the literature review maintenance types are broadly classified as planned and unplanned maintenance. And they are further categorized as preventive, corrective, immediate, and routine maintenance.

According to the condominium proclamation maintenance works are assigned for residents. The gathered information assures that there is no maintenance activity performed by AAHDPO and also by wereda housing development office. All the offices have no facility

management department to prepare documents related to the overall building management and maintenance works. Neither AAHDPO nor residents have a planned maintenance program rather residents prefer to maintain when the case is only critical.

The research tries to assess the maintenance strategy for condominium buildings used so far. . The result is summarized in the chart below.

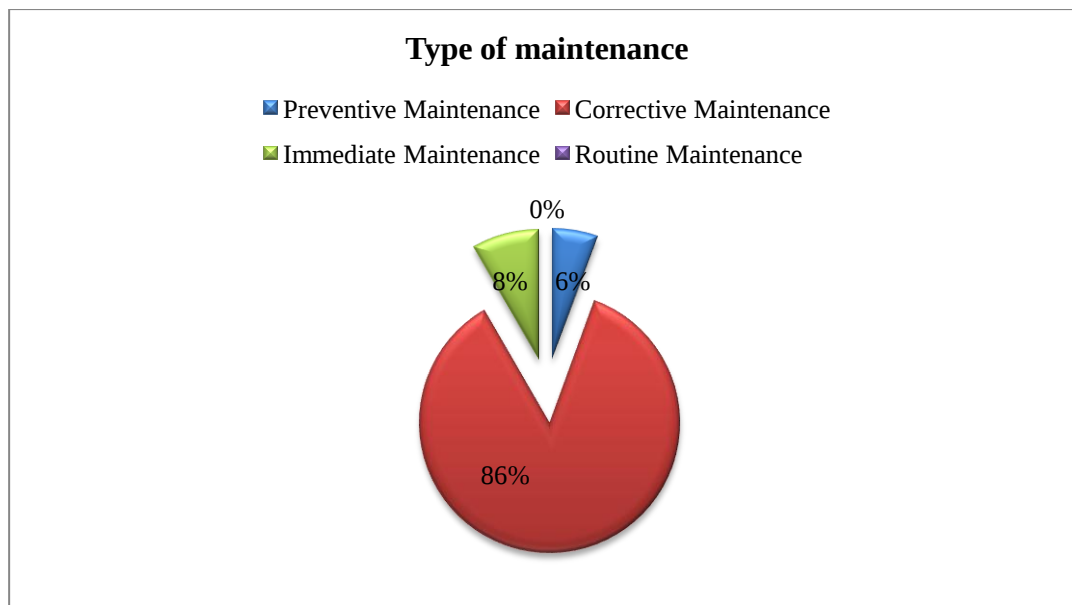


Figure 4-2 Currently applied maintenance strategy

The result shows that 86% of respondents agree that the type of maintenance performed so far is corrective maintenance 8% of respondent agreed as they are using preventive maintenance and 4% of respondents said that immediate maintenances are performed so far. And 0% is recorded for routine maintenance type.

4.3.3 Regular inspection plan of building facilities

In the case of condominium buildings, a single building accommodates an average of 30 house owners. Each house owner has a diverse number of family members. Hence the number of occupants in one block is huge. These condominium houses are assisting the government in accommodating a numerous number of people which solves housing problems of the city. This indicates condominium buildings are very sensitive buildings that need more attention.

To keep the values of condominium buildings, regular inspection and immediate corrective action on the defects are mandatory. Data collected on this sub-section indicates the result shown below.

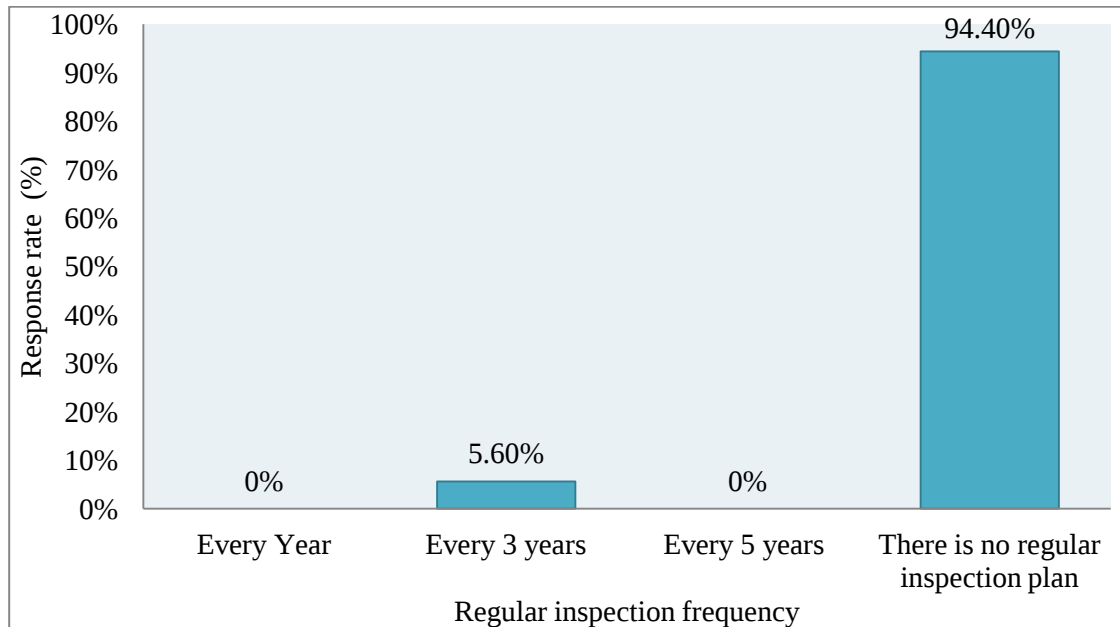


Figure 4-3 Regular inspection schedule

94.4% of respondents agreed as there is no regular inspection plan. 5.6% of them said regular inspection is conducted every 3 years and 0% for every year and for every 5-year regular inspections.

The buildings are giving services for more than eight years, but according to the data majority of the respondents agreed as there is no regular inspection. Frequency for building component inspection is listed in table 2.8, but according to the regular inspection standard, condominium buildings does not satisfy the inspection requirements.

4.3.4 Major sources of maintenance complaints

In condominium houses, there are lots of complaints by the residents which arise due to either poor construction, lack of regular maintenance, or users' misuse of facilities. Early construction problems are solved in the first year by the contractors under the defects liability period. But due to lack of regular maintenance work, buildings are deteriorating over time. According to data gathered through questionnaire, respondents view is summarized below.

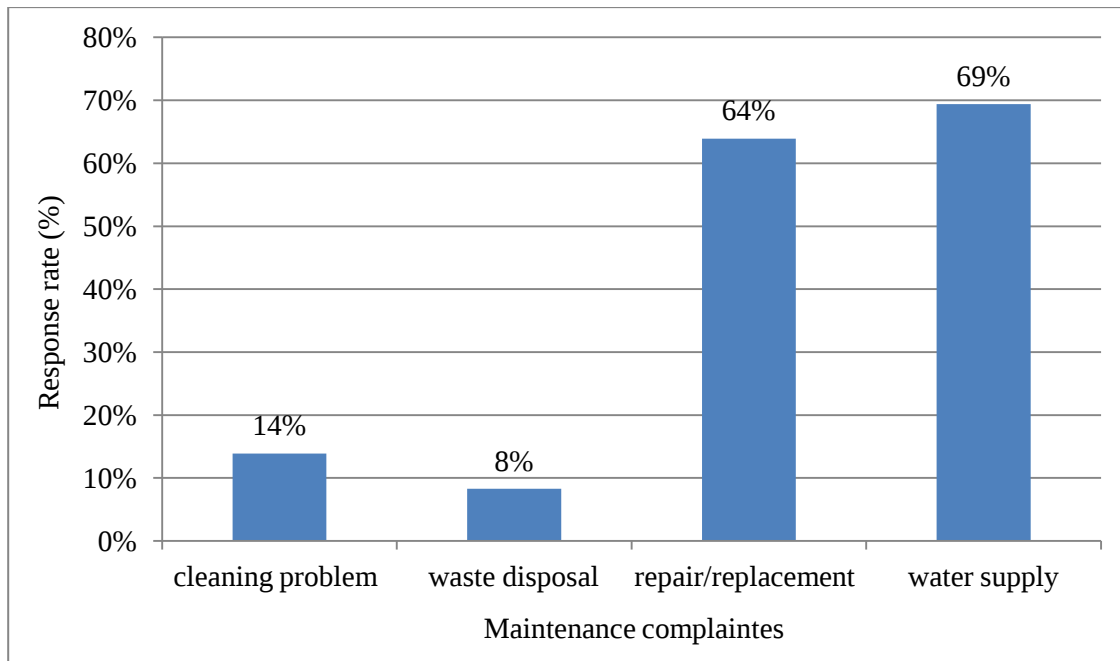


Figure 4-4 Sources of maintenance complaints

The result shows that 69% of respondents agreed that the problem arises from a water supply, 64 % of the respondents said that repeated problems are arising from repair/ replacement problems. 14% of the problem is due to cleaning problem and 8% of response shows that major source of complaint is related to waste disposal.

According to the data, repair/replacement-related complaints are larger, but there is no organized department to solve the issue.

4.3.5 Response rate for the required maintenance work

Since there is no organized maintenance department, officers at AAHDPO could not respond to the response rate. There are maintenance-related complaints from residents as indicated above, but there is no maintenance administration to solve related issues. This case is considered by wereda housing development officers and residents associations.

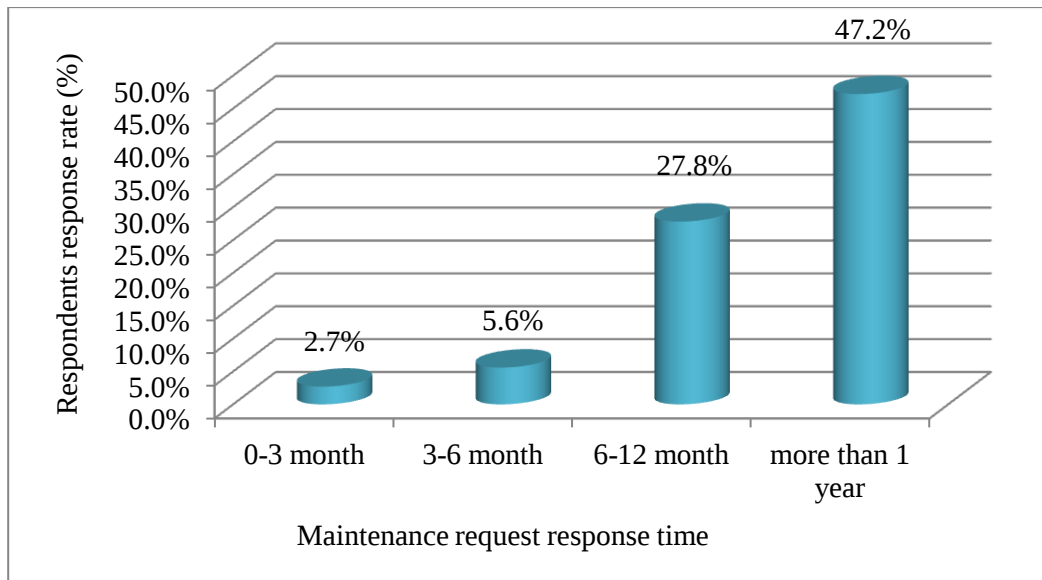


Figure 4-5 Maintenance request response rate

The assessment result shows that 47.2% of the response rate agreed on the maintenance work is taking more than one year. 27.8% agreed as it takes 6month to 1 year.

During physical observation of the researcher, it is observed that condominium building facilities require a centralized facility maintenance sector due to the following reasons; there is a limitation of knowledge on the requirement of facility maintenance of condominium buildings, there is no clear demarcation on the division of responsibilities between AAHDPO and residents; for example, major maintenance works like exterior painting and sewer line located outside the building are works out of the scope of residents association but AAHDPO also does not have maintenance department for regular inspect and rectification of problems which are out of the scope of residents.

The buildings are serving for about ten years, but there is no major maintenance work performed to date. Rather residents prefer to undertake corrective maintenance to rectify problems.

It is known that condominium buildings are huge in number hence centralized facility management system is vital to keep the building values.

4.4 Cause of Defects on Condominium Building Facilities

4.4.1 Evaluation of the current operational state of the building

Condominium buildings are planned for low-income residents and are constructed under low-cost projects. As discussed in the introduction part the weakness during construction time can be enhanced by continuous and preventive maintenance activities.

For this study, building components are broadly classified into four major categories of Structural elements, Nonstructural elements, Finishes, and Service lines

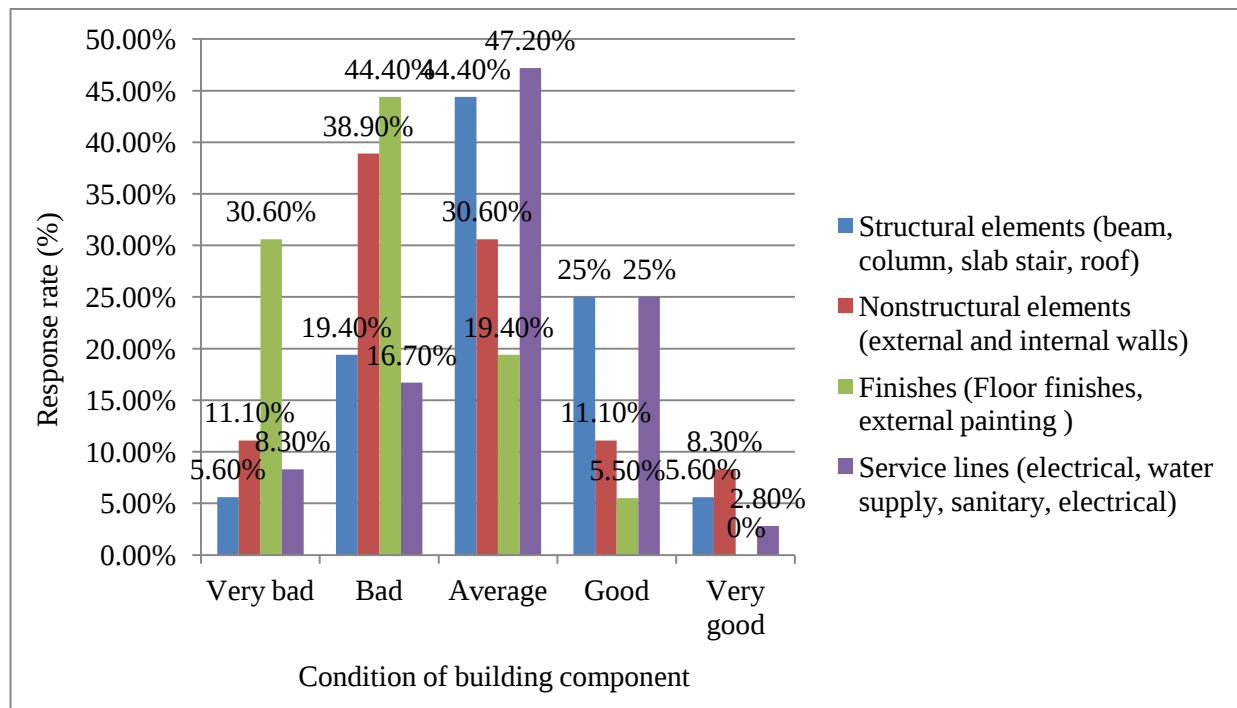


Figure 4-6 Operational state of condominium buildi

For the structural elements, 44.4% of respondents agreed that the current operational state is an average level. 25% of the responses indicate that the structural elements are good. 19.4 % of responses show that the structural elements are at a bad level.

38.9% of responses show that the operational state of non-structural elements is at a bad level. 30.6% of respondents said it is at the average level. And 11.1% of respondents reply shows a good level of the operational state.

44.4% of respondents agreed that the operational state of finishing is at a bad level. 19.4% of response rate indicate average status and 5.5% of response shows as the status is good.

47.2% of the respondents agreed that the operational state of the service line is at the average level. 25% of them agreed as it is in a good condition. 16.7% of the responses indicate that the service lines are at a bad level.

To summarize the above-listed figures, one question was raised for the respondents to judge the overall building condition and the result is summarized in the chart below.

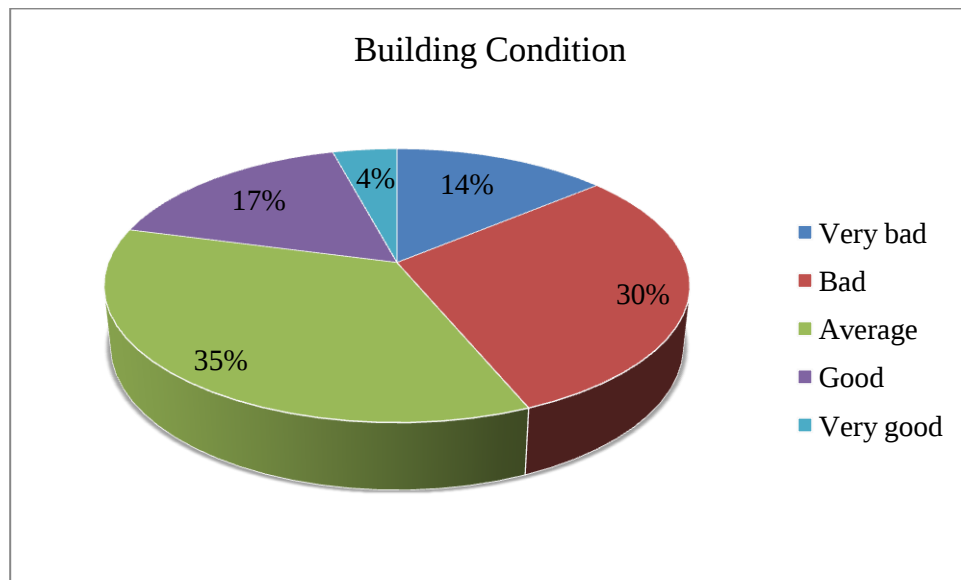


Figure 4-7 Building condition

35% of the respondents agreed that the overall building condition is at the average level. 30% of response shows that the buildings are at bad conditions. 17% of responses indicate that the buildings are at good status. 14% and 4% of respondents show that the buildings are very good and very bad levels respectively.

Gathered information on the overall building condition indicates that the status and functionality of building facilities are on average level.

4.4.2 Root causes for the need of maintenance work

Several causes are raised as a reason for building degradation. The major causing factors for condominium building deterioration are gathered from physical observation and interview with the condominium stakeholders. The target stakeholders for the interview were AAHDPO officers, districts housing development office officers, condominium associations and residents.

The casing factors are classified in to two broad catageories; causing factors happened during design and construction stage and causing factors happened after completion of construction works.

The casing factors are listed separately using root cause analysis (RCA) and their effects are presented in a fishbone diagram as shown in Figure 4.8. The causing factors are based on the physical observation and interviews held on site and AAHDPO.

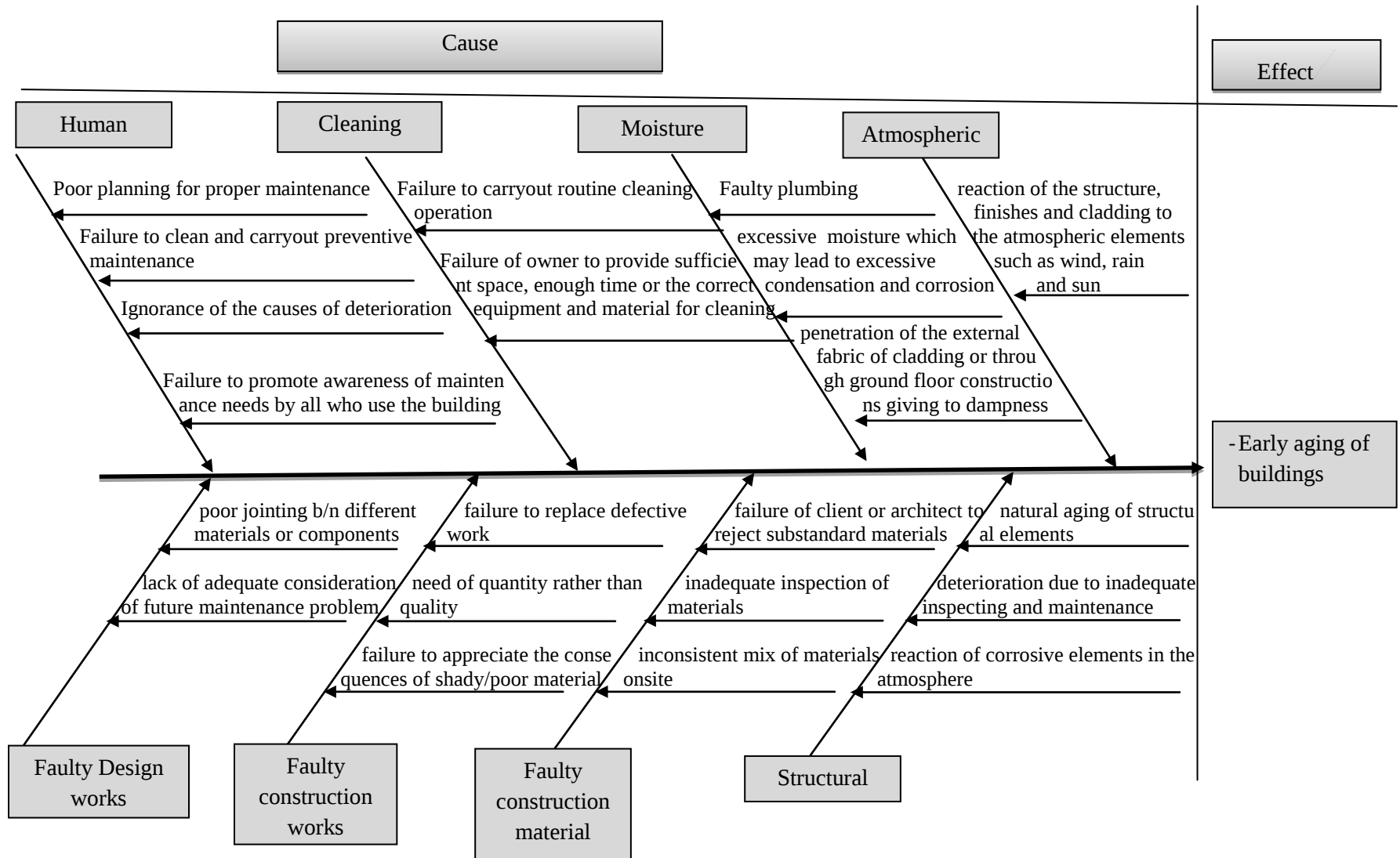


Figure 4-8 Fish bone diagram

As shown in the diagram above, several causing factors are listed as a reason for building deterioration. The above row in the diagram indicates reasons of deterioration caused when the building is giving service. The bottom row of causes indicates reasons of early aging of the building which are caused due to poor design and construction. The cumulative effect of causes during construction and during service period lead the building in to an early aging. The effects of the aforementioned causes can be defects on utility lines, building deterioration, and the early aging of the buildings.

Considering the existing conditions of condominium buildings, the cases are summarized in five categories for data collection purposes and the results are presented below.

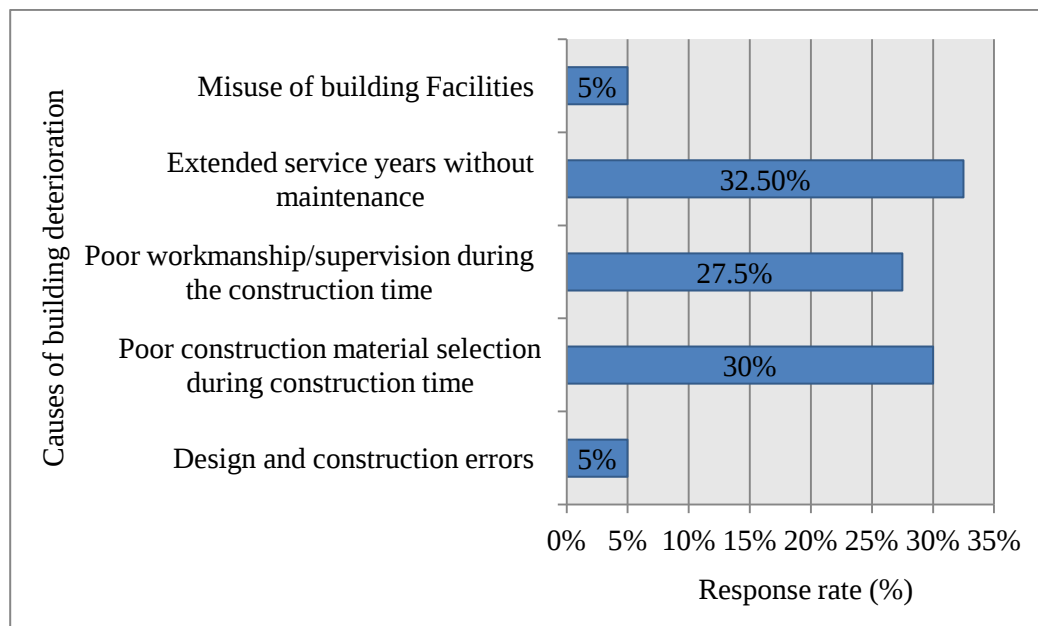


Figure 4-9 Causes for building deterioration

The result shows 32.5% of respondents agreed that the extended service year without maintenance is the main causing factor for building degradation. 30% of the response rate indicates that poor construction material selection during the construction time is the reason for building deterioration. 27.5% of the respondents' emphasized that the reason for building degradation is due to poor workmanship/ supervision during the construction time and 5% agreed misuse of building facilities and design & construction errors as the reasons for building deterioration.

4.4.3 Unavailability of maintenance standard and manual

Maintenance manual is an important reference tool in maintaining a building facility. It guides in inspections, adjustments, cleaning, and care for a building (Rusli, 2014). A maintenance manual is an essential part of a regular maintenance program. It is a technical communication document intended to give recommendations and information necessary to maintain the system effectively. Maintenance manual and standard for a building facility need to be prepared and documented together with the building-related documents. For the condominium buildings, there is no prepared maintenance manual and standard. Maintenance standards are established criteria for performing various maintenance tasks such as cleaning, repairs, parts replacement, and maintenance data collection.

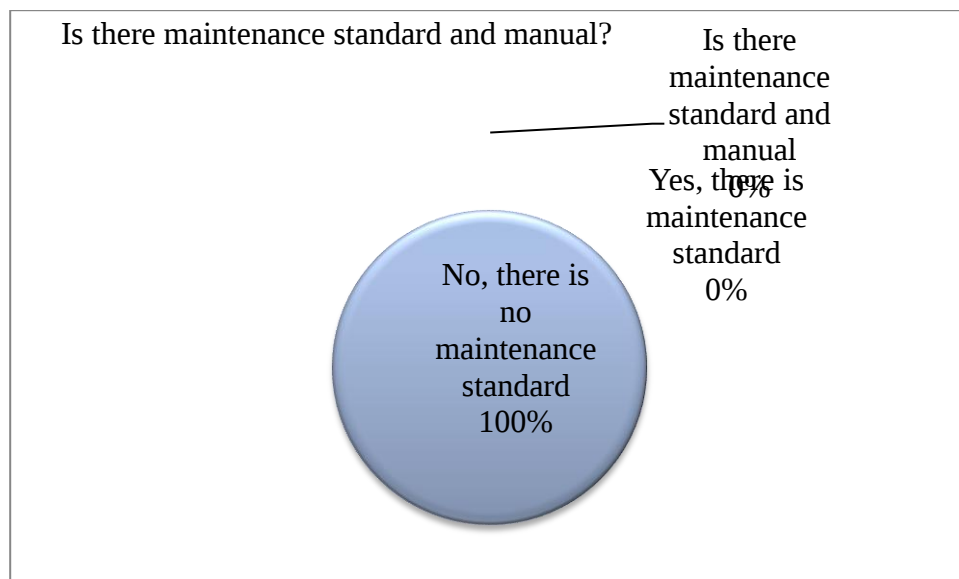


Figure 4-10 Existence of maintenance standard and manual

Architects need to provide a maintenance manual together with the working drawings. Such manuals on the dos and don'ts' of how to use the facility should be part of the design documents right from the design stage. Facility managers (maintenance managers) needs to be members of the design team as advisers to the architect (Adejimi, 2005).

The data collected from the questionnaire shows 100% of respondents agree that there is no building maintenance standard and manual. The result indicates that there was no organized facility management department to follow up acceptance of maintenance and repair-related documents at the design stage. To date also there is no maintenance department to prepare

maintenance standards & schedule and follow up maintenance activities of condominium buildings.

4.5 Failure Factors Affecting The Application of Facility Maintenance Management

4.5.1 Problems related to facility maintenance

The following points summarize the major problems raised concerning facility maintenance.

Table 4-2 Problems of facility maintenance

Problem	Reason
<i>Shortage of money to spend for maintenance:</i>	Condominium houses are planned for low-income residents of the city and they are not expected to expend maintenance expenses. Considering the problem of shortage of money the proclamation gives responsibility to residents association to collect a monthly contribution from residents and to deposit. As per the physical investigation, in addition to residents' contributions, some associations collect money using other income-generating options like renting communal buildings. According to the site investigation by the researcher, the associations are willing to conduct preventive maintenance for the buildings, but a shortage of money is their major complaint. Hence they prefer to follow corrective maintenance techniques.
<i>Lack of awareness on the importance of maintenance manual and schedule.</i>	Architects need to provide a maintenance manual together with the working drawings. Such manuals on the dos and don'ts' of how to use the facility should be part of the design documents right from the design stage. This is why the facility managers (maintenance managers) need to be members of the design team as advisers to the architect. The architect should therefore as a matter of duty give the client adequate instruction on how to maintain the building after the construction (Adejimi, 2005). Maintenance is one of the building management strategies that aims to protect the importance and usability of the buildings. Maintenance also becomes an important approach in ensuring the building and its contents can be operated and function properly. However, based on previous studies, maintenance is always been

	neglected and has not become the main activity in managing and protecting valuable and non-replaceable assets. The building maintenance manual is an important reference tool in maintaining building components. It guides in inspections, adjustments, cleaning, and care for a building (Ribeiro, 2014). The maintenance schedule is a useful tool that keeps the cost down and property function and appearance up. This allows work to get done in the most efficient, economical way. The researcher investigates that there is no maintenance manual or maintenance schedule prepared either during the design, construction, or service stage. Maintenance works are done to correct critical failures only.
<i>Unavailability of facility maintenance department:</i>	Facility maintenance is always been neglected and has not become the main activity in managing and protecting valuable and non-replaceable assets. The chain of responsibility in condominium building management is summarized in figure 4.2. But there is no facility management department in the hierarchy. Due to lack of a facility maintenance section, there is no team to plan, organize, supervise and control activities related to facility management. The officers accept maintenance-related complaints from residents but there is no organized team to solve problems. This was also the major problem of the researcher during data collection

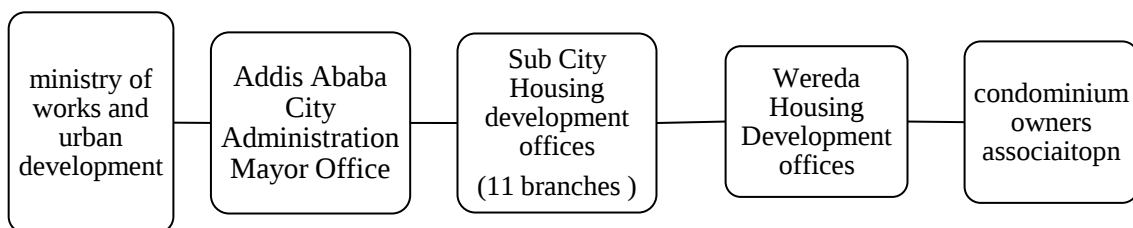


Figure 4-11 Organizational hierarchy

The feedback of respondents on major problems which condominium buildings are facing in terms of facility maintenance is presented below in the chart.

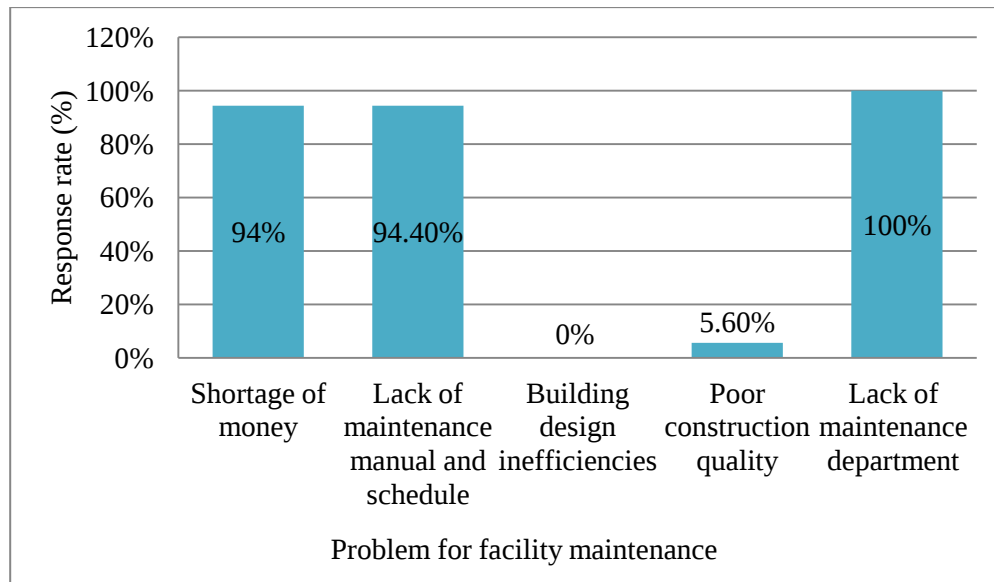


Figure 4-12 Problem for facility maintenance

100 % of respondents agreed that the major problem for condominium building facility maintenance is the lack of a maintenance department. 94.4% and 94% of response rates indicate the main problems for facility maintenance are lack of maintenance manual & schedule and shortage of money. 5.6% of responses raise the poor construction quality as a reason for the problem of facility maintenance.

4.5.2 Evaluation of The Level of Previously Performed Maintenance Works

Condominium buildings, in general, follow corrective maintenance strategy to rectify failed components. As per the site physical inspection of the researcher, there are maintenance works performed by the owners association. Some of the maintained building components are replacement of downpipes, roof maintenance (change in rare blocks), and minor level of leakage prevention work on the wall cracks (few blocks re-painted the exterior wall). Most blocks' external walls are deteriorated due to efflorescence, poor quality of painting, dampness because of incorrect installation of roof gutter, and downpipes. But there is no satisfactory maintenance is performed on the external wall paintings.

The result of data analysis on the level of satisfaction on the previously maintained works the outcome of analysis indicates the corrective maintenance works done is good on average.

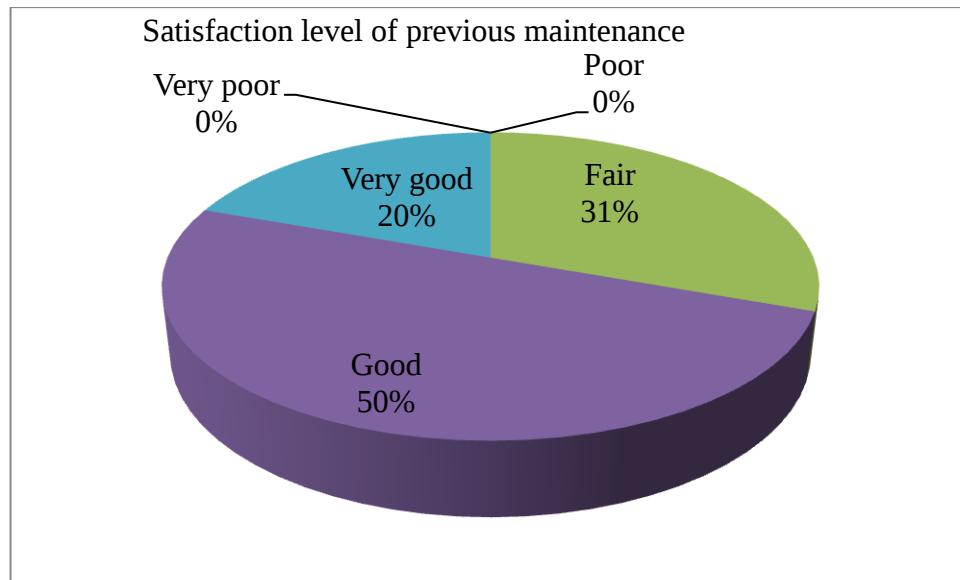


Figure 4-13 Quality of maintenance works

50% of responses indicate that the quality of previously conducted maintenance works is good. 30 % of response rate shows the quality is fair. 20% of the response said the quality of the work is very good. 0% is scored for poor and very poor options of the satisfaction level of quality of maintenance work.

4.6 Evaluation of the maintenance strategy selection criteria

Evaluation and selection of convenient maintenance strategy for condominium buildings using AHP method:-

Step 1 Development of hierarchial model for maintenance strategy selection criteria.

The model is developed by setting the goal of selecting convenient maintenance strategy for condominium buildings. Four criteria and four alternatives are considered for the study as indicated in figure 3.6.

Step 2 derive weights for the cvriteria and develop Comparison matrix

The weights are derived based on the intensity of importance using Saaty fundamental criteria scale indicated on table 3.7. The comparison matrix is evaluated based on the importance level.

Table 4-3 weights for comparison matrix

	Cost	Safety	Ease of implementation	Owners satisfaction
Cost	1	1/7	1/5	1/4
Safety	7	1	7	7
Ease of implementation	5	1/7	1	5
Owners satisfaction	4	1/7	1/5	1

Calculation

Development of matrix from the weight comparison matrix

Cost $\bar{w} = 0.290$ where 4 is number of criterias

Safety $\bar{w} = 4.303$

Ease of implementation $\bar{w} = 1.374$

Owners satisfaction $\bar{w} = 0.581$

Collect the weights of cost, safety, ease of implemetaton and owners satisfaction in matrix A.

$$A = \begin{bmatrix} 1 & 1/7 & 1/5 & 1/4 \\ 7 & 1 & 7 & 7 \\ 5 & 1/7 & 1 & 5 \\ 4 & 1/7 & 1/5 & 1 \end{bmatrix}$$

The total estimated values are calculated using each weights and number of criteria and are presented in the matrix A_1 .

$$A_1 = \begin{bmatrix} 1.16 & 0.58 & 0.69 & 0.23 \\ 29.16 & 1.16 & 29.16 & 29.16 \\ 17.45 & 0.58 & 1.16 & 17.45 \\ 11.62 & 0.58 & 0.69 & 1.16 \end{bmatrix}$$

The summation of column matrix $A_1 = 6.548$

Matrix B is developed from the ratios of matrix A_1 and its summation.

$$\begin{array}{c} \frac{w}{w} \\ \frac{w}{w} \\ \frac{w}{w} \\ \frac{w}{w} \\ \frac{w}{w} \\ \frac{w}{w} \end{array} \begin{array}{c} w \\ w \\ w \\ w \\ w \\ w \end{array} \longrightarrow \text{Matrix B} = \begin{array}{c} w \\ w \\ w \\ w \\ w \\ w \end{array}$$

$$\text{Sum} = 1$$

Matrix B is the weight. The summation of matrix B shall be equal to 1.

Step 3. Consistency check

Using equation 3-1 the value of matrix C is obtained. Which helps to check the consistency of the weights.

$$C = \begin{array}{c} - & - & - \\ - & & \\ - & - & \end{array} * \begin{array}{c} w \\ w \\ w \\ w \end{array} = \begin{array}{c} w \\ w \\ w \\ w \end{array}$$

Using equation 3-2, the value of [D] equals.

$$D = \begin{array}{c} w \\ w \\ w \\ w \end{array} \begin{array}{c} w \\ w \\ w \\ w \end{array} = \begin{array}{c} w \\ w \\ w \\ w \end{array}$$

Matrix D indicates the number of criteria that is 4, and there are 4 criteria initially which are cost, safety, ease of implementation and owners satisfaction. [C] and [D] assures for the consistency of weights and criterias.

Measurement of inconsistency:-

Inconsistency measurement is basically considered from matrix D.

is higher. 20.9% of the priority is for ease of implementation because the maintenance techniques need to be easier which does not interrupt the day-to-day living activity of residents. To achieve easier maintenance techniques regular inspection and preventive maintenance plans need to be implemented. Owners' satisfaction rates 8.8%, it is known for developing countries to keep customer satisfaction is considered as luxury, and the government and also owners may not be interested to invest additional cost to keep satisfaction. Cost is given the least priority criteria which are 4.4%. It is known that giving the least priority is difficult to implement in developing countries, but safety, ease of implementation, and owners' satisfaction need to give all priorities besides the cost.

Step 5. Prioritization

Prioritization simply means listing alternatives in descending order of their score. The score of maintenance strategies are listed in table 4.4.

Table 4-5 Priority score of maintenance strategies

Alternative	Description	Score
	The alternatives have their own advantage and disadvantage indicated in Literature review	
Preventive	Refer Table 2.3	3
Corrective	Refer Table 2.5	2
Immediate	Refer Table 2.6	1
Routine	Refer Table 2.7	0

Weights are given based on the advantages and disadvantages of maintenance strategies, considering the actual conditions of condominium buildings. The low quality of buildings can be enhanced by adopting preventive maintenance technique. In addition condominium houses solve the huge problem of the city by accommodating hundreds of thousands of the city population, keeping the values of the buildings using preventive maintenance strategy guarantees the safety of buildings and occupants. Once if the condominium housing system is

failed, then solving the house requirement of the city population will be a huge problem for the city administration.

4.7 Development of The Maintenance Management Format

4.7.1 Maintenance Management Format (MMF)

Development of MMF improves the building maintenance management practice of condominium buildings. MMF is the whole-of-Government policy for managing the building maintenance. One of these requirements is maintenance sections can assess the condition of buildings by site inspection at least every three years. Depending on the nature of the facility, more frequent assessments may be deemed necessary.

The facility maintenance format for condominium buildings is developed considering the condominium building case. The format is presented in table 4.6. The table composed of 10 columns each column to record information related to the actual building condition.

Table 4-6 Maintenance Management Framework

Facility Maintenance Format									
Building type	Condition Standard	Location	Block Number	Building Component	Condition Index	Defect description	Work to rectify defect	Cause code	Priority rank
Condominium	S5	Jemo 1		External wall and painting	3	Fading/Poor Color Retention, Mildew and Algae, cracks	Renew external painting, correct gutter and downpipe	D	2
				Gutter and down Pipe	3	Leaking gutters & downpipes, Inadequate guttering,	Maintain leaking line, change gutter size	D	1
				Roof	4	Lack of maintenance	Yearly inspection	D	1
				Stair and Handrail	3	Damages on edges of threads & risers, disconnected handrail	Maintain damaged steps and handrail	A,C	2
				Floor slabs and finishes	3	Minor cracks, Peeling off tiles	Peel off damaged tiles and rework	B,D	2
				Electric lines	3	Unprotected wiring	Correction work on installation	B	1
				Water supply and drainage lines	3	Low water pressure, Blockage of sewer lines	Upgrade municipality line, upgrade the size of sewer line	B,C	1

Condition standard describe functional purpose of building. Refer table 3.9

Cause code a code for cause of defects. Refer table 3.11

Condition index rating for condition of building asset. Refer table 3.10

Priority ranking rating for the recommended maintenance work. Refer table 3.12

Facility Maintenance Format									
Building type	Condition Standard	Location	Block Number	Building Component	Condition Index	Defect description	Work to rectify defect	Cause code	Priority rank
Condominium	S5	Summit		External wall and painting	2	Peeling Paint Due to Poor Adhesion, minor wall cracks	Peel off existing paint and renew, Fix wall cracks and paint	B	1
				Gutter and down Pipe	3	Sagging gutters, leaking gutters and downpipes	Change gutter size, maintain leaking points	B,C	1
				Roof	4	Lack of maintenance Roof leaks,	Inspect every year	D	1
				Stair and Handrail	3	Damages on edges of threads & risers	Maintain damaged steps and handrail	A,C	2
				Floor slabs and finishes	3	Minor cracks, Peeling off tiles	Peel off damaged tiles and rework	B,D	2
				Electric lines	3	Insecure Wiring	Correction work on installation	B	1
				Water supply and drainage lines	3	Low water pressure, Blockage of sewer lines	Upgrade municipality line, upgrade the size of sewer line	B,C	1

Facility Maintenance Format									
Building type	Condition Standard	Location	Block Number	Building Component	Condition Index	Defect description	Work to rectify defect	Cause code	Priority rank
Condominium	S5	Gofa Mebrat Hail		External wall and painting	2	Alligatoring, Fading/Poor Color Retention, Mildew and Algae, minor wall cracks	Remove old paint and re-paint, Renew external painting, correct gutter and downpipe	D	1
				Gutter and down Pipe	2	Missing and broken downpipes,	Replace missing and broken pipes with new pipe	D	1
				Roof	4	Lack of maintenance	Inspect every year	D	1
				Stair and Handrail	4	Damages on edges of threads & risers	Maintain damaged steps and handrail	A,C	2
				Floor slabs and finishes	4	Minor cracks, Peeling off tiles	Peel off damaged tiles and rework	B,D	2
				Electric lines	4	Insecure Wiring	Correction work on installation	B	1
				Water supply and drainage lines	4	Low water pressure, Blockage of sewer lines	Upgrade municipality line, upgrade the size of sewer line	B,C	1

Facility Maintenance Format									
Building type	Condition Standard	Location	Block Number	Building Component	Condition Index	Defect description	Work to rectify defect	Cause code	Priority rank
Condominium	S5	Gerji Mebrat Hail		External wall and painting	2	Fading/Poor Color Retention, Mildew and Algae,	Renew external painting, correct gutter and downpipe	D	1
				Gutter and down Pipe	3	Leaking gutters & downpipes	Maintain the leaking points	D	1
				Roof	4	Lack of maintenance	Inspect every year	D	1
				Stair and Handrail	3	Damages on edges of threads & risers	Maintain damaged steps and handrail	A,C	2
				Floor slabs and finishes	3	Minor cracks, Peeling off tiles	Peel off damaged tiles and rework	B,D	2
				Electric lines	4	Unprotected wiring	Correction work on installation	B	1
				Water supply and drainage lines	4	Low water pressure, Blockage of sewer lines	Upgrade municipality line, upgrade the size of sewer line	B,C	1

- **Condition standard** describe functional purpose of building. Refer table 3.9
- **Condition index** rating for condition of building asset. Refer table 3.10
- **Cause code** a code for cause of defects. Refer table 3.11
- **Priority ranking** rating for the recommended maintenance work. Refer table 3.12

Facility Maintenance Format									
Building type	Condition Standard	Location	Block Number	Building Component	Condition Index	Defect description	Work to rectify defect	Cause code	Priority rank
Condominium	S5	Mikililand		External wall and painting	2	Fading/Poor Color Retention, Mildew and Algae	Renew external painting, correct gutter and downpipe	D	2
				Gutter and down Pipe	2	Incorrect downpipe positioning, Sagging gutters, broken downpipe	Correct downpipe position, replace narrow gutter with larger size, replace broken pipes	D	1
				Roof	4	Lack of maintenance	Inspect every year	D	1
				Stair and Handrail	3	Damages on edges of threads & risers	Maintain damaged steps and handrail	A,C	2
				Floor slabs and finishes	3	Minor cracks, Peeling off tiles	Peel off damaged tiles and rework	B,D	2
				Electric lines	4	Unprotected wiring	Correction work on installation	B	1
				Water supply and drainage lines	3	Low water pressure, Blockage of sewer lines	Upgrade municipality line, upgrade the size of sewerline	B,C	1

- **Condition standard** describe functional purpose of building. Refer table 3.9
- **Condition index** rating for condition of building asset. Refer table 3.10
- **Cause code** a code for cause of defects. Refer table 3.11
- **Priority ranking** rating for the recommended maintenance work. Refer table 3.12

5. CONCLUSION

The main objective of this thesis was to evaluate the facility maintenance management practice of condominium buildings. The thesis deeply investigates the maintenance behavior of condominiums buildings and conclusions are derived based on the investigations of the specific objectives.

- The AAHDPO offices and owners associations do not have a maintenance department to receive maintenance-related complaints and to give a swift reply. Due to the unavailability of organized maintenance section at all levels of condominium administration, there are no regular inspection works. Also from the four major types of maintenance works the condominium associations prefer to conduct corrective maintenance.
- Several reasons are stated as the causing factors for building deterioration. Root cause analysis is conducted to figure out the causing factors and their effect and the result is summarized in a fishbone diagram. The analysis result shows that the overall operational state of the buildings is at average state. Due to the unavailability of maintenance manual and standard, the required maintenance works are performed only when necessary and also using different techniques.
- The major critical failure factors for the application of facility maintenance management systems are the lack of facility management departments at all level of organizational hierarchy. Lack of awareness on the importance of maintenance and shortage of the reserve fund is the main reasons. The maintenance schedule is inevitably a useful tool to keep costs down, property function, and appearance up, but maintenance works are performed in a fragmented manner only when the case is severe. This reduces the quality of maintenance works to the average level.
- Of the existing types of maintenance, a convenient maintenance strategy for condominium buildings is selected using AHP method. In the process, priority is given to safety. Even though it costs money, the safety of the building components is guaranteed by a preventive maintenance strategy.
- MMF is essential for improved asset planning, maintenance procedure, and risk management. The frame is easier and direct forward to inspect building components and to reach the priority rank that helps to plan preventive maintenance within the specified time frame.

6. RECOMMENDATION

Based on the research findings, and conclusion, the following recommendations are drawn to improve the maintenance management practice in condominium buildings.

- Addis Ababa City Administration shall organize a facility management department at all levels of the condominium management which is also responsible for facility maintenance works to conduct regular inspection on the building facilities, prepare preventive maintenance plan, and also to solve maintenance-related complaints in a shorter time.
- Since condominium buildings have similar features and purposes, a centralized facility management department shall be organized at all levels of the hierarchy. The department shall be responsible for the preparation of the maintenance manual & schedule, control of the maintenance plan, and maintenance work qualities of each condominium site. The maintenance department shall also investigate the actual deterioration causing factors and their effect on each building. This may enhance the operational state of condominium buildings.
- Officers at all levels of the organizational hierarchy shall be aware of the importance of condominium facility maintenance. The quality of maintenance works can be enhanced by providing maintenance standards & manuals and by conducting a regular inspection of the building components.
- Preventive maintenance shall be applied for condominium building maintenance. Eventhough it costs money, the risk of building component failure is not comparable with money because it accommodates a larger population.
- Maintenance management format shall be used by the maintenance officers for the inspection of building components. It assists the preventive maintenance strategy in gathering information on the actual status and on the maintenance requirements of the building. Based on the condition assessment in MMF, the buildings shall be maintained within maximum of 2 years.

6.1 FURTHER STUDY AREAS

Condominium owners associations collect monthly contributions from owners which is a reserve fund for maintenance work. But the result of this study indicates one of the major reasons related to maintenance is the shortage of money. This research paper focused on the necessities of maintenance only hence, further researches shall be conducted on the cost estimation for preventive maintenance with the amount of money collected by the owners' associations.

A suitable maintenance strategy for condominium buildings is selected using AHP model considering four selection criteria. Several authors specify different selection criteria as indicated in table 3.6. The researcher recommends to conduct further research works on other maintenance strategy selection criteria.

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APPENDIX

Pictorial Testimony



Figure 7-1 Different painting color



Figure 7-2 Different painting color



Figure 7-3 Broken downpipe



Figure 7-4 Broken downpipe



Figure 7-5 Sag in gutter



Figure 7-6 Peeled wall paint



Figure 7-7 Peeled wall paint



Figure 7-8 Cracks on grade beam



Figure 7-9 Cracks on wall



Figure 7-10 Crack on wall



Figure 7-12 Poorly maintained beam



Figure 7-13 Major crack on wall



Figure 7-14 Major crack on wall



Figure 7-15 Cracks on grade beam and wall



Figure 7-16 Cracks on grade beam and wall

Questionnaire



Adama Science and Technology University
School of Civil Engineering and Architecture
Department of Construction Engineering and Management

Questionnaire for thesis on:

**Facility Maintenance Management Practice Of Condominium Buildings In
Addis Ababa**

Advisor: Meseret Getnet (PHD)

Prepared by: Helen Tafesse

April 2021

Part 1. Personal Information

1. Academic status _____
2. Title/Profession _____
3. Work Experience _____
4. Your employment time in Addis Ababa Housing Development office

Part 2. General information about the selected condominium buildings (to be filled by Wereda housing development office)

1. Condominium Location _____ wereda _____
2. Number of building blocks under the wereda administration _____
3. Age of the building _____

Part 3. Assessment of maintenance practices

1. What type of maintenance has been carried out in the condominium buildings?
 - Preventive Maintenance
 - Corrective Maintenance
 - Immediate Maintenance
 - Routine Maintenance
2. Does the office have a written long term plan for the condominium building maintenance and repair?
 - Yes
 - No
3. If your answer for question no. 2 is “YES”, then how it is implemented?
 - _____
 - _____
 - _____
4. The buildings have similar feature and purpose; does the office have regular inspection and maintenance schedule?
 - Yes
 - No

5. If your answer for question no. 4 is “YES”, how do you implement?

6. How frequent does the office conduct regular inspection to identify sites requiring maintenance?

- Every year
- Every 3 years
- Every 5 years
- There is no regular inspection

7. Is there a maintenance guideline/maintenance standard for the condominium houses?

- Yes
- No

8. If your answer for question no. 7 is “YES”, then how do you integrate and supervise with condominium owners associations?

9. How do you get information regarding required maintenance activities?

- From regular inspection
- From request by residents
- Equipment/ system failure

10. How long does it take to response maintenance requests?

- 0-3 month
- 3-6 month
- 6-12 month
- More than 1 year

11. Please indicate the major maintenance activities performed to date.

Part 4. Information on the cause of defects on condominium buildings

12. The average operational state of the condominium buildings by your personal judgment

Building Element	Very bad	Bad	Average	Good	Very good
Structural elements (beam, column, slab stair, roof)					
Nonstructural elements (external and internal walls)					
Finishes (Floor finishes, external painting)					
Service lines (electrical, water supply, sanitary, electrical)					

13. What are the major sources of maintenance complaints? (you can tick more than 1 option)

Cleaning problem

Waste disposal

Repair/Replacement

Water supply and drainage /Electric/ Telecommunications system

Others, Please state

14. What are the causes for the need of maintenance work? (you can tick more than 1 option)

Design and construction errors

Poor construction material selection during construction time

Poor workmanship/supervision during the construction time

Extended service years without maintenance

Misuse of buildings by residents

15. What is your satisfaction level with the performed maintenance works?

Very poor

Poor

Fair

Very good

Part 5. Factors that determines maintenance management

16. Is there any improvement or modification plan to keep the building values from year to year?

Yes

No

17. If your answer is “YES” please justify

18. Is there awareness creation program for condominium owners associations on how to keep the values of their building by maintaining regularly?

Yes

No

19. According to your personal view who shall be responsible for **Major** maintenance activities? (Activities like external painting, roof maintenance, staircase, supply and drainage lines)

Addis Ababa Housing Development Office/ Maintenance officer

Condominium associations/residents

20. Do you think a standard maintenance manual and schedule is helpful for the maintenance activities?

Yes

No

21. Who shall be responsible to prepare standards and control **Major** maintenance activities?

Addis Ababa Housing Development Office/ Maintenance officer

Condominium associations/residents

22. What do you think are the problems that condominium houses face in terms of building maintenance?

Not enough money

Lack of maintenance manual and schedule

Building design inefficiencies

Poor construction quality

Others, please state _____

23. In general, describe the final situation of previously maintained building

Better

The same as before

Worse

24. Forecast and state the future fate of condominium buildings considering current maintenance activities

Thank You!

Facility Maintenance Format

Facility Maintenance Format									
Building type	Condition Standard	Location	Block Number	Building Component	Condition Index	Defect description	Work to rectify defect	Cause code	Priority rank